Department for Energy Security & Net Zero

Offshore Oil & Gas Licensing

33rd Seaward Round

Habitats Regulations Assessment

Draft Appropriate Assessment: West of Shetland and Central North Sea

July 2023

Contents

1 Introduction

1.1 Background and purpose

The plan/programme covering this (and potential future) seaward licensing rounds has been subject to a Strategic Environmental Assessment (OESEA4), completed in September 2022. The SEA Environmental Report includes detailed consideration of the status of the natural environment and potential effects of the range of activities which could follow licensing, including potential effects on conservation sites. Public consultation on OESEA4 concluded on 27th May 2022 and the Government Response was published on 22nd September 2022, which summarised the comments received and provided further clarifications, at which time, the plan/programme was also adopted. The North Sea Transition Authority (NSTA) subsequently decided to offer 931 Blocks or part-Blocks for licensing as part of a 33rd Seaward Licensing Round covering areas of the UK Continental Shelf (UKCS), and applications were received for licences covering 258 Blocks or part-Blocks.

The *Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001* (as amended) provide a regulatory regime for certain activities, including oil and gas activities, that could affect Special Protected Areas (SPAs) and Special Areas of Conservation (SACs) in UK territorial seas and on the UKCS[1]. The *Conservation of Offshore Marine Habitats and Species Regulations 2017* cover other relevant activities in offshore waters (i.e. excluding territorial seas). Within territorial seas, the following apply, the *Conservation of Habitats and Species Regulations 2017* in England and Wales, the *Conservation (Natural Habitats, &c.) Regulations 1994* in Scotland (for non-reserved matters), and the *Conservation (Natural Habitats, &c) Regulations (Northern Ireland) 1995* (as amended) in Northern Ireland.

As the petroleum licensing aspects of the plan/programme are not directly connected with or necessary for nature conservation management of SPAs and SACs, to comply with its obligations under the relevant regulations, the Department for Energy Security and Net Zero (formerly the Department for Business, Energy and Industrial Strategy)[2] (the Department) is undertaking a Habitats Regulations Assessment (HRA). To comply with obligations under the *Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001* (as amended), in winter 2022, the Secretary of State undertook a screening assessment to determine whether the award of any of the Blocks offered would be likely to have a significant effect on a relevant site, either individually or in combination[3] with other plans or projects (DESNZ 2023). In doing

[1] A range of environmental legislation applicable for offshore oil and gas has been extended to carbon dioxide storage under the *Energy Act 2008 (Consequential Modifications) (Offshore Environmental Protection) Order 2010*, which includes the *Offshore Petroleum Activities (Conservation of Habitat) Regulations 2001.*
[2] Note that while certain licensing and related regulatory functions were passed to the Oil and Gas Authority, now operating as the NSTA (a government company wholly owned by the Secretary of State) on 1 October 2016, environmental regulatory functions are retained by the Department, and are administered by the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED).
[3] Note that "in-combination" and "cumulative" effects have similar meanings, but for the purposes of HRA, and in keeping with the wording of Article 6(3) of the Habitats Directive, "in-combination" is used to describe the potential for such effects throughout. More information on the definitions of "cumulative" and "in-combination" effects are available in MMO (2014a) and Judd *et al.* (2015).

so, the Department has applied the statutory test, as elucidated by relevant case law[4], which is:

> *…any plan or project not directly connected with or necessary to the management of the site is to be subject to an appropriate assessment of its implications for the site in view of the site's conservation objectives if it cannot be excluded, on the basis of objective information, that it will have a significant effect on that site, either individually or in combination with other plans or projects.*
>
> *…where a plan or project not directly connected with or necessary to the management of a site is likely to undermine the site's conservation objectives, it must be considered likely to have a significant effect on that site. The assessment of that risk must be made in the light inter alia of the characteristics and specific environmental conditions of the site concerned by such a plan or project.*

1.2 Relevant Blocks and sites

The screening assessment (including consultation with the statutory nature conservation agencies/bodies) formed the first stage of the HRA process. The assessment was undertaken in the period within which applications for Blocks were being accepted, and therefore considered all 931 Blocks offered. The screening identified 267 whole or part Blocks as requiring further assessment prior to the NSTA making decisions on whether to grant licences (DESNZ 2023). Following the closing date for 33rd Seaward Round applications, those Blocks identified as requiring further assessment were reconsidered against the list of actual Blocks applied for. It was concluded that further assessment (Appropriate Assessment) was required for 96 Blocks that were applied for. Because of the wide distribution of these Blocks around the UKCS, the Appropriate Assessments (AA) in respect of each potential licence award are contained in three regional reports as follows:

- Southern North Sea and Mid North Sea High
- Central North Sea and West of Shetland
- Eastern Irish Sea

[4] See, in particular, the European Court of Justice case of Waddenzee (C-127/02). At the time of this assessment, this remains relevant to interpretation of the UK's legislation as retained EU case law under the *European Union (Withdrawal) Act 2018*.

1.2.1 West of Shetland and Central North Sea

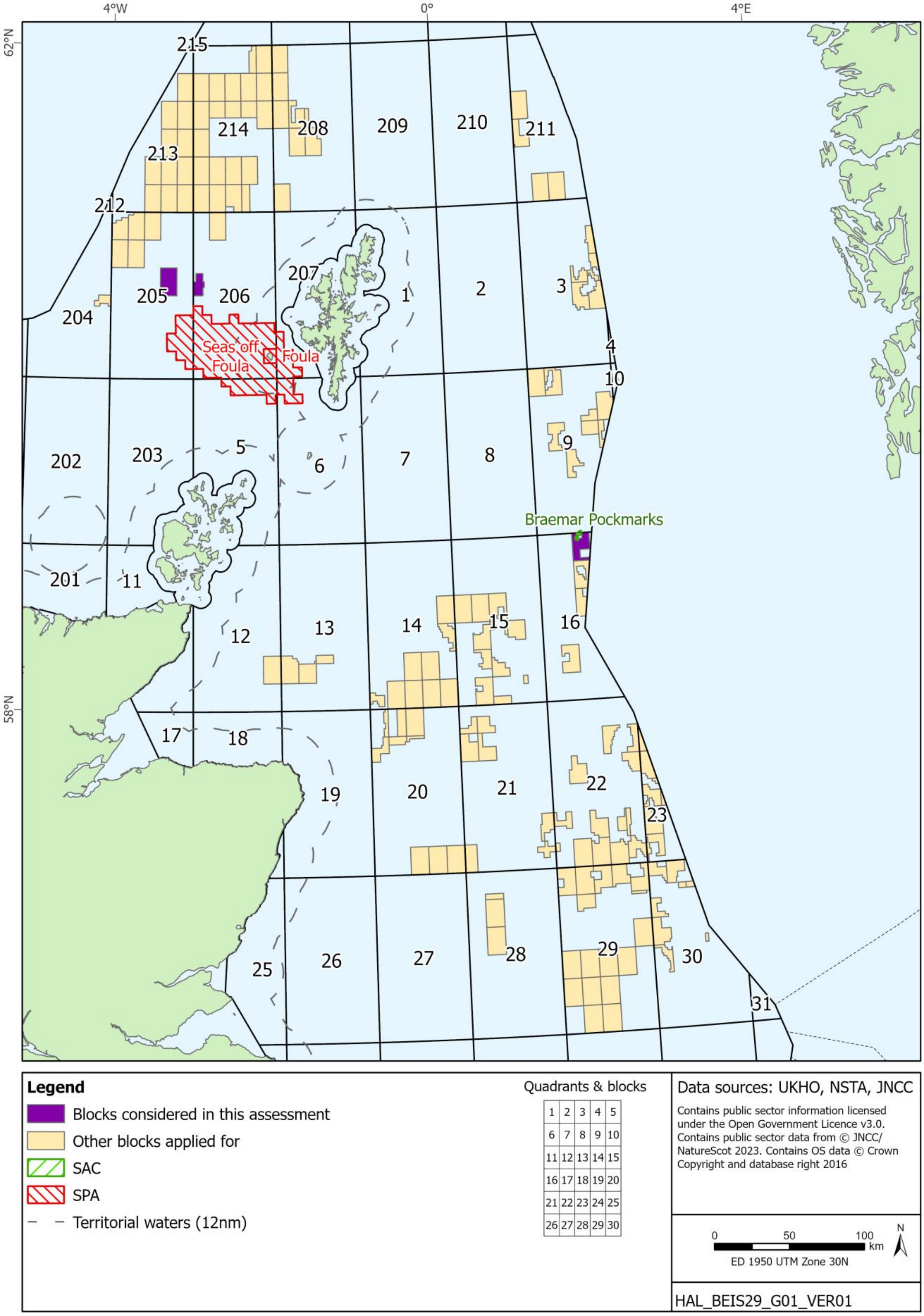
The relevant Blocks applied for in the 33rd Round and considered in this assessment (Figure 1.1, Table 1.1) are 205/14, 206/11d (West of Shetland) and 16/3d (Central North Sea)

Table 1.1: Relevant sites requiring further assessment

Relevant site Features	Relevant Blocks applied for	Sources of potential effect
SPAs		
Seas off Foula Arctic skua, great skua, guillemot, Atlantic puffin, northern fulmar. Breeding and over-wintering seabird assemblages	206/11d	Physical disturbance and drilling: rig siting, drilling discharges
Guillemot, Atlantic puffin. Breeding and over-wintering seabird assemblages	205/14, 206/11d	Underwater noise: deep geological seismic survey, rig site survey, VSP, conductor piling, drilling, vessel & rig movements
Foula SPA[1] Great skua, guillemot, Atlantic puffin. Breeding seabird assemblage	206/11d	Physical disturbance and drilling: rig siting, drilling discharges
Guillemot, Atlantic puffin. Breeding seabird assemblage	205/14, 206/11d	Underwater noise: deep geological seismic survey, rig site survey, VSP, conductor piling, drilling, vessel & rig movements
SACs		
Braemar Pockmarks Annex I habitat: Submarine structures made by leaking gases	16/3d	Physical disturbance and drilling: rig siting, drilling discharges

Notes: [1] screened in for being a source colony or adjoining waterbird site with likely connectivity to a site already screened in (see DESNZ 2023).

Figure 1.1: Blocks and sites relevant to this Appropriate Assessment



1.3 Assessment overview

This document sets out the key assumptions and approach to the AA, the evidence base underpinning the assessment and the assessment of relevant Blocks and sites. The document is organised as follows:

- Overview of the licensing process and nature of the activities that could follow including assumptions used to underpin the AA process (Section 2)
- Description of the approach to ascertaining the absence or otherwise of adverse effects on the integrity of relevant sites (Section 3)
- Evidence base on the environmental effects of offshore oil and gas activities to inform the assessment (Section 4)
- The assessment of effects on the integrity of relevant sites, including in-combination with other plans or projects (Section 5)
- Overall conclusion (Section 6)

As part of this HRA process, the draft AA document is being subject to consultation with appropriate nature conservation bodies and the public (via the DESNZ consultation pages of the gov.uk website) and will be amended as appropriate in light of comments received.

2 Licensing and potential activities

2.1 Licensing

The exclusive rights to search and bore for petroleum in Great Britain, the territorial sea adjacent to the United Kingdom and on the UKCS are vested in the Crown and the *Petroleum Act 1998* gives the NSTA the power to grant licences to explore for and exploit these resources. The main type of offshore Licence is the Seaward Production Licence. Offshore licensing for oil and gas exploration and production commenced in 1964 and progressed through a series of Seaward Licensing Rounds. A Seaward Production Licence grants exclusive rights to the holders “to search and bore for, and get, petroleum” in the area covered by the Licence but does not constitute any form of approval for activities to take place in the Blocks, nor does it confer any exemption from other legal or regulatory requirements. Offshore activities are subject to a range of statutory permitting and consenting requirements, including, where relevant, activity-specific HRA under the Habitats Regulations.

Several sub-types of Seaward Production Licence (Traditional, Frontier and Promote) were replaced after the 28th Round by the single “Innovate” licence[5]. As per previous licensing structures, the Innovate licence is made up of three terms covering exploration (Initial Term), appraisal and field development planning (Second Term), and development and production (Third Term). The lengths of the first two terms are flexible; but have a maximum duration of nine and six years respectively[6]. The Third Term is granted for 18 years but may be extended if production continues beyond this period. The Innovate licence introduces three Phases to the Initial Term, covering:

- Phase A: geotechnical studies and geophysical data reprocessing (this phase will not involve activities in the field)
- Phase B: acquisition of new seismic data and other geophysical data
- Phase C: exploration and appraisal drilling

Applicants may propose the Phase combination in their submission to the NSTA. Phase A and Phase B are optional and may not be appropriate in certain circumstances, but every application must propose a Phase C, except where the applicant does not think any exploration is needed (e.g. in the development of an existing discovery or field re-development) and proposes to go straight to development (i.e. ‘straight to Second Term’). The duration of the Initial Term and the Phases within it are agreed between the NSTA and the applicant. Applicants may choose to spend up to four years on a single Phase in the Initial Term but cannot take more than nine years to progress to the Second Term, and the NSTA has indicated that it expects 33rd Round applicants to request initial term durations of no more than six years, as the areas offered are relatively mature. Failure to complete the work agreed in a

[5] *The Petroleum and Offshore Gas Storage and Unloading Licensing (Amendment) Regulations 2017* amend the Model Clauses to be incorporated in Seaward Production Licences.
[6] Note that the duration of licence terms may be extended subject to clause 7 of the Model Clauses, however, an extension of each term affects the duration of the next, for example, extending the initial term would reduce the duration of the second term by the same amount.

Phase, or to commit to the next Phase means the licence ceases and determines, unless the term or phase has been extended by the NSTA.

Financial viability is considered prior to licence award for applicants proposing to start at Phase A or B, but further technical and financial capacity for Phase C activities would need to be demonstrated before the licence could enter Phase C and drilling could commence. If the applicant proposes to start the licence at Phase C or go straight to the Second Term, the applicant must demonstrate that it has the technical competence to carry out the activities that would be permitted under the licence during that term, and the financial capacity to complete the Work Programme, before the licence is granted. It is noted that the safety and environmental capability and track record of all applicants are considered by the NSTA (in consultation with the Offshore Major Accident Regulator)[7] through written submissions before licences are awarded[8].

Where full safety and environmental details cannot be provided via the written submissions at the application stage, licensees must provide supplementary submissions that address any outstanding requirements before approvals for specific offshore activities such as drilling can be issued. In all instances applicants must submit an environmental sensitivity assessment, demonstrating at the licence application stage that they are aware of environmental sensitivities relevant to the Blocks being applied for and the adjacent areas, and understand the constraints and potential impacts they might have on the proposed work programme.

2.2 Activities that could follow licensing

As part of the licence application process, applicants provide the NSTA with details of the minimum work programmes they propose in the Initial Term. These work programmes are considered along with a range of other factors by the NSTA before arriving at a decision on whether to license the Blocks and to whom. Activities detailed in work programmes may include the purchase, reprocessing or shooting of 2D or 3D seismic data (Phases A and B) and the drilling of wells (Phase C). There are two levels of drilling commitment:

- A Firm Drilling Commitment is a commitment to the NSTA to drill a well. Those applicant's applying to start their Initial Term in Phase C, will make a firm drilling commitment. Firm drilling commitments are preferred on the basis that, if there were no such commitment, the NSTA could not be certain that potential licensees would make full use of their licences. However, the fact that a licensee has been awarded a licence on the basis of a "firm commitment" to undertake a specific activity should not be taken as meaning that the licensee will actually be able to carry out that activity. This will depend upon the outcome of relevant activity specific environmental assessments.

- A Drill or Drop (D/D) Drilling Commitment is associated with Phases A and B of the Initial Term. Model Clauses are such that the licence will automatically cease and determine on the expiry of the current Phase unless the licensee commits to a Phase C work programme. Licensee's must write to the NSTA before the expiry of their licence to continue to Phase C, at which time the well commitment will be firm.

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[7] The Offshore Major Accident Regulator is the Competent Authority comprising OPRED and the Health and Safety Executive (HSE) working in partnership.
[8] Refer to NSTA technical guidance and safety and environmental guidance on applications for the 33rd Round at: https://www.nstauthority.co.uk/licensing-consents/licensing-rounds/offshore-petroleum-licensing-rounds

Note that Drill or Drop and Contingent work programmes (subject to further studies by the licensees) will probably result in a well being drilled in less than 50% of the cases.

The NSTA general guidance[9] makes it clear that an award of a Seaward Production Licence does not automatically allow a licensee to carry out any offshore petroleum-related activities from then on (this includes those activities outlined in initial work programmes, particularly Phases B and C). Figure 2.1 provides an overview of the plan process associated with the 33rd Seaward Licensing Round and the various environmental assessments including HRA. Offshore activities (see Table 2.2) such as drilling (Figure 2.2) or seismic survey (Figure 2.3) are subject to relevant activity-specific environmental assessments by the Department, and there are other regulatory provisions exercised by the Offshore Major Accident Regulator and bodies such as the Health and Safety Executive. It is the licensee's responsibility to be aware of, and comply with, all regulatory controls and legal requirements, and work offshore cannot proceed until the relevant consents/approvals are in place.

The proposed work programmes for the Initial Term are detailed in the licence applications. For some activities, such as seismic survey, the potential impacts associated with noise could occur some distance from the licensed Blocks and the degree of activity is not necessarily proportional to the size or number of Blocks in an area. In the case of direct physical disturbance, the licence Blocks being applied for are relevant.

[9] https://www.nstauthority.co.uk/media/8415/33rd-licensing-round-general-guidance-7-october.pdf

