Department for Energy Security & Net Zero

Offshore Oil & Gas Licensing

33rd Seaward Round

Habitats Regulations Assessment

Draft Appropriate Assessment: Southern North Sea and Mid North Sea High

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 2023a). In

[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).

doing 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

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 2023a). 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

1.2.1 Southern North Sea and Mid North Sea High Blocks

The relevant Blocks applied for in the 33rd Round and considered in this assessment are listed below in Table 1.1, and are shown in Figure 1.1.

Table 1.1: Blocks requiring further assessment

36/14	36/15	36/19	36/20	36/30c	37/11	37/16	37/26	37/27	42/12b

[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*.

42/14	42/15b	42/28j	42/3	42/30b	42/4	42/5c	42/8	43/12a	43/13
43/14	43/17	43/18	43/19d	43/20c	43/21	43/22c	43/24c	43/25	43/26b
43/29	43/2b	43/30	43/3b	43/4b	43/9	44/13	44/16	44/17	44/18a
44/19b	44/21	44/22	44/23a	44/27	47/10c	47/13	47/14	47/15	47/20
47/3j	47/3k	47/4d	47/5b	47/7b	47/8a	47/9a	48/1	48/10	48/11b
48/12a	48/14d	48/15b	48/16	48/17d	48/18c	48/20c	48/21	48/22a	48/23c
48/24	48/25d	48/28b	48/2b	48/30c	48/6c	49/11b	49/16d	49/21b	49/21d
49/25b	49/26b	49/29	49/30b	50/21	50/26	52/5c	53/2c	53/3	53/4
53/5c									

Table 1.2: Relevant sites requiring further assessment

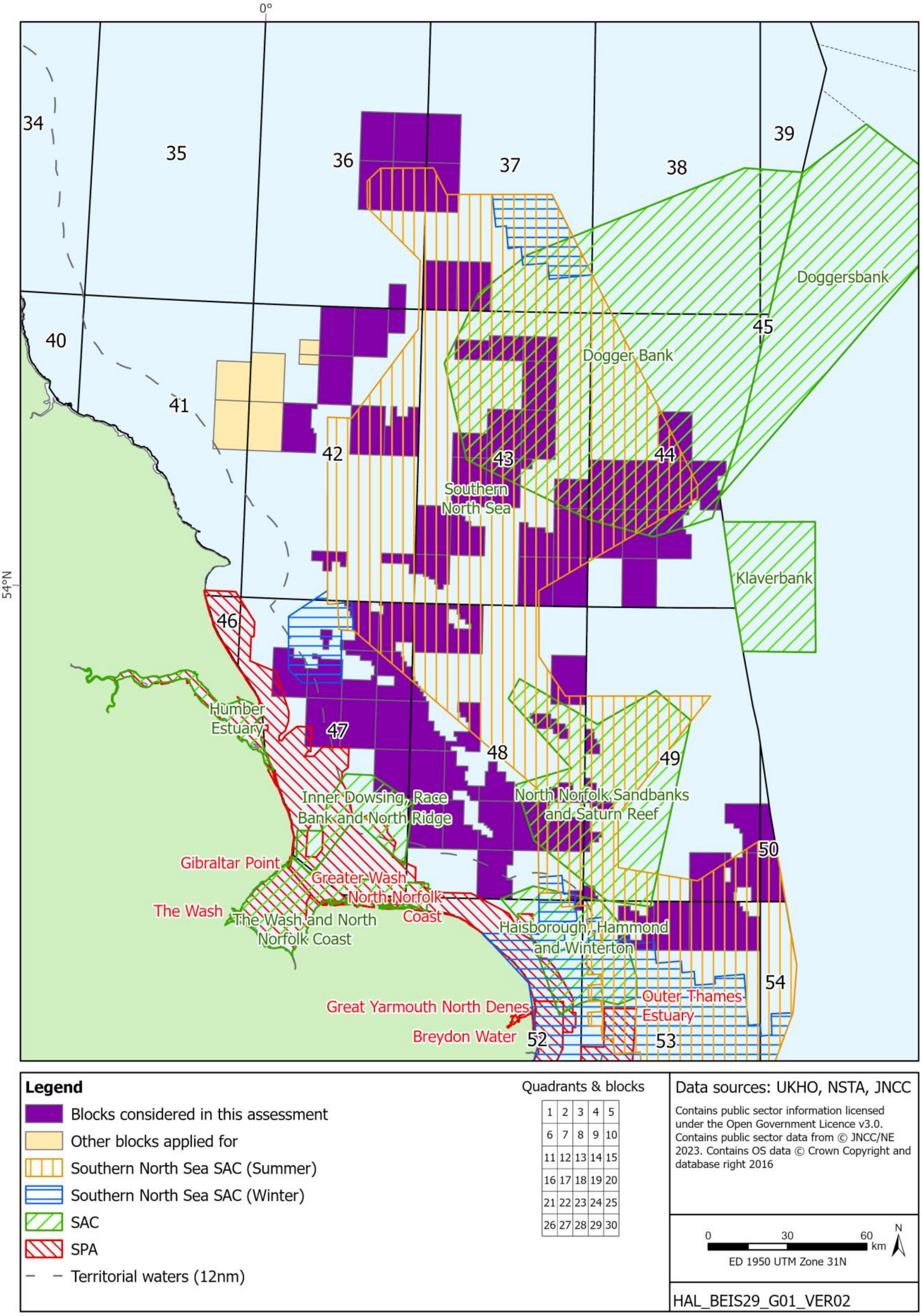
Relevant site Features	Relevant Blocks applied for	Sources of potential effect
SPAs		
Humber Estuary Breeding: avocet, bittern, little tern, marsh harrier Over winter: avocet, bar-tailed godwit, bittern, black-tailed godwit, dunlin, golden plover, hen harrier, knot, redshank, ruff, shelduck, Waterbird assemblage	47/7b	Physical disturbance and drilling: rig siting, drilling discharges
Greater Wash[1] Breeding: Sandwich tern, common tern, little tern Over winter: little gull, red-throated diver, common scoter	47/13, 47/14, 47/15, 47/20, 47/7b, 47/8a, 48/21, 48/28b	Physical disturbance and drilling: rig siting, drilling discharges
Over winter: red-throated diver, common scoter	47/13, 47/14, 47/15, 47/20, 47/7b, 47/8a, 48/16, 48/21, 48/22a, 48/28b, 48/30c, 52/5c	Underwater noise: deep geological seismic survey, rig site survey, VSP, conductor piling, drilling, vessel & rig movements
The Wash[1] Breeding: little tern Over winter: common scoter	47/13, 47/14, 47/15, 47/20, 47/7b, 47/8a, 48/21, 48/28b	Physical disturbance and drilling: rig siting, drilling discharges
Over winter: common scoter	47/13, 47/14, 47/15, 47/20, 47/7b, 47/8a, 48/21, 48/28b	Underwater noise: deep geological seismic survey, rig site survey, VSP, conductor piling, drilling, vessel & rig movements
North Norfolk Coast[1] Breeding: Sandwich tern, common tern, little tern	47/13, 47/14, 47/15, 47/20, 47/7b, 47/8a, 48/21, 48/28b	Physical disturbance and drilling: rig siting, drilling discharges

Relevant site Features	Relevant Blocks applied for	Sources of potential effect
Gibraltar Point[1] Breeding: little tern	47/13, 47/14, 47/15, 47/20, 47/7b, 47/8a, 48/21, 48/28b	Physical disturbance and drilling: rig siting, drilling discharges
Great Yarmouth North Denes[1] Breeding: little tern	47/13, 47/14, 47/15, 47/20, 47/7b, 47/8a, 48/21, 48/28b	Physical disturbance and drilling: rig siting, drilling discharges
Breydon Water[1] Breeding: common tern	47/13, 47/14, 47/15, 47/20, 47/7b, 47/8a, 48/21, 48/28b	Physical disturbance and drilling: rig siting, drilling discharges
Outer Thames Estuary[1] Breeding: common tern, little tern	47/13, 47/14, 47/15, 47/20, 47/7b, 47/8a, 48/21, 48/28b	Physical disturbance and drilling: rig siting, drilling discharges
Over winter: red-throated diver	47/13, 47/14, 47/15, 47/20, 47/7b, 47/8a, 48/16, 48/21, 48/22a, 48/28b, 48/30c, 52/5c	Physical disturbance and drilling: rig siting, drilling discharges Underwater noise: deep geological seismic survey, rig site survey, VSP, conductor piling, drilling, vessel & rig movements
SACs		
Southern North Sea Annex II species: harbour porpoise	36/14, 36/15, 36/19, 36/20, 36/30c, 37/11, 37/16, 37/26, 37/27, 42/12b, 42/14, 42/15b, 42/28j, 42/3, 42/30b, 42/4, 42/5c, 42/8, 43/12a, 43/13, 43/14, 43/17, 43/18, 43/19d, 43/20c, 43/21, 43/22c, 43/24c, 43/25, 43/26b, 43/29, 43/2b, 43/30, 43/3b, 43/4b, 43/9, 44/13, 44/16, 44/17, 44/18a, 44/19b, 44/21, 44/22, 44/23a, 44/27, 47/10c, 47/13, 47/14, 47/15, 47/3j, 47/3k, 47/4d, 47/5b, 47/7b, 47/8a, 47/9a, 48/1, 48/10, 48/11b, 48/12a, 48/14d, 48/15b, 48/17d, 48/18c, 48/20c, 48/23c, 48/24, 48/25d, 48/28b, 48/2b, 48/30c, 48/6c, 49/11b, 49/16d, 49/21b, 49/21d, 49/25b, 49/26b, 49/29, 49/30b, 50/21, 50/26, 52/5c, 53/2c, 53/3, 53/4, 53/5c	Physical disturbance and drilling: rig siting, drilling discharges
	36/14, 36/15, 36/19, 36/20, 36/30c, 37/11, 37/16, 37/26, 37/27, 42/12b, 42/14, 42/15b, 42/28j, 42/3, 42/30b, 42/4, 42/5c, 42/8, 43/12a, 43/13, 43/14, 43/17, 43/18, 43/19d, 43/20c, 43/21, 43/22c, 43/24c, 43/25, 43/26b, 43/29, 43/2b, 43/30, 43/3b, 43/4b, 43/9, 44/13, 44/16, 44/17, 44/18a, 44/19b, 44/21, 44/22, 44/23a, 44/27, 47/10c, 47/13, 47/14, 47/15, 47/3j, 47/3k, 47/4d, 47/5b, 47/7b, 47/8a, 47/9a, 48/1, 48/10, 48/11b, 48/12a, 48/14d, 48/15b, 48/16, 48/17d, 48/18c, 48/20c, 48/23c, 48/24, 48/25d, 48/28b, 48/2b, 48/30c, 48/6c, 49/11b, 49/16d, 49/21b, 49/21d, 49/25b, 49/26b, 49/29, 49/30b, 50/21, 50/26, 52/5c, 53/2c, 53/3, 53/4, 53/5c	Underwater noise: deep geological seismic survey, rig site survey, VSP, conductor piling, drilling, vessel & rig movements
Humber Estuary Annex II species: grey seal, sea lamprey	47/7b	Physical disturbance and drilling: rig siting, drilling discharges

Relevant site Features	Relevant Blocks applied for	Sources of potential effect
Annex I habitats: estuaries, mudflats and sandflats, sandbanks, saltmarsh and salt meadows, coastal lagoons, coastal dunes		
Annex II species: grey seal, sea lamprey	47/7b, 47/13	Underwater noise: deep geological seismic survey, rig site survey, VSP, conductor piling, drilling, vessel & rig movements
Haisborough, Hammond and Winterton Annex I habitats: reefs, sandbanks	48/28b, 48/30c, 49/26b, 52/5c, 53/2c, 53/3	Physical disturbance and drilling: rig siting, drilling discharges
Inner Dowsing, Race Bank and North Ridge Annex I habitats: reefs, sandbanks	47/14, 47/15, 47/20, 48/16, 48/21	Physical disturbance and drilling: rig siting, drilling discharges
North Norfolk Sandbanks and Saturn Reef Annex I habitats: reefs, sandbanks	48/10, 48/14d, 48/15b, 48/18c, 48/20c, 48/23c, 48/24, 48/25d, 48/28b, 48/30c, 49/11b, 49/16d, 49/21b, 49/21d, 49/26b, 52/5c, 53/2c, 53/3	Physical disturbance and drilling: rig siting, drilling discharges
The Wash and North Norfolk Coast Annex II species: harbour seal	48/21, 48/22a	Underwater noise: deep geological seismic survey, rig site survey, VSP, conductor piling, drilling, vessel & rig movements
Dogger Bank Annex I habitat: sandbanks which are slightly covered by sea water all the time	37/26, 37/27, 43/12a, 43/13, 43/14, 43/17, 43/18, 43/19d, 43/20c, 43/25, 43/2b, 43/3b, 43/4b, 43/9, 44/13, 44/16, 44/17, 44/18a, 44/19b, 44/21, 44/22, 44/23a, 44/27	Physical disturbance and drilling: rig siting, drilling discharges
Doggersbank (Netherlands) Annex I: Sandbanks	44/19b	Physical disturbance and drilling: rig siting, drilling discharges
Annex II species: grey seal, harbour seal, harbour porpoise	44/13, 44/18a, 44/19b, 44/23a	Underwater noise: deep geological seismic survey, rig site survey, VSP, conductor piling, drilling, vessel & rig movements
Klaverbank (Netherlands) Annex I: Reefs	44/19b	Physical disturbance and drilling: rig siting, drilling discharges
Annex II species: grey seal, harbour seal, harbour porpoise	44/18a, 44/19b, 44/23a	Underwater noise: deep geological seismic survey, rig site survey, VSP, conductor piling, drilling, vessel & rig movements

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

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.

[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. The NSTA has indicated that a number of Blocks (Table 2.1) are located within four priority cluster areas in the southern North Sea. These clusters are Blocks with known gas reserves and which are close to existing infrastructure, thereby having the potential to be developed quickly.

[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

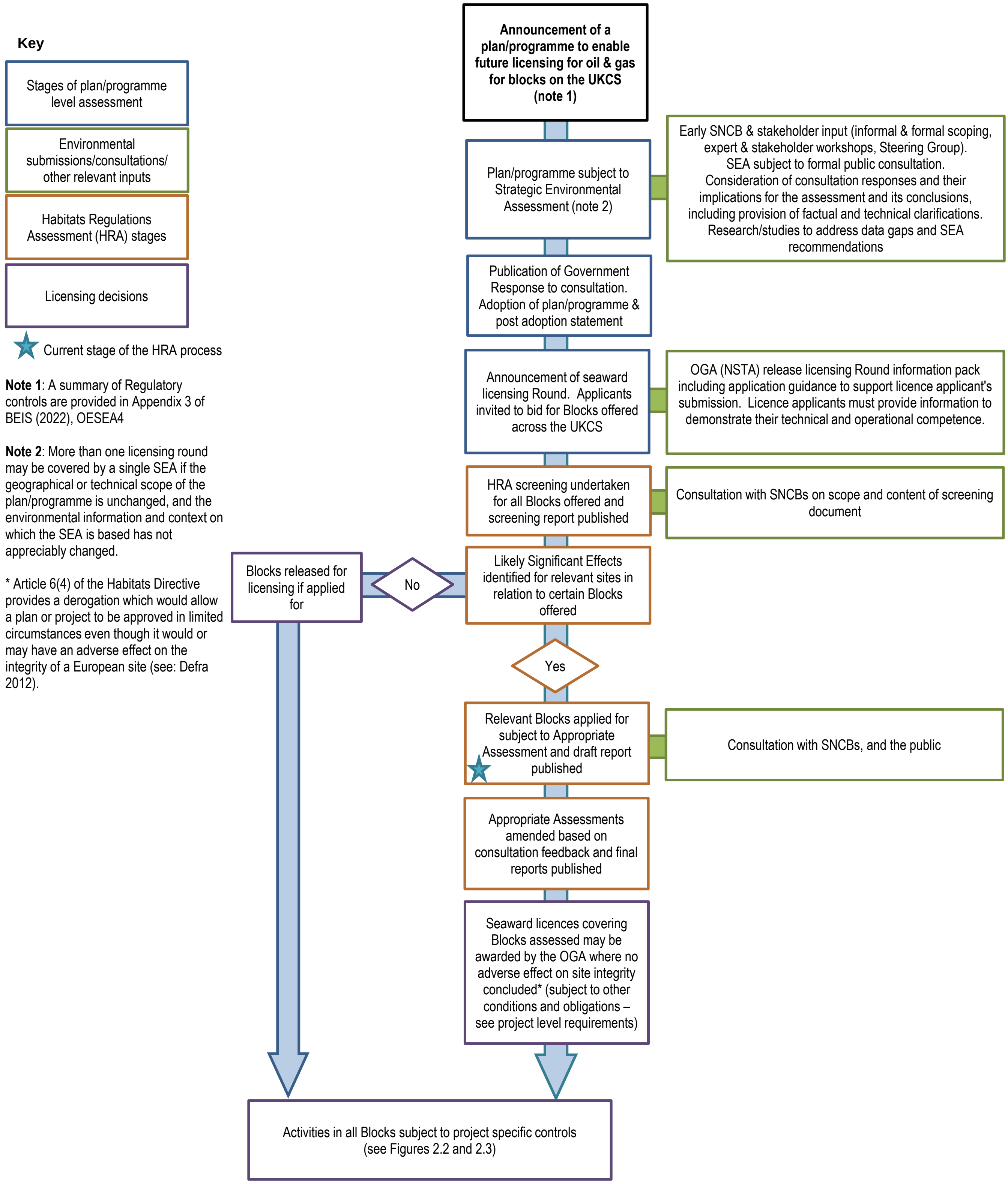
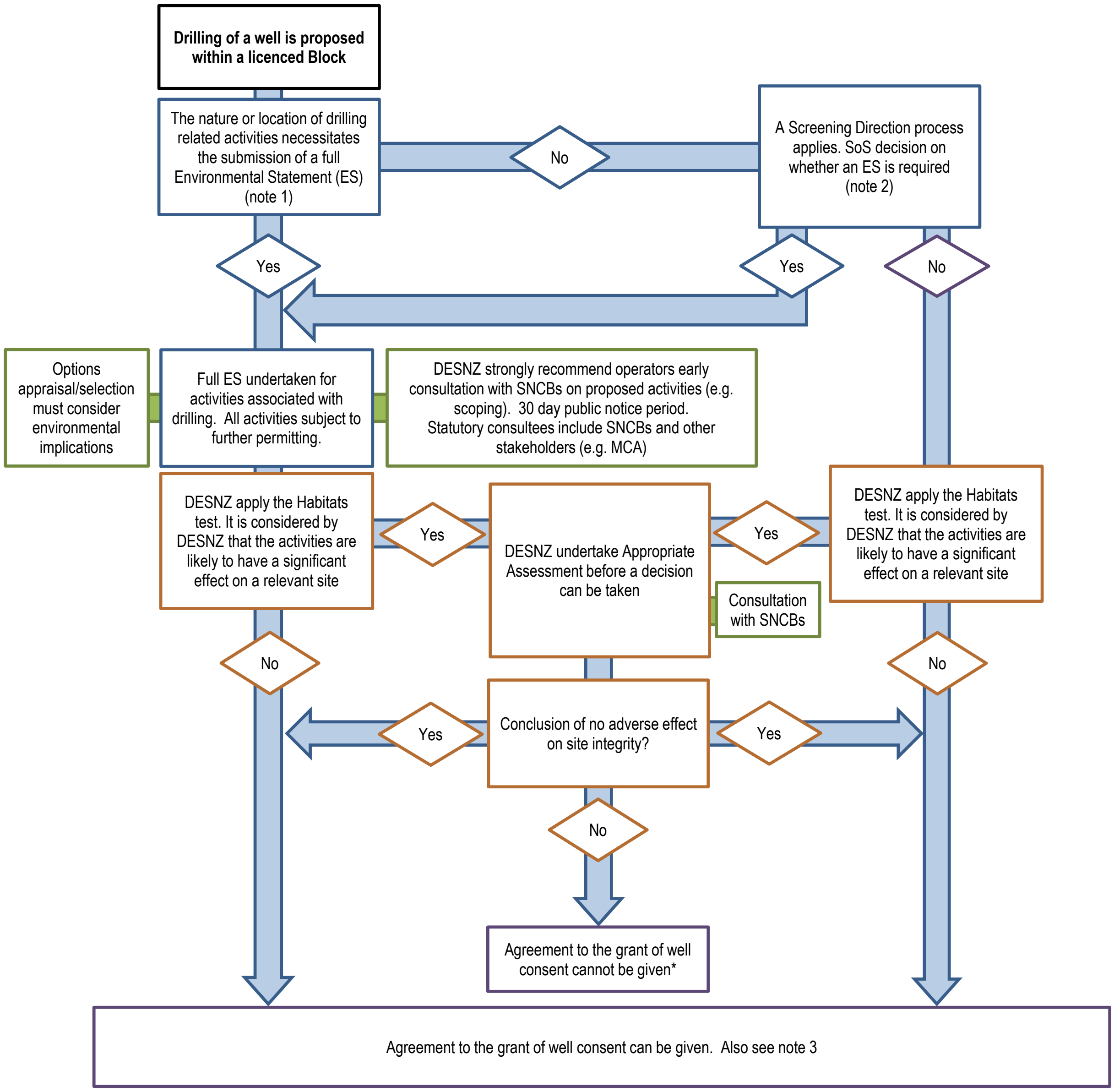


Figure 2.2: High level overview of exploration drilling environmental requirements



Key

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

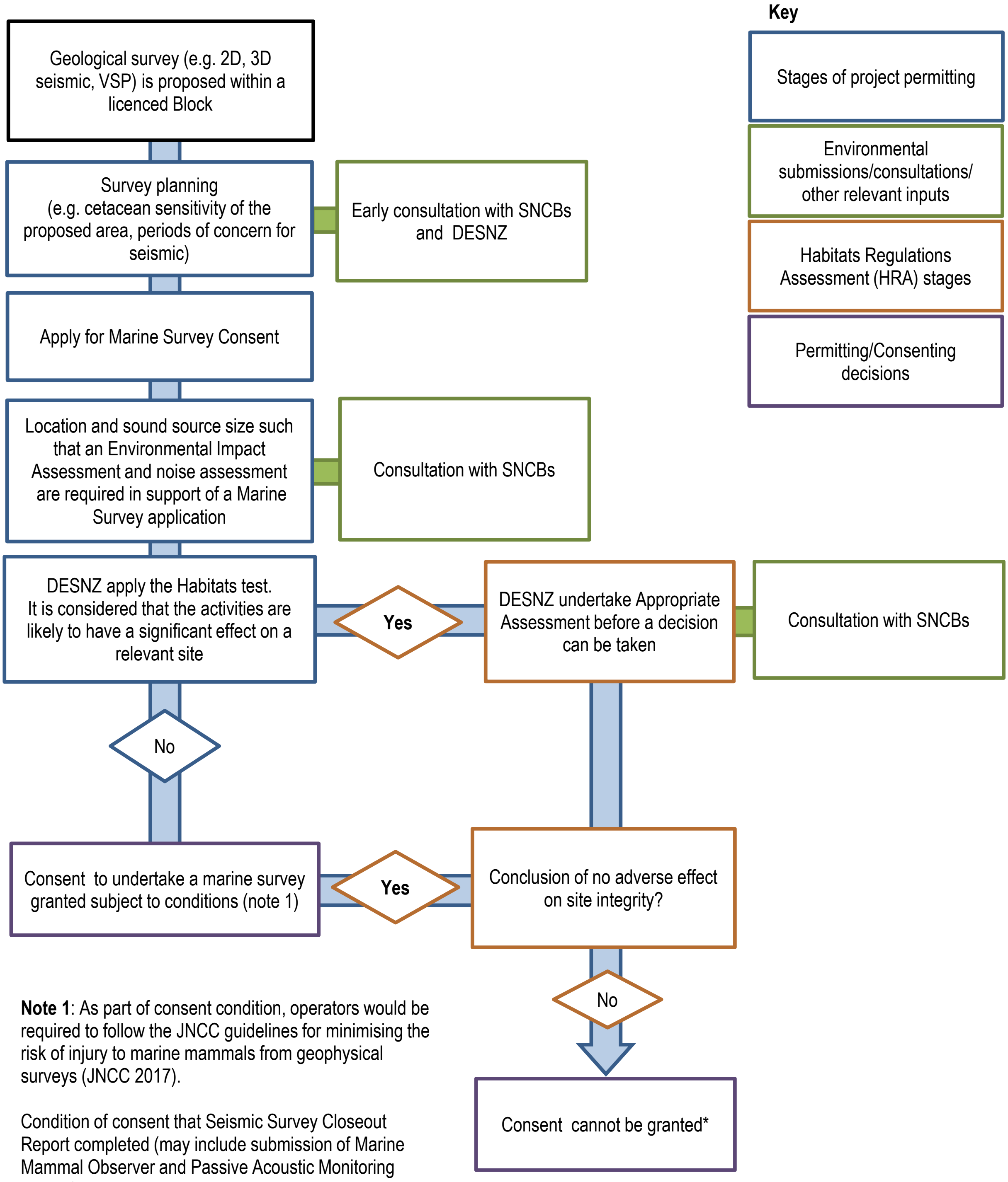
Note 1: See BEIS (2022). The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 – A Guide.

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



Note 1: As part of consent condition, operators would be required to follow the JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys (JNCC 2017).

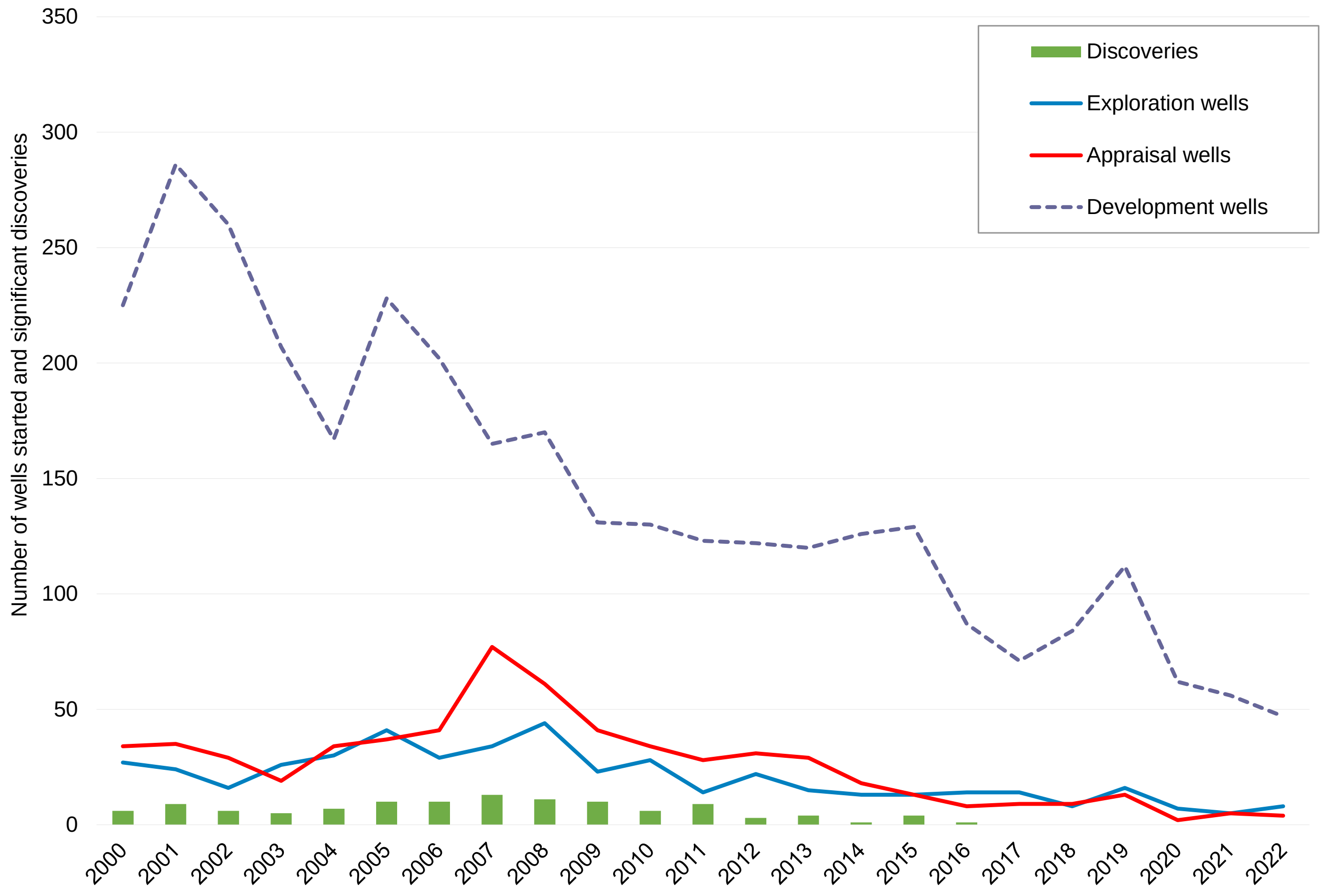
Condition of consent that Seismic Survey Closeout Report completed (may include submission of Marine Mammal Observer and Passive Acoustic Monitoring reports)

* 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).