Figure 2.1: Stages of plan level environmental assessment

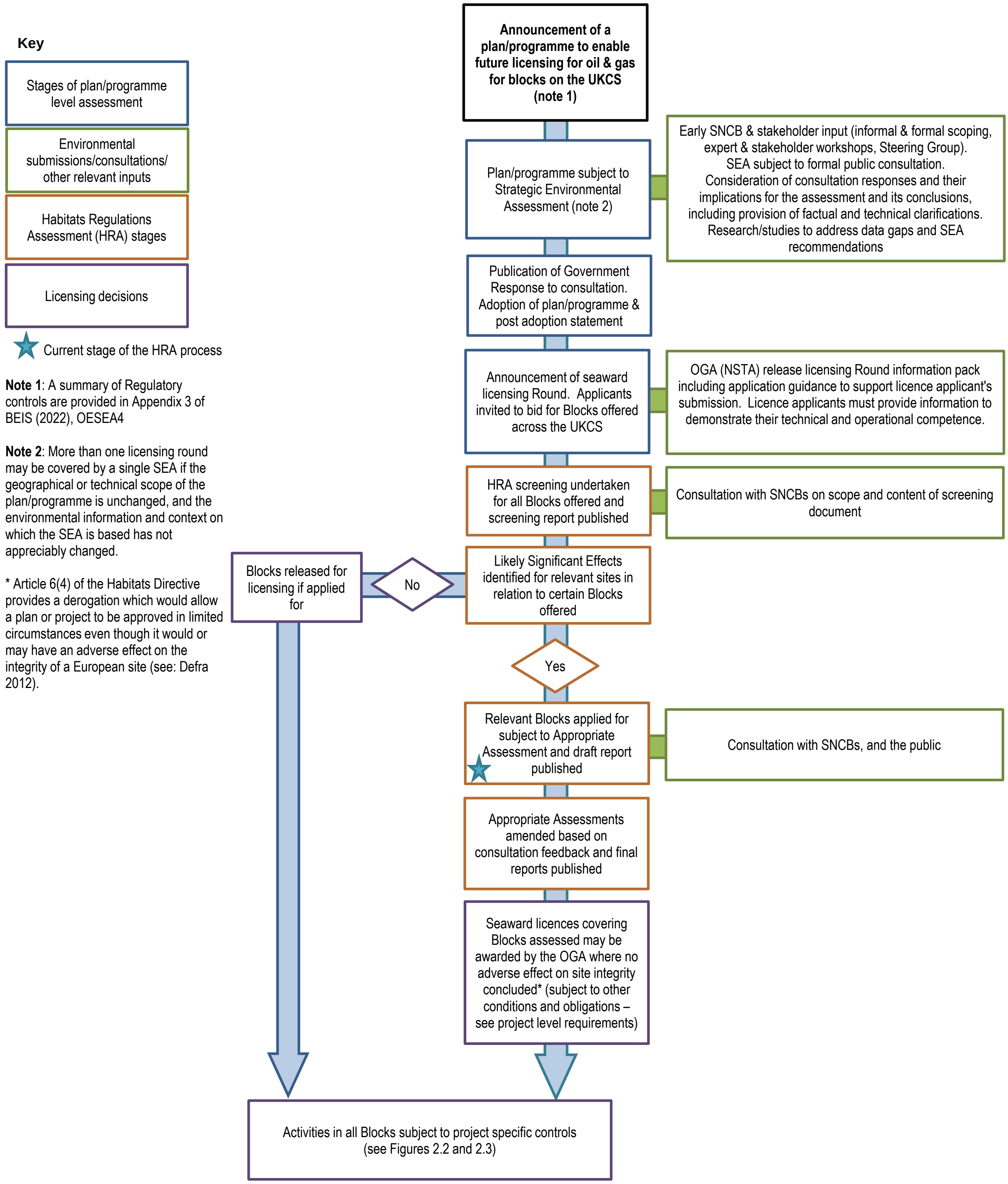
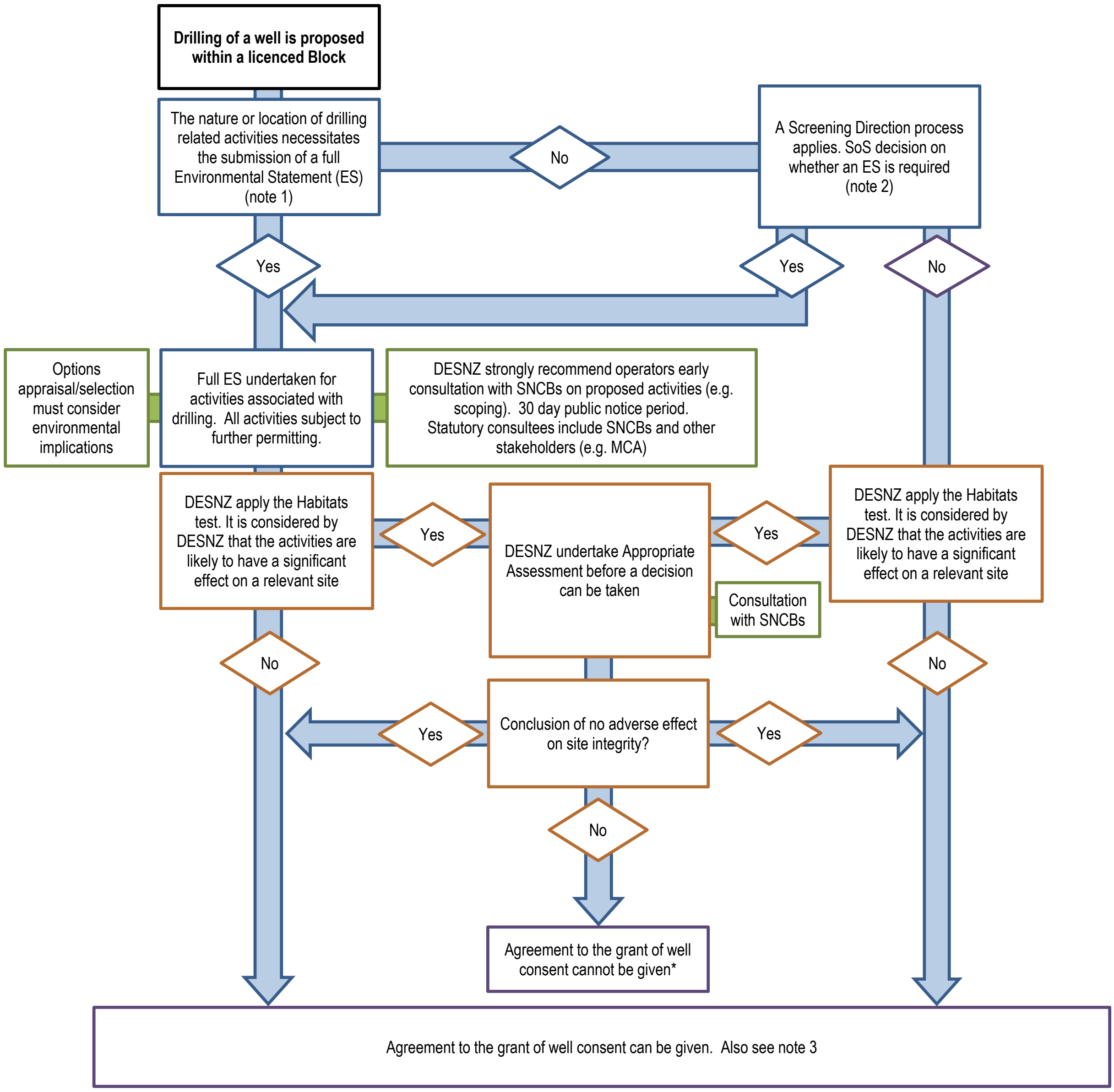


Figure 2.2: High level overview of exploration drilling environmental requirements



Key

- Stages of project permitting
- Environmental submissions/consultations/ other relevant inputs
- Habitats Regulations Assessment (HRA) stages
- Permitting/Consenting decisions

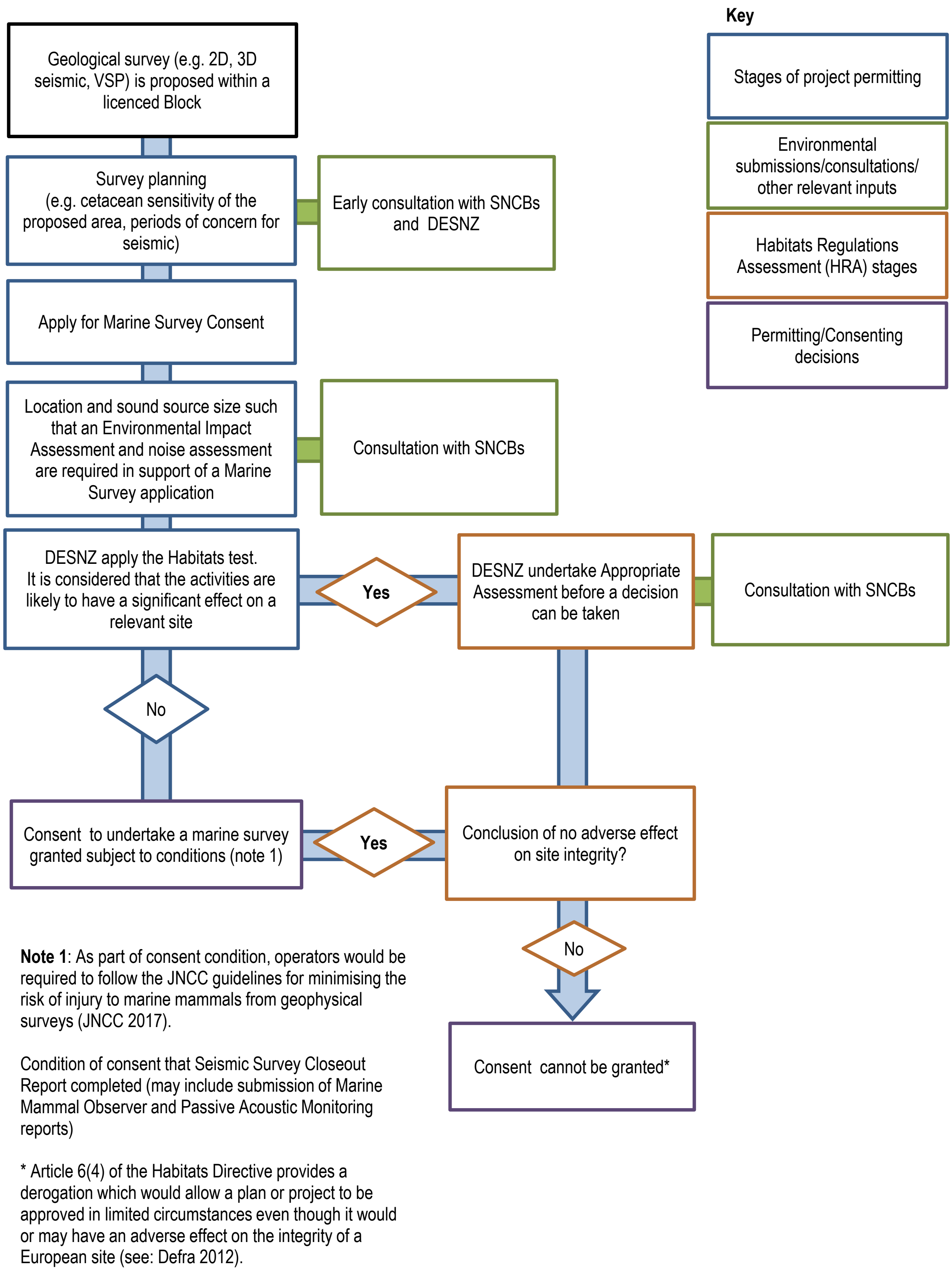
Note 1: See BEIS (2022). The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 – A Guide.

Note 2: Early consultation between DESNZ and operators is typical to mitigate against Environmental Statement (ES) requirements being identified following the request for a direction

Note 3: In cases where an ES was initially identified as not required, or where an ES has been approved, the requirement to undertake AA may still apply (e.g. due to changes in the nature of the project or the designation of additional European sites)

* Article 6(4) of the Habitats Directive provides a derogation which would allow a plan or project to be approved in limited circumstances even though it would or may have an adverse effect on the integrity of a European site (see: Defra 2012).

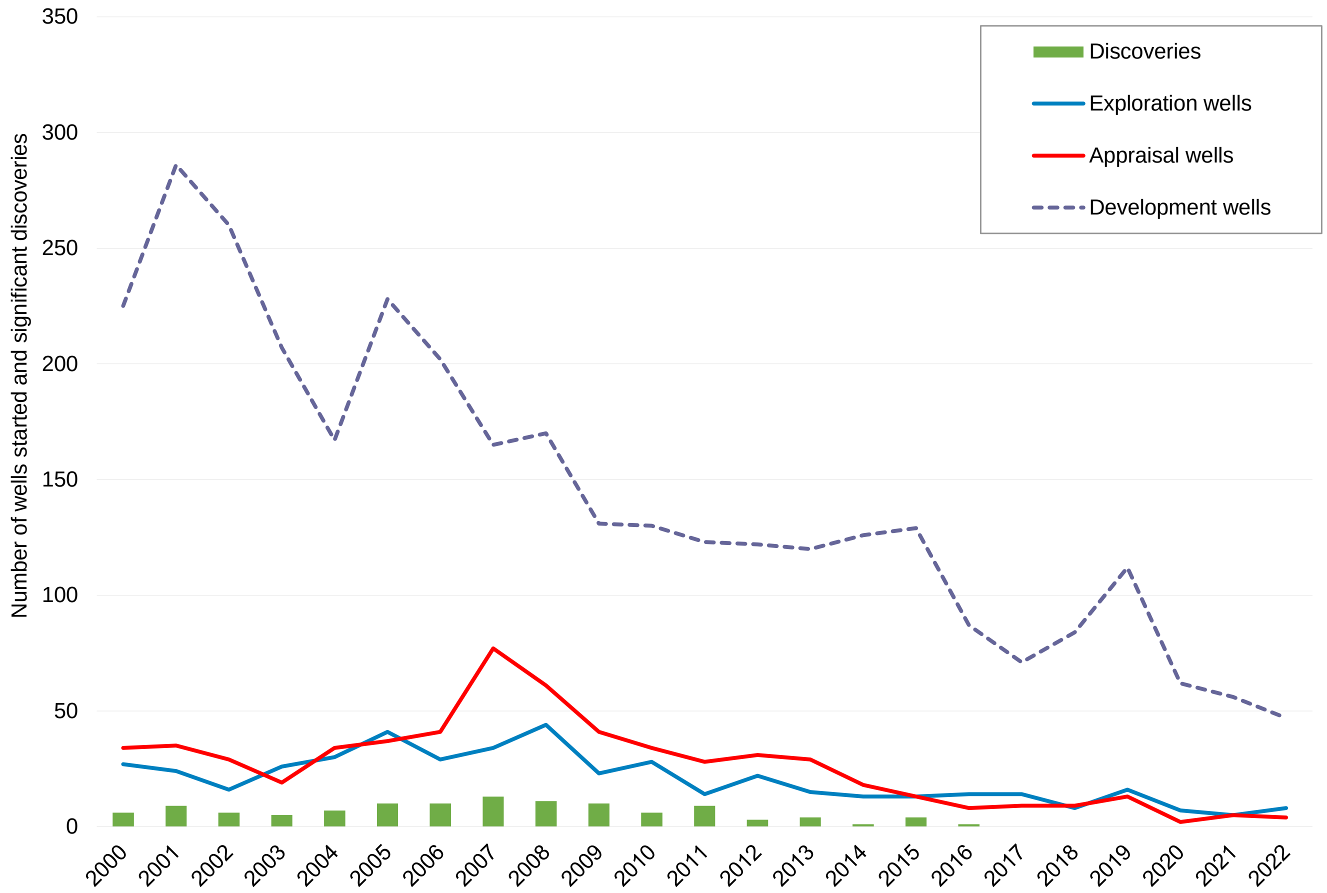
Figure 2.3: High level overview of seismic survey environmental requirements



2.2.1 Likely scale of activity

On past experience the activity that actually takes place is less than what is included in the work programme at the licence application stage. A proportion of Blocks awarded may be relinquished without any offshore activities occurring. Activity after the Initial Term is much harder to predict, as this depends on the results of the initial phase, which is, by definition, exploratory. Typically, less than half the wells drilled reveal hydrocarbons, and of that, less than half will have a potential to progress to development. For example, the NSTA analysis of exploration well outcomes from the Moray Firth & Central North Sea between 2003 and 2013 indicated an overall technical success rate of 40% with respect to 150 exploration wells and side-tracks (Mathieu 2015). Depending on the expected size of finds, there may be further drilling to appraise the hydrocarbons (appraisal wells). For context, Figure 2.4 highlights the total number of exploration and appraisal wells started on the UKCS each year since 2000 as well as the number of significant discoveries made (associated with exploration activities).

Figure 2.4: UKCS Exploration, appraisal & development wells, and significant discoveries since 2000



Note: The description "significant" generally refers to the flow rates that were achieved (or would have been reached) in well tests (15 mmcfgd or 1000 BOPD). It does not indicate the commercial potential of the discovery.

Source: NSTA Drilling Activity (January 2023), Significant Offshore Discoveries (October 2018)

Discoveries that progress to development may require further drilling, installation of infrastructure such as wellheads, pipelines and possibly fixed platform production facilities, although recent developments are mostly tiebacks to existing production facilities rather than stand-alone developments. For example, out of 21 projects identified on the NSTA's Energy

Pathfinder (as of 2nd February 2023)[10], 12 are planned as subsea tie-backs to existing infrastructure, 3 involve new stand-alone production platforms and 5 are likely to be developed via Floating Production, Storage and Offloading (FPSO) facilities. The final form of development for many of the projects is not decided, with some undergoing re-evaluation of development options. Figure 2.4 indicates that the number of development wells has declined over time and this pattern is likely to continue. The nature and scale of potential environmental impacts from the drilling of development wells are similar to those of exploration and appraisal wells and thus the evidence base in Section 4 is applicable to the potential effects of development well drilling within any of the 33rd Round Blocks.

2.2.2 33rd Round activities considered in this HRA

The nature, extent and timescale of development, if any, which may ultimately result from the licensing of 33rd Round Blocks is uncertain, and therefore it is regarded that at this stage a meaningful assessment of development level activity (e.g. pipelay, placement of jackets, subsea templates or floating installations) cannot be made. Even where an applicant has applied for a licence to go straight to the Second Term, the nature and scale of any development which might be associated with this licence is highly uncertain. This is because there will be multiple options for development (e.g. subsea tie-back, standalone platform) including export routes (e.g. pipeline to shore, or tie-back to one or more existing host facilities), most of which will not be known in detail until towards the end of the Second Term. Therefore, at this stage, based on the information provided in the licence applications, and the level of uncertainty about the nature, scale, and location of any development within the wider licence areas applied for, it is not considered that there is sufficient detail to undertake a meaningful assessment of development level activities. Moreover, once project plans are in place, subsequent permitting processes relating to exploration, development and decommissioning, would require assessment including where appropriate an HRA, allowing the opportunity for further mitigation measures to be identified as necessary, and for permits to potentially be refused. Therefore, only activities as part of the work programmes associated with the Initial Term and its associated Phases A-C are considered in this AA (see Table 2.2).

Potential accidental events, including spills, are not considered in the AA as they are not part of the work plan. Measures to prevent accidental events, response plans and potential impacts in the receiving environment are considered as part of the environmental impact assessment (EIA) process for specific projects that could follow licensing when the location, nature and timing of the proposed activities are available to inform a meaningful assessment of such risks.

The approach used in this assessment has been to take the proposed activity for the Block as being the maximum of any application for that Block, and to assume that all activity takes place. The estimates of work commitments for the relevant Blocks derived from the applications received by the NSTA are shown in Table 2.1. Two or more of the Blocks may be part of a single licence application, such that the level of activity suggested in Table 2.1 may be greater than that which occurs e.g. drilling will only take place in one licence area rather than in every Block applied for.

[10] https://www.nstauthority.co.uk/supply-chain/energy-pathfinder/

Table 2.1: Indicative work programmes relevant to Blocks considered in this assessment

Block	Obtain[11] and/or reprocess 2D or 3D seismic data	Shoot 3D seismic	Drill or drop well/contingent well	Second Term
16/3d	-	-	✓	-
205/14	-	-	✓	-
206/11d	-	-	✓	-

Completion of the work programmes is likely to involve one or more of the activities summarised in Table 2.2. A series of assumptions has been developed on the nature and scale of activities to be assessed based on the evidence base for potential effects presented in Section 4 as well as reviews of exemplar Environmental Statements of relevant activities. Subsequent development activity is contingent on successful exploration and appraisal and may or may not result in the eventual installation of infrastructure. Where relevant, such future activities will themselves be subject to activity specific screening procedures and tests under the relevant legislation.

[11] To obtain seismic data means purchasing or otherwise getting the use of existing data and does not involve shooting new seismic.

Table 2.2: Potential activities and assessment assumptions

Potential activity	Description	Assumptions used for assessment
Initial Term Phase C: Drilling and well evaluation		
Rig tow out & de-mobilisation	Mobile rigs are towed to and from the well site typically by 2-3 anchor handling vessels.	The physical presence of a rig and related tugs during tow in/out is both short (a number of days depending on initial location of rig) and transient.
Rig placement/ anchoring	Semi-submersible rigs are used in deeper waters (normally >120m). Mooring is achieved using either anchors (deployed and recovered by anchor handler vessels) or dynamic positioning (DP) to manoeuvre into and stay in position over the well location. Eight to 12 anchors attached to the rig by cable or chain are deployed radially from the rig; part of the anchoring hold is provided by a proportion of the cables or chains lying on the seabed (catenary).	Semi-submersible rig anchors/chains (if used) may extend out to a radius of 1.5-1.8km in North Sea waters of the UK. An ES for an exploration well in Block 18/05 in *ca*. 90m water depth estimated that the area of seabed affected by anchoring was *ca*. 0.01km^2 (Apache North Sea Limited 2006), and in deeper waters the seabed footprint may be in the order of 0.06km^2.
Marine discharges	Typically around 1,000 tonnes of cuttings (primarily rock chippings) result from drilling an exploration well. Water-based mud cuttings are typically discharged at, or relatively close to sea surface during "closed drilling" (i.e. when steel casing in the well bore and a riser to the rig are in place), whereas surface hole cuttings are normally discharged at seabed during "open-hole" drilling. Use of oil based mud systems, for example in highly deviated sections or in drilling water reactive shales, would require onshore disposal or treatment offshore to the required standards prior to discharge. Typical chemical use and discharge for an exploration well includes cements which are used to fix casings and liners into place inside the well, with the vast majority retained downhole and not discharged to the marine environment. Brines and clean up chemicals, designed to remove mud and cuttings traces from the well bore, and other chemicals such as rig washes, hydraulic fluids and pipe dopes, are essential during drilling programmes.	The distance from source within which smothering or other effects may be considered possible is generally a few hundred metres. For the assessment it is assumed that effects may occur within 500m of the well location covering an area in the order of 0.8km^2 (refer to Section 4.2 for supporting information). Typically, the majority of chemicals used and discharged are either PLONOR (Pose Little or No Risk to the Environment) or have a risk assessment banding of E or Gold and contain no additional warnings (i.e. they do not contain components which have been identified for substitution, for example due to toxicity, biodegradation, bioaccumulation). Chemicals are risk assessed prior to their use and discharge offshore, with those chemicals identified with warnings and/or a poorer environmental profile, requiring additional justification in order to obtain approval. Effects from chemical discharge will typically be localised to the well area.
Conductor piling	Well surface holes are usually drilled "open-hole" with the conductor subsequently inserted and cemented in place to provide a stable hole through which the lower well sections are drilled. Where the nature of the seabed sediment and shallow geological formations are such that they would not support a stable open-hole (i.e. risking collapse), the conductor may be driven into the sediments. In North Sea exploration wells, the diameter of the conductor pipe is usually 26" or 30" (<1m), which is considerably smaller than the monopiles used for offshore wind farm foundations (>3.5m diameter), and	The need to pile conductors is well-specific and is not routine. It is anticipated that a conductor piling event would last between 4-6 hours, during which time impulses sound would be generated primarily in the range of 100-1,000Hz, with each impulse of a sound pressure level of approximately 150dB re 1µPa at 500m from the source.

Potential activity	Description	Assumptions used for assessment
	therefore require less hammer energy and generate noise of a considerably lower amplitude. For example, hammer energies to set conductor pipes are in the order of 90-270kJ (see: Matthews 2014, Intermoor website), compared to energies of up to 3,000kJ in the installation of piles at some southern North Sea offshore wind farm sites. Direct measurements of underwater sound generated during conductor piling are limited. Jiang *et al.* (2015) monitored conductor piling operations at a jack-up rig in the central North Sea in 48m water depth and found peak sound pressure levels (L_{pk}) not to exceed 156dB re 1 μPa at 750m (the closest measurement to source) and declining with distance. Peak frequency was around 200Hz, dropping off rapidly above 1kHz; hammering was undertaken at a stable power level of 85 ±5 kJ but the pile diameter was not specified (Jiang *et al.* 2015). MacGillivray (2018) reported underwater noise measurements during the piling of six 26" conductors at a platform, six miles offshore of southern California in 365m water depth. After initially penetrating the seabed under its own weight, each conductor was driven approximately 40m further into the seabed (silty-clay and clayey-silt) with hammer energies that increased from 31 ±7 kJ per strike at the start of driving to 59 ±7 kJ per strike. Between 2.5-3 hours of active piling was required per conductor. Sound levels were recorded by fixed hydrophones positioned at distances of 10-1,475m from the source and in water depths of 20-370m, and by a vessel-towed hydrophone. The majority of sound energy was between 100-1,000Hz, with peak sound levels around 400Hz. Broadband sound pressure levels recorded at 10m from source and 25m water depth were between 180-190dB re 1μPa (SEL = 173-176dB re 1μPa·s), reducing to 149-155dB re 1μPa at 400m from source and 20m water depth (SEL = 143-147dB re 1μPa·s).	
Rig site survey	Rig site surveys are undertaken to identify seabed and subsurface hazards to drilling, such as wrecks and the presence of shallow gas. The surveys use a range of techniques, including multibeam and side scan sonar, sub-bottom profiler, magnetometer and high-resolution seismic involving a much smaller source (mini-gun or four airgun cluster of 160 in^3) and a much shorter hydrophone streamer. Arrays used on site surveys and some Vertical Seismic Profiling	A rig site survey typically covers 2-3km^2. The rig site survey vessel may also be used to characterise seabed habitats, biota and background contamination. Survey durations are usually of the order of four or five days.

Potential activity	Description	Assumptions used for assessment
	(VSP) operations (see below) typically produce frequencies predominantly up to around 250Hz, with a peak source level of around 235dB re 1µPa @ 1m (Stone 2015).	
Rig/vessel presence and movement	On site, the rig is supported by supply and standby vessels, and helicopters are used for personnel transfer.	Supply vessels typically make 2-3 supply trips per week between rig and shore. Helicopter trips to transfer personnel to and from the rig are typically made 2-3 times a week. A review of Environmental Statements for exploratory drilling suggests that the rig could be on location for, on average, up to 10 weeks. Support and supply vessels (50-100m in length) are expected to have broadband source levels in the range 165-180dB re 1µPa@1m, with the majority of energy below 1kHz (OSPAR 2009). Additionally, the use of thrusters for dynamic positioning has been reported to result in increased sound generation (>10dB) when compared to the same vessel in transit (Rutenko & Ushchipovskii 2015).
Well evaluation (e.g. Vertical Seismic Profiling)	Sometimes conducted to assist with well evaluation by linking rock strata encountered in drilling to seismic survey data. A seismic source (airgun array, typically with a source size around 500 in^3 and with a maximum of 1,200 in^3, Stone 2015) is deployed from the rig, and measurements are made using a series of geophones deployed inside the wellbore.	VSP surveys are of short duration (one or two days at most).

2.3 Existing regulatory requirements and controls

The AA assumes that the high-level controls described below are applied as standard to activities since they are legislative requirements. These are distinct from further control measures which may be identified and employed to avoid likely significant effects on relevant sites. These further control measures are identified in Sections 5.2.3 and 5.3.3 with reference to the two main sources of effect identified.

2.3.1 Physical disturbance and drilling effects

There is a mandatory requirement to have sufficient recent and relevant data to characterise the seabed in areas where activities are due to take place (e.g. rig placement)[12]. If required, survey reports must be made available to the relevant statutory nature conservation bodies on submission of a relevant permit application or Environmental Statement for the proposed activity, and the identification of any potential sensitive habitats by such survey (including those under Annex I of the Habitats Directive) may influence the Department's decision on a project level consent.

Discharges from offshore oil and gas facilities have been subject to increasingly stringent regulatory controls over recent decades (see review in BEIS 2022, and related Appendices 2 and 3). As a result, oil and other contaminant concentrations in the major streams (drilling wastes and produced water) have been substantially reduced or eliminated (e.g. the discharge of oil based muds and contaminated cuttings is effectively banned), with discharges of chemicals and oil exceeding permit conditions or any unplanned release, potentially constituting a breach of the permit conditions and an offence. Drilling chemical use and discharge is subject to strict regulatory control through permitting, monitoring and reporting (e.g. the Environmental Emissions Monitoring System (EEMS) and annual environmental performance reports). The use and discharge of chemicals must be risk assessed as part of the permitting process (e.g. Drilling Operations Application) under the *Offshore Chemicals Regulations 2002* (as amended), and the discharge of chemicals expected to have a significant negative impact would not be permitted.

At the project level, discharges would be considered in detail in project-specific EIAs (and where necessary through HRAs) and chemical risk assessments under existing permitting procedures.

2.3.2 Underwater noise effects

Controls are in place to cover all significant noise generating activities on the UKCS, including geophysical surveying. Seismic surveys (including VSP and high-resolution site surveys), sub-bottom profile surveys and shallow drilling activities require an application for consent under the *Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001* (as amended) and cannot proceed without consent. These applications are supported by an EIA, which includes a noise assessment. Regarding noise thresholds to be used as part of any assessment, applicants are encouraged to seek the advice of relevant SNCB(s) (JNCC 2017a) in addition to referring to European Protected Species (EPS) guidance (JNCC 2010).

[12] See BEIS (2021). The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 - A guide. July 2021 - Revision 3.

Applicants should be aware of recent research development in the field of marine mammal acoustics, including the development of a new set of criteria for injury (Southall *et al*. 2019).

The Department consults the relevant statutory nature conservation bodies on the consent applications for advice and a decision on whether to grant consent is only made after careful consideration of their comments. Statutory nature conservation bodies may request additional information or risk assessment, specific additional conditions to be attached to consent (such as specify timing or other specific control measures), or advise against consent.

It is a condition of consents issued under Regulation 4 of the *Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001* (as amended) for seismic and sub-bottom profile surveys that the JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys are followed. Where appropriate, EPS disturbance licences may also be required under the *Conservation of Offshore Marine Habitats and Species Regulations 2017*[13]. The JNCC (2017) guidelines reaffirm that adherence to these guidelines constitutes best practice and will, in most cases, reduce the risk of deliberate injury to marine mammals to negligible levels. Applicants are expected to make every effort to design a survey that minimises sound generated and consequent likely impacts, and to implement best practice measures described in the guidelines.

In addition, potential disturbance of certain qualifying species (or their prey) may be avoided by the seasonal timing of offshore activities. For example, periods of seasonal concern for individual Blocks on offer with respect to seismic survey and fish spawning are noted in Section 2 of the Department's Other Regulatory Issues listing[14]. Licensees should also be aware that seasonal concerns may influence the decision whether or not to approve particular activities.

[13] Disturbance of European Protected Species (EPS) (i.e. those listed in Annex IV) is a separate consideration under Article 12 of the Habitats Directive, and is not considered in this assessment.

[14] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1114310/Other_Regulatory_Issues_-_Sept_2022.pdf

3 Appropriate assessment process

3.1 Process

In carrying out this AA so as to determine whether it is possible to agree to the grant of licences in accordance with Regulation 5(1) of *The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001* (as amended), the Department has:

- Considered, on the basis of the precautionary principle, whether it could be concluded that the integrity of relevant sites would not be affected. This impact prediction involved a consideration of the in-combination effects.
- Examined, in relation to elements of the plan where it was not possible to conclude that the integrity of relevant sites would not be affected, whether appropriate mitigation measures could be designed which negated or minimised any potential adverse effects identified.

In considering the above the Department has taken the following approach, so that:

- Prior to the grant of any licence all activities which may be carried out following the grant of such a licence, and which by themselves or in combination with other activities can affect the site's conservation objectives, are identified in the light of the best scientific knowledge in the field.
- A licence can only be granted if the Department has made certain that the activities to be carried out under such a licence will not adversely affect the integrity of that site (i.e. cause deterioration to a qualifying habitat or habitat of qualifying species, and/or undermine the conservation objectives of any given site). That is the case where no reasonable scientific doubt remains as to the absence of such effects.

3.2 Site integrity

The integrity of a site is defined by government policy and clarified by the courts (Cairngorms judicial review case[15]) as being: *'…the coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified/[designated].'* This is consistent with the definitions of favourable conservation status in Article 1 of the Habitats Directive (JNCC 2002). The integrity of a site relates to the site's conservation objectives. These objectives are assigned at the time of designation to ensure that the site continues, in the long-term, to make an appropriate contribution to achieving favourable conservation status for the qualifying interest features. An adverse effect would be something that impacts the site features, either directly or indirectly, and results in disruption or harm to the ecological structure and functioning of the site and/or affects the ability of the site to meet its conservation objectives. For example, it is possible that a plan or project will adversely affect the integrity of

[15] WWF UK Ltd v Secretary of State for Scotland [1999] 1 C.M.L.R. 1021.

a site only in a visual sense or only with respect to habitat types or species other than those listed in Annex I or Annex II. In such cases, the effects do not amount to an adverse effect for purposes of Regulation 6 of the *Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001*, provided that the coherence of the network is not affected. The AA must therefore conclude whether the proposed activity adversely affects the integrity of the site, in the light of its conservation objectives.

3.3 Assessment of effects on site integrity

The assessment has been undertaken in accordance with the European Commission Guidance (EC 2019) and with reference to other guidance, reports and policy, including the Habitats Regulations Guidance Notes (English Nature 1997, Defra 2012, SEERAD 2000), SNH (2015), the National Planning Policy Framework (MHCLG 2021), the Marine Policy Statement (HM Government 2011), English Nature report No. 704 (Hoskin & Tyldesley 2006) and Natural England report NECR205 (Chapman & Tyldesley 2016).

The assessment of effects on site integrity is documented in Section 5. It has been informed by an evidence base on the environmental effects of oil and gas activities on the UKCS and elsewhere (Section 4), and has utilised a number of assumptions on the nature and scale of potential activities that could follow licensing (Table 2.2), along with the characteristics and specific environmental conditions of the relevant sites (see Section 5). Activities which may be carried out following the grant of a licence, and which by themselves or in combination with other activities can affect the conservation objectives of relevant sites are discussed under the following broad headings:

- Physical disturbance and drilling effects (Section 5.1)
- Underwater noise effects (Section 5.2)
- In-combination effects (Section 5.3)

4 Evidence base for assessment

4.1 Introduction

The AAs are informed by an evidence base on the environmental effects of oil and gas activities derived from the scientific literature, relevant Strategic Environmental Assessments (e.g. DECC 2009, 2011, 2016, BEIS 2022) and other literature. Recent operator Environmental Statements for offshore exploration and appraisal activities on the UKCS have also been reviewed, providing, for example, a more specific indication of the range of spatial footprints associated with relevant drilling activities to inform the further consideration of those sites where physical disturbance and drilling effects may be considered likely.

Much work has been undertaken in the area of sensitivity assessments and activity/pressure (i.e. mechanisms of effect) matrices (e.g. Tillin *et al*. 2010, JNCC 2013, Tillin & Tyler-Walters 2014, Defra 2015, Robson *et al.* 2018, the Scottish Government Feature Activity Sensitivity Tool, FeAST, the MarESA tool, Tyler-Walters *et al*. 2018). These matrices are intended to describe the types of pressures that act on marine species and habitats from a defined set of activities and are related to benchmarks where the magnitude, extent or duration is qualified or quantified in some way and against which sensitivity may be measured – note that benchmarks have not been set for all pressures. The sensitivity of features to any pressure is based on tolerance and resilience, and can be challenging to determine (e.g. see Tillin & Tyler-Walters 2014, Pérez-Domínguez *et al.* 2016, Maher *et al.* 2016), for example due to data limitations for effect responses of species making up functional groups and/or lack of consensus on expert judgements. Outputs from such sensitivity exercises can therefore be taken as indicative.

This approach underpins advice on operations for a number of the sites included in this assessment (e.g. Braemar Pockmarks SAC). The advice identifies a range of pressures for the sites in relation to oil, gas and carbon dioxide storage exploration activity, for which the site features are regarded to be either sensitive, not sensitive; or where a sensitivity assessment has not been made, or it is concluded there is insufficient evidence for a sensitivity assessment to be made at the pressure benchmark[16]. Whilst the matrices provided as part of the advice are informative and note relevant pressures associated with hydrocarbon exploration and gas storage, resultant effects are not inevitable consequences of activity since often they can be mitigated through timing, siting or technology (or a combination of these). The Department expects that these options would be evaluated by the licensees and documented in the environmental assessments required as part of the activity specific consenting regime.

A review of the range of pressures identified in SNCB advice for the relevant sites was undertaken for the purpose of this assessment. The review concluded that the evidence base for potential effects of hydrocarbon (and by extrapolation, carbon storage) exploration from successive Offshore Energy SEA, including the most recent OESEA4 (BEIS 2022) covers the range of pressures identified in the advice for the relevant sites (as summarised in Sections 4.2-4.3) and has therefore been used to underpin the assessment against site-specific information. It is noted that existing controls are in place for many relevant pressures (e.g. hydrocarbon contamination, introduction of other substances (solid, liquid or gas), synthetic

[16] Note that the advice does not take into account the intensity, frequency or cumulative impacts from activities, and pressure benchmarks are used as reference points to assess sensitivity and are not thresholds that identify a likely significant effect within the meaning of Habitats Regulations (JNCC 2017a)

compound contamination (including antifoulants), transition elements & organo-metal contamination, introduction or spread of non-indigenous species, and litter), either directly in relation to carbon dioxide storage or oil and gas activities (as outlined in Section 2.3) or generally in relation to shipping controls (e.g. MARPOL Annex I and V controls on oil and garbage respectively, and the Ballast Water Management Convention). In addition to advice on operations, the conservation objectives and any Supplementary Advice on Conservation Objectives (SACO) have been taken into account. The following sections provide a summary of the evidence informing the site-specific assessment of effects provided in Section 5. To focus the presentation of relevant information, the sections take account of the environments in which those Blocks and relevant sites to be subject to further assessment are located (Table 1.1, Figure 1.1).

4.2 Physical disturbance and drilling effects

Exploration/appraisal activities may exert the following pressures[17] which have the potential to cause physical disturbance and drilling effects on relevant sites:

- Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion from semi-submersible drilling rig anchor placement, dragging and the contact of anchor cables and chains with the seabed (see Section 4.2.1)
- Abrasion/disturbance of the substrate on the surface of the seabed and smothering/siltation rate change through the discharge of surface hole cuttings around the well, placement of wellhead assembly, and by settlement of drill cuttings onto the seabed following discharge near sea surface (see Section 4.2.2)
- Physical change to another seabed type (see Section 4.2.3)
- Contamination (see Section 4.2.4)
- Introduction or spread of non-indigenous species (see Section 4.2.5)
- Visual disturbance (and underwater noise, covered in Section 4.2.6), introduction of light and collision associated with the presence and movement of vessels causing displacement of sensitive receptors (see Section 4.4.6)
- Collisions above or below water with static or moving objects (see Section 4.2.7)

4.2.1 Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion

Semi-submersible rigs normally use anchors to hold position, typically between 8 and 12 in number at a radius related to water depth, seabed conditions and anticipated metocean conditions. The seabed footprint associated with semi-submersible rig anchoring results from a combination of anchor scars caused by anchors dragging before gaining a firm hold, and scraping by the cable and/or chain linking the anchor to the rig, where these contact the seabed (the catenary contact). In North Sea depths, rig anchors extend to a radius of up to *ca*. 1,800m (note that semi-submersible rigs are typically not used in water depths of less than

[17] Following those noted in Section 4.2.

120m). In the deeper waters of the UK the use of anchors could be avoided through the use of dynamically positioned (DP) drill ships or DP semi-submersible rigs. These use a number of thrusters and accurate positioning information to maintain their station.

The drilling of the surface hole of a well and installation of the conductor will result in highly localised changes to the substrate below the surface of the seabed, for example, a typical conductor may have a diameter of 26 inches. Following drilling, exploration wells are typically plugged and abandoned with the casing being removed to approximately 3m below the seabed.

4.2.2 Abrasion/disturbance of the substrate on the surface of the seabed and habitat structure changes – removal of substratum

The surface hole sections of wells are typically drilled riserless, producing a localised (and transient) pile of surface-hole cuttings around the surface conductor. These cuttings are derived from shallow geological formations and a proportion will be similar to surficial sediments in composition and characteristics. The persistence of cuttings discharged at the seabed is largely determined by the potential for it to be redistributed by tidal and other currents. After installation of the conductor, the surface casing (which will result in a small quantity of excess cement returns being deposited on the seabed), the blowout preventer (BOP) is positioned on the wellhead housing. These operations (and associated activities such as ROV operations) may result in physical disturbance of the immediate vicinity (a few metres) of the wellhead. When an exploration well is abandoned, the conductor and casing are plugged with cement and cut below the mudline (seabed sediment surface) using a mechanical cutting tool deployed from the rig and the wellhead assembly is removed. The seabed “footprint” of the well is therefore removed although post-well sediments may vary in the immediate vicinity of the well compared to the surrounding seabed (see for example, Jones *et al*. (2012)).

The extent and potential impact of drilling discharges have been reviewed in successive SEAs, OESEA, OESEA2, OESEA3 and OESEA4 (DECC 2009, 2011, 2016 and BEIS 2022).

Relevant information on the recovery of benthic habitats to smothering mainly comes from studies of dredge disposal areas (see Newell *at al.* 1998). Recovery following disposal occurs through a mixture of vertical migration of buried fauna, together with sideways migration into the area from the edges, and settlement of new larvae from the plankton. The community recolonising a disturbed area is likely to differ from that which existed prior to construction. Opportunistic species will tend to dominate initially and on occasion, introduced and invasive species may then exploit the disturbed site (Bulleri & Chapman 2010). Harvey *et al.* (1998) suggest that it may take more than two years for a community to return to a closer resemblance of its original state (although if long lived species were present this could be much longer). Shallow water (<20m) habitats in wave or current exposed regimes, with unconsolidated fine grained sediments have a high rate of natural disturbance and the characteristic benthic species are adapted to this. Species tend to be short lived and rapid reproducers and it is generally accepted that they recover from disturbance within months. By contrast a stable sand and gravel habitat in deeper water is believed to take years to recover (see Newell *et al.* 1998, Foden *et al*. 2009). Changes in water quality from increased suspended sediment loads are noted as a pressure relevant to exploration drilling[18], though is justified in relation to vessel use in shallow waters and in ports rather than drilling activities

[18] https://hub.jncc.gov.uk/assets/97447f16-9f38-49ff-a3af-56d437fd1951, also see Advice on Operations for SACs SPAs: https://designatedsites.naturalengland.org.uk/; note that changes in suspended solids (water clarity) is generally not noted as a pressure against exploration drilling for SPAs relevant to this assessment.

themselves. While drilling activities may results in enhanced turbidity, e.g. from cuttings discharge, these are widely and quickly dispersed and are not likely to impact, for example, shallow plunge diving birds such as terns.

4.2.3 Physical change to another seabed type

The introduction of rock into an area with a seabed of sand and/or gravel can in theory provide “stepping stones” which might facilitate biological colonisation including by non-indigenous species by allowing species with short lived larvae to spread to areas where previously they were effectively excluded. On the UKCS, natural “stepping stones” are widespread and numerous for example in the form of rock outcrops, glacial dropstones and moraines, relicts of periglacial water flows, accumulations of large mollusc shells, carbonate cemented rock etc., and these are often revealed in rig site and other (e.g. pipeline route) surveys. The potential for man-made structures to act as stepping stones in the North Sea and the impact of their removal during decommissioning is being investigated as part of the INSITE[19] programme. Phase 1 projects (2015-2017) are now complete; those of relevance suggest that man-made structures may influence benthic community structure and function but only on a limited spatial scale. Modelling indicates the strong potential for biological connectivity between structures in the North Sea (e.g. Henry *et al.* 2018, Mayorga-Adame *et al.* 2022), but this has not been validated by empirical data (ISAB 2018). Phase 2 of the INSITE research aimed to tackle gaps in understanding of the role of man-made structures in marine ecosystems and results from this phase of the work were recently summarised in a series of webinars[20]. An additional project has been commissioned to provide a synthesis of evidence relating to man-made structures in the marine environment, building on phases 1 and 2 of the INSITE programme, is also due to complete in the same timeframe as Phase 2[21].