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 described in Section 4 are 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, although seismic survey may cover parts of several or all Blocks comprising a single licence.

[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
36/14	✓	✓c	✓	N
36/15	✓	✓c	✓	N
36/19	✓	✓c	✓	N
36/20	✓	✓c	✓	N
36/30c	✓	-	✓	N
37/11	✓	✓c	✓	N
37/16	✓	✓c	✓	N
37/26	✓	-	✓	N
37/27	✓	-	✓	N
42/3	✓	-	✓	N
42/4	-	-	✓	N
42/5c	✓	✓c	✓	N
42/8	-	-	✓	N
42/12b	✓	✓c	✓	N
42/14	-	-	-	Y
42/15b	-	-	-	Y
42/28j	✓	-	✓	N
42/30b	-	-	✓	N
43/2b	✓	-	✓	N
43/3b	✓	-	✓	N
43/4b	✓	-	✓	N
43/9	✓	-	✓	N
43/12a*	✓	✓c	✓	Y

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

Block	Obtain[11] and/or reprocess 2D or 3D seismic data	Shoot 3D seismic	Drill or drop well/contingent well	Second Term
43/13*	✓	✓c	✓	Y
43/14*	✓	✓c	✓	Y
43/17*	✓	✓c	✓	Y
43/18*	✓	✓c	✓	Y
43/19d*	✓	✓c	✓	Y
43/20c*	✓	-	✓	N
43/21*	✓	✓c	✓	Y
43/22c	-	-	✓	N
43/24c	-	-	✓	N
43/25	✓	✓	✓	N
43/26b	-	-	✓	N
43/29	-	-	✓	N
43/30	✓	-	✓	N
44/13	✓	-	✓	N
44/16*	✓	-	✓	N
44/17*	✓	-	✓	N
44/18a	✓	-	✓	N
44/19b	✓	-	✓	N
44/21	✓	✓	✓	N
44/22	✓	-	✓	N
44/23a	✓	-	✓	N
44/27	✓	-	✓	N
47/3j	✓	-	✓	N
47/3k	✓	-	✓	N
47/4d	✓	-	✓	N

Block	Obtain[11] and/or reprocess 2D or 3D seismic data	Shoot 3D seismic	Drill or drop well/contingent well	Second Term
47/5b*	✓	✓c	✓	Y
47/7b	✓	✓c	✓	N
47/8a	✓	✓c	✓	N
47/9a	✓	-	✓	N
47/10c	✓	-	✓	N
47/13	✓	✓c	✓	N
47/14	✓	✓c	✓	N
47/15	✓	✓c	✓	N
47/20	✓	✓c	✓	N
48/1*	✓	✓c	✓	Y
48/2b*	✓	-	✓	N
48/6c	✓	-	✓	N
48/10	✓	-	✓	N
48/11b	-	-	✓	N
48/12a	✓	✓c	✓	N
48/14d	✓	✓c	✓	N
48/15b	✓	✓c	✓	N
48/16	✓	✓c	✓	N
48/17d	✓	✓c	✓	N
48/18c	✓	✓c	✓	N
48/20c	✓	-	✓	N
48/21	✓	✓c	✓	N
48/22a	✓	✓c	✓	N
48/23c	✓	✓c	✓	N
48/24	✓	✓c	✓	N

Block	Obtain[11] and/or reprocess 2D or 3D seismic data	Shoot 3D seismic	Drill or drop well/contingent well	Second Term
48/25d	✓	✓c	✓	N
48/28b	✓	✓c	✓	N
48/30c	✓	-	✓	N
49/11b	-	-	✓	N
49/16d	✓	-	✓	N
49/21b	✓	-	✓	N
49/21d	✓	✓c	✓	N
49/25b	✓	-	✓	N
49/26b	✓	-	✓	N
49/29	✓	-	✓	N
49/30b	✓	-	✓	N
50/21	✓	-	✓	N
50/26	✓	-	✓	N
52/5c	✓	-	✓	N
53/2c	✓	-	✓	N
53/3	✓	-	✓	N
53/4	✓	-	✓	N
53/5c	✓	-	✓	N

Note: c = contingent, * Block identified as in a SNS Priority Cluster by NSTA

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.

Table 2.2: Potential activities and assessment assumptions

Potential activity	Description	Assumptions used for assessment
Initial Term Phase B: Geophysical survey		
Seismic (2D and 3D) survey	2D seismic involves a survey vessel with an airgun array and a towed hydrophone streamer (up to 12km long), containing several hydrophones along its length. The reflections from the subsurface strata provide an image in two dimensions (horizontal and vertical). Repeated parallel lines are typically run at intervals of several kilometres (minimum *ca*. 0.5km) and a second set of lines at right angles to the first to form a grid pattern. This allows imaging and interpretation of geological structures and identification of potential hydrocarbon reservoirs. 3D seismic survey is similar but uses several hydrophone streamers towed by the survey vessel. Thus, closely spaced 2D lines (typically between 25 and 75m apart) can be achieved by a single sail line.	These deep-geological surveys tend to cover large areas (300-3,000km^2) and may take from several days up to several weeks to complete. Typically, large airgun arrays are employed with 12-48 airguns and a total array volume of 3,000-8,000in^3. From available information across the UKCS, arrays used on 2D and 3D seismic surveys produce most energy at frequencies below 200Hz, typically peaking at 100Hz, and with a peak broadband source level of around 256dB re 1μPa @ 1m (Stone 2015). While higher frequency noise will also be produced which is considerably higher than background levels, these elements will rapidly attenuate with distance from source; it is the components <1,000Hz which propagate most widely.
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	Jack-up rigs are used in shallower waters (normally <120m) and jacking the rig legs to the seabed supports the drilling deck. Each of the rig legs terminates in a spud-can (base plate) to prevent excessive sinking into the seabed. Unlike semi-submersible rigs, jack-up rigs do not require anchors to maintain station, and these are not typically deployed for exploration activities, with positioning achieved using several tugs, with station being maintained by contact of the rig spudcans with the seabed. Anchors may be deployed to achieve precision siting over fixed installations or manifolds at injection facilities, which are not considered in this assessment.	It is assumed that jack-up rigs will be three or four-legged rigs with 20m diameter spudcans with an approximate seabed footprint of 0.001km^2 within a radius of *ca*. 50m of the rig centre. For the assessment it is assumed that effects may occur within 500m of a jack-up rig which would take account of any additional rig stabilisation (rock placement) footprint. A short review of 20 Environmental Statements, which included drilling operations in the southern North Sea since 2007 (specifically in quadrants 42, 43, 44, 47, 48, 49 and 53) indicated that rig stabilisation was either not considered necessary and/or assessed as a worst-case contingency option. Where figures were presented, the spatial scale of potential rock placement operations was estimated at between 0.001-0.004km^2 per rig siting. Mud mats are routinely used in offshore oil & gas and offshore wind infrastructure. In particular they tend to be used below templates and pipeline end manifolds to control vertical and lateral

Potential activity	Description	Assumptions used for assessment
		movements of the structures, and also on the footings of jacket-type structures to provide on-bottom stability prior to the installation of piles, particularly on soft sediments (Dunne & Martin 2017, IFC 2021, Shell 2022, Ørsted 2022). Mud mats are generally made from steel, and are used to distribute the weight of the overlying infrastructure to prevent sinking into the sediment but also control lateral movements (Dunne & Martin 2017). Mud mats are also used for jack-up rig drilling (Stewart 2007) as an alternative to rock placement, though examples are fewer than for fixed infrastructure. Mud mats, if used, would be expected to be removed as part of the overall drilling programme, and would therefore, be only a temporary feature which would be permanently removed on completion of the work programme.
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 5.2.1 and 5.3.1 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 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 2017) in addition to referring to European Protected Species (EPS) guidance (JNCC 2010). 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).

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

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 the 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. Dogger Bank SAC, Humber Estuary SAC, The Wash and North Norfolk Coast SAC, North Norfolk Coast SPA, North Norfolk Sandbanks and Saturn Reef 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

[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 2017)

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 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 jack-up drilling rig spud can placement[18] (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 through rock placement around jack-up legs for rig stabilisation (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

Jack-up rigs, normally used in shallower water (<120m), leave three or four seabed depressions from the feet of the rig (the spudcans) of around 15-20m in diameter. The form of the footprint depends on factors such as the spudcan shape, the soil conditions, the footing penetration and methods of extraction, with the local sedimentary regime affecting the

[17] Following those noted in Section 4.2.
[18] It is unlikely that semi-submersible rigs would be used in the southern North Sea and mid-North Sea High areas due to shallow water depths across the area.

longevity of the footprint (HSE 2004). For example, side scan survey data from a 2011 pipeline route survey in Blocks 30/13c and 30/14 showed spudcan depressions from the drilling of a well in 2006 (no information on the depths of the depressions was provided). The well was located in a *ca*. 70m water depth, exposed to low tidal currents (0.1-0.26m/s) with sediments consisting of fine to medium silty sand with gravel, cobbles and coarse sand also present (Maersk 2011). By comparison, swathe bathymetry data collected as part of FEPA monitoring of the Kentish Flats wind farm off the Kent coast indicated a set of six regular depressions in the seabed at each of the turbine locations resulting from jack-up operations. Immediately post-construction, a January 2005 survey recorded these depressions as having depths of between 0.5 and 2.0m. By November 2007, these depths had reduced by an average of 0.6m indicating that the depressions were naturally infilling as a result of the mobile sandy sediments present across the area (Vattenfall 2009). Similar results are noted for Lincs wind farm (EGS 2016), with post construction monitoring indicating bathymetric changes to the seabed of up to 1.2m from jack-up depressions, and their infilling over time. In locations with an uneven or soft seabed, material such as grout bags or rocks may be placed on the seabed to stabilise the rig feet, and recoverable mud mats may be used in soft sediment (see below).

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. As noted above in relation to depressions from jack-up rig rigs, some natural infilling and recovery of the seabed would be expected following conductor removal, subject to local hydrodynamic conditions.

Broadly, physical effects of seabed disturbance may include mortality to benthic fauna as a result of physical trauma, smothering by re-suspended sediment. The majority of seabed species recorded from the European continental shelf are known, or believed to have, short lifespans (a few years or less) and relatively high reproductive rates, indicating the potential for rapid population recovery, typically between one to five years (Jennings & Kaiser 1998). In general, macrofaunal population levels are limited by post-settlement factors rather than larval availability.

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, respectively).

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[19], though is justified in relation to vessel use in shallow waters and in ports rather than drilling activities 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

As noted, there may be a requirement for jack-up rig stabilisation (e.g. rock placement or use of mud mats) depending on local seabed conditions, but this is not typical. In soft sediments, rock deposits may cover existing sediments resulting in a physical change of seabed type, and related habitat loss, which in the context of HRA, could lead to a reduction in feature extent that would need to be considered in relation to the site's conservation objectives and conservation status. 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[20] 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

[19] 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.
[20] https://www.insitenorthsea.org/

webinars[21]. 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[22].

4.2.4 Contamination[23]

In contrast to historic oil based mud (OBM) discharges[24], 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 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 (note that this is over 400m deeper than any of the areas on offer in this round). 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

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[21] https://insitenorthsea.org/impact
[22] https://insitenorthsea.org/projects/insite-overall-synthesis-project-2021-2023
[23] Including contamination from transition elements and organo-metals, hydrocarbons and PAHs, synthetic compounds and the introduction of other substances (solid, liquid or gas).
[24] 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.

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[25]. The Convention includes Regulations with specified technical standards and requirements (IMO Globallast website[26]). 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 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). 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.

With respect to the disturbance and subsequent displacement of seabirds in relation to offshore wind farm (OWF) developments, the Joint SNCB interim displacement advice[27] recommends for most species a standard displacement buffer of 2km with the exception of the species groups of divers and sea ducks for which JNCC (2022) recommend a 4km displacement buffer. Whilst displacement effects for divers have been detected at greater distances (e.g. 5-7km, Webb 2016; 8km, HiDef 2017; 10-16.5km, Mendel *et al.* 2019, Heinänen *et al.* 2020, APEM 2021; 10km, MacArthur Green 2019; 10-15km, Dorsch *et al.* 2019, Vilela *et al.* 2022), and a buffer of 10km is recommended by JNCC (2022), this relates to

[25] 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
[26] http://archive.iwlearn.net/globallast.imo.org/the-bwmc-and-its-guidelines/index.html
[27] https://hub.jncc.gov.uk/assets/9aecb87c-80c5-4cfb-9102-39f0228dcc9a

the construction and operation of offshore wind farms which have a much larger spatial and temporal footprint than oil and gas exploration activities.

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.

The presence and/or movement of vessels from and within the Blocks offered during exploration and appraisal activities could also potentially disturb marine mammals foraging within or close to sites for which they are a qualifying feature. Reported responses include avoidance, changes in swimming speed, direction and surfacing patterns, alteration of the intensity and frequency of calls and increases in stress-related hormones (Rolland *et al.* 2012, Dyndo *et al.* 2015, Veirs *et al.* 2016). Harbour porpoises, white-sided dolphins and minke whales have been shown to respond to survey vessels by moving away from them, while white-beaked dolphins have shown attraction (Palka & Hammond 2001). A study on captive harbour porpoises in a semi-natural net-pen complex in a Danish canal, recorded their behaviour while simultaneously measuring underwater noise of vessels passing the enclosure; reaction to noise was defined to occur when a highly stereotyped ‘porpoising’ behaviour was observed. Porpoising occurred in response to almost 30% of vessel passages; the most likely behavioural trigger were medium- to high- frequency components (0.25–63 kHz octave bands) of vessel noise, while low- frequency components of vessel noise and additional pulses from echo-sounders could not explain the results (Dyndo *et al*. 2015). A tagging study of a small number of free-ranging porpoises in Danish coastal waters estimated that porpoises encountered vessel noise 17–89% of the time (from evaluation of the wideband sound and movement tag recordings). Occasional high-noise levels (coinciding with a fast ferry) were associated with vigorous fluking, bottom diving, interrupted foraging and even cessation of echolocation, leading to significantly fewer prey capture attempts at received levels greater than 96 dB re 1 mPa (16 kHz third-octave, Wisniewska *et al.* 2018).

More evidence is available on bottlenose dolphins, especially for coastal populations. Shore-based monitoring of the effects of boat activity on the behaviour of bottlenose dolphins off the US South Carolina coast, indicated that slow moving, large vessels, like ships or ferries, appeared to cause little to no obvious response in bottlenose dolphin groups (Mattson *et al*. 2005). Pirotta *et al*. (2015) used passive acoustic techniques to quantify how boat disturbance affected bottlenose dolphin foraging activity in the inner Moray Firth. The presence of moving motorised boats appeared to affect bottlenose dolphin buzzing activity (foraging vocalisations), with boat passages corresponding to a reduction by almost half in the probability of recording a buzz. The boat effect was limited to the time where a boat was physically present in the sampled area and visual observations indicated that the effect increased for increasing numbers of boats in the area (Pirotta *et al.* 2013). Dolphins appeared to temporarily interrupt their activity when disturbed, staying in the area and quickly resuming foraging as the boat moved away.

Of primary concern for this HRA, is whether vessels linked to potential operations result in a significant increase to overall local traffic. New *et al*. (2013) developed a mathematical model simulating the complex social, spatial, behavioural and motivational interactions of coastal bottlenose dolphins in the Moray Firth to assess the biological significance of increased rate of behavioural disruptions caused by vessel traffic. A scenario was explored in which vessel traffic increased from 70 to 470 vessels a year but despite the more than six-fold increase traffic, the dolphins' behavioural time budget, spatial distribution, motivations and social structure remained unchanged. While harbour porpoises appear to be more sensitive to potential disturbance than bottlenose dolphins, the increase in vessel traffic linked to the proposed plan is expected to be negligible (see Table 2.2). In UK waters, a modelling study indicated a negative relationship between the number of ships and the presence and abundance of harbour porpoises within relevant management units when shipping intensity exceeded a suggested threshold of approximately 50 ships per day (within any of the model's 5km grid cells) in the Celtic Sea/Irish Sea and 80 ships per day in the North Sea (Heinänen & Skov 2015). The Marine Management Organisation project "Mapping UK shipping density and routes from AIS" (MMO 2014b) and the 2015 national dataset of marine vessel traffic[28] provides relevant shipping density information[29]. From 2015 AIS-derived ship density data, the approaches to major ports such as in the Humber and Thames regions had estimated shipping densities of up to 500 vessels per week, with the majority of coastal waters (10-25 vessels per week) and offshore waters (<5 vessels per week) supporting much lower densities. Jones *et al.* (2017) used the MMO (2014b) data to highlight areas where high rates of co-occurrence between seals at-sea and shipping coincided with SACs. They predicted exposure to shipping (and associated shipping noise) was likely to be high in areas where very high intensities of spatial overlap occurred for one or both species of seals such as Orkney (e.g. Faray and Holm of Faray SAC), Shetland (e.g. Yell Sound Coast SAC), east coast of Scotland and England (e.g. Berwickshire and North Northumberland Coast SAC, Humber Estuary SAC, the Wash and North Norfolk Coast SAC), west Scotland (South East Islay Skerries SAC) and north Wales (no adjacent SAC with seals as a feature).

4.2.7 Collisions above or below water with static or moving objects

Worldwide, collisions with vessels are a potential source of mortality to marine mammals, primarily cetaceans. Whales are occasionally reported to be struck and killed, especially by fast-moving ferries but smaller cetacean species and seals can also be impacted by propeller strikes from smaller vessels. In the UK certain areas experience very high densities of commercial and recreational shipping traffic, some of which may also be frequented by large numbers of marine mammals; despite this, relatively few deaths are recorded as results of collisions (Hammond *et al.* 2008). Between 2000 and 2009, only 11 out of 1,100 post-mortems on harbour porpoises and common dolphins identified collision as the cause of death (UKMMAS 2010). Advice on operations for the Southern North Sea SAC[30] indicates that post mortem investigations of harbour porpoise deaths have revealed death caused by trauma (potentially linked with vessel strikes) is not currently considered a significant risk (e.g. see Deaville & Jepson 2011).

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[28] https://data.gov.uk/dataset/vessel-density-grid-2015
[29] Note that shipping densities are low over the majority of Blocks with higher densities primarily in coastal waters close to major ports.
[30] https://hub.jncc.gov.uk/assets/206f2222-5c2b-4312-99ba-d59dfd1dec1d#SouthernNorthSea-conservation-advice.pdf

4.3 Underwater noise effects[31]

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 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. 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[32] 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

[31] Note that all underwater noise effects fall within the "underwater noise change" and "vibration" pressure definitions.

[32] 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).

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.

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[33] 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 experiment undertaken at the Energy Island lease area in Danish waters, at water depths of ~35m, Pace *et al.* (2021) 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.

While acknowledging that some of the results from the above studies require refinement, for all the aforementioned devices, broadband sound levels recorded a few hundred metres from the source were significantly lower than the criteria for permanent or temporary hearing loss (Southall *et al*. 2019).

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[34]).

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,

[33] “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

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

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 effects therefore it is considered appropriate to focus on marine mammals when assessing risk from underwater noise; however, high amplitude impulsive noise also potentially presents a risk to fish and diving birds.

Marine mammals

The risk of physical injury (hearing loss) from an activity can be assessed by modelling the propagation of sound from an activity and using threshold criteria corresponding to the sound levels at which permanent hearing loss (permanent threshold shift, PTS) would be expected to occur. For marine mammals, the applicable SEA (DECC 2016) reflects the injury thresholds criteria developed by Southall *et al.* (2007), including the subsequent update for harbour porpoises in Lepper *et al*. (2014), based on the work by Lucke *et al.* (2009). Since then, NOAA has further updated the acoustic thresholds, including alternative frequency-weighting functions (NMFS 2016, 2018) which were adopted as updated criteria thresholds in the peer-reviewed literature (Southall *et al.* 2019). It is recognised that geophysical surveys (primarily 2D and 3D seismic) have the potential to generate sound that exceeds thresholds of injury, but only within a limited range from source (tens to hundreds of metres); for site surveys and VSP, the range from source over which injury may occur will be even smaller. Within this zone, JNCC (2017) guidelines are considered to be sufficient in minimising the risk of injury to marine mammals to negligible levels. Hastie *et al.* (2019) notes application of the criteria thresholds typically assumes that the broad characteristics of a source (impulsive or non-impulsive) remains constant throughout its propagation range. However, a range of impulsive characteristics (e.g. peak pressure, signal duration, rise time and kurtosis) are known to vary with distance from source (Hastie *et al*. 2019, von Benda-Beckmann et al. 2022, Guan *et al*. 2022), with Hastie *et al*. (2019) indicating the greatest change within <10km from the source. Given that published thresholds for PTS onset as a result of exposure to impulsive signals are lower than the non-impulsive thresholds in all species groups (Southall *et al*. 2007, 2019), there is the potential that the risk of auditory damage may be overestimated in cases where impulsive signals become non-impulsive with propagation (Hastie *et al.* 2019). Other factors such as duty cycle and the respective recovery periods between signals will also likely influence the risk of hearing damage from repetitive sounds such as from pile driving and seismic surveys (Hastie *et al*. 2019).

With respect to behavioural disturbance of marine mammals, it is more difficult to establish broadly applicable threshold criteria based on exposure alone. This is due, in part, to the challenges encountered in studies of wide-ranging species with complex behaviour, but is largely because many behavioural responses are context-specific (e.g. Gomez *et al*. 2016, Harding *et al*. 2019). For compliance with the Habitat Directive, the guidance for the protection of marine European Protected Species from injury and disturbance (JNCC 2010) recommends that ‘disturbance’ is interpreted as sustained or chronic disruption of behaviour scoring five or more in the Southall *et al*. (2007) behavioural response severity scale[35]. This is to highlight that a disturbance offence is unlikely to occur from sporadic changes in behaviour with negligible consequences on vital rates and population effects (i.e. trivial disturbance). While it is possible to envisage how some behavioural effects may ultimately influence vital rates, evidence is currently limited. The focus of field studies has been on measuring displacement and changes in vocalisation with the assumption that these may influence vital rates mainly via a reduction in foraging opportunities. It is noted that Southall *et al*. (2021) proposes a revised

[35] See Table 4 (p450) of Southall *et al.* (2007) for a full description of response scores.

framework more focused on expected longer term and ultimately population-level consequences of behavioural responses affecting key vital functions (survival, feeding and reproduction).

Evidence of the effects of seismic surveys on odontocetes and pinnipeds is limited but of note are studies in the Moray Firth observing responses to a 10 day 2D seismic survey in September 2011 (Thompson *et al.* 2013a). The survey exposed a 200km^2 area to noise throughout that period; peak-to-peak source levels generated by the 470 cubic inch airgun array were estimated to be 242-253 dB re 1 µPa at 1m and are therefore representative of the volume of a typical array used in VSP, and larger than that used in rig-site survey. Within 5-10km from the source, received peak-to-peak SPLs were estimated to be between 165 and 172 dB re 1 µPa, with SELs for a single pulse between 145 and 151 dB re 1 µPa^{2}s. A relative decrease in the density of harbour porpoises within 10km of the survey vessel and a relative increase in numbers at distances greater than 10km was reported; however, these effects were short-lived, with porpoise returning to affected areas within 19 hours after cessation of activities. Overall, it was concluded that while short-term disturbance was induced, the survey did not lead to long-term or broad-scale displacement (Thompson *et al*. 2013a). Further acoustic analyses revealed that for those animals which stayed in proximity to the survey, there was a 15% reduction in buzzing activity associated with foraging or social activity; however, a high level of natural variability in the detection of buzzes was noted prior to survey (Pirotta *et al*. 2014). Passive acoustic monitoring provided evidence of short-term behavioural responses also for bottlenose dolphins, but no measurable effect on the number of dolphins using the Moray Forth SAC could be revealed (Thompson *et al*. 2013b). Analysis of ten years of PAM data covering the 2011 seismic survey and pile-driving activities associated with the construction of two offshore windfarms in the Moray Firth in 2017 and 2019 (Fernandez-Betelu *et al*. 2021), revealed potential far-field effects on the coastal bottlenose dolphin population associated with the Moray Firth SAC. Comparing between years, dolphins used Moray Firth inshore areas regularly, albeit the extent of use varied from year to year without any consistent relationship to the impulsive noise generated by offshore activities (which were over 20km (seismic survey), 40km (Moray East) and 50km (Beatrice) from the southern coast). At the smaller temporal scale comparing days in which impulsive noise was present or absent, showed an increase in dolphin detections on the southern coast on days with impulsive noise (whether as a result of an increase in group size or change in vocalisation rate was not possible to determine). This increase was consistent between all three offshore projects suggesting that distant impulsive noise sources may have caused modifications of bottlenose dolphin vocalisations but only over the short term (less than a day).

High frequency sources with central operating frequencies at the upper end of marine mammal hearing ranges or above (e.g. echosounders, side-scan sonar) have been shown to emit energy at lower frequencies audible to most marine mammals (e.g. Risch *et al.* 2017), although at reduced amplitudes and with a small, emitted sound field which is unlikely to cause behavioural effects (Cotter *et al.* 2019). Consideration of the higher frequency signals, typically lower source levels and higher directionality of these and other similar sources has led to the assumption that these would not propagate far enough for marine species to be negatively affected by received levels (Halvorsen & Heaney 2018). Similar conclusions were drawn by Ruppel *et al.* (2022) as described in the previous section. Pace *et al.* (2021) considered the cumulative exposure from a typical geophysical survey which incorporated vessel noise, sub-bottom profilers (parametric and sparker), MBES, and SSS with USBL positioning, which indicated that TTS thresholds for the SEL were exceeded <10m from the source for all functional hearing groups (Southall *et al.* 2019) other than very-high frequency cetaceans (333m), which was the only group to exceed PTS thresholds, within a range of 7.2m (90% CI of 502.2m and 16.9m respectively). A precautionary approach has been adopted where it is acknowledged that such sources are within the hearing range of marine mammals and therefore could, in a few cases, cause localised short-term impacts on behaviour or temporary displacement of a small number of individuals (Boebel *et al.* 2005).

A conservative assessment of the potential for marine mammal disturbance from seismic surveys will assume that firing of airguns will affect individuals within 10km of the source (in keeping with the Effective Deterrence Radius (EDR) suggested by SNCBs), resulting in changes in distribution and a reduction of foraging activity, but the effect is short-lived. A 5km Effective Deterrence Radius (EDR) has also been suggested by UK SNCBs as appropriate in assessing geophysical survey disturbance. The precautionary criterion applied during initial screening (15km from relevant sites) is maintained here to identify the Blocks applied for to be considered with respect to likely significant effects in this assessment (see Section 5.2); this is to reflect the degree of uncertainty and the limited direct evidence available and to allow for a greater potential for disturbance when large array sizes are used.