The use of semi-submersible rigs in the water depths and hydrographic conditions within and around the central North Sea and West of Shetland Blocks considered in this AA removes the possible need for stabilisation material for rig siting.

4.2.4 Contamination[22]

In contrast to historic oil based mud (OBM) discharges[23], effects on seabed fauna resulting from the discharge of cuttings drilled with water based muds (WBM) and of the excess and spent mud itself are usually subtle or undetectable. Although the presence of drilling material at the seabed close to the drilling location (<500m) is often detectable chemically (e.g. Cranmer 1988, Neff *et al.* 1989, Hyland *et al.* 1994, Daan & Mulder 1996, Currie & Isaacs 2005, OSPAR 2009, Bakke *et al.* 2013). Recent studies (e.g. Aagaard-Sørensen *et al.* 2018, Junttila *et al.* 2018, Dijkstra *et al.* 2020, Gillett *et al.* 2020, Nguyen *et al.* 2021) have investigated the spread and effects of WBM discharges on various aspects of seabed ecology including those not typically included in benthic monitoring programmes; the results indicate that, where effects were detected, they were of small spatial scale and relatively short duration. Analysis of UKBenthos data (Henry *et al.* 2017) for 19 installations spanning the northern, central and southern North Sea, suggested strong benthic responses for 12 structures, with 10 having their maximum ecological footprint within 1km of the discharge, and the remaining two

[19] https://www.insitenorthsea.org/
[20] https://insitenorthsea.org/impact
[21] https://insitenorthsea.org/projects/insite-overall-synthesis-project-2021-2023
[22] Including contamination from transition elements and organo-metals, hydrocarbons and PAHs, synthetic compounds and the introduction of other substances (solid, liquid or gas).
[23] OSPAR Decision 2000/3 on the Use of Organic-Phase Drilling Fluids (OPF) and the Discharge of OPF-Contaminated Cuttings came into effect in January 2001 and effectively eliminated the discharge of cuttings contaminated with oil based fluids (OBF) greater than 1% by weight on dry cuttings.

within 1.2km, with recovery time varying between zero years (i.e. no effect) to between 6.8 and 8.3 years. The datasets largely reflected the effects of discharged OBM rather than WBMs, and the authors could not disentangle the effects of OBMs and WBMs in terms of persistence with the available data.

Considerable data from oil and gas activities has been gathered from the North Sea and other production areas, indicating that localised physical effects are the dominant mechanism of ecological disturbance where water-based mud and cuttings are discharged. Modelling of WBM cutting discharges has indicated that deposition of material is generally thin and quickly reduces away from the well. Jones *et al.* (2006, 2012) compared pre- and post-drilling ROV surveys of a West of Shetland exploration well in Block 206/1a in *ca*. 600m water depth and documented physical smothering effects within 100m of the well. Outside the area of smothering, fine sediment was visible on the seafloor up to at least 250m from the well. After three years, there was significant reduction of cuttings material visible particularly in the areas with relatively low initial deposition (Jones *et al*. 2012). The area with complete cuttings cover had reduced from 90m to 40m from the drilling location, and faunal density within 100m of the well had increased considerably and was no longer significantly different from conditions further away. The use of a ROV has also allowed the detection of small scale changes in benthic fauna in the immediate vicinity of a wellbore in the Norwegian sector of the North Sea, for example Hughes *et al.* (2010) found declines of the density of sea urchin *Gracilechinus acutus* within 50m of a well; such effects are considered temporary and negligible.

OSPAR (2009) concluded that the discharge of water-based muds and drill cuttings may cause some smothering in the near vicinity of the well location. The impacts from such discharges are localised and transient, but may be of concern in areas with sensitive benthic fauna, for example corals and sponges. Field experiments on the effects of water-based drill cuttings on benthos by Trannum *et al*. (2011) treated two “fine” and “coarse” sediment samples with water-based drill cuttings and placed these in water depths of 27-37m. After six months there were only minor differences in faunal composition between the controls and those treated with drill cuttings. This corresponds with the results of field studies where complete recovery was recorded within 1-2 years after deposition of water-based drill cuttings (Daan & Mulder 1996, Currie & Isaacs 2005).

Finer particles may be dispersed over greater distances than coarser particles although exposure to WBM cuttings in suspension will in most cases be short-term (Bakke *et al.* 2013). Chemically inert, suspended barite has been shown under laboratory conditions to potentially have a detrimental effect on suspension feeding bivalves. Standard grade barite, the most commonly used weighting agent in WBMs, was found to alter the filtration rates of four bivalve species (*Modiolus modiolus, Dosinia exoleta, Venerupis senegalensis* and *Chlamys varia*) and to damage the gill structure when exposed to 0.5mm, 1.0mm and 2.0mm daily sedimentation depth equivalent doses (Strachan 2010, Strachan & Kingston 2012). All three barite treatments altered the filtration rates leading to 100% mortality. The horse mussel (*M. modiolus*) was the most tolerant to standard barite with the scallop (*C. varia*) the least tolerant. Fine barite, at a 2mm daily sedimentation depth equivalent, also altered the filtration rates of all species, but only affected the mortality of *V. senegalensis*, with 60% survival at 28 days. The bulk of WBM constituents (by weight and volume) are on the OSPAR list of substances used and discharged offshore which are considered to Pose Little or No Risk to the Environment (PLONOR). Barite and bentonite are the materials typically used in the greatest quantities in WBMs and are of negligible toxicity. Field studies undertaken by Strachan (2010) showed that the presence of standard grade barite was not acutely toxic to seabed fauna but did alter benthic community structure. When the suspended barite levels used in laboratory studies are translated to field conditions (i.e. distances from the point of discharge) it is clear that any effects will be very local to a particular installation (in the case of oil and gas facilities, well within 500m).

Most studies of ecological effects of drilling discharges have involved soft-sediment species and habitats. Studies of the effects of water based mud discharges from three production platforms in 130-210m water depth off California found significant reductions at some stations in the mean abundance of four of 22 hard bottom taxa investigated using photographic quadrats (Hyland *et al.* 1994). These effects were attributed to the physical effects of particulate loading, namely disruption of feeding or respiration, or the burial of settled larvae. The impacts from WBM discharges may be of more concern in areas with sensitive benthic fauna, for example corals and sponges. Laboratory experiments by Allers *et al.* (2013) indicated that cold water coral (*Lophelia pertusa*) fragments were resilient to sedimentation-induced oxygen stress, but if coverage by sediment was complete and lasted long enough, the coral could not recover and died. Such effects can be mitigated in areas of sensitive species presence through site specific controls on whether, and where, drilling discharges are made. Järnegren *et al.* (2017) noted that natural high turbidity events lasting hours or days can occur in areas with adult corals, but based on their experiments (also see Järnegren *et al.* 2020) suggested that the planktonic larvae of *L. pertusa* were susceptible to damage or mortality from suspensions of drill cuttings which included bentonite.

4.2.5 Introduction or spread of non-indigenous species

Through the transport and discharge of vessel ballast waters (and associated sediment), and to a lesser extent fouling organisms on vessel/rig hulls, non-native species may be introduced to the marine environment. Should these introduced species survive and form established breeding populations, they can result in negative effects on the environment. These include: displacing native species by preying on them or out-competing them for resources; irreversible genetic pollution through hybridisation with native species, and increased occurrence of harmful algal blooms (as reviewed in Nentwig 2007). The economic repercussions of these ecological effects can also be significant (see IPIECA & OGP 2010, Lush *et al*. 2015, Nentwig 2007). In response to these risks, a number of technical measures have been proposed such as the use of ultraviolet radiation to treat ballast water or procedural measures such as a mid-ocean exchange of ballast water (the most common mitigation against introductions of non-native species). Management of ballast waters is addressed by the International Maritime Organisation (IMO) through the International Convention for the Control and Management of Ships Ballast Water & Sediments, which entered into force in 2017[24]. The Convention includes Regulations with specified technical standards and requirements (IMO Globallast website[25]). Further, oil and gas exploration and appraisal activity is unlikely to change the risk of the introduction of non-native species as the vessels typically operate in a geographically localised area (e.g. rigs may move between the Irish Sea and North Sea), and the risk from hull fouling is low, given the geographical working region and scraping of hulls for regular inspection.

4.2.6 Visual disturbance

The Blocks offered may support important numbers of birds at certain times of the year including overwintering birds and those foraging from coastal SPAs. Therefore, the presence and/or movement of vessels and aircraft from and within 33rd Round licence blocks during exploration and appraisal activities could temporarily disturb birds from relevant SPA sites. In areas where helicopter transits are regular, a degree of habituation to disturbance amongst

[24] http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Control-and-Management-of-Ships%27-Ballast-Water-and-Sediments-(BWM).aspx
[25] http://archive.iwlearn.net/globallast.imo.org/the-bwmc-and-its-guidelines/index.html

some birds has been reported (see Smit & Visser 1993). The anticipated level of helicopter traffic associated with exploration/appraisal drilling activity (2-3 trips per week, see Table 2.2) is likely to be insignificant in the context of existing helicopter, military and civilian aircraft activity levels.

Physical disturbance of seaduck and other waterbird flocks by vessel and aircraft traffic associated with oil and gas exploration and appraisal is possible, particularly in SPAs established for shy species (e.g. common scoter, see JNCC 2022), however such sites are not located close to any of the Blocks subject to assessment. Such disturbance can result in repeated disruption of bird feeding, loafing and roosting. Divers and sea ducks have been assessed as being the most sensitive species groups to offshore development and associated boat and helicopter traffic. For example, large flocks of common scoter were observed being put to flight at a distance of 2km from a 35m vessel, though smaller flocks were less sensitive and put to flight at a distance of 1km (Kaiser 2002, also see Schwemmer *et al.* 2011). Larger vessels would be expected to have an even greater disturbance distance (Kaiser *et al.* 2006). Mendel *et al.* (2019) further note behavioural response in red-throated diver within 5km of ships.

A significant number of various bird species migrate across the North Sea region twice a year or use the area as a feeding and resting area (OSPAR 2015). Some species crossing or using the area may become attracted to offshore light sources, especially in poor weather conditions with restricted visibility (e.g. low clouds, mist, drizzle, Wiese *et al*. 2001), and this attraction can potentially result in mortality through collision (OSPAR 2015). As part of navigation and worker safety, and in accordance with international requirements, drilling rigs and associated vessels are lit at night and the lights will be visible at distance (some 10-12nm in good visibility). Guidelines (applicable to both existing and new offshore installations) aimed at reducing the impact of offshore installations lighting on birds in the OSPAR maritime area are available (OSPAR 2015). Exploration/appraisal drilling activities are temporary so a drilling rig will be present at a location for a relatively short period (e.g. on average up to 10 weeks per well), limiting the potential for significant interaction with migratory bird populations. Given the seasonal nature of the sensitivity, where relevant it is more appropriate to consider this in project level assessment (e.g. EIA and HRA where necessary), when the location and timing of activities are known.

4.3 Underwater noise effects[26]

The current level of understanding of sources, measurement, propagation, ecological effects and potential mitigation of underwater noise associated with hydrocarbon exploration and production have been extensively reviewed, assessed and updated in each of the successive offshore energy SEAs (see DECC 2009, 2011, 2016, BEIS 2022). The following description of noise sources and potential effects builds on these previous publications, augmented with more recent literature sources.

4.3.1 Noise sources and propagation

For all sources of anthropogenic underwater noise, there is now a reasonable body of evidence to quantify sound levels associated with these activities and to understand the likely

[26] Note that all underwater noise effects fall within the “underwater noise change” and “vibration” pressure definitions.

propagation of these sounds within the marine environment, even in more complex coastal locations (DECC 2016, BEIS 2022).

Of those activities that generate underwater sound, deep geological seismic survey (2D and 3D) is of primary concern due to the high amplitude, low frequency and impulsive nature of the sound generated over a relatively wide area – note that none of the Block work programmes propose shooting new seismic survey, and the information on seismic survey is provided here as context to those other sources which may be used for other surveys, such as rig site survey. Typical 2D and 3D seismic surveys consist of a vessel towing a large airgun array, made up of sub-arrays or single strings of multiple airguns, along with towed hydrophone streamers. Total energy source volumes vary between surveys, most commonly between 1,000 and 8,000 cubic inches, with typical broadband source levels of 248-259 dB re 1µPa (OGP 2011). Most of the energy produced by airguns is low frequency: below 200Hz and typically peaking around 100Hz; source levels at higher frequencies are low relative to that at the peak frequency but are still loud in absolute terms and relative to background levels.

In addition to seismic surveys, relevant sources of impulsive sound are restricted to the smaller volume air-guns and some sub-bottom profilers (SBPs) used in site surveys and well evaluation (i.e. Vertical Seismic Profiling, VSP), and also from occasional pile-driving of conductors during drilling (see Table 2.2). Compared to deep geological survey, these smaller volume seismic sources tend to generate sound of lower amplitude, are typically complete within several hours on a single day, are conducted from either a fixed point (VSP) or cover a small area (site surveys). Consequently, the overall magnitude and area of risk from sound effects is considerably smaller than in the case of deep geological seismic surveys.

Electromechanical sources such as ‘pinger’ or ‘chirper’ SBPs, side-scan sonar and multi-beam echosounders (MBES) have narrower beam widths and dominant frequencies much higher than those of air guns[27] such that, even at high amplitudes, the generated sound would be expected to rapidly attenuate and likely not propagate far enough for marine species to be negatively affected by received sound levels. For example, the absorption coefficient alone in seawater is approximately -36dB/km at 100kHz, rising to -61dB at 200kHz (Lurton 2016). SBPs of the ‘boomer’ and ‘sparker’ type do generate a true broadband seismic pulse of low frequency, although the peak pressures produced by these small devices are considerably lower than those generated by airguns. Ruppel *et al.* (2022) considered most high-resolution geophysical (HRG) sources, with the exception of seismic sources (e.g. boomers, sparkers), to be intermittent and non-impulsive (although see Hartley Anderson Limited 2020 for commentary on lack of clear definition of impulsiveness). Two studies commissioned by the US Bureau of Ocean Energy Management investigated sound generated by equipment commonly used in high-resolution geophysical surveys, including electromagnetic sources. Calibrated source levels were measured under controlled conditions in a test tank (Crocker & Fratantonio 2016); acoustic characteristics of several example equipment types tested are provided in Table 4.1.

[27] It should be noted that airgun (including VSP) and sub-bottom profiling site surveys undertaken in relation to licences issued under the *Petroleum Act 1998* require consent under the *Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001* (as amended), but side-scan sonar and multibeam echosounder surveys only require to be notified to the Regulator (JNCC 2017).

Table 4.1: Measured acoustic characteristics for example sources used in high-resolution geophysical surveys

Source tested	Category; signal type	Source levels at maximum power tested (dB re 1µPa@1m)[1]		Approximate frequency of dominant energy (kHz)	-3dB beam width (degrees); across track
		SPLpeak-peak	SEL		
Delta Sparker	SBP 'sparker'; impulse	206-225	163-185	< 1	n/a
Applied Acoustics 251	SBP 'boomer' (single plate); impulse	208-216	166-174	< 4	49-76
EdgeTech 512i	SBP 'chirper'; chirp	176-191	145-160	3-5	51-80
Reson Seabat 7111	MBES; tone burst	197-233	152-197	100	~160
EdgeTech 4200	Side-scan sonar; tone burst	206-216	165-205	100 or 400	~50 (1.6-2.6 along track)

Notes: 1. Values represent minimum and maximum according to different source configurations (e.g. power level, pulse width or centre frequency); maximum values typically correspond to the highest power level tested. SBP = sub-bottom profiler; MBES = multibeam echosounder. Source: Crocker & Fratantonio (2016).

The test tank experiments were followed by measurements in shallow (≤ 100m depth) open-water environments to investigate sound propagation (Halvorsen & Heaney 2018). Problems were encountered during the open-water testing resulting in a lack of calibration in the reported sound source levels (Labak 2019). The accompanying advice note (Labak 2019) emphasises that these uncalibrated data should not be used to provide source level measurements, and consequently the reported isopleths (summarising sound propagation) should not replace project-specific sound source verifications.

Despite the caveats on the current open-water test results, it is worth noting some general patterns observed. In all test environments, broadband received levels from all MBES, side-scan sonar and SBP 'chirper' or 'boomer' devices tested were rapidly attenuated with distance from source, with particularly pronounced fall-off for directional sources when the receiver was outside of the source's main beam. Acoustic signals from the SBP 'sparkers' tested showed slightly greater propagation, as would be expected from the lower-frequency impulsive signals these devices produce. The greatest propagation was generally observed at the deepest test site (100m water depth) from sources generating low frequencies (<10kHz) whilst some of the highest frequency sources (>50kHz) experienced such attenuation that they were only weakly detectable or undetected by recording equipment. These preliminary results, combined with the calibrated source measurements in test tanks, suggest that SBPs and other electromechanical sources used in high-resolution geophysical surveys have a very low potential for significant disturbance of sensitive marine fauna. Similarly, Ruppel *et al.* (2022) classified most high resolution geophysical sources (e.g. MBES, SSS, hull-mounted SBP, towed SBP and parametric SBP) in Tier 4, considered unlikely to result in incidental take[28] of marine mammals and therefore termed *de minimis*. Some sparker and boomer systems were considered Tier 3, with characteristics that did not meet the *de minimis* category (e.g. some sparkers) or could not be fully evaluated due to lack of information (e.g. some boomers). In an

[28] "Take" as defined under the US Marine Mammal Protection Act 1972 means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal". An incidental take is an unintentional, but not unexpected, taking. Harassment is statutorily defined as, any act of pursuit, torment, or annoyance which has the potential to injure (Level A harassment) or disturb (Level B harassment) a marine mammal or marine mammal stock in the wild. Source: https://www.fisheries.noaa.gov/laws-and-policies/glossary-marine-mammal-protection-act#take-and-incidental-take-under-the-marine-mammal-protection-act

experiment undertaken at the Energy Island lease area in Danish waters, at water depths of ~35m, Pace *et al.* (2022) recorded a peak frequency of a sparker of between 0.2 and 0.8kHz and source levels (SEL) of up to 156.8dB re 1μPa^{2}s, for a station set at 0m from the source. At 100m, 750 and 2km, the source levels reduced to up to 144.1, 136.6 and 123.3dB re 1μPa^2.

Drilling operations and support vessel traffic are sources of continuous noise (non-impulsive), of a comparable amplitude, dominated by low frequencies and of a lower amplitude than deep geological seismic survey. Sound pressure levels of between 120dB re 1μPa in the frequency range 2-1,400Hz (Todd & White 2012) are probably typical of drilling from a jack-up rig, with slightly higher source levels likely from semi-submersible rigs due to greater rig surface area contact with the water column. In general, support and supply vessels (50-100m) are expected to have broadband source levels in the range 165-180dB re 1μPa@1m, with the majority of energy below 1kHz (OSPAR 2009). The use of thrusters for dynamic positioning has been reported to result in increased sound generation (>10dB) when compared to the same vessel in transit (Rutenko & Ushchipovskii 2015).

Encounters with unexploded ordnance (UXO) from past military conflicts or training are possible almost anywhere across the UKCS, however, they are most frequent in the southern North Sea and eastern Irish Sea. UXO are generally less frequently encountered during exploration activities, and if they are, there is considerable scope to avoid interaction with any suspected device and avoid the need for disposal. To date, clearance of UXO has generally been undertaken by high-order detonation using a charge to destroy the device, but this is a source of loud underwater noise with the potential to generate significant effects for noise sensitive receptors. Alternative “low-order” approaches (e.g. deflagration) which render the UXO safe but without causing it to explode are available, and their use is being encouraged (e.g. see BEIS 2022 and the unexploded ordnance clearance joint interim position statement[29]).

4.3.2 Potential ecological effects

Potential effects of anthropogenic noise on receptor organisms range widely, from masking of biological communication and small behavioural reactions, to chronic disturbance, physiological injury and mortality. While generally the severity of effects tends to increase with increasing exposure to noise, it is important to draw a distinction between effects from physical (including auditory) injury and those from behavioural disturbance. In addition to direct effects, indirect effects may also occur, for example via effects on prey species, complicating the overall assessment of significant effects. Marine mammals, and in particular the harbour porpoise, are regarded as the most sensitive to underwater noise, however, high amplitude impulsive noise also potentially presents a risk to fish and diving birds. No site with marine mammal features has been screened in for assessment and the following text therefore covers fish and diving birds.