Evidence on harbour porpoise responses to impact piling during wind-farm construction is also relevant since the impulsive character of the sound generated during piling is comparable with that from seismic airguns and for assessing in-combination effects with wind farms currently planned or under construction across the North Sea. Empirical studies during the construction of OWFs in the North and Baltic Seas (Carstensen *et al*. 2006, Tougaard *et al*. 2009, Brandt *et al*. 2011, 2018, Dähne *et al.* 2013, Thompson *et al*. 2020, Benhemma-Le Gall *et al.* 2021, Graham *et al*. 2023, Voß et al. 2023) have all observed displacement of harbour porpoises in response to pile-driving. The magnitude of the effect (spatial extent and duration) varied between studies as a function of the many factors including exposure level, duration of piling, use of technical mitigation measures and ecological importance of the area. Nonetheless, from the available evidence it has been concluded that impact piling will displace individual harbour porpoises within an area of approximately 20km radius (BEIS 2022).

Graham *et al.* (2019) investigated harbour porpoise behavioural responses to piling noise using echolocation detectors (C-PODs) and noise recorders during the 10-month foundation installation of a wind farm in the Moray Firth. Each turbine base was secured using four 2.2m diameter steel piles, installed with a typical hammer energy of 600-700kJ. Using an array of acoustic loggers moored between 0.4 and 76.5km from piling locations, acoustic detections of porpoise in the 24 hours following the end of piling events (lasting *ca.* 5 hours) were examined relative to detections during a baseline period 24-48 hours prior to the onset of piling. Harbour porpoise were present within the windfarm construction site throughout the construction period. The probability of response (significantly reduced detections) reduced with increasing distance to piling and as the number of locations piled increased: there was a ≥50% probability of a behavioural response at a distance of 7.4km from piling at the start of construction, reducing to 4.0km midway through construction, and 1.3km at the final piling event. Acoustic Deterrent Devices (ADDs) were used prior to almost all piling events examined. While data for piling without ADD use was limited, thereby reducing the ability to distinguish the effects of different sound sources, the study results suggest that response levels were increased with ADD use. Thompson *et al*. (2020) also reported a strong harbour porpoise behavioural response to ADD mitigation usage prior to piling at Beatrice, noting a 50% chance of response within 21.7km. Interestingly, during the installation of the pin piles at Beatrice, Thompson *et al.* (2020), recorded, contrary to expectation, the highest received noise levels at lower hammer energies during the soft-start period. The authors noted that pin piles of between 35 and 45m were driven to within 2m of the seabed using a submersible hammer in depths of up to 45m. Thus, during soft starts, the entire pile could be within the water column, while at the highest hammer energies, most of the pile was embedded in the sediment. It was suggested that with respect to the installation of pin-pile jackets at deeper offshore windfarm sites, regulators consider limiting initial hammer energies and encourage the use of installation systems that best minimise these.

Graham *et al*. (2023) used a linear array of hydrophone clusters within the Moray East offshore wind farm to determine whether harbour porpoise responded to ADD usage by moving away. During baseline periods, porpoise movements were evenly distributed in all directions. However, animals showed significant directional movement away from sound sources during ADD use and piling soft starts. Evasive responses were reported at distances of up to 7km during ADD use and 9km (the maximum distance between hydrophone clusters and the construction site) during the piling soft start. Alternative acoustic porpoise deterrents (APD) developed to reduce the scale of disturbance produced by traditional ADDs have been tested with Voß *et al*. (2023), reporting a 30-100% decrease in harbour porpoise detection rates at 750m distance during APD operation compared to 6 hours before APD operation. Significantly, reduced detection rates during APD operation were only observed up to about 2.5 km distance. See also recent JNCC review of ADD usage for marine mammal mitigation (McGarry *et al.* 2022).

SNCB advice (e.g. JNCC 2020) assumes a 15km zone of disturbance for conductor pile-driving. Graham *et al*. (2019) provided evidence that the probability of harbour porpoise behavioural responses to piling was low at distances >10km and unlikely to exceed 20km, and diminished over time. Considering these results relative to the typical pile diameters and hammer energies used in conductor piling, the 15km noise effects criterion applied in this screening is considered to be suitably precautionary for harbour porpoise.

At the Danish Horns Rev wind farm, satellite telemetry showed that harbour seals were still transiting the site during periods of piling, but no conclusive results could be obtained from analysis of habitat use with regard to a change in response to piling (Tougaard *et al*. 2006). Evidence of a response was obtained by Edrén *et al.* (2010) at a haul-out site 4km away from the Danish Nysted windfarm; during piling, numbers hauling out were reduced by 10-60% but the effect was only of short duration since the overall number of seals increased slightly during the whole construction phase. Russell *et al*. (2016) used telemetry data from 23 harbour seals to investigate potential avoidance of seals to the construction of the Lincs wind farm in The Wash off the east coast of England, including pile-driving of mono-pile foundations. While there was no significant displacement during construction as a whole, seal abundance during piling was significantly reduced up to 25km from the piling activity, with a 19-83% (95% confidence intervals) reduction in usage compared to breaks in piling activity. This displacement was temporary, with seals returning to their non-piling distribution within two hours of the cessation of piling.

Information on the potential effects of other geophysical surveys (e.g. sub-bottom profilers) is limited, with empirical studies of animal responses to such surveys lacking. Recent laboratory and field studies of the source levels and propagation of a variety of high-resolution geophysical survey sources (see Section 4.5.1) provided evidence to support the conclusion of negligible risk of significant effects from electromagnetic sources, with received levels dropping to below that which might be expected to cause behavioural disturbance within a few hundred metres of the source (Halvorsen & Heaney 2018).

With regard to conductor piling, the low hammer energy, narrow diameter of pipes and short duration of piling, combined with field measurements of sound propagation from this activity (Jiang *et al*. 2015, MacGillivray 2018), and the behavioural responses reported in Graham *et al*. (2019), suggest a very low potential for significant disturbance of marine mammals.

Noise from vessels and drilling activity is audible to marine mammals but are not of the characteristics sufficient to cause injury. Vessel noise may elicit low-level disturbance effects in marine mammals (e.g. changes in vocalisation rates and dive behaviour)[36]; however, such effects are temporary, of limited spatial extent. Benhemma-Le Gall *et al*. (2021) noted with respect to offshore wind farms, that whilst pile-driving produced the highest amplitude noise, active piling occurred for <10% of the time in the 9–10-month piling phases at Beatrice and Moray East. It was noted that whilst responses to these short but intense periods of impulsive noise sources were of greater magnitude, harbour porpoise occurrence and buzzing activity also decreased in response to more chronic exposure to vessel traffic throughout construction. The probability of detecting porpoises and buzzing activity was positively related to the distance from vessel and construction activities, and negatively related to levels of vessel intensity and background noise with displacement observed at up to 12km from pile-driving activities and up to 4km from construction vessels.

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 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

[36] Note that in studies of animals in the wild it is difficult to determine the relative contribution of noise and physical presence of vessels in the observed responses, with the latter discussed in Section 4.4.6.

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[37]. 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 cormorant (Garthe & Hüppop 2004, Fliessbach *et*

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

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

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 2023a) 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. 91 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 southern North Sea and mid North Sea High Blocks is documented in Sections 5.2-5.4.

Southern North Sea SAC

The Southern North Sea SAC is an area with predicted persistent high densities of harbour porpoise. Individuals in the UK are part of the north east Atlantic population which is mainly considered to be a single ‘continuous’ population, even though some degree of genetic differentiation has been observed (Andersen *et al.* 1997, 2001, Tolley *et al.* 2001, Fontaine *et al.* 2007). From a management and conservation perspective however, three distinct UK Management Units (MU) have been identified; the North Sea, West Scotland and the Celtic & Irish Seas (IAMMWG 2022). The Southern North Sea SAC supports an estimated 17.5% of the UK North Sea Management Unit (MU) population. It was selected primarily on the basis of preferential and prolonged use by harbour porpoises in contrast to other areas of the North Sea, but variability in numbers within the site and across the North Sea (seasonally and between years) is known to be high. Approximately two thirds of the site, the northern part, is recognised as important for porpoises during the summer season, whilst the southern part supports persistently higher densities during the winter (see Figure 5.2). A large southerly shift in distribution was reported across the North Sea between 1994 and 2005 when SCANS and SCANS-II surveys took place (Hammond *et al*. 2013). As part of the site identification process, analysis of the observed density of harbour porpoise against different environmental variables (Heinänen & Skov 2015) indicated that the coarseness of the seabed sediment was an important determinant of porpoise density, with porpoises showing a preference for coarser sediments (such as sand/gravel) rather than fine sediments (e.g. mud). Sandeels, which are known prey for harbour porpoises, exhibit a strong association with sandy substrates. The majority of the substrate types within the site are categorised as sublittoral sand and sublittoral coarse sediment. Moderate energy levels at the seabed (including wave and tidal energy) are estimated across the majority of the site[38]. The conservation objectives[39] indicate that the

[38] https://hub.jncc.gov.uk/assets/206f2222-5c2b-4312-99ba-d59dfd1dec1d#SouthernNorthSea-SAC-selection-assessment-document.pdf
[39] https://hub.jncc.gov.uk/assets/206f2222-5c2b-4312-99ba-d59dfd1dec1d#SouthernNorthSea-conservation-advice.pdf

concept of 'site population' may not be appropriate for this species. It highlights the need to assess impacts on the site based on how the proposed activities translate into effects on the relevant MU population. In the case of this AA, it refers to the North Sea MU ranging from the east coast of the UK to part of Denmark (Skagerrak and northern Kattegat). The abundance of harbour porpoise for the North Sea MU was estimated in 2016 (Hammond *et al.* 2021) as part of SCANS-III (369,560, CV = 0.22), which is similar to the 2005 estimate (335,000 CV = 0.22); the most recent estimate (IAMMWG 2022) is 364,601 (CV = 0.09).

Dogger Bank SAC

The Dogger Bank SAC was formed by glacial processes before being submerged through sea level rise during the last marine transgression (by *ca*. 8,000 years BP). The southern part of the bank is covered by water seldom deeper than 20m and extends within the SAC in UK waters down to 35-40m deep. The bank structure slopes down to greater than 50m deep in UK, Dutch and German waters and its location in open sea exposes the bank to substantial wave energy preventing the colonisation of the sand by vegetation on the shallower parts of the bank. Large parts of the Dogger Bank are situated above the storm-wave base (Connor *et al.* 2006) and it is estimated that during a storm event, sediment up to medium sand particles can be mobilised in 60m water depth at the northern slope of the Dogger Bank (Klein *et al*. 1999). Models of natural disturbance have estimated that the Dogger Bank is disturbed to 4cm depth at least once every year by tides and waves (Diesing *et al*. 2013). The majority of sediments present across the Dogger Bank consist of fine sands with mud content below 5% (JNCC 2011) with sandy gravel in patches mainly concentrated on the western edge of Dogger Bank. There is evidence of small mixed sediment patches near the centre of the site. Coarse sediment patches are widespread, most of which are relatively small, but a few larger patches are notable towards the western and southern edges of the site. There are also a few muddy sediments in the central north area (Eggleton *et al.* 2017). Key and influential species associated with the sandbank feature include a variety of bioturbators, predators and grazers which have been recorded from surveys within the site, such as polychaete worms *(Spiophanes bombyx),* brittle stars *(Amphiura filiformis)*, as well as sea urchins, gastropods, hermit crabs and other unidentified crustaceans (Eggleton *et al*. 2017). The most frequently observed taxonomic groups in the epifauna were Asteroidea *(Asterias rubens, Astropecten irregularis)*, the Cnidarian, *Alcyonium digitatum*, the bryozoan *Flustra* sp. and Paguridae *(Pagurus bernhardus*) although these varied widely with sediment composition (Eggleton *et al*. 2017). Sandeels have been recorded on the western side of the bank (Forewind 2013).

The condition of the Annex I sandbank feature for which the site is designated is considered to be unfavourable (Eggleton *et al.* 2017), such that the SACO for the Dogger Bank SAC[40] advises that the site feature extent and distribution, and structure and function should be restored, while supporting processes be maintained. Related to this, a fisheries byelaw came into force in June 2022 which prohibits the use of bottom towed fishing gear across the entirety of the SAC[41].

Doggersbank SAC & Klaverbank SAC (Netherlands)

A profile of the habitat type associated with the Dutch Doggersbank SAC site is not available[42] but it is a continuation of the UK Dogger Bank SAC and contains similar habitat types[43].

[40] https://hub.jncc.gov.uk/assets/26659f8d-271e-403d-8a6b-300defcabcb1#DoggerBank-3-SACO-v1.0.pdf
[41] https://www.gov.uk/government/publications/the-dogger-bank-special-area-of-conservation-specified-area-bottom-towed-fishing-gear-byelaw-2022
[42] https://www.noordzeeloket.nl/en/policy/noordzee-natura-2000/gebieden/doggersbank/dogger-bank/habitattype/
[43] https://www.emodnet-seabedhabitats.eu/

Similarly, a profile of the reef habitat of the Dutch Klaverbank SAC is not available[44]. Both sites have grey and harbour seal and harbour porpoise listed as qualifying features although this reflects that animal's range throughout the Dutch EEZ rather than the sites having special significance for reproduction, foraging or otherwise (Jak *et al.* 2009). Models based on grey seals (Jones & Russell 2016) and harbour seals tagged in the UK (Jones *et al.* 2017) and Dutch coast (Aarts *et al*. 2016) suggest a low density of both species in the sites and surrounding area (i.e. < 0.1 seal per km^2). Data from grey seals tagged on the Dutch coast also suggest limited presence of grey seals in the area compared to coastal waters, although animals do pass through the sites when moving between Dutch and UK waters (Brasseur *et al.* 2015). While the sandbank and reef habitats and associated fish communities may provide valuable foraging opportunities for seals, the sites are located >180km from the nearest UK and continental landfalls, placing them beyond the 50km (harbour) and 100km (grey) ranges from haul-out sites where the majority of foraging activity occurs (Jones *et al*. 2015). For both species, their abundance in the site was assessed as 0-2% of the national (Dutch) population, although no specific values were available. Harbour porpoise abundance within the site was assessed as 2-15% of the national (Dutch) population, with no specific values available, and modelling studies estimate that the site represents an area of higher harbour porpoise density relative to many other areas in the North Sea. Those further west, in UK waters (i.e. the Southern North Sea SAC), typically support the highest densities in the region, although the distribution of this highly mobile, wide-ranging species varies (Heinänen & Skov 2015; Gilles *et al.* 2016).

Humber Estuary SAC

The Humber Estuary SAC is a muddy, macro-tidal estuary, fed by a number of rivers including the Rivers Ouse, Trent and Hull. Suspended sediment concentrations are high, and are derived from a variety of sources, including marine sediments and eroding boulder clay along the Holderness coast. The extensive mud and sand flats support a range of benthic communities, which in turn are an important feeding resource for birds and fish. Wave exposed sandy shores are found in the outer/open coast areas of the estuary. These change to the more moderately exposed sandy shores and then to sheltered muddy shores within the main body of the estuary and up into the tidal rivers. Fish species include river lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus* which breed in the River Derwent, a tributary of the River Ouse.

Grey seals *Halichoerus grypus* come ashore in autumn to form breeding colonies on the sandy shores of the south bank at the mouth of the Humber at Donna Nook, where annual pup production has almost doubled in the past 10 years to approximately 2,000 pups in the 2019 breeding season (SCOS 2021, Lincolnshire Wildlife Trust[45]). Colonies on the mainland coast and especially in the southern North Sea, have increased rapidly since 2000, but the rate of increase has been lower in recent years (*ca.* 10.1% p.a., 2016-2019 compared to 22% p.a., 2010-2014), perhaps an early indication it is approaching a carrying capacity (SCOS 2021). Tagging studies show that grey seals use offshore areas, with the majority using areas within 100km from the coast connected to their haul-out sites by prominent corridors, although density is greatest in coastal waters adjacent to colonies.

Models of the at-sea distribution of grey seals (e.g. Jones *et al.* 2015, Russell *et al.* 2017, Carter *et al.* 2020) show that a large area of estimated high density (relative to the majority of UK and Irish waters) of grey seals radiates out from the Humber Estuary SAC. While the

[44] https://www.noordzeeloket.nl/en/policy/noordzee-natura-2000/gebieden/klaverbank/cleaver-bank/habitattype/
[45] Lincolnshire Wildlife Trust website: http://www.lincstrust.org.uk/donna-nook/weekly-update

highest predicted densities of ≥100 seals per grid cell are within *ca*. 12km of the site boundary, densities of 50-100 seals per grid cell extend up to almost 20km from the site boundary. Furthermore, there are several discrete areas of relatively high density (50-100 seals per grid cell) up to *ca*. 60km offshore and over 80km from the site boundary, lying within a larger area of moderate-high relative density (10-50 seals per grid cell) extending from the site. While it is likely that some grey seals occurring in these offshore areas breed at colonies elsewhere on the UK east coast (e.g. Blakeney Point, Farne Islands), due to the area's proximity to the large colony at Donna Nook (at the mouth of the Humber Estuary), and the tracks of individuals seals tagged there connected with these areas, the majority of seals using these waters are likely to be associated with the Humber Estuary SAC. Furthermore, tracks from seals tagged at Donna Nook suggest that this area provides a route for seals in transit to/from foraging patches further offshore, over the Dogger Bank.

North Norfolk Sandbanks and Saturn Reef SAC

The North Norfolk Sandbanks and Saturn Reef SAC contains the most extensive example of offshore linear ridge sandbanks in UK waters, and encompasses an area where previous seabed surveys identified an extensive biogenic reef created by the ross worm *Sabellaria spinulosa*, called Saturn reef (Jenkins *et al*. 2015). The sandbanks are subject to a range of current strengths which are strongest on the banks closest to shore and are dominated by sandy sediments (see Parry *et al.* 2015). Whilst the sandbanks are very similar in terms of the biological communities present, increasing species numbers have been recorded on the outermost banks, likely related to the change in hydrodynamic regime with increasing distance from the coast[46]. First discovered in 2002, the Saturn reef covered an area approximately 750m by 500m just to the south of Swarte Bank. More recent surveys failed to identify the extensive areas of *S. spinulosa* reef previously observed but did find reefs in the area which highlights the ephemeral nature of the feature and indicates that favourable conditions for *S. spinulosa* formation occur within the site (see JNCC website and Jenkins *et al*. 2015). The reef and sandbank features of the site are considered to be in unfavourable condition, being subject to a range of pressures including those from demersal fishing, aggregate extraction, and offshore energy related activity. The site is subject to significant fisheries pressures, which the MMO concluded were likely to have an adverse effect on site integrity. The MMO are presently considering the need for, and nature of, any fisheries management measures for the site[47].

Haisborough, Hammond and Winterton SAC

The Haisborough, Hammond and Winterton SAC contains a series of sandbanks that run parallel to the coast. The sandy sediments within the site are very mobile in the strong tidal currents of the area, and though large-scale bank migration or movement appears to be slow, there is a level of sediment movement around and across the banks evidenced by megaripple and sandwave formations. Infaunal communities of the sandy bank tops are consequently of low biodiversity, characterised by mobile polychaetes and amphipods which are able to rapidly re-bury themselves into the dynamic sediment environments. Along the flanks of the banks, and towards the troughs between the banks the sediments tend to be slightly more stable with gravels exposed in areas. In these regions of the site, infaunal and epifaunal communities are much more diverse. *Sabellaria spinulosa* reefs are located at Haisborough Tail, Haisborough Gat and between Winterton Ridge and Hewett Ridge and arise from the surrounding coarse sandy seabed to heights of between 5cm to 10cm. The site is subject to significant fisheries pressures, which the MMO has concluded are likely to have an adverse effect on site integrity.

[46] http://jncc.defra.gov.uk/page-6537
[47] https://www.gov.uk/government/publications/managing-fisheries-in-marine-protection-areas-call-for-evidence

Some parts of the site in territorial waters are subject to fisheries bylaws that prevent the use of bottom-towed fishing gear, however, offshore areas are not subject to measures but are subject to demersal fisheries pressures. The MMO are presently considering whether fisheries management measures in the offshore aera of the site would be appropriate[48].

The Wash and North Norfolk Coast SAC

Subtidal sandbanks and reefs are widespread throughout The Wash and North Norfolk coast, with the site containing a significant proportion of the *Sabellaria spinulosa* reef located on the eastern coast of the UK. The large areas of intertidal sand and mudflats form important habitat for polychaete worms, bivalves and crustaceans and foraging ground for wading bird species (see The Wash SPA and North Norfolk Coast SPA). Further inland, the site supports saltmarsh and saline reedbeds, with *Salicornia* and saltmarsh communities colonising the sand and mudflats. Atlantic salt meadows in the site form one of the most diverse and extensive examples of this habitat in the UK. The salt meadow expanse within the site also includes the only location in the UK where all the more typically Mediterranean species that characterise Mediterranean and thermo-Atlantic halophilous scrubs occur together.

Harbour seals haul-out to rest on the sandbanks at Blakeney Point and in the Wash with numbers varying throughout the year. In winter, seals appear to spend more time at sea, during the breeding season (late June – early July) they appear more dispersed and in smaller groups than during their moult. Throughout the annual moult, late July to early September, groups tend to be larger than at other times and the numbers at haul-out sites reaches a maximum. Population numbers across the site have decreased in recent years, with 2,724 adults in The Wash and 135 at Blakeney Point in 2021, relative to 3,762 and 460 in 2015 at those locations respectively (SCOS 2021).

At a British Isles-level, harbour seals primarily occur in coastal waters and spend only 3% of their time >50km from the coast; however, The Wash is one exception, where harbour seals spend more time farther offshore and have been observed travelling to sandbanks up to 150km offshore (Jones *et al*. 2015). The predicted at-sea usage map for harbour seal reflects this, with a large area of higher use (relative to the majority of UK and Irish waters) extending north-east from The Wash, with values of 10-50 seals per 5 x 5km grid cell up to approximately 100km from the site boundary (Russell *et al*. 2017). From tracks of individual seals tagged at The Wash, and consideration of the distribution of adjacent colonies, it can be assumed that the majority of harbour seals using this offshore area are associated with The Wash and North Norfolk Coast SAC.

The condition of relevant marine features of the SAC were assessed in 2019, concluding that 72% of the sandbank feature of the site was in favourable condition with the remainder unfavourable recovering. Only 1% of the reef feature was considered to be in favourable condition, with the remainder either unfavourable recovering (37%) or unfavourable with no change (61%). Additionally, adverse impacts on site integrity were concluded for the Hornsea Three offshore wind farm project, specifically in relation to habitat loss and modification associated with cable protection. A Sandbank Implementation Plan was submitted as part of the planning process for the project, in keeping with its DCO requirements, and was approved in April 2022[49].

[48] https://www.gov.uk/government/publications/managing-fisheries-in-marine-protection-areas-call-for-evidence
[49] https://infrastructure.planninginspectorate.gov.uk/projects/eastern/hornsea-project-three-offshore-wind-farm/

Inner Dowsing, Race Bank and North Ridge SAC

The Inner Dowsing, Race Bank and North Ridge SAC occupies The Wash Approaches. Water depths are mostly shallow (<30m) and the site encompasses a wide range of sandbank types and biogenic reef formed by *Sabellaria spinulosa*. The group of banks within the Wash Approaches are made up of fine to medium sands derived from coastal erosion processes following the last glacial retreat and marine inundation. Inner Dowsing is a sandbank of coarse sand with some areas of gravel to the west of the site, with a distinctive elongate shape maintained by the tidal currents in the area. The Race Bank-North Ridge-Dudgeon Shoal sandbank system is an example of a sinusoidal sandbank that also has a complex pattern of smaller sandbanks associated with it. The tops of the sandbanks are characterised by low diversity communities dominated by polychaete worms and mobile amphipod crustaceans. The trough areas between the sandbanks are composed of mixed and gravelly sands, predominantly as veneers over glacial till. In these areas diverse mosaics of biotopes occur, which are dominated by the ascidian *Molgula* sp. along with a number of nemertean worms and polychaetes. Abundant *S. spinulosa* agglomerations have consistently been recorded and these support attached epifauna such as bryozoans, hydroids, sponges and anemones[50]. The site has been subject to significant fisheries pressures, which the MMO concluded were likely to have an adverse effect on site integrity. The site is now subject to fisheries management measures, with all bottom-towed gear prohibited across the reef and sandbank features of the site, and all static gear prohibited in areas to be managed as reef[51].

Greater Wash SPA

The Greater Wash SPA extends from Bridlington Bay in the north, to the boundary of the Outer Thames Estuary SPA in the south. In the northernmost section of the site, off the Holderness coast, seabed habitats primarily comprise coarse sediments, with occasional areas of sand, mud and mixed sediments. The inshore environment is highly dynamic, with large volumes of material being eroded from the shoreline and seabed and transported southwards. Water depth is generally shallow, reaching up to 20m towards the offshore boundary. Subtidal sandbanks occur at the mouth of the Humber Estuary, primarily comprising sand and coarse sediments. The site is classified for the protection of red-throated diver, common scoter, and little gull during the non-breeding season, and for breeding sandwich tern, common tern and little tern. The seaward boundary is defined by the area of importance to red-throated diver, and by the foraging area of sandwich tern off the north Norfolk Coast. Red-throated diver are distributed throughout the SPA with 1,511 individuals or 8.9% of the GB wintering population estimated to be present within the site. Higher densities of birds were recorded close inshore, particularly in the area outside The Wash SPA, north of the Humber Estuary, along the eastern part of North Norfolk Coast and in the south of the site where it abuts the Outer Thames Estuary SPA (Lawson *et al.* 2016). Highest densities of common scoter were observed in the area outside The Wash SPA and along the North Norfolk Coast SPA[52].