Fish

Many species of fish are highly sensitive to sound and vibration and broadly applicable sound exposure criteria have recently been published (Popper *et al.* 2014). Studies investigating fish mortality and organ damage from noise generated during seismic surveys are very limited and results are highly variable, from no effect to long-term auditory damage (reviewed in Popper *et al.* 2014). Slabbekoorn *et al*. (2019) note that there are few good case-studies in the peer-reviewed literature that report on the impact of a seismic survey on the behavioural response

[29] https://www.gov.uk/government/publications/marine-environment-unexploded-ordnance-clearance-joint-interim-position-statement/marine-environment-unexploded-ordnance-clearance-joint-interim-position-statement

of free-ranging fish or the direct impact on local fisheries. Behavioural responses and effects on fishing success ("catchability") have been reported following seismic surveys (Pearson *et al.* 1992, Skalski *et al.* 1992, Engås *et al.* 1996, Wardle *et al*. 2001, Bruce *et al.* 2018). Potential effects on migratory diadromous fish is an area of significant interest for which empirical evidence is still limited, especially as salmonids and eels are sensitive to particle motion (not sound pressure) (Gill & Bartlett 2010). Atlantic salmon *Salmo salar* have been shown through physiological studies to respond to low frequency sounds (below 380Hz), with best hearing at 160Hz (threshold 95 dB re 1 μPa). Harding *et al.* (2016) note a lower sensitivity at 100Hz than previously reported (Hawkins & Johnstone 1978), and greater sensitivity at frequencies of >200Hz, with evidence of some response at 400-800Hz. However, the authors qualify their results with differences in methodological approach, and the use of fish maintained in tanks receiving low frequency ambient sound within the greatest range of sensitivity (<300Hz) for some time in advance of the experiments taking place. The ability of salmon to respond to sound pressure is regarded as relatively poor with a narrow frequency span, a limited ability to discriminate between sounds, and a low overall sensitivity relative to other fish species (Hawkins & Johnstone 1978, cited by Gill & Bartlett 2010, Harding *et al.* 2016). The Mickle *et al*. (2018) study of the hearing ability of sea lamprey (*Petromyzon marinus*) reported that, consistent with fish lacking a swim bladder, sea lamprey showed a limited sensitivity to sound, with juveniles detecting tones of 50-300Hz, but not higher frequencies.

In addition to considering direct effects on fish as qualifying features of national network sites, fish also form important prey items of seabird, marine mammal and fish qualifying features. Fish species of known importance to both diving seabirds and marine mammals in the North Sea include sandeels, pelagic species such as herring and sprat, and young gadoids. Sandeels lack a swim bladder, which is considered to be responsible for their observed low sensitivity to underwater noise (Suga *et al*. 2005) and minor, short-term responses to exposure to seismic survey noise (Hassel *et al*. 2004), although data are limited. By contrast, herring are considered hearing specialists, detecting a broader frequency range than many species. Sprat are assumed to have similar sensitivities to herring due to their comparable morphology, although studies on this species are lacking. Observed responses of herring to underwater noise vary. For example, Peña *et al*. (2013) did not observe any changes in swimming speed, direction, or school size as a 3D seismic vessel slowly approached schools of feeding herring from a distance of 27km to 2km; conversely, Slotte *et al*. (2004) observed herring and other mesopelagic fish to be distributed at greater depth during periods of seismic shooting than non-shooting, and a reduced density within the survey area. Evidence for and against avoidance of approaching vessels by herring exists (e.g. Skaret *et al*. 2005, Vabø *et al*. 2002), with the nature of responses believed to be related to the activity of the school at the time. The effect of a seismic survey on the movement behaviour of free-swimming cod in the southern North Sea was investigated by van der Knapp *et al*. (2021). During the experimental survey, tagged cod decreased their activity, with time spent being ‘‘locally active’’ (moving small distances, showing high body acceleration) becoming shorter, and time spent being ‘‘inactive’’ (moving small distances, having low body acceleration) becoming longer. Additionally, diurnal activity cycles were disrupted with lower locally active peaks at dusk and dawn, periods when cod are known to actively feed.

Following a review of relevant studies, MMS (2004) consider that the "consensus is that seismic airgun shooting can result in reduced trawl and longline catch of several species when the animals receive levels as low as 160dB". These reduced catches are temporary in nature and likely reflect temporary displacement and/or altered feeding behaviour. No associations of lower-intensity, continuous drilling noise and fishing success have been demonstrated, and large numbers of fish are typically observed around producing installations in the North Sea (e.g. Løkkeborg *et al*. 2002, Fujii 2015) and elsewhere (e.g. Stanley & Wilson 1991).

Diving birds

Direct effects from seismic exploration noise on diving birds could potentially occur through physical damage, or through disturbance of normal behaviour, although evidence for such effects is very limited. Unlike other receptor groups, no dedicated reviews on the effects of noise on diving birds have been undertaken; distillations of available evidence can be found in Hartley Anderson Limited (2020), U.S. Department of the Navy (2020) and the DOSITS website[30]. The exposure of shallow plunge-diving or surface-dipping aquatic birds to underwater noise is likely to be negligible due to the very short period of time they spend underwater (U.S. Department of the Navy 2020). Deeper-diving species which spend longer periods of time underwater (e.g. auks) may be most at risk of exposure to high-intensity noise from seismic survey and consequent injury or disturbance, but all species which routinely submerge in pursuit of prey and benthic feeding opportunities (i.e. excluding shallow plunge feeders) may be exposed to anthropogenic noise. A full list of relevant species occurring in the UK is provided in Box 4.1.

Very high amplitude low frequency underwater noise may result in acute trauma to diving seabirds, with several studies reporting mortality of diving birds in close proximity (i.e. tens of metres) to underwater explosions (Yelverton *et al*. 1973, Cooper 1982, Stemp 1985, Danil & St Leger 2011). However, mortality of seabirds has not been observed during extensive seismic operations in the North Sea and elsewhere. While seabird responses to approaching vessels are highly variable, flushing disturbance would be expected to displace most diving seabirds from close proximity to seismic airgun arrays, particularly among species more sensitive to visual disturbance such as scoter, divers and great cormorant (Garthe & Hüppop 2004, Fliessbach *et al*. 2019). Therefore, the potential for acute trauma to diving birds from seismic survey is considered to be very low.

Data relating to the potential behavioural disturbance of diving birds due to underwater noise are very limited. The reported in-air hearing sensitivity for a range of diving duck species, red-throated diver and northern gannet have been tested for tone bursts between frequencies of 0.5-5.7kHz; results revealed a common region of greatest sensitivity from 1-3kHz, with a sharp reduction in sensitivity >4kHz (Crowell e*t al.* 2015). Similar results were observed for African penguin; tests of in-air hearing showed a region of best sensitivity of 0.6-4kHz, consistent with the vocalisations of this species (Wever *et al*. 1969). Testing on the long-tailed duck underwater showed reliable responses to high intensity stimuli (> 117 dB re 1µPa) from 0.5-2.9kHz (Crowell 2014). An underwater hearing threshold for great cormorant of 70-75 dB re 1µPa rms for tones at tested frequencies of 1-4kHz has been suggested (Hansen *et al*. 2017). The authors argue that this underwater hearing sensitivity, which is broadly comparable to that of seals and small odontocetes at 1-4kHz, is suggestive of the use of auditory cues for foraging and/or orientation and that great cormorant, and possibly other species which perform long dives, are sensitive to underwater sound. The use of acoustic pingers mounted on the corkline of a gillnet in a salmon fishery, emitting regular impulses of sound at *ca.* 2kHz, was associated with a significant reduction in entanglements of guillemot, but not rhinoceros auklet (Melvin *et al*. 1999). In a playback experiment on wild African penguins, birds showed strong avoidance behaviour (interpreted as an antipredator response) when exposed to killer whale vocalisations and sweep frequency pulses, both focussed between 0.5-3kHz (Frost *et al*. 1975).

McCauley (1994) inferred from vocalisation ranges that the threshold of perception for low frequency seismic noise in some species (e.g. penguins, considered as a possible proxy for auk species) would be high, hence individuals might be adversely affected only in close

[30] https://dosits.org/animals/sound-reception/how-do-aquatic-birds-hear/

proximity to the source. An investigation of seabird abundance in Hudson Strait (Atlantic seaboard of Canada) during seismic surveys over three years (Stemp 1985); comparing periods of shooting and non-shooting, no significant difference was observed in abundance of northern fulmar, black-legged kittiwake and thick-billed murre (Brünnich's guillemot). Pichegru *et al*. (2017) used telemetry data from breeding African penguins to document a shift in foraging distribution concurrent with a 2D seismic survey off South Africa. Pre/post shooting, areas of highest use (indicated by the 50% kernel density distribution) bordered the closest boundary of the survey; during shooting, their distribution shifted away from the survey area, with areas of higher use at least 15km from the closest survey line. However, insufficient information was provided on the spatio-temporal distribution of seismic shooting or penguin distribution to determine an accurate displacement distance. It was reported that penguins quickly reverted to normal foraging behaviour after cessation of seismic activities, suggesting a relatively short-term influence on these birds' behaviour and/or that of their prey (Pichegru *et al*. 2017).

The data are limited, but the observed regions of greatest hearing sensitivity for great cormorants in water and other diving birds in air are above those low frequencies (i.e. <500Hz) which dominate and propagate most widely from geological survey. There is some evidence of noise-induced changes in the distribution and behaviour of diving birds in response to impulsive underwater noise, but these were temporary and may be a direct disturbance or reflect a change in prey distribution (possibly as a result of seismic activities).

Box 4.1: Migratory and/or Annex I diving bird species occurring in the UK considered potentially vulnerable to underwater noise effects

Divers and grebes	**Diving ducks**
Great northern diver *Gavia immer*	Pochard *Aythya ferina*
Red-throated diver *Gavia stellata*	Tufted duck *Aythya fuligula*
Black-throated diver *Gavia arctica*	Scaup *Aythya marila*
Little grebe *Tachybaptus ruficollis*	Eider *Somateria mollissima*
Great crested grebe *Podiceps cristatus*	Long-tailed duck *Clangula hyemalis*
Slavonian grebe *Podiceps auritus*	Common scoter *Melanitta nigra*
Seabirds	Velvet scoter *Melanitta fusca*
Manx shearwater *Puffinus puffinus*	Goldeneye *Bucephala clangula*
Northern gannet *Morus bassanus*	Red-breasted merganser *Mergus serrator*
Great cormorant *Phalacrocorax carbo carbo*	Goosander *Mergus merganser*
European shag *Phalacrocorax aristotelis*	
Guillemot *Uria aalge*	
Razorbill *Alca torda*	
Atlantic puffin *Fratercula arctica*	

Note: Includes species which are known to engage in pursuit diving or benthic feeding in marine, coastal and estuarine waters at least during part of the year.

5 Assessment

The screening process (DESNZ 2023) identified a number of sites where there was the potential for likely significant underwater noise, physical disturbance and/or drilling effects associated with proposed activities that could follow licensing of Blocks offered in the 33rd Round. Three of these Blocks have been applied for (see Section 1.2) and the further assessment of licensing of these Blocks on relevant sites is given below. This assessment has been informed by the evidence base on the environmental effects of oil and gas activities (Sections 4.2 and 4.3), and the assumed nature and scale of potential activities (Table 2.2).

5.1 Relevant sites

A description of each of the relevant sites is provided below based on the site citation and site selection information, which has been augmented by additional information from grey and primary sources relevant to site qualifying features. The assessment of these sites in relation to the 33rd Round west of Shetland and central North Sea Blocks is documented in Sections 5.2-5.4.

Foula SPA and Seas off Foula SPA

The island of Foula provides habitat for more than 190,000 seabirds; the land mass and immediately surrounding waters have been protected as the Foula SPA[31] since 1995, with the Seas off Foula SPA extending this protection to cover 3,412km^2 of waters surrounding the island. These waters provide foraging habitat for several species of seabird in both breeding and non-breeding seasons. Analyses of European Seabirds at Sea (ESAS)[32] data found that some 1,500 great skuas regularly use Seas off Foula during the breeding season, corresponding to approximately 4% of the estimated biogeographic population and satisfying criteria for designation as a SPA (JNCC 2016). Analyses of movement data from great skua (n=12) tagged at Foula (Thaxter *et al*. 2011, Wade *et al*. 2013) provided further evidence of the importance of this area to foraging birds during the breeding season. ESAS data also indicated a qualifying seabird assemblage during the breeding season (listed species include northern fulmar, Arctic skua, guillemot and Atlantic puffin) and non-breeding season (listed species include great skua, northern fulmar, guillemot). All species are distributed throughout the entire extent of the site, albeit in variable densities (JNCC 2016). While the highest predicted densities of great skua (1.1 bird per km^2) are closer to the island of Foula, densities of 0.25-0.5 birds per km^2 are predicted at the edges of the site. Atlantic puffin predicted densities are lowest in the northwest of the site and increase to the southeast, with the highest densities just south of Foula. Guillemot densities are lowest in the north of the site and its southeast extent; highest values occur predominately southwest of Foula. Densities of northern fulmar are low across most of the site, with higher values in the west and southeast, while the highest densities of Arctic skua are towards Shetland and an area 20km northeast of Foula.

Counts of breeding pairs of great skua at Foula between 1986 and 2000 remained between *ca*. 2,100-2,500, with lower numbers of 1,657 and 1,846 breeding pairs reported in 2007 and 2015 respectively; no more recent counts are available[33]. Numbers of great skua amongst three

[31] http://jncc.defra.gov.uk/pdf/SPA/UK9002061.pdf
[32] http://www.seabirds.net/esas.html
[33] https://app.bto.org/seabirds/

colonies (Hermaness, Noss and Fair Isle) have shown a decrease of 49% since 2007, which was the last common year all were surveyed. Numbers on Fair Isle have steadily increased from 1986, but there has been considerable variation within this trend. The data for sites across Scotland illustrate a complicated picture with no clear trend (JNCC website[34]). With the exception of red-throated diver (*favourable maintained*, assessed in 2013), all of the other seabird species listed for the Foula SPA (Arctic tern, Leach's storm petrel, guillemot, Atlantic puffin and European shag) were assessed as *unfavourable declining* (majority assessed 2015/2016 with Leach's storm petrel assessed 2001), as was the breeding seabird assemblage (which also included northern fulmar, black-legged kittiwake, razorbill, Arctic skua and Arctic tern).

The medium and shallow parts of the site, which are generally close to Foula and to the north and east of the island, are within a depth range which is favoured by sandeel (30-80m, Wright *et al*. 2000). Different studies suggest that the site fully (Ellis *et al.* 2012), or at least in its southern extent (Coull *et al*. 1998), overlaps with low intensity sandeel spawning and nursery grounds; sandeels form an important part of the diet of great skua (Furness & Hislop 1981, Votier *et al*. 2007). Due to the reliance of many of the qualifying seabird species on locally available sandeels, the maintenance of both sandeel habitat and associated populations is important to ensure the ability of the site to support the qualifying species in the long term[35]. Additionally, the Shetland-Orkney thermal front overlaps with the site, suggesting that this feature might create relatively predictable foraging habitat for seabirds and other marine predators (Begg & Reid 1997) and be an important driver of the regular aggregations of seabirds in the area.

This site was screened into the AA process as it contains guillemot, great skua and Atlantic puffin, and the named assemblage features Arctic skua and northern fulmar, which are also relevant to the Seas off Foula SPA. The AA will therefore only consider the potential for adverse effects on these qualifying interests.

Braemar Pockmarks SAC

The Braemar pockmarks are a series of crater-like depressions on the sea floor at a depth of ~120m and are believed to be formed by the venting of biogenic/petrogenic fluids or gases into the water column. The site contains 48 pockmarks ranging in size from 20m to 200m diameter and 0.32-5.77m in depth, which are irregular in shape due to multiple venting points or sidewall slumping. Six contain verified records of the Annex I habitat, *Submarine structures made by leaking gases*, with a further 14 showing strong acoustic reflectance which is indicative of the habitat type (Gafeira & Long 2015, JNCC 2017b). Large blocks, pavement slabs and smaller fragments of methane derived authigenic carbonate (MDAC) (a type of the Annex I habitat, submarine structures made by leaking gases) have formed through precipitation during the oxidation of methane gas. These MDAC and carbonate structures are ecologically significant because they provide a habitat for marine fauna usually associated with rocky reef, and chemosynthetic organisms which feed off both methane (seeping from beneath the sea floor) and its microbial degradation by-product under anaerobic conditions, hydrogen sulphide. Larger blocks of carbonate also provide shelter for fish species such as wolf-fish and cod[36]. There is evidence of demersal fishing effort within the SAC by UK and non-UK registered vessels, and progress is ongoing in developing management options for the site. The features for which the site has been designated are presently regarded to be in unfavourable condition

[34] https://jncc.gov.uk/our-work/great-skua-stercorarius-skua/
[35] https://www.nature.scot/sites/default/files/2017-12/Marine%20Protected%20Area%20%28Proposed%29%20-%20Conservation%20Objectives%20and%20Advice%20-%20Seas%20off%20Foula.pdf
[36] https://jncc.gov.uk/our-work/braemar-pockmarks-mpa/

due to the influence of demersal trawling (JNCC 2020), and it is further noted that it may not be feasible to restore some of the feature's attributes.

5.2 Assessment of physical disturbance and drilling effects

The conservation objectives of relevant sites that could be impacted by physical disturbance and drilling effects, and information relating to site selection and advice on operations have been considered against the activities in the proposed work programmes for the licence areas applied for to determine whether they could adversely affect site integrity. The results are given in Table 5.1 below. All mandatory control requirements (as given in Section 2.3.1), are assumed to be in place as a standard for all activities assessed.