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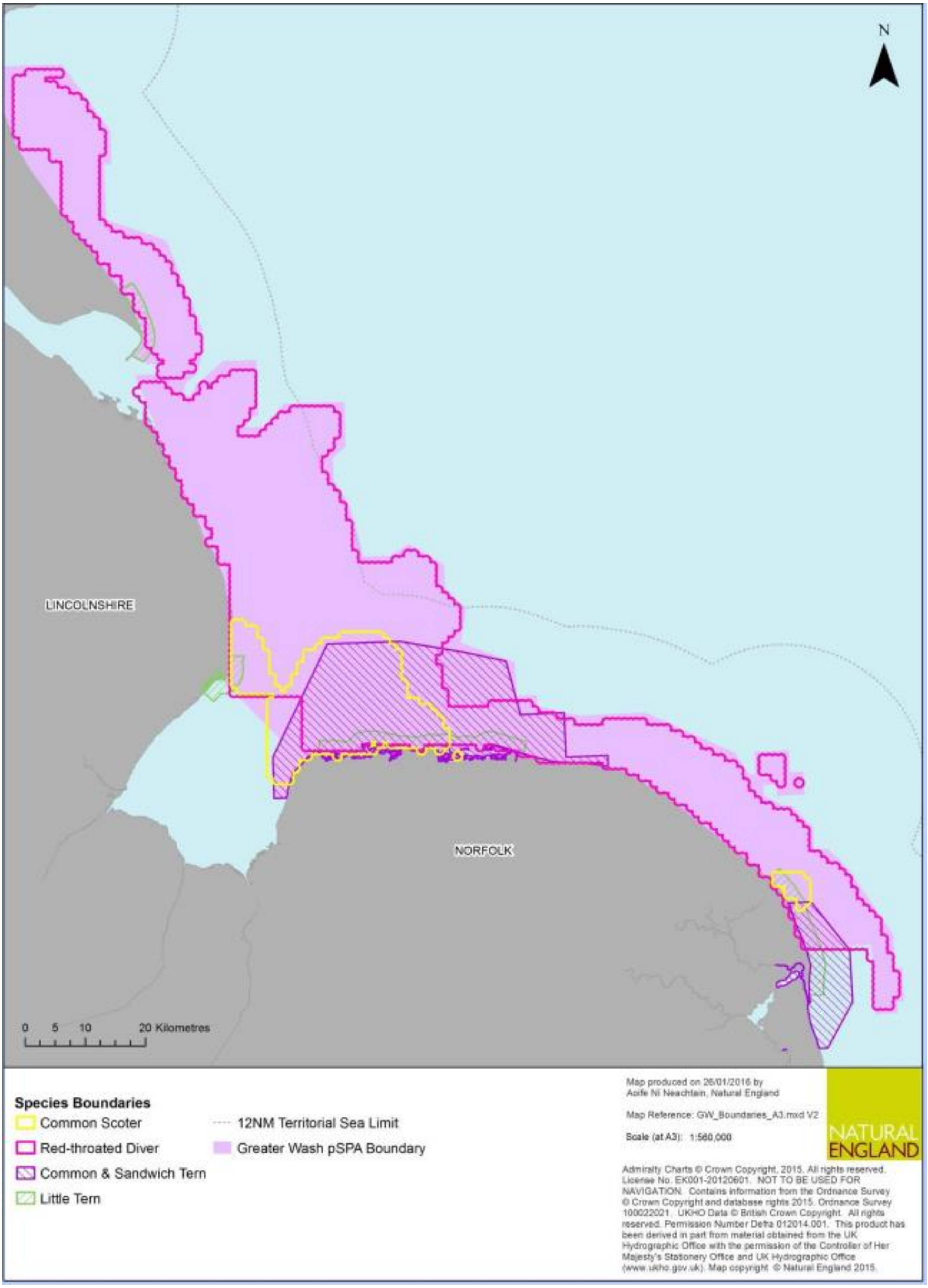
[50] https://jncc.gov.uk/our-work/inner-dowsing-race-bank-and-north-ridge/
[51] https://www.gov.uk/government/publications/the-inner-dowsing-race-bank-and-north-ridge-special-area-of-conservation-specified-areas-prohibited-fishing-gears-byelaw-2022b
[52] https://consult.defra.gov.uk/natural-england-marine/greater-wash-potential-special-protection-area-com/supporting_documents/V9%20FINAL%20Greater%20Wash%20Departmental%20Brief%2017%20October%202016%20ready%20for%20consultation.pdf

Figure 5.1: Greater Wash SPA boundary in relation to the Maximum Curvature Analysis boundaries for relevant qualifying species



Source: Natural England & JNCC (2016)

Humber Estuary SPA

The physical characteristics of this site are summarised above in relation the Humber Estuary SAC. The SPA was formerly named the Humber Flats, Marshes and Coast SPA, classified in July 1994, which was the first of two planned phases of classification for the Humber estuary. The second phase of designation was not taken forward, and instead the Humber Flats, Marshes and Coast SPA was subsumed into the wider Humber Estuary SPA, classified in August 2007. The range of habitats on the Estuary (detailed in the feature descriptions) support a variety of wintering, passage and breeding birds, including internationally important populations of a number of species, which include, avocet (breeding and wintering), black-tailed godwit (passage and wintering), bittern (breeding; already classified as wintering), knot, dunlin and redshank (all passage), and ruff (on passage).

The SACO does not include any information which suggests current levels of oil and gas activity represent a current issue for any of the site features, however, the advice on operations notes a number of potential sensitivities mainly relating to supporting habitat. The SACO notes that recreational disturbance at the site is at levels which would influence waterbird usage, in particular from dog walking, such that there is a target to reduce such disturbance to roosting, foraging, feeding, moulting and/or loafing birds.

Outer Thames Estuary SPA

The Outer Thames Estuary SPA is classified for the protection of wintering red-throated diver, breeding little terns and breeding common terns. The area supports the largest aggregations of wintering red-throated diver in the UK, 38% of the GB population[53]. Red-throated divers occur throughout the entire area, but at greatest density and with greatest frequency off the coast of Suffolk and over sandbanks in the centre of the estuary and those extending toward the coast of south Essex and part of north Kent. To the north, the site is continuous with the Greater Wash SPA and red-throated diver are likely to move between sites (see Greater Wash SPA summary above). The site contains areas of shallow and deeper water, with high tidal current streams and a range of mobile sediments, including several shallow sandbanks. The sandbanks may have a functional role (as nursery, spawning, or feeding grounds or in providing shelter) in supporting prey species of the red-throated diver (small fish such as gadoids, sprat, herring and sandeel; Guse *et al*. 2009)[54]. The seabed in the area of the Norfolk and Suffolk coast is of a similar composition to that in the main Thames estuary with large shallow areas of mud, sand, silt and gravely sediments but, in the absence of main port areas within this area, there is consequently less disturbance through shipping or dredging.

This site was screened into the AA process as it contains breeding common tern and little tern colonies, and over wintering red-throated diver which are also relevant to the Greater Wash SPA, and the AA will therefore only consider the potential for adverse effects on these qualifying interests.

The Wash SPA

The Wash SPA is composed of tidal rivers, estuaries, lagoons, mud, and sand flats and in the centre, deep channels surrounded by shallower waters. These areas predominantly consist of saltmarsh, intertidal banks of sand and mud, sandy and shingle beaches, and subtidal sandy sediments. Shallow coastal waters support small fish which are preyed upon by tern species. Intertidal mud and sand flats support a variety of polychaete worms and bivalve molluscs including cockle and mussel beds which alongside algae provide rich foraging grounds for a

[53] https://jncc.gov.uk/our-work/outer-thames-estuary-spa/
[54] https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK9020309

number of bird species including common scoter and goldeneye. Other relevant diving species which are part of the non-breeding waterbird assemblage include great cormorant, eider and little grebe[55].

This site was screened into the AA process as it contains breeding little tern colonies and over wintering common scoter which are also relevant to the Greater Wash SPA, and the AA will therefore only consider the potential for adverse effects on these qualifying interests.

North Norfolk Coast SPA

The North Norfolk Coast SPA extends 40km along the northern coastline of Norfolk from Holme to Weybourne. Coastal waters within the site are shallow and follow the complex series of harbours and inlets along the coast. These support large populations of small fish including sand eel and sprat which provide vital food for breeding tern populations upon which breeding success depends. In summer, the site and its surroundings are important for breeding populations of waders, four species of tern, bittern and wetland raptors including the marsh harrier. In winter, the site becomes important for large numbers of geese, sea-ducks, other ducks, and waders using the site for roosting and feeding[56]. Some species, such as the breeding terns and overwintering common scoter feed in coastal waters outside but adjacent to the SPA and are included as qualifying features of the Greater Wash SPA. The site is of also important to migrating birds in the spring and autumn passage periods[57].

This site was screened into the AA process as it contains breeding sandwich tern, common tern and little tern colonies which are also relevant to the Greater Wash SPA, and the AA will therefore only consider the potential for adverse effects on these qualifying interests.

Gibraltar Point SPA

Gibraltar Point SPA is classified for breeding little tern and non-breeding bar-tailed godwit, sanderling and grey plover. The site was screened in on the basis of it being contiguous with the Greater Wash SPA for which little tern is a qualifying feature, therefore, only little tern will be considered in this assessment. The coastal waters adjacent to the SPA provide a vital food source for the breeding little tern populations by supporting large populations of small fish, and the shingle ridges and beaches further support breeding little terns during the summer (April to August)[58], by providing important nesting areas.

This site was screened into the AA process as it contains breeding little tern which is also relevant to the Greater Wash SPA, and the AA will therefore only consider the potential for adverse effects on that qualifying interest.

Great Yarmouth North Denes SPA

The site contains two linked component areas of relevance to little tern, the Great Yarmouth North Denes actively accreting low dune system and beach, and the beach and foredune ridge at Winterton-Horsey Dunes. Little tern populations found at Caister, Eccles, Kessingland and Scroby Sands are functionally linked to colonies protected within the Great Yarmouth North Denes SPA. Scroby Sands is now a popular nesting and foraging area for little tern and common tern from neighbouring SPA sites, including Great Yarmouth North Denes SPA and Breydon Water SPA and their functionally linked colonies. The site was classified in 1998, and

[55] https://designatedsites.naturalengland.org.uk/Marine/Seasonality.aspx?SiteCode=UK9008021
[56] https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9009031
[57] https://designatedsites.naturalengland.org.uk/Marine/Seasonality.aspx?SiteCode=UK9009031
[58] https://designatedsites.naturalengland.org.uk/Marine/Seasonality.aspx?SiteCode=UK9008022

the site citation refers to a little tern population of 227 pairs, representing 11.5% of the British breeding population.

This site was screened into the AA process as it contains breeding little tern which is also relevant to the Greater Wash SPA, and the AA will therefore only consider the potential for adverse effects on that qualifying interest.

Breydon Water SPA

The estuary forms the lower reaches of the Yare and Waveney rivers, which drain most of central East Anglia. The SPA incorporates a number of important supporting habitats such as, intertidal mudflats, saltmarsh and fresh water grazing marsh, and shallow tidal waters provide key feeding and roosting habitat for many of the bird species using this site. The site supports internationally important wintering populations of Bewick’s swan, avocet, golden plover, ruff, and an internationally important breeding population of common tern[59].

This site was screened into the AA process as it contains breeding common tern which is also relevant to the Greater Wash SPA, and the AA will therefore only consider the potential for adverse effects on that qualifying interest.

[59] https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9009181

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 5.2: Sites and areas to be subject to further assessment for physical disturbance and drilling effects in the southern North Sea and Mid North Sea High

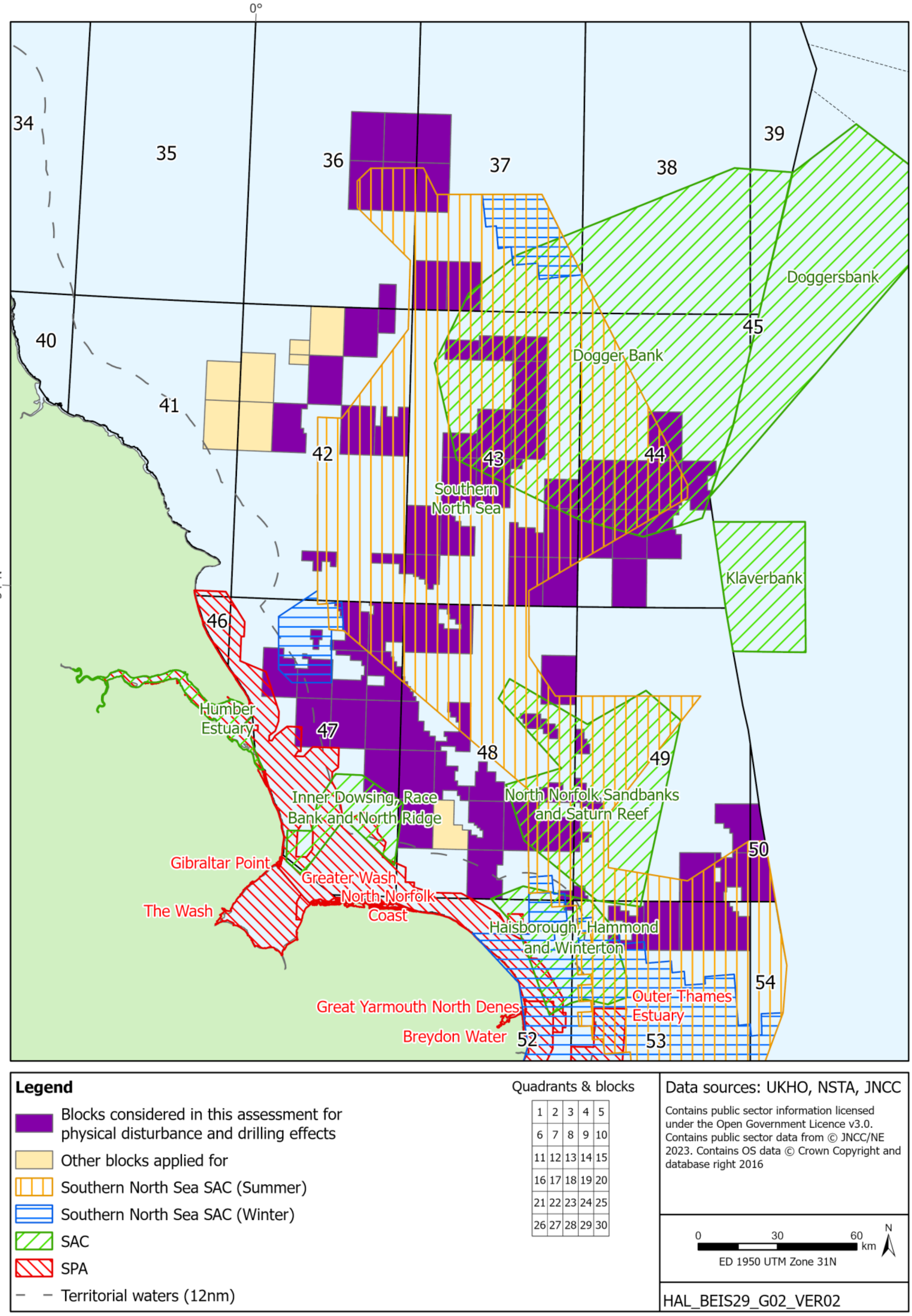


Table 5.1: Consideration of potential physical disturbance and drilling effects and relevant site conservation objectives

Southern North Sea SAC[60]
Site Information
Area (ha/km^2): 3,695,054/36,951 **Relevant qualifying features:** Harbour porpoise **Conservation objectives:** To avoid deterioration of the habitats of the harbour porpoise or significant disturbance to the harbour porpoise, thus ensuring that the integrity of the site is maintained, and the site makes an appropriate contribution to maintaining Favourable Conservation Status (FCS) for the UK harbour porpoise. To ensure for harbour porpoise that, subject to natural change, the following attributes are maintained or restored in the long term: • The species is a viable component of the site. • There is no significant disturbance of the species. • The supporting habitats and processes relevant to harbour porpoises and their prey are maintained.
Relevant Blocks with potential for physical disturbance and drilling effects
36/14, 36/15, 36/19, 36/20, 36/30c, 37/11, 37/16, 37/26, 37/27, 42/12b, 42/14, 42/15b, 42/28j, 42/3, 42/30b, 42/4, 42/5c, 42/8, 43/12a, 43/13, 43/14, 43/17, 43/18, 43/19d, 43/20c, 43/21, 43/22c, 43/24c, 43/25, 43/26b, 43/29, 43/2b, 43/30, 43/3b, 43/4b, 43/9, 44/13, 44/16, 44/17, 44/18a, 44/19b, 44/21, 44/22, 44/23a, 44/27, 47/10c, 47/13, 47/14, 47/15, 47/3j, 47/3k, 47/4d, 47/5b, 47/7b, 47/8a, 47/9a, 48/1, 48/10, 48/11b, 48/12a, 48/14d, 48/15b, 48/17d, 48/18c, 48/20c, 48/23c, 48/24, 48/25d, 48/28b, 48/2b, 48/30c, 48/6c, 49/11b, 49/16d, 49/21b, 49/21d, 49/25b, 49/26b, 49/29, 49/30b, 50/21, 50/26, 52/5c, 53/2c, 53/3, 53/4, 53/5c
Activities associated with the proposed work programmes within the relevant licence areas
Drilling up to 87 wells involving - siting of rig, drilling discharges
Assessment of effects on site integrity
Rig siting ***Relevant pressures:*** *No relevant pressures identified[61]. In view of available pressure definitions (e.g. the current JNCC pressures-activity database) and the focus of the Conservation Objectives on addressing pressures that affect site integrity, including significantly damaging relevant habitats, the following pressures are considered: 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 and physical change (to another seabed/sediment type)* The delineation of the Southern North Sea SAC site was based on the prediction of ‘harbour porpoise habitat’ within the North Sea (Heinänen & Skov 2015). The analysis indicated a preference for water depths between 30 and 50m throughout the year, and in general, the coarseness of the seabed sediment was important, with porpoises showing a preference for coarser sediments (such as sand/gravel)[62]. Physical disturbance or abrasion to surface and subsurface substrates by the placement of spud cans as part of rig installation has the potential to impact the extent of supporting habitat within the site. Blocks 43/30, 44/13, 44/21, 44/22, 47/7b, 47/8a, 47/10c, 48/6c, 48/10, 48/24, 49/25b, 49/29 and 50/21 have significant areas outside the site boundaries in which rig siting would be possible, and therefore interaction with the supporting habitats of the qualifying features could be avoided. With respect to those Blocks which are largely or wholly within the site (36/19, 36/20, 37/26, 37/27, 42/14, 42/15b, 42/28j, 42/3, 42/30b, 43/12a, 43/13, 43/14, 43/17, 43/18, 43/19d, 43/20c, 43/21, 43/22c, 43/24c, 43/25, 43/26b, 43/29, 43/2b, 43/3b, 43/4b, 43/9, 44/16, 44/17, 44/18a, 44/19b, 44/23a, 47/3j, 47/3k, 47/4d, 47/5b, 48/1, 48/2b, 48/16, 48/18c, 48/20c, 48/25d, 48/30c, 49/30b, 49/11b, 49/16d, 49/21b, 49/21d, 49/26b, 50/26, 52/5c, 53/2c, 53/3, 53/4, 53/5c), the maximum spatial footprint of physical damage associated with jack-up rig siting is small (0.8km^2, Table 2.2) compared to the large site (covering 0.002%); see below for a consideration of intra-plan in-combination effects. Recovery from physical damage in relevant sand/gravel habitats across the relatively shallow and dynamic site (majority of site less than 40m) is expected to be relatively rapid. The small scale and temporary nature of the potential

[60] https://jncc.gov.uk/our-work/southern-north-sea-mpa/
[61] https://hub.jncc.gov.uk/assets/206f2222-5c2b-4312-99ba-d59dfd1dec1d#SouthernNorthSea-conservation-advice.pdf
[62] http://jncc.defra.gov.uk/pdf/SouthernNorthSeaSelectionAssessmentDocument.pdf

physical damage, and the mobile nature of the qualifying features will ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

The requirement for rig stabilisation measures would be determined by site survey of local conditions. In soft sediments, rock placement may cause smothering of existing sediments and a physical change to another seabed type. The majority of the substrate types within the site are categorised as sublittoral sand and sublittoral coarse sediment. It is assumed that rock placement (if required) would be within 500m of the rig and cover an estimated area of 0.001-0.004km^2 per rig siting (Table 2.2). Hence, the potential loss of extent of sandy sediment is small compared to the widespread nature of this sediment type across the very large site (36,958km^2). There is the potential for alternatives to rock placement (Section 5.2.1), allowing the conclusion that the site conservation objectives will not be undermined and there will be no adverse effect on site integrity. Plan level mitigation relating to rig stabilisation has been identified for other SACs considered in this assessment (e.g. Dogger Bank, North Norfolk Sandbanks and Saturn Reef, Haisborough, Hammond and Winterton). This mitigation would, therefore, equally apply to the Southern North Sea SAC where those other sites overlap with it.

Drilling discharges
Relevant pressures: *Contaminants. In view of available pressure definitions and given the focus of the Conservation Objectives on addressing pressures that affect site integrity including significantly damaging relevant habitats, the following pressures are considered: 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) and habitat structure changes – removal of substratum (extraction)*

The advice on operations indicates that use of most of the relevant pollutants with respect to harbour porpoise have been effectively phased out by action under the OSPAR Convention and the EU (e.g. PCBs). However, their chemical stability will lead to them remaining in the marine environment for some time and, consequently, human activities such as dredging may cause the re-release of these chemicals into the environment or introduce other contaminants of which the impacts are poorly known. In view of the small scale and temporary nature of drilling discharges and the mandatory controls on drilling chemical use and discharge (Section 2.3.1), site conservation objectives will not be undermined and there will be no adverse effects on site integrity.

It is assumed that effects relating to drilling discharges occur within 500m of the well location (Table 2.2). Blocks 43/30, 44/13, 44/21, 44/22, 47/7b, 47/8a, 47/9a, 47/10c, 48/6c, 48/10, 48/24, 49/25b, 49/29 and 50/21 have significant areas outside the site boundaries in which drilling would be possible, and therefore impacts on supporting habitats could be largely avoided, and effects from activities in Blocks greater than 500m distance from the site (36/14, 36/15, 36/30c, 37/11, 42/12b, 42/4, 42/5c, 42/8, 44/27, 47/13, 47/15, 48/11b, 48/17d, 48/18c, 48/23c) are not predicted. For the Blocks that are largely or wholly within the site (see above), the maximum spatial footprint within which smothering of surface sediments or habitat structure changes may occur (0.8km^2, Table 2.2) is small (representing 0.002% of the total site area) and recovery from smothering in relevant sand/gravel habitats across the relatively shallow and exposed site (majority of site less than 40m) is expected to be rapid (see below for a consideration of intra-plan in-combination effects. Therefore, site conservation objectives will not be undermined.

Other effects
N/A

In-combination effects
Intra-plan in-combination effects are possible although spatial footprints associated with rig installation and drilling discharges in those Blocks entirely or largely within the site are localised and temporary, and unlikely to overlap between areas applied for either spatially or temporally. The combined spatial footprint within which physical disturbance and drilling effects could occur (within 500m of the rig/well location) across the Blocks applied for (an improbable worst-case scenario that all 68 wells are drilled[63]) is estimated at 54km^2 (<0.15% of the site area). However, the temporary nature of the disturbance, the mobile nature of the qualifying feature and mandatory control measures (Section 2.3.1), and other measures (Section 5.2.1) will ensure that site conservation objectives are not undermined. Section 5.4 provides a consideration of potential activities in-combination with other relevant plans and projects.

[63] Note that several Blocks may make up a single licence application for which a single well is proposed, such that the number of potential wells will be far fewer than the number of Blocks applied for.

Dogger Bank SAC[64]
Site Information
Area (ha/km²): 1,233,115/12,331 **Relevant qualifying features:** Sandbanks which are slightly covered by sea water all the time. **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 1 sandbanks. This contribution would be achieved by maintaining or restoring, subject to natural change: • The extent and distribution of the qualifying habitat in the site; • 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[65].
Relevant Blocks with potential for physical disturbance and drilling effects
37/26, 37/27, 43/12a, 43/13, 43/14, 43/17, 43/18, 43/19d, 43/20c, 43/25, 43/2b, 43/3b, 43/4b, 43/9, 44/13, 44/16, 44/17, 44/18a, 44/19b, 44/21, 44/22, 44/23a, 44/27
Activities associated with the proposed work programmes within the relevant licence areas
Drilling up to 23 wells 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* The qualifying feature is sensitive to penetration and/or disturbance of the seabed surface and subsurface[66] by the placement of spud cans as part of rig siting. Blocks 37/27, 43/17, 43/18, 43/25, 44/21, 44/22 and 44/23a have significant areas outside the site boundaries in which rig siting would be possible, or are entirely outside of the site (37/26, 44/27), and therefore interaction with the qualifying features could be avoided, noting the assumed distance from a jack-up rig within which effects may occur (500m, see Table 2.2). With respect to those Blocks largely or entirely within the site (43/12a, 43/13, 43/14, 43/17, 43/18, 43/19d, 43/20c, 43/2b, 43/30, 43/3b, 43/4b, 43/9, 44/13, 44/16, 44/17, 44/18a and 44/19b), the maximum spatial footprint of the penetration and/or disturbance pressure associated with jack-up rig siting is small (0.8km², see Table 2.2) compared to the large site (covering 0.006%), in relatively shallow water depths (15-40m). As a result, it is exposed to substantial wave energy, particularly during storm events which may cause significant natural disturbance of sediments (see Section 5.1). Recovery of damage to surface and sub-surface features of the scale associated with temporary rig placement is expected to be rapid due to its localised scale and the energetic nature of the environment, and the temporary nature of the activities. The justifications for the relevant penetration and/or disturbance pressures in the site's Advice for Operations (December 2022) indicate a low Risk Profiling of Pressure (RPP) score[67] for exploratory drilling, although it is noted risk will increase depending on the spatial/temporal scale and intensity of the activity, the proximity of the activity to the feature and the sensitivity of the feature to the pressure. Cumulative and in-combination effects may increase the risk further (see below for a consideration of intra-plan in-combination effects). Further mitigation measures are also available and will be required as appropriate as part of consenting (e.g. rig siting to ensure sensitive seabed surface features are avoided, see Section 5.2.1), which will ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity. It is assumed the extent of physical disturbance generated by a jack-up rig occurs within 500m (Table 2.2). Activities within those Blocks screened for potential for physical effects on the basis of the screening criteria (DESNZ 2023a) and which are further than 500m from the site boundary (44/27), are not considered likely to result in significant effects on the site qualifying feature.

[64] https://jncc.gov.uk/our-work/dogger-bank-mpa/
[65] https://data.jncc.gov.uk/data/26659f8d-271e-403d-8a6b-300defcabcb1/dogger-bank-saco-v2.pdf
[66] https://data.jncc.gov.uk/data/26659f8d-271e-403d-8a6b-300defcabcb1/dogger-bank-aooworkbook-v2.xlsx
[67] The Risk Profiling of Pressure (RPP) score indicates the general risk the pressures pose to the environment under normal conditions. Description of low risk indicates, *"Unless there are evidence-based case or site-specific factors that increase the risk, or uncertainty on the level of pressure on a receptor, this pressure generally does not occur at a level of concern and should not require consideration as part of an assessment*" (https://data.jncc.gov.uk/data/16506231-f499-408f-bdc8-ea9a6dfbf8b5/JNCC-Report-624-REVISED-WEB.pdf)

There may be a requirement for rig stabilisation depending on local seabed conditions. In soft sediments, deposited rock may cover existing sediments resulting in a physical change (to another seabed type), and the qualifying feature is considered highly sensitive to this pressure, which assumes a permanent change of habitat. This pressure has a medium-high[68] RPP score with respect to exploratory drilling. The Dogger Bank SACO (2022) indicates that introduced substrates, such as rock placement, normally consisting of gravel, pebbles or cobbles, and historic cuttings piles have been deposited onto the seabed although it is not possible to quantify the amount of material introduced, and consequently it is unclear what impact this may have on site sediment composition and distribution. JNCC advise that activities must look to minimise, as far as is practicable, changes in substratum (beyond expected substratum types in the site) and the biological assemblages within the site to minimise further impact on feature extent and distribution. It is assumed that rock placement (if required) would be within 500m of the rig and cover an estimated area of 0.001-0.004km^2 per rig siting (Table 2.2). Hence, the potential loss of sandy sediment extent is small compared to the predominance of this sediment type across the very large site (12,331km^2).

It is noted, however, that physical damage to the sandbank habitat, including habitat loss from the use of protection materials, has led to conclusions in other plan level HRA (TCE 2022) of adverse effects on site integrity in view of the site's conservation objectives, the condition of the site features and advice on operations (see Section 5.1). As noted above, recovery of the sandbank feature following cessation of appraisal/exploration drilling would be expected to be rapid and not result in permanent habitat change. The use of rock placement for rig stabilisation, which is not easily removed, would likely result in a localised but permanent change in habitat, for which adverse effects on site integrity could not be ruled out. In order to avoid such adverse effects, any well being drilled within the boundaries of the Dogger Bank SAC must use alternatives to rock placement if rig stabilisation is required, for example, removable mud mats or anti-scour mats (see Section 5.2.1). Further assessment, including HRA where appropriate, would be undertaken at the project level, at which stage the assessment would be informed by specific rig siting information.

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*

The advice on operations indicates that the qualifying feature is sensitive to the above pressures, most of which relate to seabed disturbance and habitat changes associated with smothering by drill cuttings near the well location, and that these cuttings can accumulate in piles where currents are generally weak. It is assumed that effects relating to drilling discharges occur within 500m of the well location (Table 2.2). Therefore, with respect Blocks 37/27, 43/17, 43/18, 43/25, 44/21, 44/22 and 44/23a which have significant areas outside the site boundaries in which drilling will be possible, and those others entirely outside of the site and at greater than 500m distance (44/27), drilling discharges will not significantly impact the extent and distribution or the structure and function of the qualifying habitat. For those Blocks applied for which are entirely or largely within the site, the maximum spatial footprint within which smothering by drilling discharges and associated habitat structure changes may occur (0.8km^2) is small (representing 0.006% of the total site area) and given the site's exposure to wave energy, redistribution of drilling discharges and recovery from smothering would be rapid, and there would be no permanent change in site habitat. Therefore, site conservation objectives will not be undermined.

The advice on operations indicates that no sensitivity assessment has been made of the qualifying feature to the contamination pressures listed above and described in Section 4.2.4. The SACO indicates that the available evidence of contamination is inconclusive regarding sediment quality within the site. However, the small scale and temporary nature of drilling discharges and the mandatory control requirements with respect to drilling chemical use and discharge (Section 2.3.1) will ensure that site conservation objectives are not undermined.

Other effects
N/A

In-combination effects
Intra-plan in-combination effects are possible although spatial footprints associated with rig installation and drilling discharges for those Blocks entirely or partly within the site will be localised and temporary, and unlikely to overlap between these Blocks either spatially or temporally. Given the indicative work programmes (Table

[68] Pressure is commonly induced by activity at a level that needs to be considered further as part of an assessment (https://data.jncc.gov.uk/data/16506231-f499-408f-bdc8-ea9a6dfbf8b5/JNCC-Report-624-REVISED-WEB.pdf).

2.2), the combined spatial footprint within which physical disturbance and drilling effects could occur (within 500m of the rig/well location) across the areas applied for (a worst case scenario of up to 21 wells) is estimated at 17km^2 (0.14% of the site). For rig stabilisation, this would be for an area of up to 0.08km^2 or 0.001% of the site, however, the mitigation outlined above would be required (Section 5.2.1). The temporary nature of the disturbance, energetic nature of the environment, required controls and mitigation, including the avoidance of permanent habitat change (Sections 2.3.1 and 5.2.1), will ensure that site conservation objectives are not undermined as there will be no permanent change to the habitat. Section 5.4 provides a consideration of potential activities in-combination with other relevant plans and projects.
Humber Estuary SAC[69]
Site information
Area (ha/km^2): 36,657/367 **Relevant qualifying features:** Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*), Coastal lagoons, Dunes with *Hippophae rhamnoides*, embryonic shifting dunes, estuaries, fixed dunes with herbaceous vegetation ("Grey dunes"), shifting dunes along the shoreline with *Ammophila arenaria* ("White dunes"), mudflats and sandflats not covered by seawater at low tide, *Salicornia* and other annuals colonising mud and sand, sandbanks which are slightly covered by sea water all the time, grey seal, river lamprey, sea lamprey. See Natural England guidance for details of qualifying features[70]. **Conservation objectives:** The site's conservation objectives apply to the site and the individual species and/or assemblage of species for which the site has been classified. The objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the Favourable Conservation Status of its qualifying features, by maintaining or restoring: • The extent and distribution of qualifying natural habitats and habitats of qualifying species • The structure and function (including typical species) of qualifying natural habitats • The structure and function of the habitats of qualifying species • The supporting processes on which qualifying natural habitats and habitats of qualifying species rely • The populations of qualifying species, and, • The distribution of qualifying species within the site. Attributes and related targets have been set for the site features which are presented in the site SACO[71]. Advice on seasonality for the site indicates year-round grey seal presence at the site.
Relevant Blocks with potential for physical disturbance and drilling effects
47/7b
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 invasive non-indigenous species* Block 47/7b is 7km from the site. Given the assumed distance within which effects may occur (500m, see Table 2.2), rig installation will not result in effects on the extent, distribution, structure or function of the habitats within the site. It is noted that a higher area of relative grey seal density extends from the Humber Estuary and overlaps with Block 47/7b (see DESNZ 2023a). Rig siting could impact the extent and distribution of habitats of this qualifying species outside of the site. The maximum spatial footprint of physical damage associated with

69 https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK0030170

70 https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK0030170&SiteName=humber&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&HasCA=1&NumMarineSeasonality=8&SiteNameDisplay=Humber%20Estuary%20SAC

71 https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK0030170&SiteName=humber&SiteNameDisplay=Humber+Estuary+SAC&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=8

jack-up rig siting is small (0.8km^2), potential supporting habitats (e.g. sand and gravel) are widespread over the region and recovery from physical damage of the scale associated with rig placement is expected to be rapid given the combined influence of tidal currents and waves in this relatively shallow area. The small scale and temporary nature of the potential physical damage, which would take place well outside the site boundary, will ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

As noted in Section 4.2.5, management of the spread of non-native species from vessels and rigs is being progressed through international measures, and the risk is limited by the operational range of rigs on the UKCS.

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*

The maximum spatial footprint within which smothering by drilling discharges may occur (0.8km^2) is small and well outside the site boundaries. The environment off the Holderness coast and Humber is highly dynamic, with large volumes of material eroded from the shoreline and seabed and transported southwards, creating high suspended sediment concentrations (e.g. see Cefas 2016). Given the environmental conditions, the redistribution of drilling discharges and recovery from smothering would be rapid and would not impact the extent and distribution or structure and function of the habitats, including those of mobile species which travel beyond the site boundaries, including grey seal. The small scale and temporary nature of the potential physical damage, all of which will take place beyond the site boundaries (at least 7km distance), and mandatory control requirements with respect to drilling chemical use and discharge (Section 2.3.1) will ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

Other effects
N/A

In-combination effects
Intra-plan in-combination effects are unlikely as only Block 47/7b was identified as relevant to the assessment, and the Block and any related well are too distant for physical or discharge related effects to lead to an adverse impact on site integrity, or else the scale of potential effect is considered to be negligible in relation to the use of habitat by grey seal beyond the site boundaries. Section 5.4 provides a consideration of potential activities in-combination with other relevant plans and projects.

North Norfolk Sandbanks and Saturn Reef SAC[72]

Site information

Area (ha/km^2): 360,341/3,603
Relevant qualifying features: Sandbanks which are slightly covered by sea water all of the time, reefs

Conservation objectives:
For the features to be in favourable condition thus ensuring site integrity in the long term and contribution to Favourable Conservation Status of Annex I Sandbanks which are slightly covered by sea water all of the time and Annex I Reefs. This contribution would be achieved by maintaining or restoring, subject to natural change:

- The extent and distribution of the qualifying habitats in the site;
- The structure and function of the qualifying habitats in the site; and
- The supporting processes on which the qualifying habitats rely

Attributes and related targets have been set for the site features which are presented in the site SACO[73].

Relevant Blocks with potential for physical disturbance and drilling effects

48/10, 48/14d, 48/15b, 48/18c, 48/20c, 48/23c, 48/24, 48/25d, 48/28b, 48/30c, 49/11b, 49/16d, 49/21b, 49/21d, 49/26b, 52/5c, 53/2c, 53/3

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

Drilling up to 19 wells involving - siting of rig, drilling discharges

Assessment of effects on site integrity

72 https://jncc.gov.uk/our-work/north-norfolk-sandbanks-and-saturn-reef-mpa/
73 https://hub.jncc.gov.uk/assets/d4c43bd4-a38d-439e-a93f-95d29636cb17#NNSSR-3-SACO-v1.0.pdf

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 invasive non-indigenous species*

Both the sandbank and reef qualifying features are sensitive to penetration and/or disturbance of the seabed surface and subsurface[74] by the placement of spud cans as part of rig siting. Blocks 48/10, 48/24, 49/26b and 53/2c have significant areas outside the site boundaries in which a rig may be sited, or are entirely outside the site (48/18c, 48/23c, 48/28b, 48/30c, 52/5c, 53/3), however a number of Blocks substantially overlap or are within the site (48/14d, 48/15b, 48/20c 48/25d, 49/11b, 49/16d, 49/21b, 49/21d). The maximum spatial footprint of the penetration and/or disturbance pressure associated with jack-up rig siting is small (0.8km^2, see Table 2.2) compared to the large site (covering 0.02%); see below for a consideration of intra-plan in-combination effects. It is noted that both the reef and sandbank features are considered to be in unfavourable condition[75] (see Section 5.1), however, recovery of the sandbank feature from physical disturbance of the scale associated with rig placement is expected to be rapid given the dynamic nature of the site and the temporary nature of the activities, and further mitigation measures are available (e.g. rig siting to ensure sensitive seabed features are avoided such as reef, see Section 5.2.1). These measures will be required, where appropriate, to ensure that impacts do not result in long-term or permanent change to the habitats and that the site conservation objectives are not undermined, and there is no adverse effect on site integrity.

There may be a requirement for rig stabilisation depending on local seabed conditions. The SACO notes that the deposition of material (rock) may lead to a persistent change in substrate which is not suitable habitat characterising sandbank communities and advise that activities must look to minimise, as far as is practicable, changes in substratum and the biological assemblages within the site to minimise further impact on feature extent and distribution. As indicated by Parry *et al*. (2015), sandy sediment dominates the site covering approximately 80% of the seabed, though patches of coarse and mixed sediment including pebbles and cobbles are present within the site (see Section 5.1). It is likely that if rock placement is required it would be within 500m of a rig and based on a review of submitted ESs it is estimated this could cover an area of 0.001-0.004km^2 (Table 2.2). Hence, the potential loss of extent of sandy sediment is small compared to the predominance of this sediment type across the large site (3,603km^2). However, in view of the unfavourable conservation status of the sandbank feature, further mitigation measures should be used such as removable mud mats or anti-scour mats as an alternative to rock placement (Section 5.2.1), or where feasible, the siting the rig outside of the site boundaries (e.g. in relation to Blocks 48/18c, 48/23c, 48/28b, 48/30c, 52/5c, 53/3), to avoid further reduction in the extent and distribution of the feature within the site. These will be required, where appropriate, to ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

As noted in Section 4.2.5, management of the spread of non-native species from vessels and rigs is being progressed through international measures, and the risk is limited by the operational range of rigs on the UKCS.

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*

The sandbank and reef qualifying features are sensitive to abrasion/disturbance of the seabed surface, siltation rate changes including smothering and habitat structure changes, removal of substratum (extraction) pressures associated with drilling discharges. The advice on operations indicates that the qualifying features are not sensitive to the contaminants pressures and physical change (to another sediment type) is not included within the advice. The SACO notes that alteration of surface sediment by drill cuttings may lead to a persistent change in substrate which is not suitable habitat for characterising sandbank communities. However, the impacts from such discharges are localised and transient, and as noted in Section 4.2, such drill cuttings piles do not generally accumulate in shallow, high energy waters, such as in the southern North Sea.

It is expected that effects from drilling discharges occur within 500m of the well location (Table 2.2). For each well, the maximum spatial footprint within which smothering by drilling discharges may occur (0.8km^2) is small (representing 0.02% of the total site area) and given the site's dynamic nature, redistribution of drilling discharges and recovery from smothering would be rapid. A number of Blocks (Blocks 48/10, 48/24, 49/26b

[74] https://hub.jncc.gov.uk/assets/d4c43bd4-a38d-439e-a93f-95d29636cb17#NNSSR-5-AoO-v1.0.xlsx
[75] https://hub.jncc.gov.uk/assets/d4c43bd4-a38d-439e-a93f-95d29636cb17#NNSSR-4-Statements-v1.0.pdf

and 53/2c) have substantial area outside of the SAC within which rig siting may be possible or are greater than 500m from the site boundary (48/18c, 48/23c, 48/28b, 48/30c, 52/5c, 53/3), such that interaction with the site may be avoided. The small scale and temporary nature of potential smothering, as well as mandatory control requirements with respect to drilling chemical use and discharge (Section 2.3.1), will ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

Other effects
N/A

In-combination effects
Intra-plan in-combination effects are possible although spatial footprints associated with rig installation and drilling discharges in Blocks 48/14d, 48/15b, 48/10, 48/20c, 48/24, 48/25d, 49/11b, 49/16d,49/21b, 49/21d, 49/26b and 53/2c which are entirely or partly within the site, are localised and temporary, and unlikely to overlap either spatially or temporally. Block 53/3 is outside, but within 500m of the site boundaries. Given the indicative work programmes (Table 2.1), the combined spatial footprint within which physical disturbance and drilling effects could occur (within 500m of the rig/well location) across these Blocks (a worst case scenario of 13 wells) is estimated at 10.4km^2 (0.29% of the site). With regards to rig stabilisation, should all 13 wells be drilled within the site, this could cover an area of 0.05km^2 or 0.001% of the SAC area. The localised and temporary nature of the disturbance and proposed or available mitigation to prevent permanent change to the extent and distribution of the sandbank and reef features within the site (Sections 2.3.1 and 5.2.1), will ensure that site conservation objectives are not undermined. Section 5.4 provides a consideration of potential activities in-combination with other relevant plans and projects.

Haisborough, Hammond and Winterton SAC[76]

Site information

Area (ha/km^2): 146,759/1,468
Relevant qualifying features: Sandbanks which are slightly covered by sea water all of the time, reefs

Conservation objectives:
The objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the Favourable Conservation Status of its qualifying features, by maintaining or restoring:

- the extent and distribution of qualifying natural habitats and habitats of the qualifying species
- the structure and function (including typical species) of qualifying natural habitats
- the structure and function of the habitats of the qualifying species
- the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely
- the populations of each of the qualifying species
- the distribution of qualifying species within the site

Attributes and related targets have been set for the site features which are presented in the site SACO[77].

Relevant Blocks with potential for physical disturbance and drilling effects

48/28b, 48/30c, 49/26b, 52/5c, 53/2c, 53/3

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

Drilling up to 6 wells 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/sediment type) and introduction or spread of invasive non-indigenous species*

Both the sandbank and reef qualifying features are sensitive to penetration and/or disturbance of the seabed surface and subsurface by the placement of spud cans as part of rig siting. Blocks 48/28b, 48/30c, 49/26b and 53/2c have a significant area outside the site boundaries in which a rig may be sited and 53/3 is entirely outside of the site boundary, and therefore, there is considerable potential that physical disturbance effects may be avoided; Block 52/5c is entirely within the site. Should a well be drilled within the site boundaries, the maximum spatial footprint of the penetration and/or disturbance pressure associated with jack-up rig siting is small

[76] https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK0030369
[77] https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK0030369

(0.8km^2, see Table 2.2) compared to the large site (covering 0.05%). It is noted that the entirety of both the reef and sandbank features are considered to be in unfavourable condition[78] (see Section 5.1; there is a low confidence in this condition assessment), however, recovery of the sandbank feature from physical disturbance of the scale associated with rig placement is expected to be rapid given the dynamic nature of the site and the temporary nature of the activities, and further mitigation measures are available (see Section 5.2.1), for example, rig siting to ensure sensitive seabed surface features are avoided including reef and sandbanks, noting that the entire area of the site is not considered to contain the Annex I sandbank feature (Eggleton *et al.* 2020). These measures will be required, where appropriate, to ensure that impacts do not result in long-term or permanent change to the habitats and that the site conservation objectives are not undermined, and there is no adverse effect on site integrity.

There may be a requirement for rig stabilisation depending on local seabed conditions. The sandbanks and reefs features are considered sensitive to physical change to another seabed/sediment type. The SACO notes that there are pipelines within the site which are rock armoured in places, leading to a reduction in the extent and distribution of the sandbank feature within the site. The deposition of additional rock as part of rig stabilisation may lead to a persistent change in substrate which is not suitable habitat for characterising sandbank communities, and is not compatible with the restore target for the feature. It is likely that if rock placement is required it would be within 500m of a rig and based on a review of submitted ESs it is estimated this could cover an area of 0.001-0.004km^2 (Table 2.2). Hence, the potential loss of extent of sandy sediment is small compared to the predominance of this sediment type across the large site (1,468km^2). However, in view of the unfavourable conservation status of the sandbank feature, further mitigation measures should be used such as removable mud mats or anti-scour mats as an alternative to rock placement (Section 5.2.1) to avoid further reduction in the extent and distribution of the feature within the site. These will be required, where appropriate, to ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

As noted in Section 4.2.5, management of the spread of non-native species from vessels and rigs is being progressed through international measures, and the risk is limited by the operational range of rigs on the UKCS.

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*

The sandbank and reef qualifying features are sensitive to abrasion/disturbance of the seabed surface, siltation rate changes including smothering and habitat structure changes, removal of substratum (extraction) pressures associated with drilling discharges. The advice on operations indicates that the qualifying features have not been assessed against whether they are sensitive to contaminants pressures, but they are considered to be at moderate-high risk. Any discharge from exploration well drilling would be subject to risk assessment as part of existing regulatory controls (see Section 2.3.1). It is assumed that effects relating to drilling discharges occur within 500m of the well location (Table 2.2). For each well, the maximum spatial footprint within which smothering by drilling discharges may occur (0.8km^2) is small (representing 0.05% of the total site area) and given the site's dynamic nature, redistribution of drilling discharges and recovery from smothering would be rapid and drill cuttings piles do not generally accumulate in shallow, high energy waters, such as in the southern North Sea. With the exception of Block 52/5c, all relevant Blocks have considerable area outside of the site boundaries within which siting may be possible. The small scale and temporary nature of potential smothering, as well as mandatory control requirements with respect to drilling chemical use and discharge (Section 2.3.1), will ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

Other effects
N/A

In-combination effects
Intra-plan in-combination effects are possible although only Block 52/5c is entirely within the site, with all other Blocks (48/28b, 48/30c, 49/26b, 53/2c, 53/3) having a substantial area outside of the site within which rig siting may be possible. Rig spatial footprints are localised and temporary, and unlikely to overlap either spatially or temporally. Given the indicative work programmes (Table 2.1), the combined spatial footprint within which physical disturbance and drilling effects could occur (within 500m of the rig/well location) across the Blocks (a

[78] https://designatedsites.naturalengland.org.uk/Marine/MarineFeatureCondition.aspx?SiteCode=UK0030369

worst case scenario of 5 wells) is estimated at 4km² (0.27% of the site). With regards to rig stabilisation, should all nine wells be drilled within the site, this could cover an area of 0.02km² or 0.001% of the SAC area. The localised and temporary nature of the disturbance and proposed or available mitigation to prevent permanent change to the extent and distribution of the sandbank and reef features within the site (Sections 2.3.1 and 5.2.1), will ensure that site conservation objectives are not undermined. Section 5.4 provides a consideration of potential activities in-combination with other relevant plans and projects.

Inner Dowsing, Race Bank and North Ridge SAC[79]

Site information

Area (ha/km²): 84,514/845
Relevant qualifying features: sandbanks, reefs

Conservation objectives:
The objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the Favourable Conservation Status of its qualifying features, by maintaining or restoring:

- the extent and distribution of qualifying natural habitats and habitats of the qualifying species
- the structure and function (including typical species) of qualifying natural habitats
- the structure and function of the habitats of the qualifying species
- the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely
- the populations of each of the qualifying species
- the distribution of qualifying species within the site

Attributes and related targets have been set for the site features which are presented in the site SACO[80].

Relevant Blocks with potential for physical disturbance and drilling effects

47/14, 47/15, 47/20, 48/16, 48/21

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

Drilling up to 5 wells 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/sediment type) and introduction or spread of invasive non-indigenous species*

Both the sandbank and reef qualifying features are sensitive to penetration and/or disturbance of the seabed surface and subsurface by the placement of spud cans as part of rig siting. Blocks 47/20 and 48/21 overlap the site but they have substantial area outside of the site within which rig siting may be possible; Block 48/16 is immediately adjacent to the site. The remaining Blocks screened in for this site are at least 10km distance away (Blocks 47/14, 47/15). Should a well be drilled within the site boundaries, the maximum spatial footprint of the penetration and/or disturbance pressure associated with jack-up rig siting is small (0.8km², see Table 2.2) compared to the large site (covering 0.05%). It is noted that the entirety of the reef feature, and at least 33% of the sandbank feature are considered to be in unfavourable condition[81] (see Section 5.2.1; there is a low confidence in these condition assessments), however, recovery of the sandbank feature from physical disturbance of the scale associated with rig placement is expected to be rapid given the dynamic nature of the site and the temporary nature of the activities, and further mitigation measures are available (see Section 5.2.1), for example, rig siting to ensure sensitive seabed surface features are avoided including reef and sandbanks, noting that the entire area of the site is not considered to contain the Annex I sandbank feature (Eggleton *et al.* 2020). These measures will be required, where appropriate, to ensure that impacts do not result in long-term or permanent change to the habitats and that the site conservation objectives are not undermined, and there is no adverse effect on site integrity.

There may be a requirement for rig stabilisation depending on local seabed conditions. The sandbanks and reefs features are considered sensitive to physical change to another seabed/sediment type. The SACO notes that cable and scour protection has been installed within the site at Race Bank offshore wind farm, leading to a reduction in the extent and distribution, and structure, of the sandbank feature within the site. The deposition of

[79] https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK0030370
[80] https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK0030370
[81] https://designatedsites.naturalengland.org.uk/Marine/MarineFeatureCondition.aspx?SiteCode=UK0030370

additional rock as part of rig stabilisation may lead to a persistent change in substrate which is not suitable habitat for characterising sandbank communities, and is not compatible with the restore target for the feature. It is likely that if rock placement is required it would be within 500m of a rig it is estimated this could cover an area of 0.001-0.004km^2 (Table 2.2). Hence, the potential loss of extent of sandy sediment is small compared to the predominance of this sediment type across the large site (845km^2). However, in view of the unfavourable conservation status of much the sandbank feature, further mitigation measures should be used such as removable mud mats or anti-scour mats as an alternative to rock placement (Section 5.2.1), and where feasible, the siting of the rig well outside the site boundaries to avoid further reduction in the extent and distribution of the feature within the site. These will be required, where appropriate, to ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

As noted in Section 4.2.5, management of the spread of non-native species from vessels and rigs is being progressed through international measures, and the risk is limited by the operational range of rigs on the UKCS.

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*

The sandbank and reef qualifying features are sensitive to abrasion/disturbance of the seabed surface, siltation rate changes including smothering and habitat structure changes, removal of substratum (extraction) pressures associated with drilling discharges. The advice on operations indicates that the qualifying features have not been assessed against whether they are sensitive to contaminants pressures, but they are considered to be at moderate-high risk. Any discharge from exploration well drilling would be subject to risk assessment as part of existing regulatory controls (see Section 2.3.1). It is assumed that effects relating to drilling discharges occur within 500m of the well location (Table 2.2). All of the Blocks applied for either have substantial areas outside of the site within which rig siting may be possible or are entirely outside of the site. For each well, the maximum spatial footprint within which smothering by drilling discharges may occur (0.8km^2) is small (representing 0.09% of the total site area) and given the site's dynamic nature, redistribution of drilling discharges and recovery from smothering would be rapid; drill cuttings piles do not generally accumulate in shallow, high energy waters, such as in the southern North Sea. There is potential, through rig site selection, to avoid the features of the site, however, should this not be possible, the small scale and temporary nature of potential smothering, as well as mandatory control requirements with respect to drilling chemical use and discharge (Section 2.3.1), will ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

Other effects
N/A

In-combination effects
Intra-plan in-combination effects are possible although the spatial footprint associated with rig installation and drilling discharges in Blocks 47/20 and 48/21, which all have substantial area outside of the site within which a rig may be sited, are localised and temporary, and unlikely to overlap either spatially or temporally. Block 48/16 is entirely outside of the site, but is within 500m of its boundary. Given the indicative work programmes (Table 2.1), the combined spatial footprint within which physical disturbance and drilling effects could occur (within 500m of the rig/well location) across these Blocks (a worst case scenario of 2 wells) is estimated at 1.6km^2 (0.19% of the site). With regards to rig stabilisation, should all 2 wells be drilled within the site, this could cover an area of 0.02km^2 or 0.001% of the SAC area. The localised and temporary nature of the disturbance and proposed or available mitigation to prevent permanent change to the extent and distribution of the sandbank and reef features within the site (Sections 2.3.1 and 5.2.1), will ensure that site conservation objectives are not undermined. Section 5.4 provides a consideration of potential activities in-combination with other relevant plans and projects.

Greater Wash SPA[82]

Site Information

Area (ha/km^2): 353,578/3,536
Relevant qualifying features: breeding: Sandwich tern, common tern, little tern; non-breeding: little gull, red-throated diver, common scoter

[82] https://jncc.gov.uk/our-work/greater-wash-spa/

Conservation objectives: With regard to the SPA and the individual species and/or assemblage of species for which the site has been classified, and subject to natural change; Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring; • The extent and distribution of the habitats of the qualifying features • The structure and function of the habitats of the qualifying features • The supporting processes on which the habitats of the qualifying features rely • The population of each of the qualifying features, and, • The distribution of the qualifying features within the site. *tern features of this site are associated with colonies relating to Gibraltar point SPA (little tern), Great Yarmouth North Denes SPA (little tern), The Wash SPA (little tern), Humber Estuary SPA (little tern), Breydon Water SPA (common tern), and the Outer Thames Estuary SPA (common tern, little tern, red-throated diver). The following assessment also covers the relevant features of these sites, noting that they are all >10km from any Block screened in.
Relevant Blocks with potential for physical disturbance and drilling effects
47/7b, 47/8a, 47/13, 47/14, 47/15, 47/20, 48/21, 48/28b
Activities associated with the proposed work programmes within the relevant licence areas
Drilling up to 8 wells 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/sediment type* Advice on operations is not presently available for the site, but the above pressures are considered to be relevant to a consideration of potential effects on the supporting habitat of the site. A small proportion of Blocks 47/7b, 47/13, 47/14 and 48/28b overlap the site boundary, though a substantial portion of these Blocks is located outside of the site, within which rig siting may be possible, and Block 47/15 is entirely outside of the site. The maximum spatial footprint of physical damage associated with jack-up rig siting is small (0.8km^2, Table 2.2) relative to the area over which site features including Sandwich (mean maximum foraging range 34.3km) and common terns (18km) may forage, and the area used by wintering little gull. Additionally, model predictions of tern usage relating to colonies at Scolt Head, Blakeney Point and at Breydon water, show limited potential overlap with the Blocks applied for, and the maximum curvature analysis suggests that the core densities of birds are all within the Greater Wash SPA site boundaries, and some distance from the Blocks (Natural England & JNCC 2016). The mean maximum foraging range for little tern is reportedly 5km (Woodward *et al.* 2019), and so interaction with activities which could result in effect on supporting habitat is not considered to be possible; note this is applicable to the Greater Wash SPA and all other related sites screened in based on their association with little tern (Gibraltar point SPA, Great Yarmouth North Denes SPA, The Wash SPA, Humber Estuary SPA, Outer Thames Estuary SPA). Red-throated diver are widely distributed throughout the site in winter, with this distribution largely forming the basis for the site boundaries, with common scoter having a more restricted distribution, with highest densities off The Wash (Lawson *et al.* 2015), some distance from any of the Blocks applied for. The scale of any physical damage to the seabed and supporting habitat of the site would be small relative to the large site, particularly given the limited overlap of any Block with the site, such that rig siting may avoid any interaction. Recovery from physical disturbance of the scale associated with rig siting is expected to be relatively rapid given the moderate to high energy seabed environment across much of the area. The small scale and temporary nature of the potential physical disturbance will not have a significant effect on the extent and distribution of the supporting habitats of the features either in the site or within their wider foraging ranges, and therefore, there will be no adverse effect on site integrity. The requirement for rig stabilisation measures would be determined by site survey of local conditions. In soft sediments, rock placement may cause smothering of existing sediments and a physical change to another seabed type. It is assumed that rock placement (if required) would be within 500m of the rig and cover an estimated area of 0.001-0.004km^2 per rig siting (Table 2.2). Hence, the potential change in the extent of habitat is small compared to the wide areas over which birds forage, and when considered in the context of available project level mitigation (see Section 5.2.1), which could include the siting of the rig outside of the site

boundaries, site conservation objectives will not be undermined 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) and contaminants*

It is assumed that effects relating to drilling discharges occur within 500m of the well location (Table 2.2). Large areas of the Blocks are outside the site, and there is considerable scope to site rigs in these areas, within which drilling discharges would not result in impacts. However, if located within the site, the maximum spatial footprint within which smothering by drilling discharges may occur (0.8km^2) is small (representing 0.02% of the total site area). As indicated in Section 5.1, the environment off the Holderness coast is highly dynamic, with large volumes of material eroded from the shoreline and seabed and transported southwards, and in general, this area has relatively high levels of suspended sediments compared to other areas of the UKCS (Cefas 2016). The small scale and temporary nature of potential smothering, and mandatory mitigation requirements with respect to drilling chemical use and discharge (Section 2.3.1), will ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

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

Of the qualifying features, terns and little gull have a low sensitivity to disturbance by ship and helicopter traffic, while red-throated diver and common scoter are both known to be highly sensitive to visual disturbance (Garthe & Hüppop 2004, also see Schwemmer *et al.* 2011, MMO 2018, and Mendel *et al.* 2019, and Section 4.2.6). There is considerable scope for drilling to take place outside of the site boundaries, and considering the seasonal nature of the sensitivity, operators should seek to undertake activity outside of the wintering period (1st November-31st March inclusive) to avoid the potential for effects on scoter and red-throated diver features. The need for such mitigation would be identified once project plans are known.