Figure 5.1: Sites and areas to be subject to further assessment for physical disturbance and drilling effects in the West of Shetland and Central North Sea

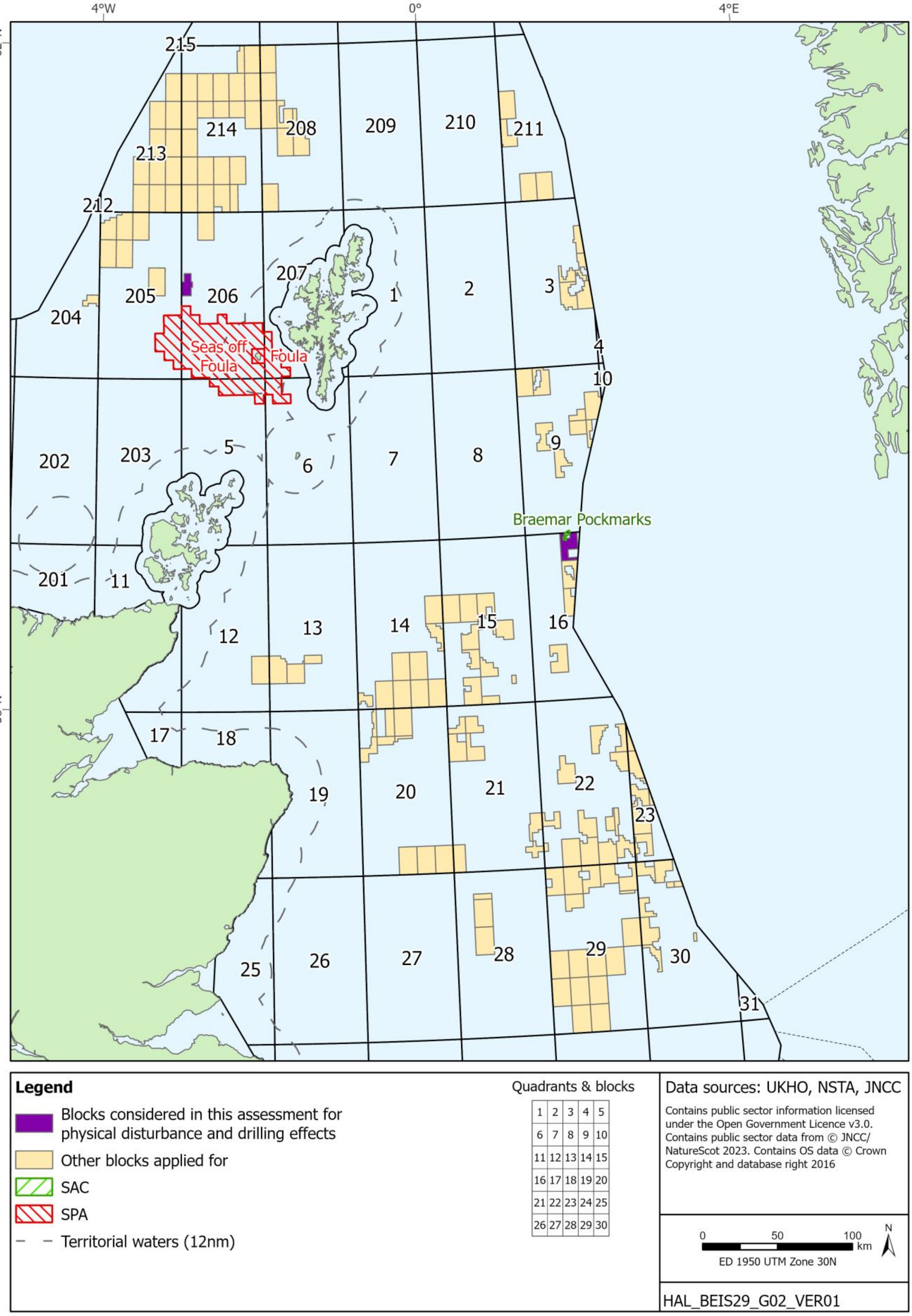


Table 5.1: Consideration of potential physical disturbance and drilling effects and relevant site conservation objectives

Seas off Foula SPA[37]
Site Information
Area (ha/km^2): 341,215/3,412 **Relevant qualifying features:** Arctic skua, northern fulmar, great skua, guillemot, Atlantic puffin, breeding/non-breeding seabird assemblage **Conservation objectives[38]:** To ensure that the qualifying features of Foula SPA and the Seas off Foula SPA are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status. To ensure that the integrity of Foula SPA and the Seas off Foula SPA is restored in the context of environmental changes by meeting the following objectives for each qualifying feature: • The populations of the qualifying features are viable components of Foula SPA and Seas off Foula SPA • The distributions of the qualifying features throughout Foula SPA and Seas off Foula SPA are maintained by avoiding significant disturbance of the species • The supporting habitats and processes relevant to qualifying features and their prey/food resources are maintained, or where appropriate restored, at Foula SPA and Seas off Foula SPA
Relevant Blocks with potential for physical disturbance and drilling effects
206/11d
Activities associated with the proposed work programmes within the relevant licence areas
Drilling up to 1 well involving - siting of rig, drilling discharges
Assessment of effects on site integrity
Rig siting ***Relevant pressures:*** *penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion and abrasion/disturbance of the substrate on the surface of the seabed* Block 206/11d is located 6.9km from the site boundary and given the assumed distance from a semi-submersible rig within which effects may occur (1.5-1.8km, see Table 2.2), rig installation will not cause significant deterioration of the habitats and food resources of the qualifying species. Whilst the assumed area within which effects may occur is quite large (1.5-2.5km^2, given 1.5-1.8km radius), the actual seabed footprint of physical damage associated with semi-submersible rig anchoring is relatively small (*ca*. 0.1km^2, see Table 2.2). Recovery from physical disturbance of the scale associated with rig anchoring is expected to be relatively rapid given the moderate to high energy seabed environment. The small scale and temporary nature of the potential physical disturbance, and its distance from the site, are such that it will not have a significant effect on the extent and quality of the supporting habitats[39] and there will be no adverse effect on site integrity. **Drilling discharges** ***Relevant pressures:*** *abrasion/disturbance of the substrate on the surface of the seabed; changes in suspended solids (water clarity); smothering and siltation rate changes (light); physical change (to another sediment type); habitat structure changes – removal of substratum (extraction), contamination* It is assumed that effects relating to drilling discharges occur within 500m of the well location (Table 2.2). Therefore, drilling discharges related to Block 206/11d will not cause significant deterioration of the habitats and food resources of the qualifying species due to their distance from the site boundary (6.9km). The small scale and temporary nature of the activities, the mandatory mitigation requirements with respect to drilling chemical use and discharge (Section 2.3.1), and the distance between the site and the Block, will ensure that the extent and quality of the supporting habitats are not impacted and therefore there will be no adverse effect on site integrity.

[37] https://jncc.gov.uk/our-work/seas-off-foula-spa/, https://sitelink.nature.scot/site/10489
[38] https://sitelink.nature.scot/site/10489
[39] https://data.jncc.gov.uk/data/a4ddbc00-500a-4c4b-9250-ed180356db00/seas-off-foula-sas-conservation-objectives-reg-18.pdf

Other effects
Relevant pressures: *visual disturbance, above water noise*

Of the qualifying features, guillemot and Atlantic puffin are moderately sensitive to disturbance by ship and helicopter traffic with the other features of the site being of lower sensitivity (Garthe & Hüppop 2004, Furness *et al*. 2013, Fliessbach *et al.* 2019). Block 206/11d is currently exposed to very low shipping densities (see Figure 5.7), and is located 6.9km from the site. The temporary and localised nature of drilling activities and limited number of associated supply vessel and helicopter trips (see Table 2.2) are not likely to impact the Seas off Foula SPA qualifying features' distribution and use of the site such that their ability to survive and/or breed is compromised in the longer term. However, further control measures are available (Section 5.2.1) and will be required, where appropriate, to ensure that the site conservation objectives are not undermined and there is no adverse effect on site integrity.

In-combination effects
No intra-plan in-combination effects are likely given that 206/11d is the only Block applied for that is of relevance to the site, and is not within the site boundaries. Section 5.4 provides a consideration of potential activities in-combination with other relevant plans and projects.

Foula SPA[40]

Site Information

Area (ha/km^2): 7,985.49/79.86
Relevant qualifying features: Arctic skua, northern fulmar, great skua, guillemot, Atlantic puffin, breeding seabird assemblage

Conservation objectives:
To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
To ensure for the qualifying species that the following are maintained in the long term:

- Population of the species as a viable component of the site
- Distribution of the species within site
- Distribution and extent of habitats supporting the species
- Structure, function and supporting processes of habitats supporting the species
- No significant disturbance of the species

Relevant Blocks with potential for physical disturbance and drilling effects

206/11d

Activities associated with the proposed work programmes within the relevant licence areas

Drilling up to 1 well involving - siting of rig, drilling discharges

Assessment of effects on site integrity

Block 206/11d is *ca*. 54km from the site boundary. The site and Block were screened in for appropriate assessment due to the site's functional link with the Seas off Foula SPA, which surrounds the site and provides foraging grounds for the SPA's qualifying features. The assessment of effects for the Foula SPA and relevant Blocks is therefore covered by that undertaken for the Seas off Foula SPA (above). There will be no adverse effects on site integrity from the licensing of Block 206/11d alone, and intra plan in-combination effects are not likely as only one Block is relevant to the assessment. Section 5.4 provides a consideration of potential activities in-combination with other relevant plans and projects.

Braemar Pockmarks SAC[41]

Site Information

Area (ha/km^2): 1,143/11.43
Relevant qualifying features: Submarine structures made by leaking gases

Conservation objectives:
For the feature to be in favourable condition thus ensuring site integrity in the long term and contribution to Favourable Conservation Status of Annex I Submarine structures made by leaking gases. This contribution would be achieved by maintaining or restoring, subject to natural change:

- The extent and distribution of the qualifying habitat in the site;

[40] https://sitelink.nature.scot/site/8504
[41] https://jncc.gov.uk/our-work/braemar-pockmarks-mpa/

• The structure and function of the qualifying habitat in the site; and • The supporting processes on which the qualifying habitat relies. Attributes and related targets have been set for the site features which are presented in the site SACO[42].
Relevant Blocks with potential for physical disturbance and drilling effects
16/3d
Activities associated with the proposed work programmes within the relevant licence areas
Drilling up to 1 well involving - siting of rig, drilling discharges
Assessment of effects on site integrity
Rig siting ***Relevant pressures:*** *penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion; abrasion/disturbance of the substrate on the surface of the seabed, physical change (to another seabed type) and introduction or spread of non-indigenous species* Whilst not assessed in the advice on operations, the qualifying feature is likely to be sensitive to penetration and/or disturbance of the seabed surface and subsurface (e.g. through anchoring)[43]. Faint channels close to an abandoned wellhead have been interpreted as probably being from anchor mooring cables (Rance *et al.* 2017), and JNCC (2017b) consider such activities have the potential to impact the site. Much of Block 16/3d is outside the site boundaries and rig siting in this area would avoid interaction with the site, subject to it being greater than the assumed potential distance from a semi-submersible rig within which effects could take place (1.5-1.8km). If located within the site, anchoring and well placement could affect the extent and distribution, and structure and function of the qualifying habitat, and there is also the potential to affect the supply of shallow gas to the pockmarks (see Section 5.1). The likelihood and scale of impact will depend on the proposed location of drilling activities and further mitigation measures are available (see Section 5.2.1) and will be required, where appropriate, to ensure site conservation objectives are not undermined and there is no adverse effect on site integrity. This includes the re-siting of activities (e.g. wellhead or rig leg/anchor positions) to ensure sensitive seabed surface features are avoided, and further mitigation may be required to ensure that the supply of shallow gas to the pockmarks is not interrupted (see Section 5.2.1). **Drilling discharges** ***Relevant pressures:*** *abrasion/disturbance of the substrate on the surface of the seabed, changes in suspended solids (water clarity); smothering and siltation rate changes (light); physical change (to another sediment type), habitat structure changes – removal of substratum (extraction) and contaminants* Whilst not assessed in the advice on operations, the qualifying feature is likely to be sensitive to the abrasion/disturbance of the seabed surface, smothering and siltation rate changes and habitat structure changes associated with the discharge of cuttings. As the feature lies in a low energy environment, drill cuttings may not be removed by currents and the feature's associated biological community is unlikely to be accustomed to changing sediment levels[44]. For the assessment, it is assumed that effects associated with drilling discharges may occur within 500m of the well location (Table 2.2). Block 16/3d partly overlaps the site and smothering from drill cuttings could impact the extent and distribution, and structure and function of the qualifying habitat. The likelihood and scale of impact will depend on the proposed location of drilling activities and further mitigation measures are available (see Section 5.2.1) and will be required, where appropriate and in addition to mandatory requirements with respect to drilling chemical use and discharge (Section 2.3.1), to ensure site conservation objectives are not undermined and there is no adverse effect on site integrity. **Other effects** N/A **In-combination effects** No intra-plan in-combination effects are likely given that 16/3d is the only Block applied for that is of relevance to the site, and is not within the site boundaries. Section 5.4 provides a consideration of potential activities in-combination with other relevant plans and projects.

[42] https://hub.jncc.gov.uk/assets/a64415df-0ef0-4a45-84d1-2ed548f70557#BraemarPockmarks-3-SACO-V1.0.pdf
[43] https://hub.jncc.gov.uk/assets/a64415df-0ef0-4a45-84d1-2ed548f70557#BraemarPockmarks-5-AdviceOnOperations-V1.0.xlsx
[44] http://nsrac.org/wp-content/uploads/2013/07/Paper-8.3-Braemar-Pockmarks-Site.pdf

5.2.1 Further physical disturbance and drilling mitigation measures

Further mitigation measures are available which are identified through the EIA process and operator's environmental management system and the Departmental permitting processes. These considerations are informed by project specific plans and the nature of the sensitivities identified from detailed seabed information collected in advance of field activities taking place. Site surveys are required to be undertaken before drilling rig placement (for safety and environmental reasons) and the results of such surveys (survey reports) allow for the identification of further mitigation including the re-siting of activities (e.g. wellhead or rig leg/anchor positions) and to ensure sensitive seabed surface features (such as reefs) are avoided. Survey reports are used to underpin operator environmental submissions (e.g. EIAs) and where requested, survey reports are made available to nature conservation bodies during the consultation phases of these assessments.

For those Blocks where proposed activities could result in the physical disturbance of sensitive qualifying features by vessels and aircraft traffic, available mitigation measures include, as far as possible, strict use of existing shipping and aircraft routes, and timing controls on temporary activities to avoid sensitive periods. Operators must demonstrate awareness of relevant seasonal sensitivities and that these have been taken into account in the planning of their operations to avoid highly sensitive periods (see BEIS 2021). In areas of high sensitivity, the Department expect operators to liaise with relevant SNCBs on the timing of their intended activities to minimise or avoid effects on seasonally sensitive qualifying interests.

If the scale and location of the proposed drilling discharges could lead to significant smothering effects on sensitive features of the Braemar Pockmarks SAC, the Department will expect the application of additional mitigation such as discharge near the seabed rather than near sea surface, zero discharge, or relocation of the cuttings discharge point further away from the site, where appropriate.

Holmes & Stoker (2005) investigated the origin of shallow gas in Blocks 15/20c and 15/25d, the latter containing the Scanner Pockmark, and concluded that "*if suitable precautions are taken, drilling operations in these areas should not significantly affect the supply of shallow gas to the active pockmarks*". The recommendations made by Holmes & Stoker (2005) on protection of the pockmark gas supply are regarded to be equally applicable to the Scanner Pockmark and Braemar Pockmarks SACs, and Block 16/3d, and provide for specific mitigation measures to ensure that the conservation objectives of the sites are not compromised by drilling activities which could follow licensing.

In all instances, consent for project-level activities will not be granted unless the operator can demonstrate that the proposed exploration activities will not have an adverse effect on the integrity of relevant sites. The information provided by operators in their applications must be detailed enough for the Department (and its advisors) to make a decision on whether the activities could lead to a likely significant effect.

5.2.2 Conclusions

Likely significant effects identified with regards to physical damage to the seabed, drilling discharges and other effects, when considered along with further mitigation (Section 5.2.1) and relevant activity permitting requirements (see Section 2.3.1), will not have an adverse effect on the integrity of the sites considered in this assessment. At the project level, there is a legal framework through the implementation of the EIA Regulations and the Habitats Regulations, to ensure that there are no adverse effects on the integrity of SACs and SPAs. Their application at the project level allows for an assessment to be made of likely significant effects on the basis of detailed project-specific information and allows for applicants to propose project specific mitigation measures.

The AA recommends that the following conditions be attached to any licences for Block 16/3d[45]:

- No drilling will be permitted through the shallow gas accumulations supplying the pockmarks or through the migration pathways to them;

- The operator will liaise with JNCC in advance of any activities within the Block.

Taking into account the information presented above, it is concluded that activities arising from the licensing of Blocks 16/3d and 206/11d, insofar as they may generate physical disturbance and drilling effects, will not cause an adverse effect on the integrity of the Braemar Pockmarks SAC, Seas off Foula SPA, and by association with this latter site, Foula SPA. Consent for activities will not be granted unless the operator can demonstrate that the proposed activities which may include the drilling of a number of wells and any related activity including the placement of a drilling rig, will not have an adverse effect on the integrity of relevant sites.

[45] See Note 5 in the Other Regulatory Issues for UKCS Blocks. See the Block specific issues: https://www.gov.uk/guidance/oil-and-gas-offshore-environmental-legislation#offshore-oil-and-gas-exploration-production-unloading-and-storage-environmental-impact-assessment-regulations-2020

5.3 Assessment of underwater noise

The site conservation objectives and other relevant information relating to site selection and advice on operations has been considered against indicative work programmes (see Section 2.2.1) to determine whether they could adversely affect site integrity. None of the Blocks applied for propose to undertake new seismic surveys (Table 2.1) which are relevant to the assessment for this site. Sites relevant to this part of the assessment are shown in Figure 5.2 and the results are given in Table 5.2 below. All mandatory control requirements (as given in Section 2.3.2) are assumed to be in place as a standard for all activities assessed at this stage.

Figure 5.2: Sites and Blocks to be subject to further assessment for underwater noise effects

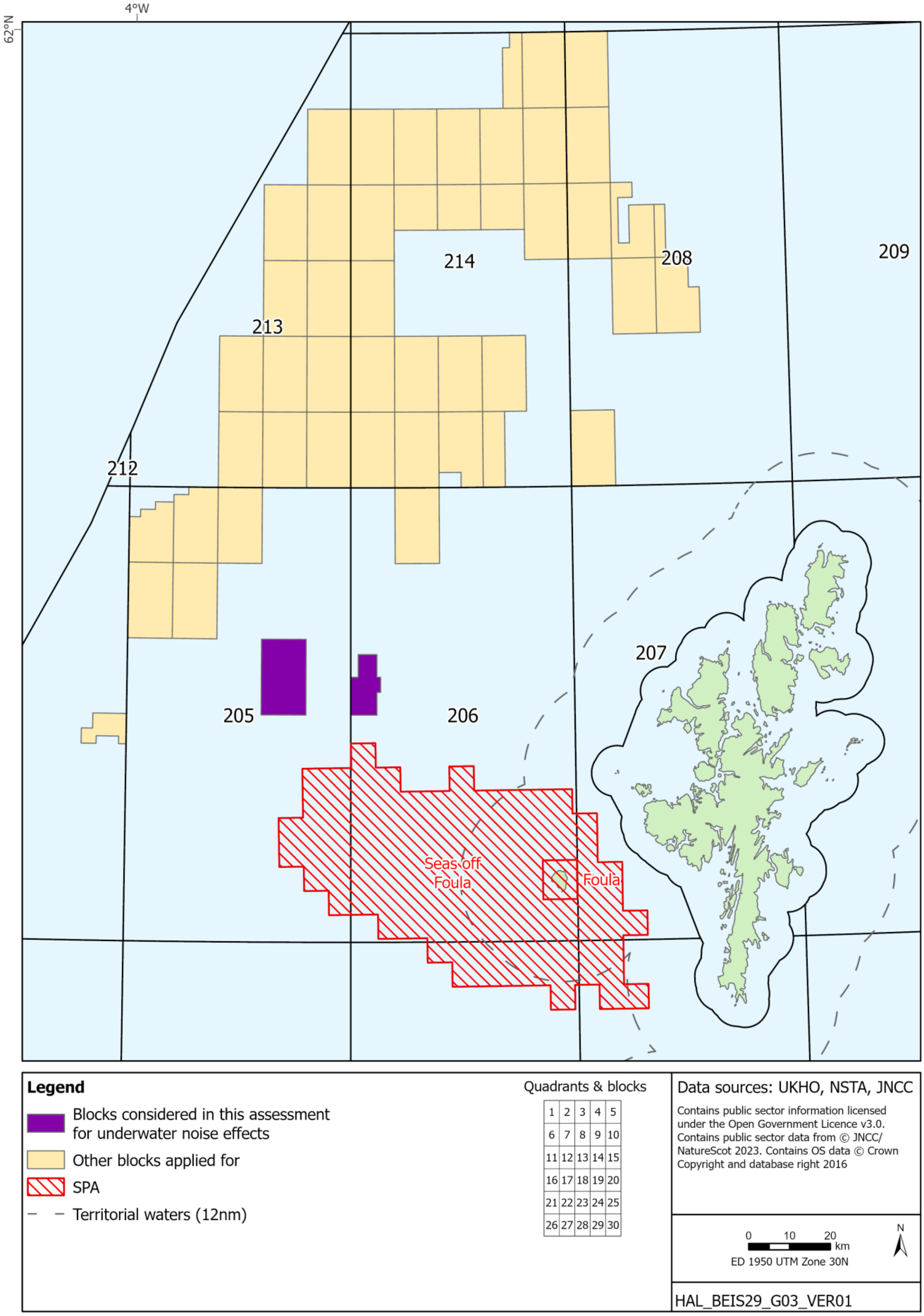


Table 5.2: Consideration of potential underwater noise effects and relevant site conservation objectives

Seas off Foula
Site Information
Area (ha/km²): 341,215/3,412 **Relevant qualifying features (diving species):** breeding guillemot and Atlantic puffin; non-breeding seabird aggregations (includes guillemot) **Conservation objectives:** See Table 5.1 above.
Relevant Blocks with potential for underwater noise effects
205/14, 206/11d
Assessment of effects on site integrity
Impulsive noise (rig site survey, VSP, conductor piling) ***Relevant pressures:*** *underwater noise change, vibration* In terms of their relative densities across the site, it is noted that the northwest part of the site experiences the lowest densities of Atlantic puffins at <2 birds/km², compared to up to 50 birds/km² in the southeast (JNCC 2016). Guillemot are also distributed throughout the site; in the breeding season the highest densities are around Foula itself; in the winter the species is more dispersed across the site (JNCC 2016, Kober *et al*. 2010, Cleasby *et al*. 2018). Given: (i) the distribution of Atlantic puffin and guillemot within the site relative to the relevant Blocks (which are at least 6.9km from the site); (ii) the evidence (albeit limited) of low hearing sensitivity and a lack of reported injury or disturbance effects; and (iii) the likely avoidance of the physical presence of survey vessel(s) and airguns (noting that no seismic survey is proposed); the risk of mortality, injury or significant disturbance is very low. Vessel avoidance behaviour of guillemot may be reduced during the post-breeding flightless moult stage (August to mid-October); this period may be considered through the activity consenting process (see Section 5.3.1), although such activities during this period are not considered likely to result in an adverse effect on site integrity. Negative indirect effects of seismic survey activities on qualifying features may arise through effects on prey species, primarily sandeels and other small fish, if these prey are subject to injury or disturbance which reduce their availability to qualifying seabirds. While there is evidence that a reduction in fish catches can be associated with seismic survey activity, these are temporary in nature, and the sensitivity of sandeels to underwater noise is considered to be low (also see Section 4.3.2). The disturbance of sensitive spawning periods will be considered through the activity consenting process. As such, any underwater noise effects on fish associated with licensing Blocks 205/14 and 206/11d are not anticipated to result in significant effects on the food resources of the qualifying seabird features. Considering the limited potential for effects of seismic survey on diving birds identified above and in Section 4.3.2, and the lower amplitude, shorter duration and smaller geographic footprint associated with other impulsive noise such as VSP, rig site survey and conductor piling (which are the only potential impulsive noise sources possible following Block licensing), it is concluded that these activities, will not result in an adverse effect on the integrity of the site or its source colony site (Foula SPA). **Continuous noise (drilling, vessel & rig movements)** ***Relevant pressures:*** *underwater noise change, vibration* No significant effects on guillemot or Atlantic puffin are anticipated from continuous underwater noise from drilling and vessel movements, due to the lower amplitude and non-impulsive nature of the sound resulting in no potential for acute trauma and no evidence of significant disturbance. **In-combination effects** Intra-plan in-combination underwater noise effects are considered highly unlikely given the low potential for effects identified above, that there is no overlap between the site and the Blocks, which are at least 6.9km from the site boundaries, the low number of Blocks applied for, the lack of seismic survey activities, and the potential to time activities to avoid intra-plan in-combination effects. Section 5.4 provides a consideration of potential Block activities in-combination with other relevant plans and projects.