Should rig siting take place within the site, and in the wintering period, disturbance of divers or scoters is possible. JNCC (2022) provide advice on potential displacement for sensitive species including seaduck and red-throated diver in relation to wind farm development. The scale and duration of exploration/appraisal drilling is significantly less than that for the installation of an offshore wind farm. JNCC/NE advise at least a 2km and 2.5km displacement buffer be considered at the project level for vessels in relation to red-throated diver and common scoter respectively. This should be considered in the context of existing levels of vessel activity in the area (see Section 5.4), and where possible, established vessel traffic routes to the drilling location should be used. The scoter and red-throated diver features of the Greater Wash SPA are not uniformly distributed throughout the site (see Section 5.2.1 and Lawson *et al.* 2016), and should rig siting take place within the site, and within the wintering period, operators should seek to avoid the core areas of use by the species (see Section 5.2.1).

The temporary and localised nature of drilling activities and limited number of associated supply vessel and helicopter trips (see Table 2.2), which would likely use established routes, are such that they will not likely lead to an impact the qualifying features' distribution and use of the site such that the population within the site would be affected in the long-term. It should be noted that the effect of displacement on mortality is unknown, as are any effects on the populations of affected areas. For example, surveys of the Outer Thames Estuary SPA (O'Brien *et al.* 2008, Goodship *et al.* 2015, Irwin *et al.* 2019), while for varying purposes and using a variety of techniques, do not appear to show a corresponding population response of red-throated diver to the estimated displacement of divers by windfarms to date (also see Vilela *et al.* 2022). It is not considered that the licensing of the Blocks listed above, and the related level of vessel traffic and potential displacement, would lead to adverse effects on site integrity through displacement of red-throated diver or common scoter.

In-combination effects
Intra-plan in-combination effects are possible although the spatial footprint associated with rig installation and drilling discharges in Blocks 47/7b, 47/13, 47/14 and 48/28b, which all have substantial area outside of the site within which a rig may be sited, are localised and temporary, and unlikely to overlap either spatially or temporally. Given the indicative work programmes (Table 2.1), the combined spatial footprint within which physical disturbance and drilling effects could occur (within 500m of the rig/well location) across these Blocks (a worst case scenario of 4 wells) is estimated at 3.2km^2 (0.09% of the site). With regards to rig stabilisation, should all 4 wells be drilled within the site, this could cover an area of 0.18km^2 or 0.005% of the SPA area. The localised and temporary nature of the disturbance and available mitigation to prevent permanent change to the

extent and distribution of the supporting habitat (Sections 2.3.1 and 5.2.1), will ensure that site conservation objectives are not undermined. Disturbance of red-throated diver and common scoter is possible should activities take place in the winter period. There is considerable scope to site rigs outside of the site boundaries, and if necessary, to use seasonal controls to avoid adverse effects on site integrity (Section 5.2.1). Section 5.4 provides a consideration of potential activities in-combination with other relevant plans and projects.

Humber Estuary SPA[83]

Site Information

Area (ha/km^2): 37,630/376
Relevant qualifying features: Breeding: avocet, bittern, little tern, marsh harrier
Over winter: avocet, bar-tailed godwit, bittern, black-tailed godwit, dunlin, golden plover, hen harrier, knot, redshank, ruff, shelduck, Waterbird assemblage

Conservation objectives: The objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- the extent and distribution of the habitats of the qualifying features
- the structure and function of the habitats of the qualifying features
- the supporting processes on which the habitats of the qualifying features rely
- the populations of each of the qualifying features
- the distribution of qualifying features within the site

Relevant Blocks with potential for physical disturbance and drilling effects

47/7b

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/sediment type)*

The advice on operations indicates that the supporting habitats for the features are sensitive to the above pressures, however, Block 47/7b is 5km from the site, and given the assumed distance from a jack-up rig within which effects may occur (500m, see Table 2.2), rig installation will not impact the extent and distribution of the habitats of the qualifying features within the site, such that the site conservation objectives will not be undermined and there will be no adverse effect on site integrity. Similarly, as any rig stabilisation materials (if required) would be within 500m of the rig, it is not considered that its use would result in any change in the extent of the supporting habitat of the site, and when considered in the context of available project level mitigation (see Section 5.2.1), site conservation objectives will not be undermined 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; smothering and siltation rate changes (light); physical change (to another seabed/sediment type), habitat structure changes – removal of substratum (extraction) and contaminants*

The supporting habitat is sensitive to the above pressures associated with drilling discharges. The advice on operations[84] indicates that the qualifying features and their supporting habitats have not been assessed against whether they are sensitive to contaminants pressures, but they are considered to be a medium-high risk. Any discharge from exploration well drilling would be subject to risk assessment as part of existing regulatory controls (see Section 2.3.1). It is assumed that effects relating to drilling discharges occur within 500m of the well location (Table 2.2), which is substantially less than the minimum distance from Block 47/7b to the site (5km). Additionally, the breeding little tern feature has a mean maximum foraging range of ~5km, such that activities in the Block are unlikely to affect their supporting habitat. This, combined with mandatory control requirements with respect to drilling chemical use and discharge (Section 2.3.1), will ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

[83] https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9006111
[84] https://designatedsites.naturalengland.org.uk/Marine/FAPMatrix.aspx?SiteCode=UK9006111

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

The site features are part of a waterbird assemblage which would be closely associated with the coast, and in view of the distance of Block 47/7b from the site (5km), visual disturbance (to which the features are considered sensitive to for exploration/appraisal activities but at low risk) is not expected to result in a change to the distribution of the features, or the site population, which could lead to adverse effects on site integrity. Additionally, the breeding little tern feature has a mean maximum foraging range of ~5km, such that they are unlikely to be present over the Block, and other tern species (common, Sandwich, Arctic) have shown a low sensitivity to disturbance such as vessel traffic (Fliessbach *et al.* 2019).

In-combination effects
Intra-plan in-combination effects are unlikely as only Block 47/7b was identified as relevant to the assessment, and it, and any related well are too distant for physical or discharge related effects to lead to an adverse impact on site integrity. Section 5.4 provides a consideration of potential activities in-combination with other relevant plans and projects.

Doggersbank SAC (Netherlands)

Site Information

Area (ha/km^2): 473,500/4,735
Relevant qualifying features: Sandbanks, grey seal, harbour seal, harbour porpoise

Conservation objectives:

- For harbour porpoise, grey seal and harbour seal: Maintain extent and quality of habitat in order to maintain population

Relevant Blocks with potential for physical disturbance and drilling effects

44/19b

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
Block 44/19b is immediately adjacent to the site but does not overlap it. Given the assumed distance from a jack-up rig within which effects may occur (500m, see Table 2.2) and the considerable area within the Block within which a rig may be sited, rig installation will not significantly impact the extent and quality of the sandbank habitat, or the related supporting habitat of the seal or porpoise features. Therefore, rig siting will not adversely affect site integrity.

Drilling discharges
It is assumed that effects relating to drilling discharges occur within 500m of the well location (Table 2.2). Therefore, given the relative location of the Block to the median line (i.e. the rig would need be within UK waters), it is highly unlikely that drilling discharges would significantly impact the extent and quality of the Annex I habitats or supporting habitats of the Annex II species, and adverse effects on site integrity are not predicted.

Other effects
N/A

In-combination effects
No intra-plan in-combination effects are likely given that 44/19b is the only Block applied for that is relevant to the site, and it is not within the site boundaries. Section 5.4 provides a consideration of potential activities in-combination with other relevant plans and projects.

Klaverbank SAC (Netherlands)

Site Information

Area (ha/km^2): 153,900/1,539
Relevant qualifying features: Reefs, grey seal, harbour seal, harbour porpoise

Conservation objectives:

• For harbour porpoise, grey seal, harbour seal, harbour porpoise: Maintain extent and quality of habitat in order to maintain population
Relevant Blocks with potential for physical disturbance and drilling effects
44/19b
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 Block 44/19b is 5km from the site boundaries. Given the assumed distance from a jack-up rig within which effects may occur (500m, see Table 2.2) and the distance between the Block and the site, rig installation will not impact the extent and quality of the Annex I habitats or their use as supporting habitat for the Annex II species. Therefore, rig siting will not adversely affect site integrity. **Drilling discharges** It is assumed that effects relating to drilling discharges occur within 500m of the well location (Table 2.2). Therefore, as the Block is at least 5km distance from the site, drilling discharges will not significantly impact the extent and quality of the habitats, and drilling discharges will not adversely affect site integrity. **Other effects** N/A **In-combination effects** No intra-plan in-combination effects are likely given that Block 44/19b is the only Block of relevance, and is some distance from the site boundaries (5km). Section 5.4 provides a consideration of potential activities in-combination with other relevant plans and projects.

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 positions) to ensure sensitive seabed surface features (such as reefs) are avoided and potential rig stabilisation issues (e.g. from scouring around spud cans, or soft sediment conditions) are minimised. 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.

It is not typical for rig stabilisation to be required, but this will be informed by site-specific survey and project specific plans which are not currently available. Where rig stabilisation is required, the Department will expect operators to provide adequate justification for the stabilisation option proposed (including for rig siting beyond site boundaries, if practical) and consider use of systems (e.g. anti-scour mats, mud mats) that can be removed following drilling. Where rock placement is required for rig stabilisation, the Department will expect operators to minimise the volume of rock deposited. Should rig stabilisation be required for drilling within the Dogger Bank SAC, the North Norfolk Sandbanks and Saturn Reef SAC, Inner Dowsing, Race Bank and North Ridge SAC, and Haisborough, Hammond and Winterton SAC, removeable methods that avoid permanent habitat change must be used, subject to these meeting the technical and safety requirements of rig placement at a particular location. This would be identified at the project level, at which time, further assessment including HRA would be required. The Blocks for which this mitigation may be relevant, subject to rig siting taking place within or within 500m of the following sites, are:

- Dogger Bank SAC (37/27, 44/17, 43/2b, 43/3b, 43/4b, 44/13, 44/19b, 43/20c, 43/9, 44/18a, 44/23a, 43/25, 44/16, 44/22, 43/14, 44/21, 43/12a, 43/18, 43/13, 43/19d, 43/17)
- North Norfolk Sandbanks and Saturn Reef SAC (48/10, 48/14d, 48/15b, 48/20c, 48/24, 48/25d, 49/11b, 49/16d, 49/21b, 49/21d, 49/26b, 53/2c)
- Inner Dowsing, Race Bank and North Ridge SAC (47/20, 48/21)
- Haisborough, Hammond and Winterton SAC (48/28b, 48/30c, 49/26b, 52/5c, 53/2c)

The red-throated diver and common scoter features of the Greater Wash SPA are highly sensitive to vessel traffic, but are only present seasonally (winter). Operators should seek to avoid activities within the site during the wintering period (1st November to 31st March inclusive). If this is not possible and a rig needs to be located within the site, the rig and related vessels should seek to avoid high areas of diver and scoter use. Where possible, vessels should use establishing routes, where diver and scoter densities are generally lower. Further assessment, including HRA, may be required at the project level.

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 project-level 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. This conclusion relies on the implementation of plan level mitigation to avoid permanent habitat change to selected sites. Specifically, that should rig stabilisation be required for any well drilled in the Dogger Bank SAC, the North Norfolk Sandbanks and Saturn Reef SAC, Inner Dowsing, Race Bank and North Ridge SAC, and Haisborough, Hammond and Winterton SAC, removeable methods must be used, subject to these meeting the technical and safety requirements of rig placement at a particular location – this would be identified once project plans are known. At the project level, there is a legal framework through the implementation of the EIA Regulations[85] 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.

[85] *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. New seismic surveys have been proposed in the work programmes for 29 Blocks applied for (Table 2.1) which are relevant to the assessment. The majority of the work programmes indicate that new seismic survey is contingent, with only two Blocks (43/25, 44/21) having work programmes which commit to acquiring new seismic data. Sites relevant to this part of the assessment are shown in Figure 5.3 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 5.3: Sites and Blocks to be subject to further assessment for underwater noise effects

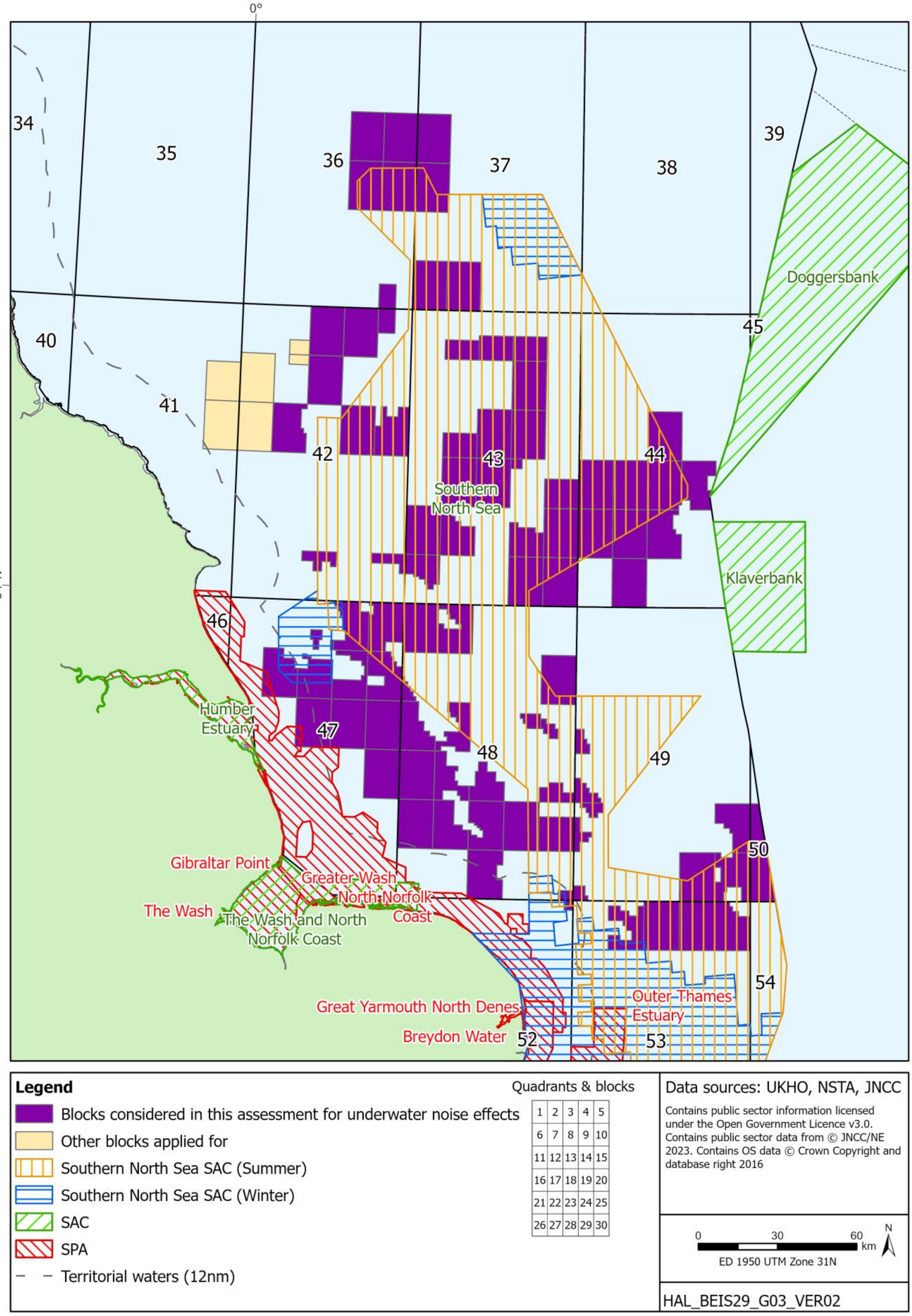


Table 5.2: Consideration of potential underwater noise effects and relevant site conservation objectives

Southern North Sea SAC
Site Information
Area (ha/km²): 3,695,054/36,951 **Relevant qualifying features:** Harbour porpoise **Conservation objectives:** See Table 5.1 above.
Relevant Blocks with potential for underwater noise effects
36/14, 36/15, 36/19, 36/20, 36/30c, 37/11, 37/16, 37/26, 37/27, 42/12b, 42/14, 42/15b, 42/28j, 42/3, 42/30b, 42/4, 42/5c, 42/8, 43/12a, 43/13, 43/14, 43/17, 43/18, 43/19d, 43/20c, 43/21, 43/22c, 43/24c, 43/25, 43/26b, 43/29, 43/2b, 43/30, 43/3b, 43/4b, 43/9, 44/13, 44/16, 44/17, 4/18a, 44/19b, 44/21, 44/22, 44/23a, 44/27, 47/10c, 47/13, 47/14, 47/15, 47/3j, 47/3k, 47/4d, 47/5b, 47/7b, 47/8a, 47/9a, 48/1, 48/10, 48/11b, 48/12a, 48/14d, 48/15b, 48/16, 48/17d, 48/18c, 48/20c, 48/23c, 48/24, 48/25d, 48/28b, 48/2b, 48/30c, 48/6c, 49/11b, 49/16d, 49/21b, 49/21d, 49/25b, 49/26b, 49/29, 49/30b, 50/21, 50/26, 52/5c, 53/2c, 53/3, 53/4, 53/5c
Assessment of effects on site integrity
Impulsive noise (2D/3D seismic survey, rig site survey, VSP, conductor piling) ***Relevant pressures:*** *underwater noise change, vibration* Individuals within approximately 12km of the airgun arrays may be affected, through temporary local displacement and reduced foraging opportunities. While a 3D survey may take up to several weeks to complete, in many cases it would be of shorter duration, and airgun activity would not be continuous throughout this period. Further, as the survey vessel travels along transects, ensonification is variable across the area surveyed. The habitat is open in nature, and harbour porpoises are known to be able to travel over large distances (>20km) within a day. While habitat quality is not uniform across the southern North Sea, considering that preliminary investigations suggest that sufficient prey are widely available both within and outside the site boundary (Ransijn *et al*. 2019) and the wide distribution of relatively high densities of harbour porpoise across this region, the spatial and temporal scale of potential displacement resulting from relevant activities is not expected to result in individuals losing access to suitable habitat. Considering: the maximum likely duration of the activity (Table 2.2); that the survey activity is likely to be spatially and/or temporally disparate across the relevant areas applied for and unlikely to result in long-term and large-scale displacement of porpoises from the area (Sarnocińska *et al.* 2020); that further mitigation measures are available (Section 5.2.6), and will be required, where appropriate, it is concluded that a 3D seismic survey will not result in an adverse effect on site integrity. In the case of rig site survey and VSP noise, given the lower amplitude source, the effects radius can reasonably be expected to be smaller (in the order of 5-10km) than that of 3D seismic survey and be of smaller spatial footprint and shorter duration (days). Consequently, it is concluded that rig site survey and VSP will not result in an adverse effect on site integrity. The impulsive underwater noise produced should conductors need to be piled into the seabed is of significantly lower magnitude than that generated in the piling of offshore wind turbine monopile foundations (see Table 2.2). Considering the noise source characteristics, the short duration of the activity, and the uncommon use of this technique to meet technical requirements; when combined with mandatory control measures (Section 2.3.2), disturbance to harbour porpoise within the site will be highly localised, short-term, and will not result in an adverse effect on site integrity. With regard to SNCB guidance on spatio-temporal thresholds for noise disturbance within the SAC[86], should a seismic survey take place wholly within the boundaries of the summer portion of the SAC (such surveys typically occur between Apr-Sep, see Figure 5.3 which shows the summer and winter areas), an approximate conservative estimate of the proportion of the relevant area from which harbour porpoise may be disturbed is 9.4%[87]. This is less than half the 20% daily threshold for what could be considered significant disturbance. With regard to season disturbance thresholds, recent HRAs for two different planned seismic surveys with partial overlap with the Southern North Sea SAC (BEIS 2021a, 2021b) estimate a worst-base of 1.3-5.4%

86 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/889842/SACNoiseGuidanceJune2020.pdf

87 Assuming a typical vessel speed of 4.5kts (8.3km/h), a survey line length of 100km and a 3hr line change, resulting in a total of 174km of lines surveyed within a 24hr period. Combined with a 12km EDR, this provides a total daily area of disturbance of 2,540km², which is 9.4% of the summer SAC area.

average seasonal (summer) disturbance[88], which is below the 10% seasonal threshold. The proportion of the site potentially disturbed by site survey, VSP and potential conductor piling will be considerably less, with these activities either being static or covering a very limited spatial footprint.

Negative indirect effects of impulsive noise on harbour porpoise may potentially arise through effects on prey species, primarily small fish, if those prey are subject to injury or disturbance which reduce their availability to harbour porpoise. While there is some evidence that a reduction in catches of some fish species can be associated with seismic survey activity, these are temporary in nature. Any such effects associated with VSP, rig site survey or conductor piling are expected to be minor, considering their shorter duration, smaller spatial extent and lower amplitude source relative to 2D and 3D seismic surveys (to which most reported effects relate). Additionally, the disturbance of sensitive spawning periods for potential fish prey species will be considered through the activity consenting process. Consequently, any underwater noise effects on fish associated with the licensing of relevant areas applied for are not anticipated to result in significant effects on the food resources of the harbour porpoise.

Continuous noise (drilling, vessel & rig movements)
Relevant pressures: *underwater noise change, vibration*

Harbour porpoise are considered sensitive to underwater noise from shipping which could make preferred habitats less attractive as a result of disturbance (habitat displacement, area avoidance). There are currently a number of large ports on the east coast which result in large vessel shipping routes throughout the site. Given existing levels of shipping activity over the site and elevated porpoise densities, the temporary nature of drilling activities and limited number of associated supply vessels will not represent a significant increase in the level of disturbance that could lead to the exclusion of harbour porpoise from a significant portion of the site for a significant period of time. Further mitigation measures are also available (Section 5.3.1) and will be required, where appropriate, to ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

In-combination effects

For the purposes of this AA, 68 Blocks partly or entirely overlap with the SAC and 12 of these have work programmes which propose contingent seismic survey, with only two which have a firm proposal to shoot new seismic (Table 2.1). Considering the following: the current understanding of the site and its feature being in favourable condition; the level of current and past seismic survey, drilling and vessel activity within the site; that further mitigation measures are available (Section 5.3.1) and will be required, where appropriate, including potential controls on activity timing; and, that evidence suggests that seismic surveys are unlikely to result in long-term and large-scale displacement of porpoises from the area (Sarnocińska *et al.* 2020), adverse effects on site integrity are not expected.

Humber Estuary SAC

Site Information

Area (ha/km^2): 36,657/367
Relevant qualifying features: grey seal

Conservation objectives: See Table 5.1 above.

Relevant Blocks with potential for underwater noise effects

47/7b, 47/13

Assessment of effects on site integrity

Impulsive noise (2D/3D seismic survey, rig site survey, VSP, conductor piling)
Relevant pressures: *underwater noise change, vibration*

Considering the distance Blocks 47/7b and 47/13 are from the site (5km and 14km respectively) and location of the breeding colony at Donna Nook, there would be limited propagation of noise from activities such as rig site surveys and VSP into the site and areas of greatest importance for seals, although emitted sound fields would overlap an area of assumed foraging habitat occurring at distance from the site; there is, however, the potential for sound generated by high amplitude, low frequency seismic survey to travel further. For VSP and rig site survey, a conservative estimate of the likely effects on qualifying features is considered to be short-term and temporary displacement of grey seals within 5-10km of the activities. Such effects would be likely to last for the

[88] Based on worst-case scenarios of 21-153 days of disturbance during the survey.

duration of the activity (several hours), with evidence suggesting a return to baseline animal distribution and activity within a matter of hours of the noise-generating activity ceasing, even in the case of louder noise sources such as high energy impact piling of wind turbine foundations (e.g. Russell *et al*. 2016). As such, no adverse effects on the integrity of the site are expected. For 3D seismic survey, while these have the potential to generate sound that exceeds thresholds of injury, this is only within a limited range from source (tens to hundreds of metres). Any survey would be required to follow the JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys (see Section 2.3.2), and would be subject to assessment, including HRA where appropriate, once project plans are known. The temporary and transient nature of any seismic survey, and the application of mandatory control measures, are such that adverse effects on the integrity of the site from 3D seismic survey are not predicted.

Negative indirect effects of impulsive noise on grey seal may arise through effects on prey species, primarily small fish such as sandeels, if those prey are subject to injury or disturbance which reduce their availability to the qualifying feature. While there is some evidence that a reduction in catches of some fish species can be associated with seismic survey activity, these are temporary in nature. Furthermore, evidence suggest that sandeels (a key prey species of grey seals in the southern North Sea) have a low sensitivity to low frequency noise. Any such effects associated with VSP or rig site survey are expected to be minor, considering their shorter duration, smaller spatial extent and lower amplitude source relative to the 2D and 3D seismic surveys (to which most reported effects relate). Additionally, the disturbance of sensitive spawning periods for potential fish prey species will be considered through the activity consenting process. Consequently, any underwater noise effects on fish associated with the licensing of relevant areas applied for are not anticipated to result in significant effects on the food resources of the grey seal qualifying features.

Sea lamprey use marine habitats for feeding prior to returning to freshwater to spawn; however, their distribution in marine habitats is largely restricted to estuaries and nearshore coastal waters (Silva *et al.* 2014), with designated UK sites considered to provide an important migration route (to spawning rivers) and/or feeding grounds. Given the limited evidence of physical injury to fish from exposure to high amplitude low-frequency seismic survey noise (Section 4.3, also see BEIS 2022), the conservation objectives of the site are not expected to be undermined in relation to sea lamprey. The location and timing of any seismic survey is presently unknown, but would be subject to assessment (Section 5.3.1) including, where appropriate, HRA prior to consent being granted.

The impulsive underwater noise produced should conductors need to be piled into the seabed is of significantly lower magnitude than that generated in the piling of offshore wind turbine monopile foundations (see Table 2.2). Considering the noise source characteristics, the short duration of the activity, and the uncommon use of this technique to meet technical requirements; when combined with mandatory control measures (Section 2.3.2), disturbance to the grey seal qualifying features beyond the site boundaries will be highly localised, short-term, and will not result in an adverse effect on site integrity.

Continuous noise (drilling, vessel & rig movements)
Relevant pressures: *underwater noise change, vibration*

Grey seals are considered sensitive to underwater noise from shipping which could make preferred habitats less attractive as a result of disturbance (habitat displacement, area avoidance). Given existing levels of shipping activity over the relevant areas applied for (see Section 5.4), the temporary nature of drilling activities and limited number of associated supply vessels will not represent a significant increase in the level of disturbance that could lead to the exclusion of grey seal from potential important areas outside of the site for a significant period of time. Further mitigation measures are also available (Section 5.3.1) and will be required, where appropriate, to ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

In-combination effects
Intra-plan in-combination underwater noise effects are considered highly unlikely given the low potential for effects identified above and the likely temporal and spatial separation of any individual licence activities which could take place. Section 5.4 provides a consideration of potential licence activities in-combination with other relevant plans and projects.

The Wash and North Norfolk Coast SAC

Site Information

Area (ha/km^2): 10,761/1,078
Relevant qualifying features: harbour seal

Conservation objectives: See Table 5.1 above.
Relevant Blocks with potential for underwater noise effects
48/21, 48/22a
Assessment of effects on site integrity
Impulsive noise (2D/3D seismic survey, rig site survey, VSP, conductor piling) ***Relevant pressures:*** *underwater noise change, vibration* Blocks 48/21 and 48/22a are at least 13km from the site, which limits the propagation of noise from activities including rig site surveys and VSP, and seismic survey (Table 2.1), to within the site boundaries. At-sea distribution modelling suggests that the majority of harbour seals of relevance to The Wash use a wide area, with highest densities extending from south of the Humber to the North Norfolk Coast (Carter *et al.* 2020), which may also be affected by seismic survey and drilling related geophysical survey. For VSP and rig site survey, a conservative estimate of the likely effects on qualifying features is considered to be short-term and temporary displacement of harbour seals within 5-10km of the activities. Such effects would be likely to last for the duration of the activity (several hours), with evidence suggesting a return to baseline animal distribution and activity within a matter of hours of the noise-generating activity ceasing, even in the case of louder noise sources such as high energy impact piling of wind turbine foundations (e.g. Russell *et al*. 2016). As such, no adverse effects on the integrity of the site are expected. For 3D seismic survey, while these have the potential to generate sound that exceeds thresholds of injury, this is only within a limited range from source (tens to hundreds of metres). Any survey would be required to follow the JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys (see Section 2.3.2), and would be subject to assessment, including HRA where appropriate, once project plans are known. The temporary and transient nature of any seismic survey, and the application of mandatory control measures, are such that adverse effects on the integrity of the site from 3D seismic survey are not predicted. Negative indirect effects of impulsive noise on harbour seal may arise through effects on prey species, primarily small fish such as sandeels, if those prey are subject to injury or disturbance which reduce their availability to the qualifying feature. While there is some evidence that a reduction in catches of some fish species can be associated with seismic survey activity, these are temporary in nature. Furthermore, evidence suggest that sandeels (a key prey species of harbour seals in the southern North Sea) have a low sensitivity to low frequency noise. Any such effects associated with VSP or rig site survey are expected to be minor, considering their shorter duration, smaller spatial extent, and lower amplitude source relative to the 2D and 3D seismic surveys (to which most reported effects relate). Additionally, the disturbance of sensitive spawning periods for potential fish prey species will be considered through the activity consenting process. Consequently, any underwater noise effects on fish associated with the licensing of the Blocks is not anticipated to result in significant effects on the food resources of the harbour seal qualifying features. The impulsive underwater noise produced should conductors need to be piled into the seabed is of significantly lower magnitude than that generated in the piling of offshore wind turbine monopile foundations (see Table 2.2). Considering the noise source characteristics, the short duration of the activity, and the uncommon use of this technique to meet technical requirements; when combined with mandatory control measures (Section 2.3.2), disturbance to the harbour seal qualifying features beyond the site boundaries will be highly localised, short-term, and will not result in an adverse effect on site integrity. **Continuous noise (drilling, vessel & rig movements)** ***Relevant pressures:*** *underwater noise change, vibration* Harbour seals are considered sensitive to underwater noise from shipping which could make preferred habitats less attractive as a result of disturbance (habitat displacement, area avoidance). Given existing levels of shipping activity over the Blocks (see Section 5.4), the temporary nature of drilling activities and limited number of associated supply vessels will not represent a significant increase in the level of disturbance that could lead to the exclusion of harbour seal from potential important areas outside of the site for a significant period of time. Further mitigation measures are also available (Section 5.3.1) and will be required, where appropriate, to ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity. **In-combination effects** Intra-plan in-combination underwater noise effects are considered highly unlikely given the low potential for effects identified above and the likely temporal and spatial separation of any individual licence activities which could take place. Section 5.4 provides a consideration of potential licence activities in-combination with other relevant plans and projects.

Doggersbank SAC (Netherlands)
Site Information
Area (ha/km^2): 473,500/4,735 **Relevant qualifying features:** grey seal, harbour seal, harbour porpoise. **Conservation objectives:** See Table 5.1 above.
Relevant Blocks with potential for underwater noise effects
44/13, 44/18a, 44/19b, 44/23a
Assessment of effects on site integrity
Impulsive noise (2D/3D seismic survey, rig site survey, VSP, conductor piling) ***Relevant pressures:*** *underwater noise change, vibration* Porpoise and seals within approximately 12km of the airgun arrays may be affected, through temporary local displacement and reduced foraging opportunities. While a 3D survey may take up to several weeks to complete, in many cases it would be of shorter duration, airgun activity would not be continuous throughout this period, and there would be no direct overlap with the site. Further, as the survey vessel travels along transects, ensonification is variable across the area surveyed. The habitat is open in nature, and harbour porpoises are known to be able to travel over large distances (>20km) within a day, and it is likely that there would be sufficient access to suitable habitat, and any effect on the extent and quality of the habitat would be short-term and would not affect the population. There would be very limited propagation of noise from activities such as rig site surveys and VSP into the site. Given the lower amplitude source, the effects radius can reasonably be expected to be smaller (in the order of 5-10km) than that of 3D seismic survey and be of smaller spatial footprint and shorter duration (days). For these activities, a conservative estimate of the likely effects on qualifying features is considered to be short-term and temporary displacement of harbour porpoise and, to a lesser extent, seals (see Section 5.2), from the periphery of the site. Such effects are likely to last for the duration of the activity (up to several days), with evidence suggesting a return to baseline animal distribution and activity within a matter of hours of the noise-generating activity ceasing, even in the case of louder noise sources than site survey or VSP. Consequently, and considering that further mitigation measures are available, no adverse effects on the integrity of the site are expected. Negative indirect effects of seismic and rig site survey, and VSP, on the qualifying features may potentially arise through effects on prey species, primarily small fish, if those prey are subject to injury or disturbance which reduce their availability to seals and harbour porpoise. While there is some evidence that a reduction in catches of some fish species can be associated with seismic survey activity, these are temporary in nature. Furthermore, evidence suggests that sandeels (a key prey species of marine mammals in the Dogger Bank area) have a low sensitivity to low frequency noise. Any such effects associated with VSP or rig site survey are expected to be minor, considering their shorter duration, smaller spatial extent, and lower amplitude source relative to the 2D and 3D seismic surveys (to which most reported effects relate). Additionally, the disturbance of sensitive spawning periods for potential fish prey species will be considered through the activity consenting process. Consequently, any underwater noise effects on fish associated with the licensing of the Blocks are not anticipated to result in significant effects on the food resources of the qualifying features. The impulsive underwater noise produced should conductors need to be piled into the seabed is of significantly lower magnitude than that generated in the piling of offshore wind turbine monopile foundations (see Table 2.2). Considering the noise source characteristics, the short duration of the activity, and the uncommon use of this technique to meet technical requirements; when combined with mandatory control measures (Section 2.3.2), disturbance to harbour porpoise and seals within the site will be highly localised, short-term, and will not result in an adverse effect on site integrity. **Continuous noise (drilling, vessel & rig movements)** ***Relevant pressures:*** *underwater noise change, vibration* Harbour porpoise and seals are considered sensitive to underwater noise from shipping which could make preferred habitats less attractive as a result of disturbance (habitat displacement, area avoidance). The Blocks do not overlap the site, which along with the likelihood that survey and support vessels associated with the work programme will travel from UK ports, the temporary nature of survey and drilling activities, and the limited number of associated supply vessel trips (Table 2.2), the activities will not represent a significant increase in the level of disturbance that could lead to the exclusion of harbour porpoise from a significant portion of the site

for a significant period of time. Further mitigation measures are also available (Section 5.3.1) and will be required, where appropriate, to ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

In-combination effects

Intra-plan in-combination underwater noise effects are considered highly unlikely given the low potential for effects identified above and the likely temporal and spatial separation of any individual licence activities which could take place. Section 5.4 provides a consideration of potential licence activities in-combination with other relevant plans and projects.

Klaverbank SAC (Netherlands)

Site Information

Area (ha/km^2): 153,900/1,539
Relevant qualifying features: grey seal, harbour seal, harbour porpoise.

Conservation objectives: See Table 5.1 above.

Relevant Blocks with potential for underwater noise effects

44/18a, 44/19b, 44/23a

Assessment of effects on site integrity

Impulsive noise (2D/3D seismic survey, rig site survey, VSP, conductor piling)
Relevant pressures: *underwater noise change, vibration*

Porpoise and seals within approximately 12km of the airgun arrays may be affected, through temporary local displacement and reduced foraging opportunities. While a 3D survey may take up to several weeks to complete, in many cases it would be of shorter duration, airgun activity would not be continuous throughout this period, and there would be no direct overlap with the site. Further, as the survey vessel travels along transects, ensonification is variable across the area surveyed. The habitat is open in nature, and harbour porpoises are known to be able to travel over large distances (>20km) within a day, and it is likely that there would be sufficient access to suitable habitat, and any effect on the extent and quality of the habitat would be short-term and would not affect the population. There would be very limited propagation of noise from activities such as rig site surveys and VSP into the site. Given the lower amplitude source, the effects radius can reasonably be expected to be smaller (in the order of 5-10km) than that of 3D seismic survey and be of smaller spatial footprint and shorter duration (days).

For these activities, a conservative estimate of the likely effects on qualifying features is considered to be short-term and temporary displacement of harbour porpoise and, to a lesser extent, seals (see Section 5.2), from the periphery of the site. Such effects are likely to last for the duration of the activity (up to several days), with evidence suggesting a return to baseline animal distribution and activity within a matter of hours of the noise-generating activity ceasing, even in the case of louder noise sources than site survey or VSP. Consequently, and considering that further mitigation measures are available, no adverse effects on the integrity of the site are expected.

Negative indirect effects of seismic survey activities on the qualifying features may potentially arise through effects on prey species, primarily small fish, if those prey are subject to injury or disturbance which reduce their availability to seals and harbour porpoise. While there is some evidence that a reduction in catches of some fish species can be associated with seismic survey activity, these are temporary in nature. Any such effects associated with VSP or rig site survey are expected to be minor, considering their shorter duration, smaller spatial extent and lower amplitude source relative to the 2D and 3D seismic surveys (to which most reported effects relate). Additionally, the disturbance of sensitive spawning periods for potential fish prey species will be considered through the activity consenting process. Consequently, any underwater noise effects on fish associated with the licensing of Blocks 44/18a, 44/19b and 44/23a are not anticipated to result in significant effects on the food resources of the qualifying features.

The impulsive underwater noise produced should conductors need to be piled into the seabed is of significantly lower magnitude than that generated in the piling of offshore wind turbine monopile foundations (see Table 2.2). Considering the noise source characteristics, the short duration of the activity, and the uncommon use of this technique to meet technical requirements; when combined with mandatory control measures (Section 2.3.2), disturbance to harbour porpoise and seals within the site is not expected, and will not result in an adverse effect on site integrity.

Continuous noise (drilling, vessel & rig movements)
Relevant pressures: *underwater noise change, vibration*

Harbour porpoise are considered sensitive to underwater noise from shipping which could make preferred habitats less attractive as a result of disturbance (habitat displacement, area avoidance). Given the offshore nature of the site and the distance of the Blocks applied for from the site boundary (5km), the temporary nature of drilling activities and limited number of associated supply vessels will not represent a significant increase in the level of disturbance that could lead to the exclusion of harbour porpoise or seals from a significant portion of the site for a significant period of time, and will not result in an adverse effect on site integrity.

In-combination effects
Intra-plan in-combination underwater noise effects are considered highly unlikely given the low potential for effects identified above and the likely temporal and spatial separation of any individual licence activities which could take place in the Blocks applied for. Section 5.4 provides a consideration of potential activities in-combination with other relevant plans and projects.

Greater Wash SPA

Site Information

Area (ha/km^2): 353,578/3,536
Relevant qualifying features: non-breeding: red-throated diver, common scoter

Conservation objectives: See Table 5.1 above.

*the following assessment also covers the red-throated diver feature of the Outer Thames Estuary SPA as it is associated with the wintering population of the Greater Wash SPA.

Relevant Blocks with potential for underwater noise effects

47/13, 47/14, 47/15, 47/20, 47/7b, 47/8a, 48/16, 48/21, 48/22a, 48/28b, 48/30c, 52/5c

Assessment of effects on site integrity

Of those Blocks screened into the noise assessment for the Greater Wash SPA, 47/15, 48/16, 48/22a have substantial areas beyond 15km from the site within which rig site survey could take place, and which all or part of any seismic survey could take place (new contingent seismic is proposed for Blocks 47/13, 47/14, 47/15, 47/20, 47/7b, 47/8a). The boundary of the Greater Wash SPA was largely defined by Maximum Curvature Analysis (MCA) for red-throated diver (Lawson *et al.* 2016, Natural England & JNCC 2016), such that all the Blocks listed above are potentially relevant to the assessment. The area of site used by common scoter is restricted to an area off The Wash and along the North Norfolk Coast, and the area defined by MCA for the feature is greater than 15km from any Block applied for (Figure 5.1).

Impulsive noise (2D/3D seismic survey, rig site survey, VSP, conductor piling)
Relevant pressures: *underwater noise change, vibration*

As detailed in Section 4.3.2, there is very little evidence of impacts of underwater noise on diving birds. Mortality of seabirds has not been observed during extensive seismic operations in the North Sea and elsewhere, and flushing disturbance associated with the physical presence of survey vessels and rigs would be expected to displace most diving seabirds from close proximity to noise sources, particularly in the case of divers and scoters which are known to display a large avoidance radius of vessels and surface infrastructure (up to several kilometres – see Sections 4.3.2 and 5.2). Such avoidance behaviour is also expected to reduce the potential for diving birds to be exposed to noise levels which may result in potential behavioural disturbance, although it is noted that very little evidence for such effects exist and, should they occur, they would be expected to be short-term, temporary and of limited spatial extent. Considering the seasonal nature of the sensitivity, where necessary, control of timing of offshore activities allows for mitigation, which would be identified once project plans are known.

Negative indirect effects of impulsive noise on qualifying features may arise through effects on prey species, primarily small fish, if those prey are subject to injury or disturbance which reduce their availability to qualifying seabirds. Such effects relate to the primarily piscivorous red-throated diver, as the winter diet of common scoter is largely restricted to sessile bivalves on the seabed (Fox 2003). While there is some evidence that a reduction in fish catches or abundance can be associated with seismic survey activity, these are temporary in nature, and the sensitivity of the relevant prey species to underwater noise is considered to be generally low. 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 those Blocks listed above are not anticipated to result in significant effects on the food resources of the qualifying diving bird features.

Considering the limited potential for effects of 2D/3D 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, any disturbance to qualifying features or their prey will be highly localised, short-term, and will not result in an adverse effect on the integrity of the site.

Continuous noise (drilling, vessel & rig movements)
Relevant pressures: *underwater noise change, vibration*

No significant effects on the relevant qualifying species 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 to diving birds from such sources.

In-combination effects
Intra-plan in-combination underwater noise effects are considered highly unlikely given the low potential for effects identified above, however, it is noted that work programmes for half of the Blocks which were screened in for this site and applied for propose contingent seismic survey. There is limited scope for temporal or spatial overlap of these activities, and some Blocks form part of wider licence application areas further reducing the potential for intra-plan in-combination effects as the scale of activity will likely be lower than that suggested if each Block were individually licenced. Mitigation measures are available to avoid intra-plan in-combination effects, which include seasonal controls. 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[89]. 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. A standard consent condition requires operators to follow the JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys.

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

The planning of seismic surveys should endeavour to minimise exposure of noise-sensitive qualifying features, including harbour porpoises, to underwater noise by careful consideration of the timing with respect to: 1) seasonal differences in the distribution of relevant species across their ranges in relation to relevant sites, and 2) the presence of other underwater noise-

[89] For example see: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1133330/Details_on_upcoming_noisy_activities_in_the_Southern_North_Sea_2023.pdf

generating activities (i.e. other geophysical surveys and impact piling). It is advised that the licensees of the areas of relevance for underwater noise effects (listed in Table 5.2) establish early discussions with the Department and also the leaseholders of OWF areas, to understand the nature and timing of proposed activities such that significant in-combination effects can be avoided (see Section 5.4). Early consultation with the relevant SNCBs is also recommended.

For those areas applied for where proposed activities could result in the physical disturbance of marine mammals by the presence and movement of vessels, available mitigation measures include strict use of existing shipping routes, and timing controls on temporary activities to avoid sensitive periods.

5.3.2 Conclusions

Although underwater sound generated during project-level activities, specifically seismic surveys, has the potential to injure and disturb individual harbour porpoises, seals, fish (including qualifying features and prey) and diving birds, the actual risk is minimised by the controls currently in place.

For any of the relevant sites, it is concluded that the likely level of activity expected to take place within the relevant areas applied for listed in Table 5.2 will not cause an adverse effect on site integrity, taking account of the following:

- Should a 3D seismic survey be proposed in any of the areas applied for, further HRA may be required to assess the potential for adverse effects on the integrity of the site once the area of survey, source size, timing and proposed mitigation measures are known and can form the basis for a definitive assessment.

Individual activities (e.g. drilling, seismic) require individual consents which will not be granted unless the operator can demonstrate that the proposed activities, which may include 3D seismic surveys, 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 and gas storage, fishing, shipping, and aggregate extraction. These activities are subject to individual permitting or consenting mechanisms or are otherwise managed at a national level. The Blocks applied for are located within the North East and East Marine Plan Areas. These plans set out objectives and policies to guide development in these areas, and are referred to where relevant, in the following sections.

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.

The principal sources of in-combination effects are regarded to be related to noise, physical disturbance, and physical presence, primarily arising from offshore wind development. OWF development will introduce noise and disturbance sources (particularly during construction) and present an additional physical presence in the marine environment. Offshore wind zones (e.g. those associated with Rounds 3 and 4) have already been subject to SEA and plan-level HRA, and any related projects have been, or will be, subject to their own individual assessment and HRA processes[90].

The UK Government believes that the oil & gas and the renewables industry can successfully co-exist, as stated in Other Regulatory Issues[91], "…*we advise that potential applicants on such blocks [(areas where oil and gas licenses and proposed or actual wind farm sites exist and indeed overlap)] should make early contact with the holders of any relevant wind farm lease or Agreement for lease (AfL), or the relevant zone developer(s), and establish in good time a mutual understanding of the respective proposals and time frames envisaged (acknowledging that not all aspects of the future plans of either side will necessarily be definitively decided at that time)*". Early discussions between the developers will ensure that any potential conflict

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[90] For those sites having already been subject to HRA, note that the competent authority is under an obligation to reconsider and review consents for projects that are likely to have a significant effect on new SAC and SPA sites once they become a candidate site. Consultation on an HRA exercise for a review of consents for the Southern North Sea SAC took place between November and December 2018, and a review of consents for SPAs is ongoing. See: https://www.gov.uk/government/consultations/southern-north-sea-review-of-consents-draft-habitats-regulations-assessment-hra and https://www.gov.uk/government/consultations/review-of-consents-for-major-energy-infrastructure-projects-and-special-protection-areas-2022

[91] See: 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, Quadrant/Block Specific Issues (version at September 2022).

can be mitigated so that both developments can proceed with minimal delay and without the need to determine any part of an existing Crown Estate Lease or Agreement for Lease. In addition to renewables activities, early engagement with other users (e.g. through fisheries liaison, vessel traffic surveys, consultation with the MoD or holders of other Crown Estate offshore interests)[92], where scheduling overlaps may occur, should allow both for developer cooperation, and the mitigation of potential cumulative or in-combination effects.

This is also reflected in the East Inshore and East Offshore Marine Plans (paragraph 295) which state "*Future oil and gas activity has the potential to require access to the same area of seabed as other activities. In most cases, the consequence of this will be insignificant due to the small footprint of oil and gas production infrastructure. In some cases this may not be the case, such as where another user of the sea bed has a lease in place. Where a lease has been agreed for a co-located activity, there may be a requirement for negotiation between parties involved*." and is supported in plan policies such as GOV2 and GOV3, which respectively promote the maximisation of activity co-existence, and the demonstration that activity displacement will be avoided, minimised, or mitigated. Policies for the other marine plan areas of relevance to the Blocks (North East Inshore and Offshore) are consistent with those of the East Marine Plans. For example, marine plan NE-CO-1 and NE-OG-1/OG-2 indicate a preference for projects that optimise their use of space and consider co-existence opportunities, and safeguard existing seaward oil and gas licences and future discoveries from new proposals respectively.

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

Relevant project	Project summary	Project status/indicative timing	Relevant sites[1]
Offshore renewables and interconnectors			
Dogger Bank A Dogger Bank B	Located some 131km offshore, these two wind farms will collectively contain up to 200 turbines with a total capacity of up to 2,400MW within an area of. 1,114km^2. The turbines may be fixed to the seabed using monopile, jacket or gravity base foundations. Additionally, collector and converter stations will be required offshore. Export cables will have their landfall on the coast of the East Riding of Yorkshire.	Consented. Under construction	Dogger Bank SAC, Southern North Sea SAC
Dogger Bank C	Located approximately 200km north-east of Flamborough Head (Yorkshire coast), the wind farm will feature up to 200 turbines with a maximum capacity of 1,200MW, along with collector, converter and other platforms. Turbines may be fixed to the seabed using monopile, multi-leg or gravity base foundations. The project will connect to the Lackenby substation in Teesside, North Yorkshire.	Consented. Earliest likely offshore construction from 2023/24.	Dogger Bank SAC, Southern North Sea SAC

[92] https://opendata-thecrownestate.opendata.arcgis.com/

Relevant project	Project summary	Project status/indicative timing	Relevant sites[1]
Sofia	Located approximately 165km east of Teesside (Yorkshire coast), the wind farm will feature 100 turbines with a maximum capacity of 1,400MW, along with an offshore converter platform. Turbines will be fixed to the seabed using monopile foundations. Export cables will have landfall on the Teesside coast and connect to a new converter station near Lazenby.	Consented. Offshore construction expected from 2023.	Dogger Bank SAC, Southern North Sea SAC
Hornsea Project One	Located approximately 100km to the east of the Yorkshire coast, Hornsea Project One has a total installed capacity of 1,218MW delivered by 174 turbines within an area of 407km^2. The turbines were installed using monopile foundations. The export cable route travels to the south west and has its landfall at Horse Shoe Point to the south of Grimsby.	Fully commissioned. Construction completed in 2019.	Southern North Sea SAC
Hornsea Project Two	The wind farm has a proposed capacity of 1,800MW generated by 165 wind turbines within an area of 462km^2 and located *ca*. 90km from the Yorkshire coast. The turbines were installed using monopile foundations. The export cable route shares that of Project One.	Fully commissioned. Construction completed in 2022.	Southern North Sea SAC
Hornsea Project Three	The wind farm is proposed to have a capacity of up to 2,400MW generated by 231 turbines using fixed foundations (i.e. monopile, jacket, gravity base) within an area of 696km^2. It is expected that up to 6 cables will take power ashore in a corridor extending from the south west corner of the zone to a landfall on the North Norfolk Coast.	Consented. Offshore construction expected from 2024.	Southern North Sea SAC, North Norfolk Sandbanks and Saturn Reef SAC, Wash and North Norfolk Coast SAC
Hornsea Project Four	The wind farm is proposed to have a capacity of up to 2,600MW generated by 180 turbines using fixed foundations (i.e. monopile, jacket, gravity base) within an array area of 846km^2. The array is located approximately 65km to the east of Flamborough Head, and the export cable corridor follows a relatively direct route to a landfall on the East Riding of Yorkshire coastline. Up to six export cables will be installed.	Consented.	Southern North Sea SAC, Greater Wash SPA
Sheringham and Dudgeon extension projects	The two projects which propose to extend the Sheringham and Dudgeon wind farms have a capacity of 317MW and 402MW respectively, and use a joint export cable system. The extensions could have up to 23 and 30 wind turbines respectively.	In planning. Proposed construction timing of 2025-2028.	Wash and North Norfolk Coast SAC, Greater Wash SPA, Inner Dowsing, Race Bank and North Ridge SAC
Humber Gateway offshore wind farm	The project has 73 turbines providing an installed capacity of 219MW, with export cabling having its landfall on the south of the Holderness coast near Easington.	Operational	Greater Wash SPA

Relevant project	Project summary	Project status/indicative timing	Relevant sites[1]
Westermost Rough offshore wind farm	The project includes 35 turbines providing an installed capacity of 210MW, with export cabling having its landfall on the Holderness coast near Withernsea.	Operational	Greater Wash SPA
Race Bank offshore wind farm	The project includes 90 turbines providing an installed capacity of 857MW, with export cabling passing through The Wash to a landfall north of Sutton Bridge.	Operational	Greater Wash SPA
Lincs, Lynn and Inner Dowsing offshore wind farms	Lynn and Inner Dowsing each have 27 turbines and capacities of 97.2MW, with Lincs having 75 turbines and a capacity of 270MW. They are all constructed relatively close to the Lincolnshire coast, where their export cables have their landfall.	Operational	Greater Wash SPA
Triton Knoll offshore wind farm	The project includes 90 turbines providing an installed capacity of 857MW. Export cables have their landfall on the Lincolnshire coast north of Anderby Creek.	Operational	Greater Wash SPA
Round 4 Preferred Projects 1 and 2	Two preferred project areas are located to the south of Dogger Bank. No firm project plans are known at this stage.	Pre-application	Dogger Bank SAC, Southern North Sea SAC
Round 4 Preferred Project 3	One preferred project area is located approximately 50km to the east of the Humber. No firm project plans are known at this stage.	Pre-application	Southern North Sea SAC
Norfolk Boreas	An offshore wind farm of capacity up to 1,800MW using up to 158 turbines and with up to four export cables with a landfall near Happisburgh.	Consented	Southern North Sea SAC
Norfolk Vanguard	An offshore wind farm of capacity up to 1,800MW using up to 158 turbines and with up to four export cables with a landfall near Happisburgh.	Consented	Southern North Sea SAC
East Anglia Three	An offshore wind farm of capacity up to 1,400MW, likely using 95 14.7MW turbines and a network of subsea inter-array cables and up to four export cables, with a landfall at Bawdsey.	Consented	Southern North Sea SAC
Eastern Green Link 2	A proposed HVDC cable of approximately 436km in length, running from Sandford Bay in Scotland to Fraisthorpe Sands in Yorkshire. The cables may be installed as a bundle of three cables or separately, along with a fibre optic line.	In-planning	Greater Wash SPA
Viking Link	A 1,400MW interconnector between Bicker Fen in Lincolnshire and Revsing in South Jutland, Denmark. The cable will be trenched and buried in the North Sea, with the landfall completed using trenchless methods.	Under construction	Southern North Sea SAC, Greater Wash SPA
Offshore Transmission Network Review: National GridESO Holistic Network Design (HND)	The HND recommends the optimal transmission network for offshore wind and has been developed to enable detailed network design which will allow for decisions to be made about connecting specific assets.	Published July 2022. Follow on work to make recommendations to developers early 2023.	Southern North Sea SAC, Greater Wash SPA, Inner Dowsing, Race Bank and North Ridge SAC