5.3.1 Further underwater noise mitigation measures

The Department require operators to provide sufficient information in the EIA, which includes a noise assessment, on the potential impact of proposed activities on relevant sites and their qualifying features as well as proposed further mitigation measures in their applications for a relevant consent. Due to the temporary nature of the activities, mitigation measures could include activity timing to avoid the most sensitive periods. Operators must demonstrate how seasonal sensitivities have been taken into account when planning operations (see BEIS 2021). The information provided by operators must be detailed enough for the Department to make a decision on whether the activities could lead to a likely significant effect, and whether the activities should require HRA. Depending on the nature and scale of the proposed activities (e.g. area of survey, source size, timing and proposed mitigation measures) and whether likely effects are identified for these, the Department may undertake further HRA to assess the potential for adverse effects on the integrity of sites at the activity specific level.

Consent for project-level activities will not be granted unless the operator can demonstrate that the proposed activities, which may include small-scale geophysical rig site survey, VSP and drilling (potentially incorporating conductor piling), will not have an adverse effect on the integrity of relevant sites.

5.3.2 Conclusions

Although underwater sound generated during some project-level activities has the potential to injure and disturb individual diving birds, the actual risk is minimised by the controls currently in place, the location of the Blocks applied for, and their related work programmes which exclude seismic survey.

For the relevant site, it is concluded that the likely level of activity expected to take place within the Blocks applied for listed in Table 5.2 will not cause an adverse effect on site integrity. Individual activities (e.g. drilling, geophysical survey) require individual consents which will not be granted unless the operator can demonstrate that the proposed activities will not adversely affect the site integrity of relevant sites. These activities will be subject to activity level EIA and, where appropriate, HRA.

5.4 In-combination effects

Potential incremental, cumulative, synergistic, and secondary effects from a range of operations, discharges and emissions (including noise) were considered in the latest Offshore Energy SEA (BEIS 2022). There are a number of potential interactions between activities that may follow licensing and those existing or planned activities, for instance in relation to renewable energy, offshore oil and gas, fishing, and shipping. These activities are subject to individual permitting or consenting mechanisms or are otherwise managed at a national level.

The relevant Blocks are located in Scottish waters and therefore the Scottish National Marine Plan policies, adopted in March 2015, are relevant to the management of oil and gas and other offshore activities. With regards to the co-existence of activities, policies within the Scottish National Marine Plan include GEN4 Co-existence, "Pr*oposals which enable coexistence with other development sectors and activities within the Scottish marine area are encouraged in planning and decision making processes, when consistent with policies and objectives of this Plan*", and more specifically, OIL&GAS3, which states "*Supporting marine and coastal infrastructure for oil and gas developments, including for storage, should utilise the minimum space needed for activity and should take into account environmental and socio-economic constraints*".

The potential for intra-plan in-combination effects was considered for those sites subject to AA in Sections 5.2 and 5.3 (i.e. that multiple areas applied for have the potential to be licensed and are relevant to the same site). The following section considers the potential for in-combination effects with other relevant plans and programmes.

Sources of potential effect

Projects for which potential interactions with operations that could arise from the licensing of the Blocks applied for (see Section 1.2) have been identified. Interactions were identified on the basis of the nature and location of existing or proposed activities and spatial datasets in a Geographic Information System (GIS). Projects relevant to this in-combination effects assessment, along with their status and relevant sites are tabulated in Table 5.3.

Table 5.3: Projects relevant to the in-combination effects assessment

Relevant project	Project summary	Project status/indicative timing	Relevant sites[1]
West of Shetland			
West of Shetland Pipeline	The 20" West of Shetland gas pipeline traverses the southeast corner of Block 206/11d, and passes within 4km of the Seas of Foula SPA.	In operation	Seas off Foula SPA, Foula SPA
32nd Round licenced Blocks	A number of Blocks licenced in the 32nd Round are adjacent to the 33rd Round Blocks applied for, including, 205/15, 206/11e and 205/20. Exploration activities are yet to take place in these Blocks.	Licenced. Potential activities as part of the Initial Term include seismic survey and the drilling of wells.	Seas off Foula SPA, Foula SPA

Relevant project	Project summary	Project status/indicative timing	Relevant sites[1]
Central North Sea			
Braemar Field	The Braemar field, including the removal of its associated subsea infrastructure, is subject to decommissioning and its decommissioning plan was approved in September 2020. The manifold is to be removed, and surface laid sections of flowlines and umbilical will be partially removed.	Schedule for activities to take place in 2025.	Braemar Pockmarks SAC
Heimdal to Brae Alpha pipeline	The decommissioning of the pipeline between Brae Alpha and Heimdal in the Norwegian sector of the North Sea was approved in April 2021 and involves the leaving of the pipeline *in situ* and rock placement.	Schedule for activities to take place from 2023.	Braemar Pockmarks SAC
32nd Round licenced Blocks	A number of Blocks licenced in the 32nd Round are adjacent to the 33rd Round Blocks applied for, including, 9/27b, 9/28c and 9/29b. Exploration activities are yet to take place in these Blocks.	Licenced. Potential activities as part of the Initial Term include seismic survey and the drilling of wells.	Braemar Pockmarks SAC
1st Carbon Storage round licence provisional awards	One licence was issued in the central North Sea as part of the 1st Carbon Storage licensing round. The licence covers an appraisal term which includes obtaining and/or reprocessing seismic data and does not involve any field activities at this stage. No details of any potential development are presently known, or are likely to be known for some time, should the licence proceed past the appraisal term.	Pre-planning	Braemar Pockmarks SAC

Sources: NSTA NDR (https://ndr.nstauthority.co.uk/), Crown Estate Scotland (https://crown-estate-scotland-spatial-hub-coregis.hub.arcgis.com/)

Notes: [1] those sites considered to be relevant to 33rd seaward round activities.

Figure 5.3: Location of areas applied for in relation to other projects, west of Shetland

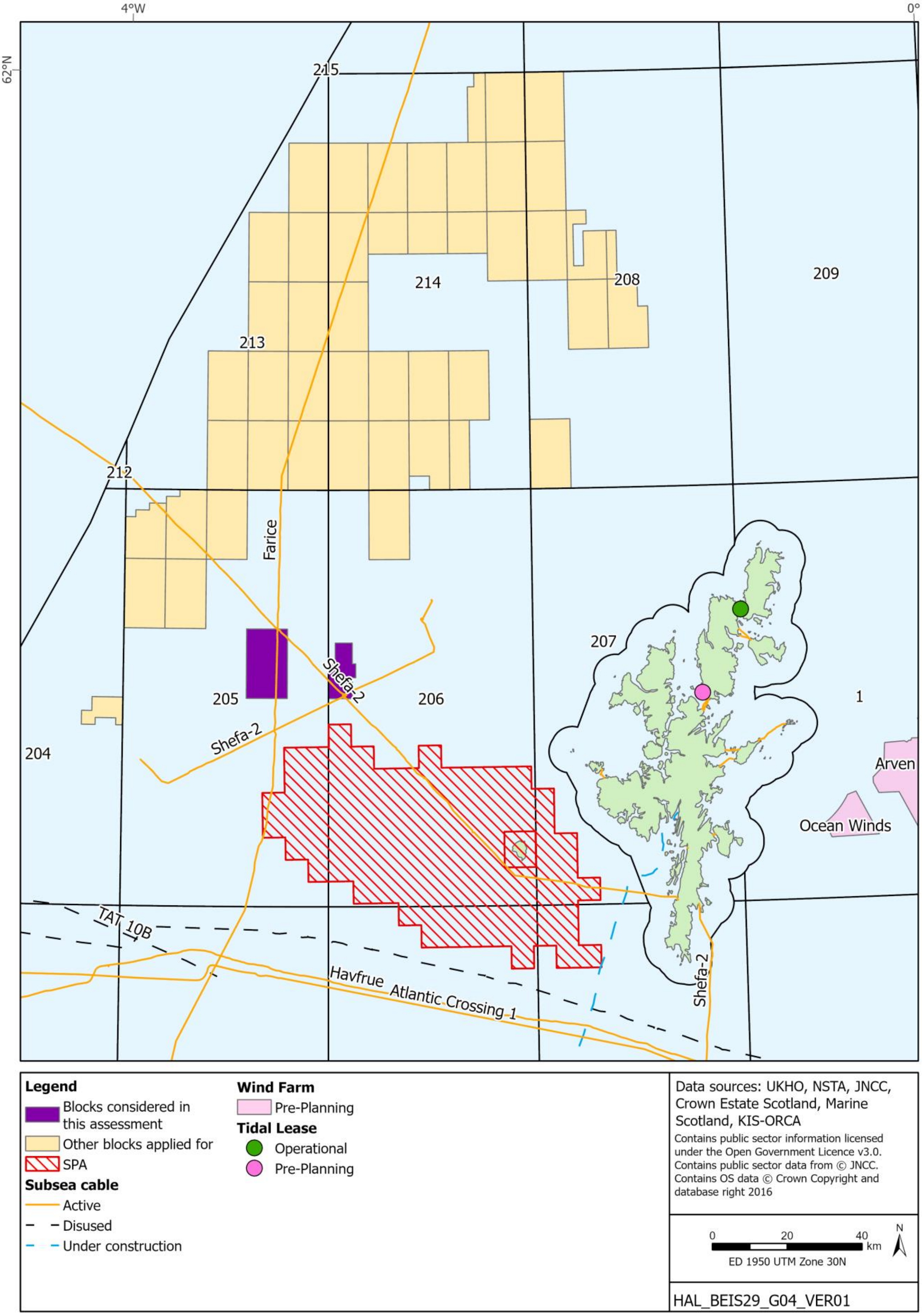


Figure 5.4: Location of areas applied for in relation to other projects, west of Shetland (continued)

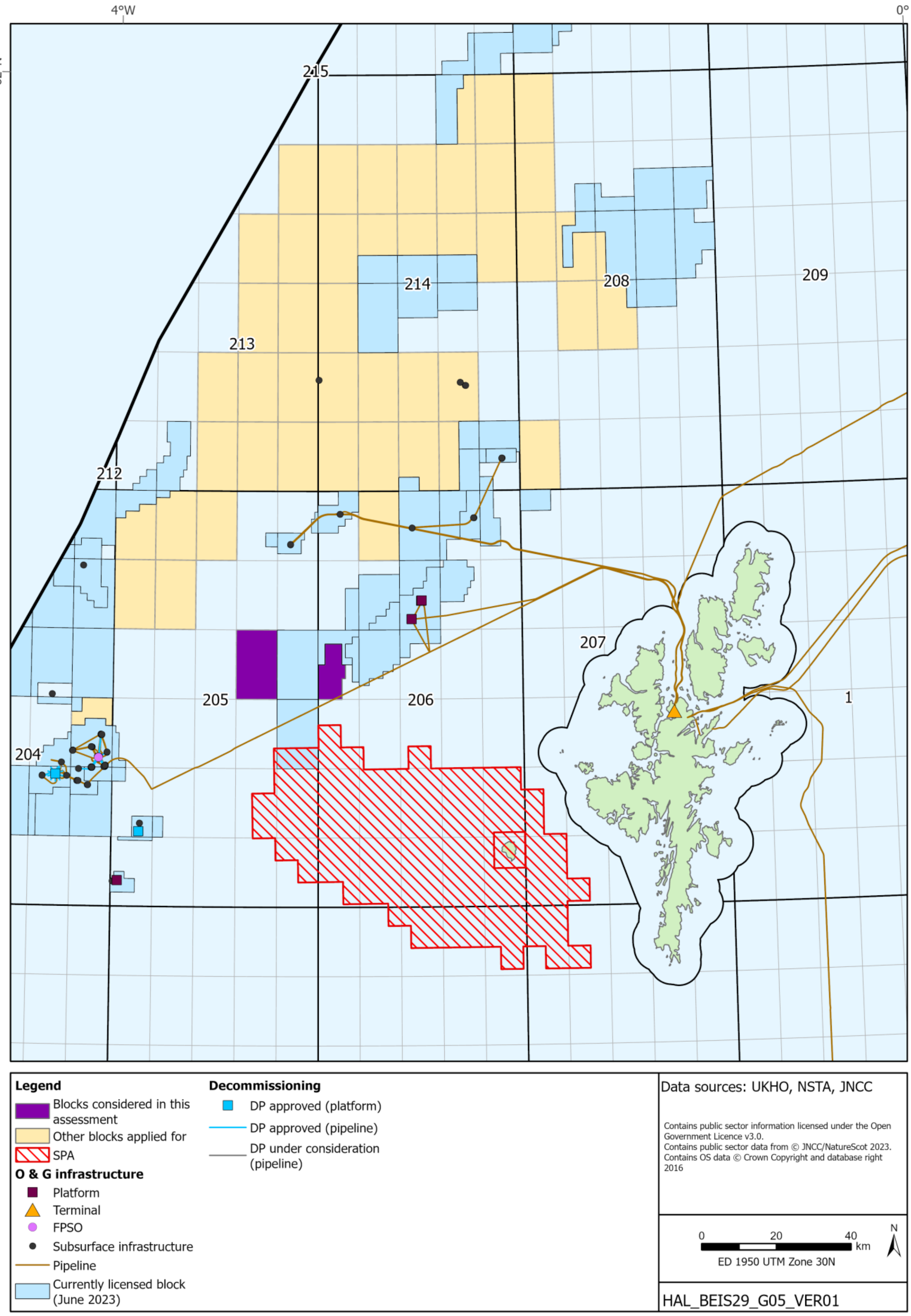


Figure 5.5: Location of areas applied for in relation to other projects, central North Sea

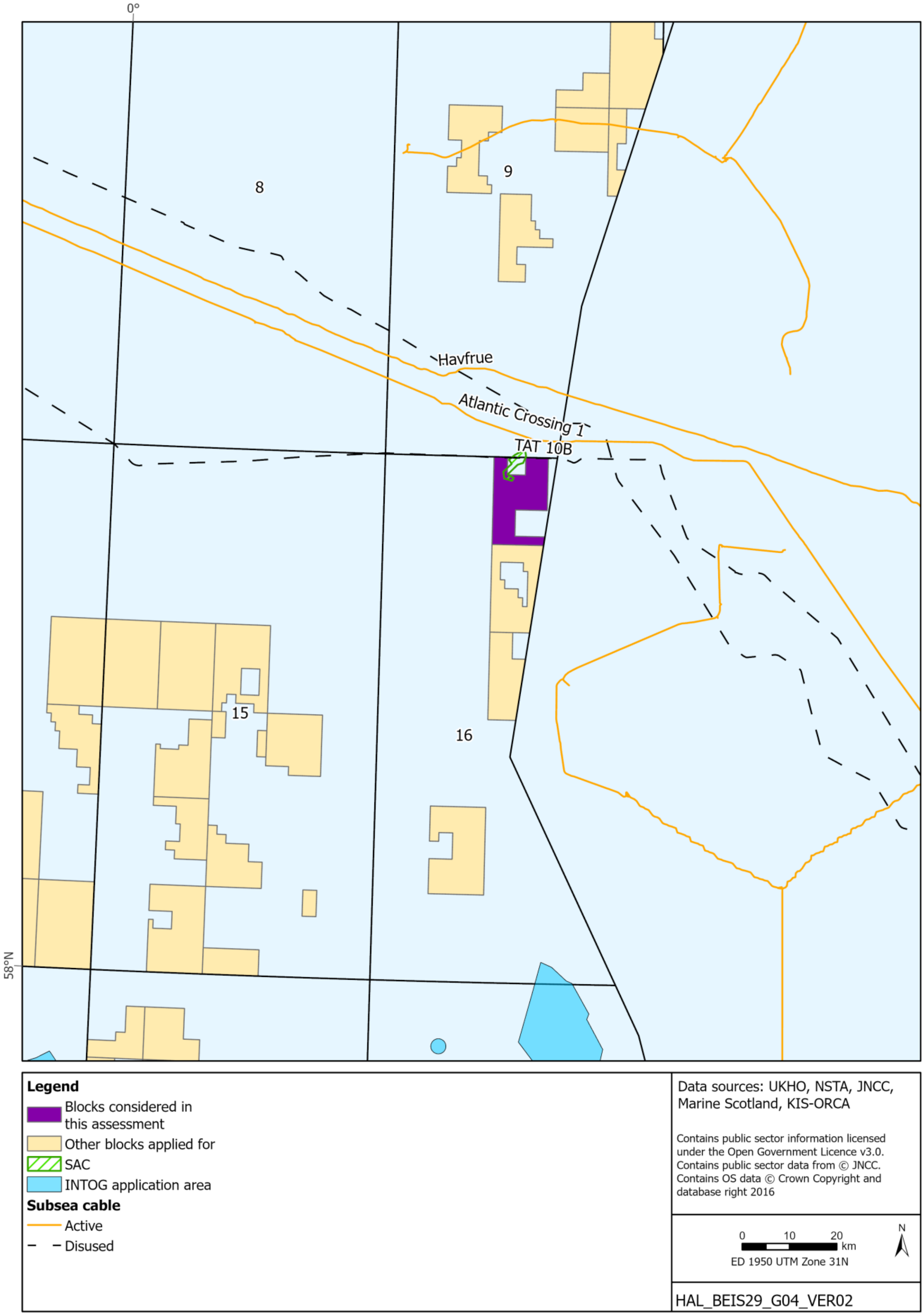


Figure 5.6: Location of areas applied for in relation to other projects, central North Sea (continued)

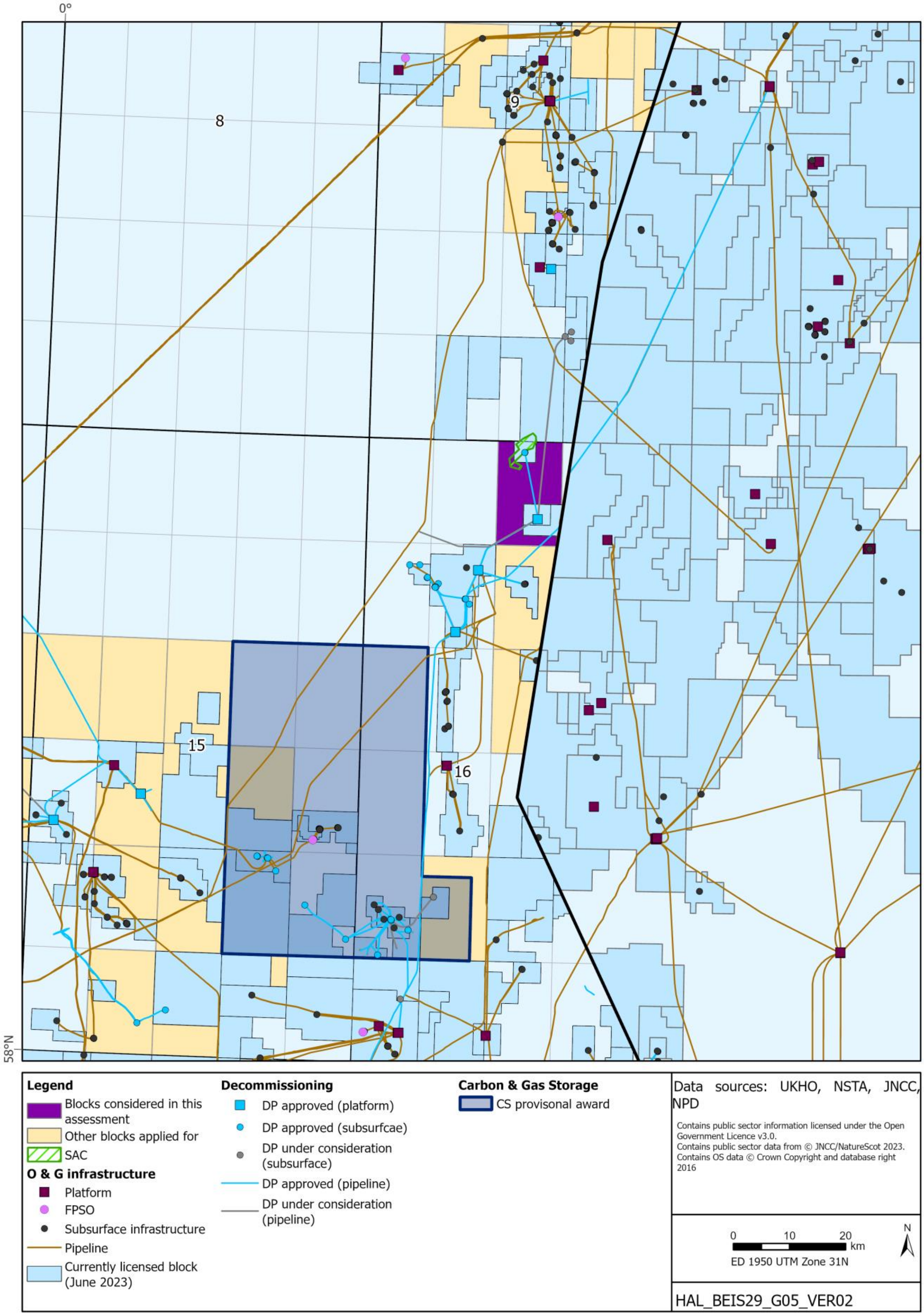
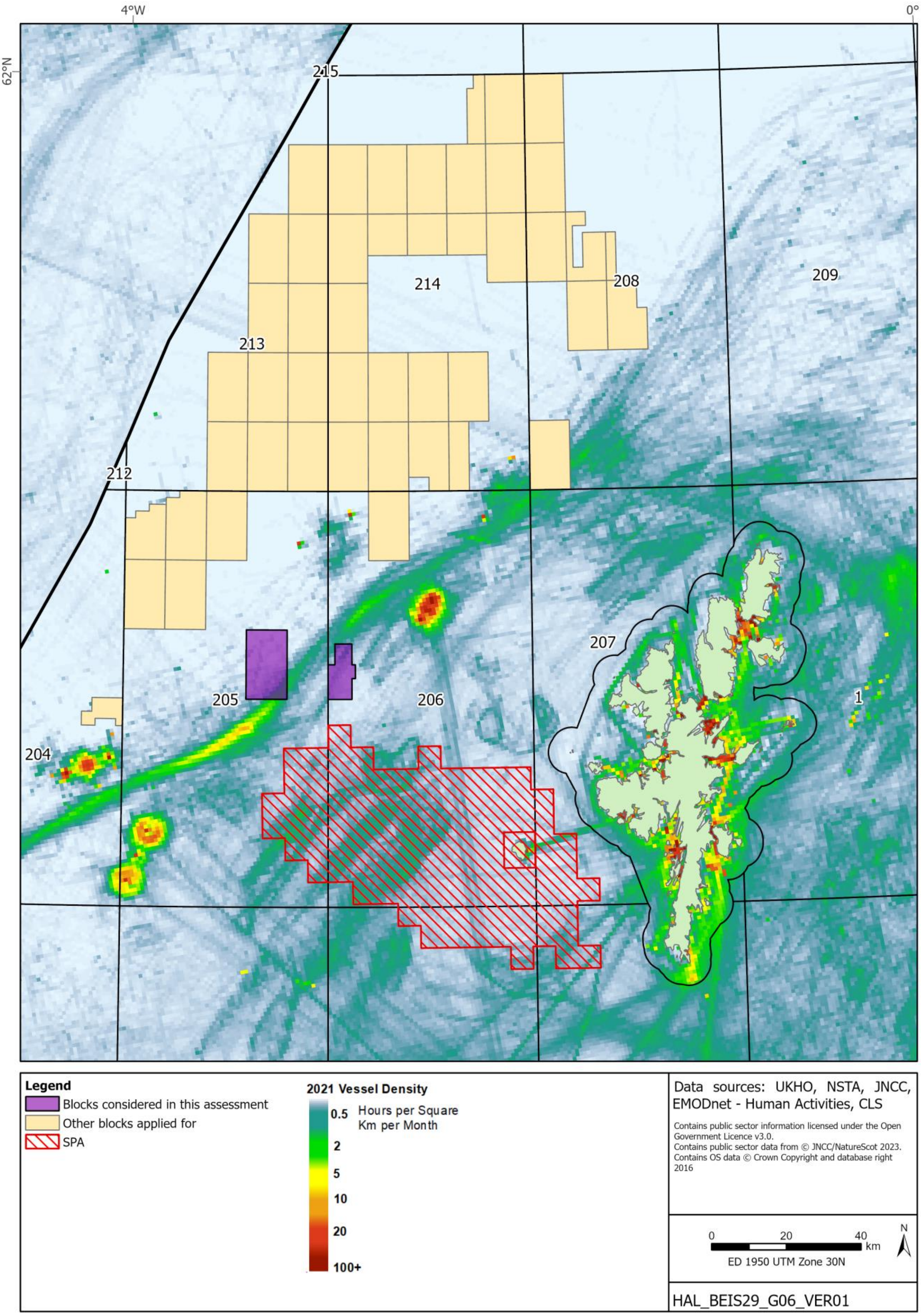


Figure 5.7: Vessel traffic to the west of Shetland



5.4.1 Physical disturbance and drilling effects

Potential sources of physical disturbance to the seabed, and damage to biotopes, associated with oil and gas activities that could result from licensing were described in Section 4.2 and Section 5.2 and include the siting of semi-submersible drilling rigs and drilling discharges.

West of Shetland

Existing oil and gas infrastructure in the west of Shetland area is limited both in density and footprint (Figure 5.3). Several existing pipelines and telecommunication cables traverse the relevant Blocks but not where they overlap with the Seas off Foula SPA (at least a distance of 4km). Site survey would inform rig placement so as to avoid such areas. The closest field developments include Clair Ridge (Block 206/8), Schiehallion (Block 204/20) and the Lancaster Field (Block 205/21); the infrastructure associated with these fields is at least 20km distant from the Blocks and sites relevant to this assessment. A number of the fields referred to are also subject to decommissioning or decommissioning planning, including Schiehallion and Lancaster. A number of blocks within 10km of the Seas off Foula SPA were licensed in the 32nd Round, or as out of round awards in 2016, including Blocks 205/15, 205/18, 205/20, 205/23a, 205/24a, following HRA[46]. One well has been drilled to date that relates to these current licences, in Block 205/23 (2017). An exploration well (Craster) was previously drilled in Block 205/15 in 2017 under a licence acquired in the 27th Round which was subsequently relinquished and awarded again in the 32nd Round, with no further activity having taken place to date. Given the small and temporary seabed footprint associated with drilling activities which may follow the licensing of Block 206/11d (the only Block of relevance to physical effects, see Section 5.2) and those standard and additional mitigation measures set out already in Section 2.3 and 5.2.2, adverse in-combination effects associated with those limited other oil and gas projects discussed are not expected.

With respect to drilling discharges, previous discharges of WBM cuttings in the UKCS have been shown to disperse rapidly and to have minimal ecological effects (See Section 4.2, also see individual site assessments in Section 5.2). Dispersion of further discharges of mud and cuttings could lead to localised accumulation in areas where reduced current allows the particles to accumulate on the seabed. The potential for in-combination effects relating to chemical usage and discharge from exploratory drilling is limited by the existing legislative and permitting controls that are in place (see Section 2.3.1 and 5.2.1), which the UK Marine Strategy[47] has identified as relevant measures contributing to managing discharges. Discharges are considered to have negligible in-combination effect (BEIS 2022).

Lease areas for other offshore renewables are some distance from the Blocks (>100km), and there are no foreseeable interactions or in-combination effects with other renewables activities and those which may following the licensing of the 33rd Round Blocks.

Fishing, and particularly bottom trawling, has historically contributed to seabed disturbance over extensive areas and was identified as an ongoing issue in the UK assessment of good

[46] https://www.gov.uk/guidance/offshore-energy-strategic-environmental-assessment-sea-an-overview-of-the-sea-process#appropriate-assessment
[47] https://www.gov.uk/government/consultations/marine-strategy-part-three-programme-of-measures Note that the updated programme of measures was due to be published by the end of 2022, but is not available at the date of this assessment.

environmental status[48]. Depending on the nature of future measures (e.g. in relation to MPA management in the wider environment and within MPAs), such effects are likely to be reduced and therefore some improvement in benthic habitats could be expected. Whilst fishing may be linked to historical damage to site features, and presents a continuing risk to these, recent, ongoing, and future management measures should limit the potential for in-combination effects with other activities (note that none have been proposed for the Seas off Foula SPA). There is fishing activity within the Seas off Foula SPA, with both mobile and static gear types. This includes trawling, traps, nets and line fishing, to which the features may be sensitive[49]. Of these, longline fishing is considered most likely to affect the qualifying features[50]. In the period from 2009 to 2013, fishing effort with longline gears was concentrated in the western part of the SPA, reflecting the distribution of the target species (hake) which generally occurs in relatively deep water. Fisheries activity data for 2019 and 2020 indicate the area to still be important for both demersal and pelagic catches, with hake still dominating the catch in this area[51]. Evidence suggests northern fulmar is susceptible to bycatch in longline fisheries (ICES 2013). Sandeels which are listed as a prey resource in the Conservation Objectives are also sensitive to trawl fishing, and while inshore areas of Shetland were historically fished, little sandeel fishing currently occurs in the area[52]. Sandeels are also sensitive to other activities which may cause seabed changes through abrasion or sedimentation.

When any surface structure (fixed and floating installations) used for drilling becomes operational, a safety zone with a radius of 500m is created under the amendment to the *Petroleum Act 1987* made by the *Energy Act 2008* and other activities are excluded from taking place within the zone, including fisheries. Safety zones apply to mobile drilling rigs and are notified to other users of the sea (e.g. through notices to mariners and Kingfisher charts). In view of the differences in relative scale of physical impacts resulting from trawling and from oil and gas exploration and appraisal (both spatially and temporally), and the distance between the Blocks applied for and the site, significant incremental effects following the licensing of 33rd Round Blocks are not predicted.

In view of the nature and scale of the exploration activities which could follow the licensing of Block 206/11d (the only Block of relevance to physical effects, see Section 5.2) and the mitigation which is available to avoid effects (see Sections 2.3.1 and 5.2.1), significant in-combination effects with respect to physical disturbance are not considered likely.

Central North Sea

Though existing oil and gas infrastructure is widespread in the central North Sea (Figure 5.6), the relative density and footprint of these is small. The main interaction relates to the Braemar field infrastructure which is located to the east of the Braemar Pockmarks SAC, just outside of the site boundary. The infrastructure is presently subject to decommissioning planning[53] and has been subject to Environmental Appraisal (Marathon Oil 2017), which concluded that

48 https://www.gov.uk/government/publications/marine-strategy-part-one-uk-updated-assessment-and-good-environmental-status
49 https://hub.jncc.gov.uk/assets/a4ddbc00-500a-4c4b-9250-ed180356db00#seas-off-foula-sas-conservation-objectives-reg-18.pdf
50 https://hub.jncc.gov.uk/assets/a4ddbc00-500a-4c4b-9250-ed180356db00#seas-off-foula-sas-management-options-paper.pdf
51 Based on data for ICES rectangle 49E7, https://data.marine.gov.scot/dataset/2020-scottish-sea-fisheries-statistics-fishing-effort-and-quantity-and-value-landings-ices
52 https://marine.gov.scot/sma/assessment/case-study-sandeels-scottish-waters
53 https://www.gov.uk/guidance/oil-and-gas-decommissioning-of-offshore-installations-and-pipelines

physical impacts of wellhead removal would not directly or indirectly affect the site. It is also noted that a decommissioning programme was approved in 2021 for the Heimdal (Norway sector) to Brae A pipeline, which passes minimum of 8km east of the Braemar Pockmarks. Relevant activities associated with this programme include the deposit of stabilisation materials to protect any exposed spans; the environmental appraisal of such activities highlighted the highly localised nature of any seabed disturbance (within a 100m radius of the pipeline) and negligible anticipated effects on seabed features (Equinor 2020).

A number of blocks within 10km of the Braemar Pockmarks SAC were licensed in the 32nd Round, which are, 9/27b, 9/28c and 9/29b. The only one of these Blocks which overlaps with the Braemar Pockmarks SAC is 9/28c, and no well has been drilled in this block to date. As with Block 16/3d considered in this assessment, the AA for the 32nd Round recommended that conditions relating to the avoidance of interaction with the shallow gas supplying the pockmarks be attached to the licence of 9/28c, which are the same as those listed in Section 5.2.2 of this document.

JNCC (2017b) note that the Braemar Pockmarks SAC is likely to have been impacted by bottom trawling, evidenced by Vessel Monitoring System (VMS) data and trawl scars (Rance *et al.* 2017), and JNCC (2020) note that the condition of the qualifying features of the site are considered unfavourable for this reason. Proposals have been made for the management of the site, with measures including the closure of all demersal fisheries (mobile and static gear), with vessels monitored across the site at 10-minute intervals, however the progress in implementing these measures (which are the responsibility of Marine Scotland) are uncertain.

In view of the large area outside of the SAC within which a rig could be sited, and those mitigation measures which would be required to avoid an adverse effect on site integrity from the drilling of a well in Block 16/3d (Section 5.2.1), adverse in-combination physical effects on site integrity are not predicted.

With respect to drilling discharges, previous discharges of WBM cuttings in the UKCS have been shown to disperse rapidly and to have minimal ecological effects (See Section 4.2). Dispersion of further discharges of mud and cuttings could lead to localised accumulation in areas where reduced current allows the particles to accumulate on the seabed. The proximity of Block 16/3d to the Braemar Pockmarks SAC means that a level of mitigation may be required to ensure that cumulative effects with previous discharges associated with the discovery and development of the Braemar Field are minimised. As described in Section 5.2.1, such mitigation could include the relocation of the cuttings discharge point further away from the site, discharge near the seabed rather than near sea surface, or zero discharge.

In view of the scale of the proposed activity, extent of the region, the water depths and currents, this is considered unlikely to be detectable and to have negligible cumulative ecological effect (BEIS 2022). Similarly, the potential for in-combination effects relating to chemical usage and discharge from exploratory drilling is controlled by the existing legislative and permitting mechanisms (e.g. see Section 2.3).

5.4.2 Physical presence

West of Shetland

Physical presence of offshore infrastructure and support activities may potentially cause behavioural responses in birds and fish (see Section 5.6 of BEIS 2022). Previous SEAs have considered the majority of behavioural responses resulting from interactions with offshore oil and gas infrastructure (whether positive or negative) to be insignificant; in part because the number of surface facilities is relatively small (of the order of a few hundred across the entire UKCS) and as the majority are a substantial distance offshore. In the west of Shetland area, the potential for large numbers of individual surface or submerged structures associated with renewable energy developments is currently limited, and project plans are distant (130km, ScotWind area offered to the east of Shetland).

Shipping densities over the relevant Blocks are very low (Figure 5.7). Additional vessels associated with drilling and site survey will represent a small increment to existing traffic, for example typical supply visits to rigs while drilling may be in the order of 2 to 3 per week.

It is not regarded that the temporary addition of a drilling rig and associated shipping of a scale outlined in Table 2.2 will lead to adverse effects on site integrity for any of the relevant sites considered in this AA for which physical presence was identified as a potential source of likely significant effect (see Table 1.1).

5.4.3 Underwater noise effects

West of Shetland

Evidence suggests the primary concern for underwater noise impacts on diving birds is that of acute trauma due to close proximity to very high amplitude impulsive noise sources (see Section 4.3). Therefore, the potential for in-combination effects with activities which may follow the licensing of 33rd Round Blocks are limited to those known to generate high-amplitude impulsive noise (see BEIS 2022), noting that seismic survey is not proposed in the Block work programmes.

There are no relevant offshore wind energy projects (either planned or under construction) in the west of Shetland area which could introduce high amplitude underwater noise through pile driving of foundations. The closest project (~256km to the south) is Moray West, consented in 2019.

There is the potential for seismic surveys to take place in adjacent Blocks which are yet to be fully explored or which have been developed (not covered by the plan being assessed), which may result from block-specific activity, or non-exclusive survey activity. The timing, location, and scale of any such surveys are unknown and a meaningful assessment of these cannot be made at this time, but they will be subject to activity specific permitting, including HRA where appropriate, and any knowledge of such surveys should be taken account of in activity specific assessments for 33rd Round block activities.

In addition to those activities which may follow licensing of the west of Shetland Blocks, there are a variety of other existing (e.g. oil and gas production, fishing, shipping, military exercise areas) noise-producing activities in overlapping or adjacent areas. Despite this, the Department is not aware of any projects or activities which are likely to cause effects that, when taken in-combination with the potential number and scale of activities likely to result from the licensing of the Blocks applied for (Section 2.2), would adversely affect the integrity of the relevant sites. This is due to the presence of effective regulatory mechanisms (Section 5.2 and also Appendix 3 of BEIS 2022) which ensure that operators, the Department, and other relevant consenting authorities take such considerations into account during activity permitting. These mechanisms generally allow for public participation in the process[54].

5.4.4 Conclusion

Available evidence (see e.g. UKBenthos database, OSPAR 2010 and the 2017 intermediate assessment[55]) indicates that past oil and gas activity and discharges have not led to adverse impacts on the integrity of relevant sites in the area. Any activities relating to the work programmes, and any subsequent development that may occur if site appraisal is successful, will be judged on its own merits and in the context of wider development in the west of Shetland area (i.e. any potential incremental effects). The current controls on terrestrial and marine industrial activities, including activities that could follow licensing, can be expected to prevent significant in-combination effects affecting relevant sites.

The Department will assess the potential for in-combination effects whilst considering project-specific EIAs and, where appropriate, through HRAs. This process will ensure that mitigation measures are put in place to ensure that activities, if consented, will not result in adverse effects on integrity of the relevant sites. Therefore, it is concluded that the in-combination effects from activities arising from the licensing of the Blocks applied for in the 33rd Seaward Licensing Round, with those from existing and planned activities to the west of Shetland and in the Central North Sea, will not adversely affect the integrity of relevant Sites.

[54] *Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020*
[55] Also see the upcoming OSPAR QSR 2023: https://www.ospar.org/work-areas/cross-cutting-issues/qsr2023

6 Overall conclusion

Taking account of the evidence and assessment presented above, it has been determined that the licensing of the three Blocks through the 33rd Licensing Round considered in this AA, will not have an adverse effect on the integrity of the relevant sites (identified in Section 1.2), and the Department have no objection to the NSTA awarding seaward licences (subject to meeting application requirements) covering those areas listed in Section 1.2. This is because there is certainty that licensing of the areas applied for will not adversely affect the integrity of relevant sites (as described in Sections 5.1 to 5.3), taking account of the mitigation measures that can be imposed through existing permitting mechanisms on the planning and conduct of activities. Plan level mitigation was identified to avoid impacts on the supporting processes of the Braemar Pockmarks SAC. The mitigation measures are listed in Table 6.1 below and will be secured through licence and/or permit conditions.

These control measures are incorporated in respect of habitat and species interest features through the range of legislation and guidance (see https://www.gov.uk/guidance/oil-and-gas-offshore-environmental-legislation) which apply to activities which could follow licensing. Where necessary, project-specific HRA based on detailed project proposals would be undertaken by the Department to ensure that permits/consents are only granted where the proposed activity will not result in adverse effects on integrity of relevant sites.

Table 6.1: Plan-level mitigation

Block applied for	Relevant sites	Relevant feature	Required mitigation
16/3d	Braemar Pockmarks SAC	Submarine structures made by leaking gases	No drilling will be permitted through the shallow gas accumulations supplying the pockmarks or through the migration pathways to them The operator will liaise with JNCC in advance of any activities within the Block

Even where a site/interest feature has been screened out, or where a conclusion of no adverse effect on integrity has been reached at plan level, the potential for likely significant effects on any relevant site would need to be revisited at the project level, once project plans are known. New relevant site designations, new information on the nature and sensitivities of interest features within sites, and new information about effects, including in-combination effects, may be available to inform future project level HRA.

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