Relevant project	Project summary	Project status/indicative timing	Relevant sites[1]
Gas storage			
Carbon Storage Licence CS001	The carbon storage licence was awarded in 2012 and was later amended in 2020 to extent the appraisal period, with an application for a storage permit due in 2024.	Pre-planning	Southern North Sea SAC
Carbon Storage Licence CS005	The carbon storage licence was awarded in 2021, with site characterisation expected to be complete by 2023, which includes the reprocessing of seismic data. The end of the "Assess" phase is due in 2024, with a storage permit application to be made in 2025.	Pre-planning	Southern North Sea SAC, North Norfolk Sandbanks and Saturn Reef SAC
Carbon Storage Licence CS006	The carbon storage licence was awarded in 2022, with site characterisation expected to be complete by 2026. New seismic is to be required over the site by 2023, with a contingent well to be completed by 2027. A storage permit application is to be made by November 2029.	Pre-planning	Southern North Sea SAC
Carbon Storage Licence CS007	The carbon storage licence was awarded in 2022, with site characterisation expected to be complete by 2028. Contingent new seismic is to be required over the site by 2025, with a contingent well to be completed by 2025. A storage permit application is to be made by November 2027.	Pre-planning	Southern North Sea SAC
1st Carbon Storage round licence provisional awards	Seven licences were issued in the southern North Sea as part of the 1st Carbon Storage licensing round. The licences cover an appraisal term which includes seismic survey and the drilling of wells. No details of any potential development are presently known, or are likely to be known for some time, should any of the licences proceed past the appraisal term.	Pre-planning	Southern North Sea SAC, North Norfolk Sandbanks and Saturn Reef SAC, Dogger Bank SAC, Haisborough, Hammond and Winterton SAC, Greater Wash SPA
Rough Gas storage	A gas storage licence was issued in July 2022 covering the Rough field. The field was previously used for gas storage, and its present phase does not include any new offshore work, i.e. existing wells, pipelines and platforms are to be used to storge gas at Rough.	In operation	Southern North Sea SAC (winter)
Oil and gas			
Tolmount	Located in Block 42/28d, the Tolmount gas field development includes a minimal facilities platform and a new gas export pipeline to shore.	Producing	Southern North Sea SAC
Tolmount East	A single gas condensate well tied back to the Tolmount platform.	Approved	Southern North Sea SAC
Blythe Hub development	Located in Blocks 48/22b, c and 49/21c, the Blythe hub development includes a subsea tie-back (Elgood) to a new platform (Blythe), and a separate field (Southwark), re-using the existing Thames export pipeline to Bacton.	Producing	Southern North Sea SAC, North Norfolk Sandbanks and Saturn Reef SAC

Relevant project	Project summary	Project status/indicative timing	Relevant sites[1]
Oil and gas decommissioning projects			
Fields and infrastructure associated with and tied back to Murdoch	Various decommissioning programmes are associated with the Caister-Murdoch area including for the Caister CM platform and associated pipelines, the Boulton BM, Katy KT, Kelvin TM, Munro MH platforms, and the CMS subsea installations including Boulton HM, Hawksley EM, McAdam MM, Murdoch K.KM and Watt QM, and all related pipelines and umbilicals, and the Murdoch MA, Murdoch MC, Murdoch MD platforms and export pipeline to Theddlethorpe. Additionally, the Ketch, Schooner, Rita and Hunter fields, also tied back to Murdoch, are subject to decommissioning. The plans variously involve the removal of platform topsides, jackets and subsea installations to shore for recycling, and the leaving *in situ* of buried pipelines, and removal of exposed ones, with rock remediation for some projects.	Approved. Murdoch MA, MC and MD platforms removed August 2022	Dogger Bank SAC, Southern North Sea SAC
Cavendish Field	Topsides and jacket to be removed and returned to shore. The pipelines will be partially removed (buried sections to remain *in situ*).	Approved	Dogger Bank SAC, Southern North Sea SAC
Windermere Field	Topsides and jacket will be removed and returned to shore. The pipelines will be partially removed. All concrete mattresses and grout bags will be recovered to shore.	Approved	Klaverbank SAC (Netherlands)
Anglia Field	Platform will be removed and transported to shore for re-use or recycling. Subsea wells will be plugged and abandoned using a drilling rig. Pipelines will remain in-situ. All tie-in spools for the 8" import line, 12" export line and 3" Methanol line will be completely removed.	Approved	Southern North Sea, North Norfolk Sandbanks and Saturn Reef SAC
Hewett Field	Six platforms to be removed and returned to shore.	Approved	Southern North Sea SAC
	Subsea installations. Proposes recovery to shore for reuse, recycling or disposal.		
Ensign Field installation and pipelines	Topsides and jacket will be removed and transported to shore for recycling. All wells will be plugged and abandoned. Buried pipelines will be left *in situ* except the exposed ends which will be cut and removed.	Approved	Southern North Sea SAC, North Norfolk Sandbanks and Saturn Reef SAC
Viking platforms, Vixen and associated pipelines (VDP2)	Removal to shore for re-use, recycling or disposal of Viking surface installations KD, LD, AR, Viking Bravo Hub BA, BC, BP, BD and Vixen sub-sea tieback in Blocks 49/12a and 49/17a. Buried pipelines left *in situ*.	Approved. Platforms were removed 2019 and 2020.	Southern North Sea SAC, North Norfolk Sandbanks and Saturn Reef SAC

Relevant project	Project summary	Project status/indicative timing	Relevant sites[1]
Victor (VDP3)	Victor platform and subsea installation in Blocks 49/22 and 49/1 removed to shore for re-use, recycling or disposal. Buried pipelines left *in situ*.	Approved	Southern North Sea SAC, North Norfolk Sandbanks and Saturn Reef SAC
Tyne South installations	Topsides, jacket and subsea installation in Block 44/18a removed to shore for reuse, recycling or disposal.	Approved	Southern North Sea SAC, Dogger Bank SAC
LOGGS Satellites Jupiter Area	Decommissioning programmes covering two Lincolnshire Offshore Gas Gathering System (LOGGS) Satellite installations (Ganymede ZD and Europa EZ installations) and pipelines and two subsea tiebacks (Callisto ZM and NW Bell ZX) with wellhead protection structures and pipelines. Installations are in Block 49/22. All installations will be recovered to shore for re-use or recycling. NW Bell pipelines will be recovered to shore. Ganymede, Europa and Callisto interfield pipelines will be decommissioned *in situ*.	Approved. Ganymede and Europa installations removed in 2020.	Southern North Sea SAC, North Norfolk Sandbanks and Saturn Reef SAC
Wenlock	The platform, mid line tee protection structure, exposed tie-in spools and stabilisation features will be removed to shore. Trenched and buried pipelines will remain *in situ,* which includes an export pipeline to the Indefatigable (Inde 23AC) platform (also subject to decommissioning.	Approved	Southern North Sea SAC, North Norfolk Sandbanks and Saturn Reef SAC
Leman 27H and 27J topsides	Topsides to be recovered to shore.	Draft DP under consideration	Southern North Sea SAC, North Norfolk Sandbanks and Saturn Reef SAC
Johnston	Subsea installations to be recovered to shore for recycling and disposal. Trenched and buried pipelines to be left *in situ* with ends remediated using rock. Flexible flowlines and umbilicals/spools/jumpers to be removed.	Approved	Southern North Sea SAC
Aggregate areas			
2021/2022 aggregates tender round[93]	A number of provision tender areas located in the southern North Sea have been released. These are yet to be subject to HRA. Area 2103 is of most relevance to this AA, and is located within the Greater Wash area.	HRA likely to be concluded 2023, following which six-year exploration and option agreements may be offered.	Greater Wash SPA, Southern North Sea SAC,
Humber production areas 1-4 (514/1-4)	These areas are licensed for the extraction of marine aggregates. As part of the wider Humber region, 32.16km^2 were actively dredged	Leased production area	Greater Wash SPA

[93] https://www.thecrownestate.co.uk/en-gb/media-and-insights/news/2022-the-crown-estate-confirms-areas-selected-for-202122-marine-aggregates-tender-round/

Relevant project	Project summary	Project status/indicative timing	Relevant sites[1]
Outer Dowsing (515/1)	in 2021, representing 10.3% of the total licensed area, with 90% of effort in 14.90km². Dredging intensity over these areas was generally low to medium (TCE & BMAPA 2022).	Leased production area	Inner Dowsing, Race Bank and North Ridge SAC
Humber Overfalls (493)		Leased production area	Greater Wash SPA
Humber Estuary (106/1-3 and 400)		Leased production area	Greater Wash SPA
Off Saltfleet (197)		Leased production area	Greater Wash SPA
Humber 3 (484)		Leased production area	Southern North Sea SAC, North Norfolk Sandbanks and Saturn Reef SAC

Sources: relevant Development Consent Orders and related post-consent modifications (https://infrastructure.planninginspectorate.gov.uk/), OPRED oil & gas: decommissioning of offshore installations and pipelines (https://www.gov.uk/guidance/oil-and-gas-decommissioning-of-offshore-installations-and-pipelines), TCE & BMAPA (2022), TCE Open Data Portal (https://thecrownestate.maps.arcgis.com/apps/webappviewer/index.html?id=b7f375021ea845fcabd46f83f1d48f0b), NSTA carbon storage public register (https://www.nstauthority.co.uk/licensing-consents/carbon-storage/), NSTA gas storage and unloading webpage (https://www.nstauthority.co.uk/licensing-consents/gas-storage-and-unloading/

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

Figure 5.4: Location of areas applied for in relation to other projects

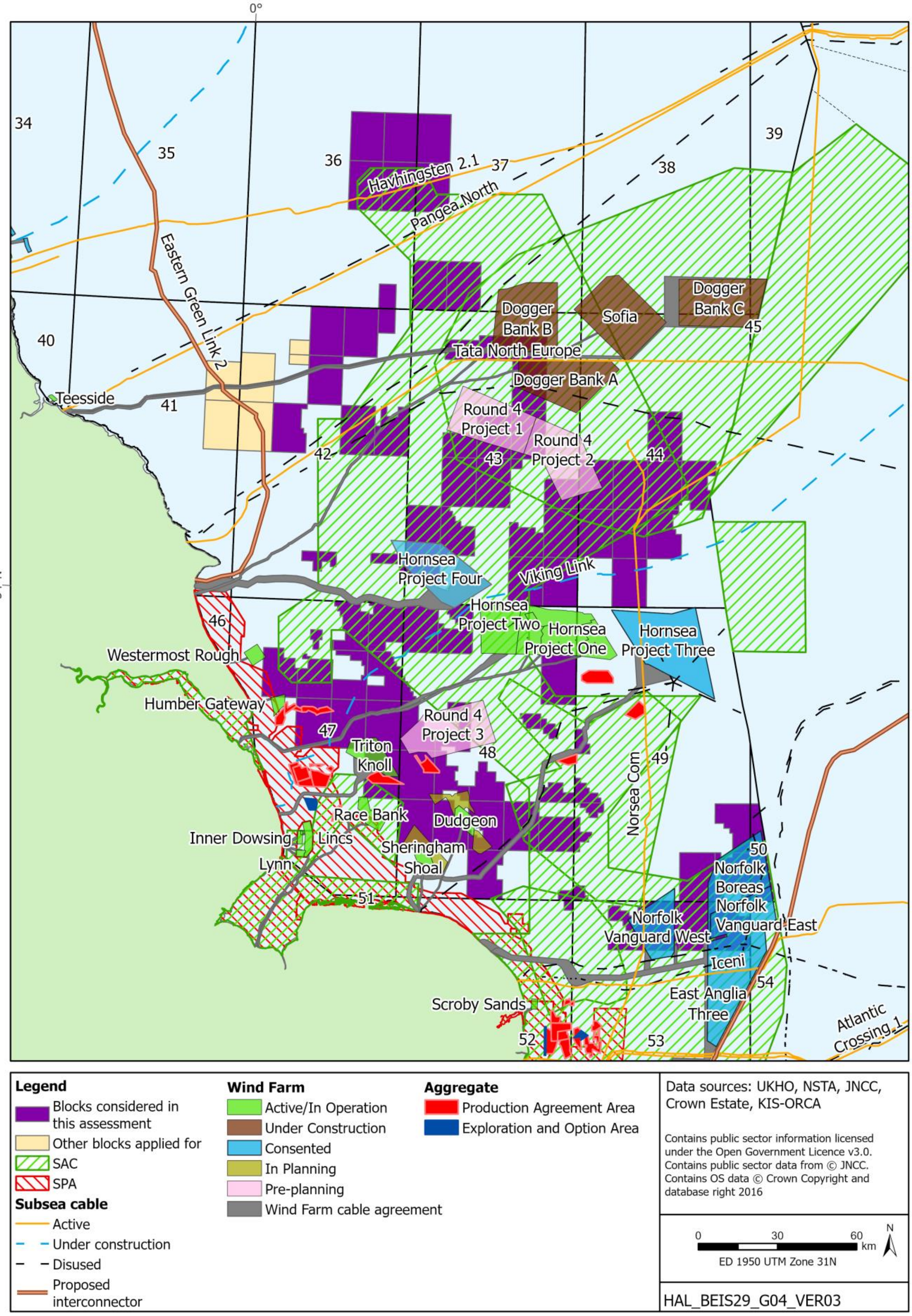


Figure 5.5: Location of areas applied for in relation to other projects (continued)

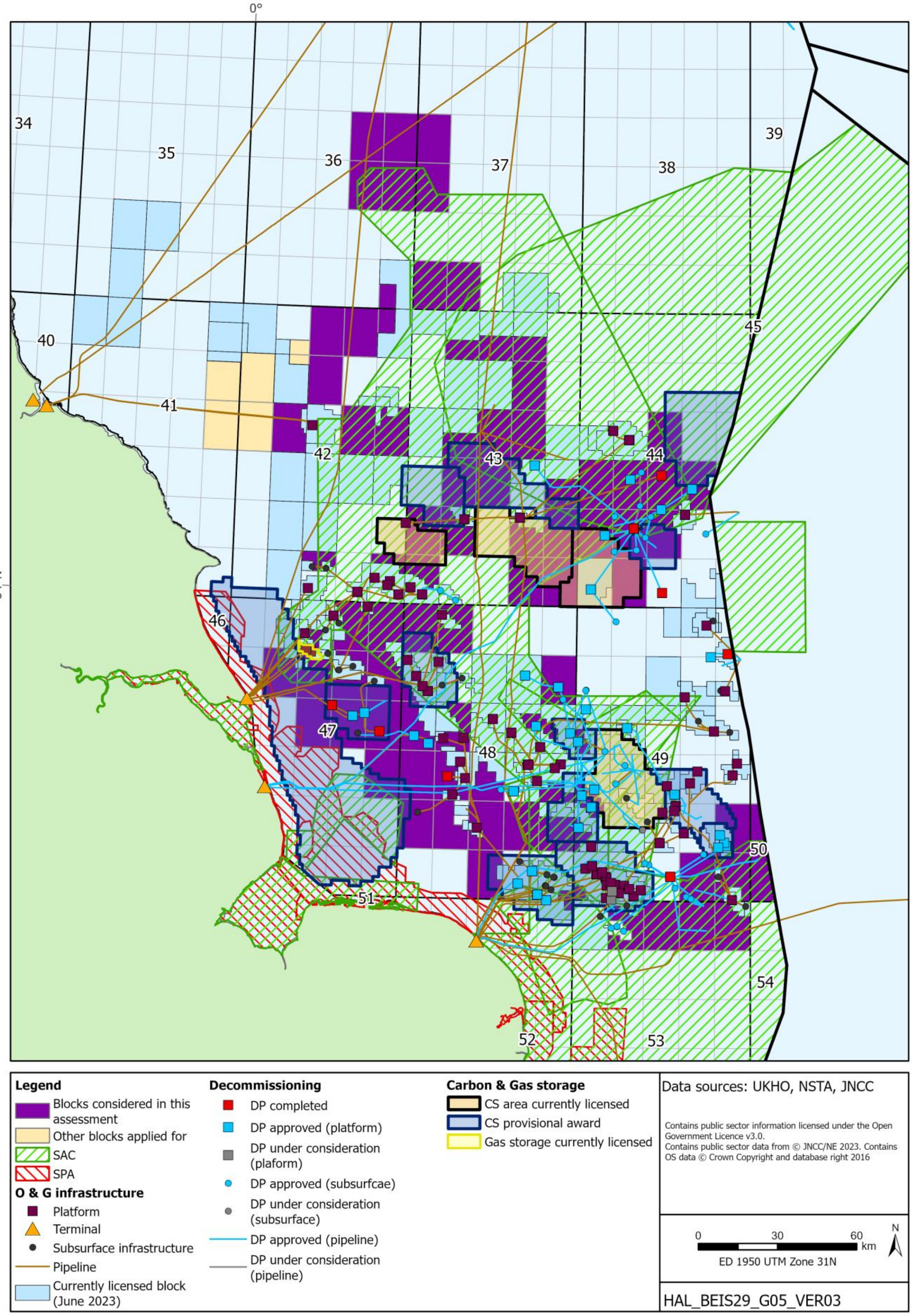
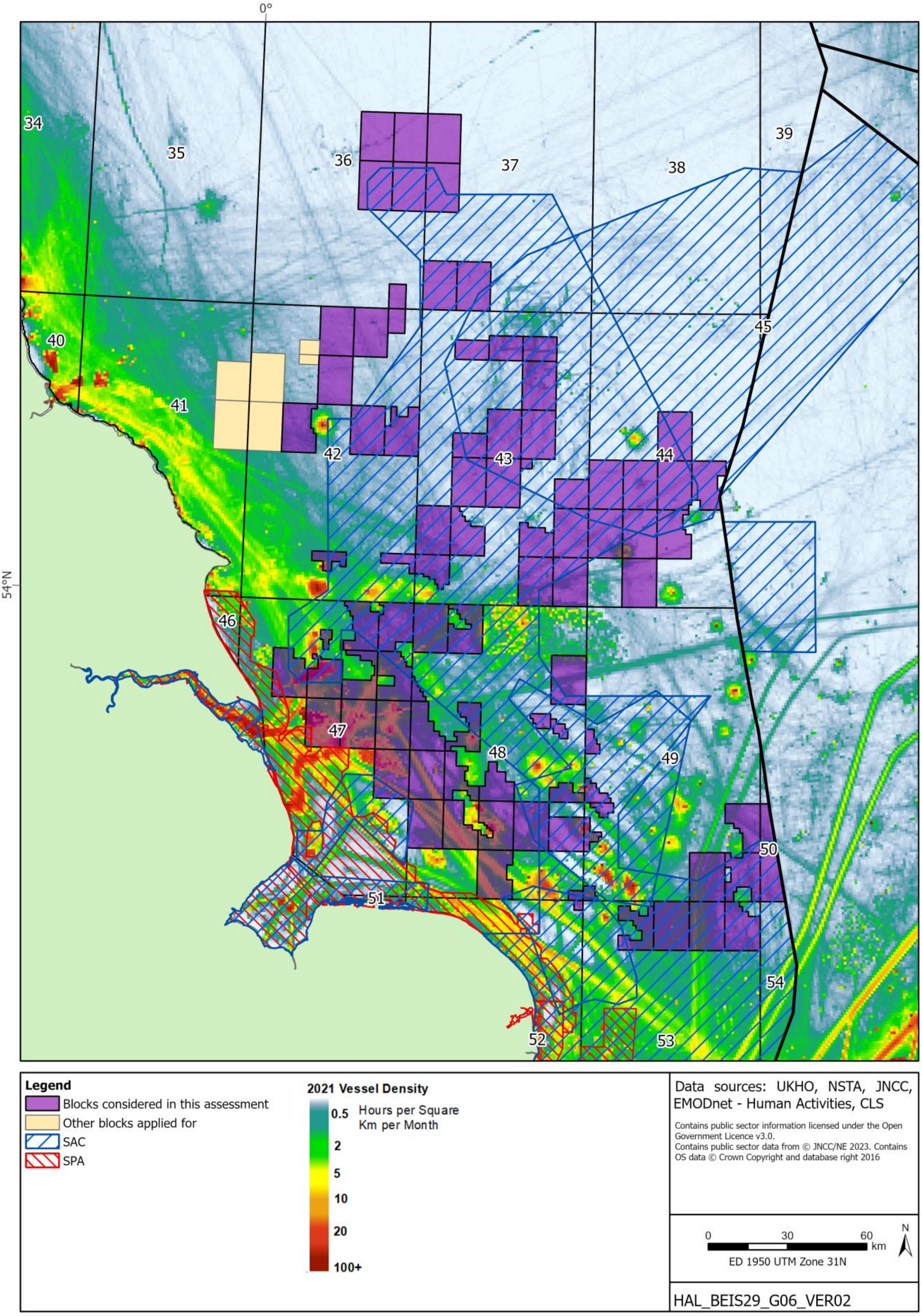


Figure 5.6: Vessel traffic in the southern North Sea and Mid North Sea High



5.4.1 Physical disturbance and drilling effects

The pressures which may result from exploration activities that could result from licensing and cause physical disturbance and drilling effects on the relevant sites were described in Section 4.2 and Section 5.2. The conclusions of Section 5.2 are considered in the following section in the context of those relevant projects identified in Table 5.3 above.

Though existing oil and gas infrastructure is widespread in the southern North Sea (Figure 5.5), the relative density and footprint of these is small. Assuming a conservative footprint of 0.8km^2 for every fixed installation in the southern North Sea (i.e. that covering the 500m safety zone), the total percentage area of the southern North Sea (defined here as Regional Sea 2) occupied by these platforms is 0.05%. Of the 167 installations considered, 48 of these have approved decommissioning plans or are subject to decommissioning planning and will be removed in the coming years. A review of field development projects (as of February 2023) indicates three projects which are relevant to sites considered in this assessment (Tolmount, Tolmount East and the Blythe Hub). The projects involve the installation of subsea wells or platforms, and related pipelines to existing infrastructure for export to terminals at Easington and Bacton (Figure 5.5). The Blythe Hub and Tolmount are both complete, with Tolmount East proposed to be completed in 2023, such that it is likely to be in operation in advance of activities following the licensing of the Blocks applied for in the 33rd licensing round. Tolmount is at least 7km from the nearest Block (42/28j) and the Blythe platform is immediately adjacent to 48/23c, with Southwark within 2km of Block 49/21d. Only the Southwark platform is located within either the North Norfolk Sandbanks and Saturn Reef SAC or the Southern North Sea SAC.

There are a number of decommissioning projects scheduled to take place in the southern North Sea in the coming years which are summarised in Table 5.3 and are also shown in Figure 5.5. These are primarily located in Quadrants 43, 44, 47, 48 and 49 and are partly or entirely relevant to the Southern North Sea SAC, North Norfolk Sandbanks and Saturn Reef SAC, Haisborough, Hammond and Winterton SAC and Dogger Bank SAC. In addition to those listed in Table 5.3, a number of fields are likely to be decommissioned in the coming years, but decommissioning plans are yet to be submitted. Activities associated with decommissioning plans will result in some physical disturbance which will largely be within existing field development areas (e.g. from removal of pipeline spool pieces, pipeline sections, protection materials, subsea wellheads, manifolds and platform footings, well abandonment where this requires a mobile rig, and any anchoring and rock placement). Levels of activity (e.g. shipping) from decommissioning may not be significantly greater than ongoing operations in the southern North Sea, will be temporary, and for many fields will represent the end of oil and gas related activities in these areas. In some circumstances decommissioning may result in the placement of rock, for example to remediate the ends of pipelines which have been left *in situ*. Additionally, there is the potential for field redevelopment in some areas, and a number of the Blocks applied for in the 33rd Round cover areas for which facilities have been decommissioned or are subject to decommissioning planning (Table 5.3). This is similarly the case for some carbon storage licences, for example CS005, and the 1st Carbon Storage Licensing Areas SNS Areas 2, 4 and 8 (see DESNZ 2023b), all of which cover areas of former gas field activity.

While the siting of a rig has the potential to have in-combination effects with the decommissioning of gas field infrastructure, incremental disturbance will be temporary, and where required, mitigation may be used to avoid permanent impacts on the habitats of sites (see Section 5.2.1). Where appropriate, the Department will undertake HRA in relation to oil and gas development and decommissioning activities, including a consideration of in-combination effects. The Department has undertaken such an assessment for the Viking and LOGGS decommissioning programmes in relation to the Southern North Sea SAC and North Norfolk Sandbanks and Saturn Reef SAC. Additionally, assessments have been undertaken for decommissioning of assets relevant to the Dogger Bank SAC (e.g. Kelvin), Southern North Sea SAC and North Norfolk Sandbanks and Saturn Reef SAC (e.g. Ganymede, Viking, Wenlock). These assessments concluded the various projects would not have an adverse effect on the integrity of the above listed sites[94]. As noted above, it is recognised that further decommissioning programmes are likely to come forward in the southern North Sea in coming years, which will be subject to further HRA as appropriate, including in relation to in-combination effects.

Blocks 42/30b, 43/21, 43/22c, 43/24c, 43/25, 43/26b, 43/29, 43/30, 44/21, 44/22, 44/27, 49/16d and 49/21b are adjacent to or overlap carbon dioxide appraisal and storage licence areas (e.g. CS001, CS005, CS006 and CS007) and their related agreements for lease, with a number of other Blocks occurring adjacent to or within provisional licence awards in the 1st Carbon Storage Licensing Round (Figure 5.5). The majority of these Blocks are partly or fully within the Southern North Sea SAC, with others also partly or fully within the North Norfolk Sandbanks and Saturn Reef SAC, Dogger Bank SAC, Haisborough, Hammond and Winterton SAC and Greater Wash SPA. As part of the Net Zero Strategy, the Government set out its ambition to deliver four carbon capture usage and storage (CCUS) clusters, capturing 20-30 $MtCO_2$ across the economy, including 6 $MtCO_2$ of industrial emissions, per year by 2030, and 9 $MtCO_2$ per year by 2035. In line with this ambition, the HyNet and East Coast Clusters have been confirmed as being Track-1 clusters following the CCUS cluster sequencing process. Developed alongside hydrogen, CCUS will be part of creating transformative “SuperPlaces” in areas such as the Humber and North East, as well as the North West, Southern England, Scotland and Wales. The storage of carbon dioxide associated with these Track-1 clusters, and any future projects, may take place in any of the currently leased/licensed carbon dioxide storage areas, and in view of the targets set out in the Net Zero strategy, development of these stores should be anticipated over the next decade and beyond. In keeping with East Marine Plan policy CCS2, and the oil and gas decommissioning guidance set out by the Department (BEIS 2018), there is the potential for re-use of existing infrastructure for carbon dioxide transport and storage. A review of the possible re-use of oil and gas infrastructure for carbon dioxide was undertaken[95], the Government response to which gave a range of future actions including ones related to further re-use assessment of offshore oil and gas assets, making data available, updated policy proposals and regulatory review. The overlap of existing carbon dioxide storage licence areas, and those 1st Round provisional awards, with gas production infrastructure, much of which is subject to decommissioning (see Figure 5.5) infers the potential for re-use which may limit further sources of effect in relation to sites such as North Norfolk Sandbanks and Saturn Reef SAC. While there are significant overlaps between the Blocks applied for and the various carbon storage licence areas, there are presently limited information to consider the potential for in-combination effects. The duration of the exploration/appraisal terms of the carbon storage licence areas applied for could overlap with the initial term of licences issued as part of the 33rd Round. The location, nature, scale, and timing of activities including the drilling of wells is not known, and there is considerable scope to avoid interaction and in-combination effects through activity timing. Additionally, the plan level mitigation proposed in relation to physical disturbance effects in this AA (see Section 5.2.1) was also proposed in the HRA for the 1st Carbon Dioxide Storage Licensing Round to

[94] See the list of Habitats Regulations Assessments undertaken by the Department at: https://www.gov.uk/guidance/oil-and-gas-offshore-environmental-legislation#offshore-petroleum-activities-conservation-of-habitats-regulations-2001-as-amended

[95] https://www.gov.uk/government/consultations/carbon-capture-usage-and-storage-ccus-projects-re-use-of-oil-and-gas-assets

avoid adverse effects on the integrity of sites, including Dogger Bank and the North Norfolk Sandbanks and Saturn Reef SACs. Further assessment will be undertaken at the project consenting stage (see Figure 2.2), allowing for further consideration of the potential for in-combination effects and the identification of mitigation. Consent will not be granted where adverse effects on site integrity cannot be discounted.

Offshore wind farms are the only type of operational or proposed renewable energy projects in the southern North Sea. Sources of effect from physical disturbance associated with these projects include installation of turbines (using monopile, jacket or gravity base foundations) and associated infrastructure such as interconnecting and export cables. With regards to cables, the Eastern Green Link 2 and Viking Link interconnector projects are of relevance (see Figure 5.4). Cables would typically be trenched and buried (e.g. in keeping with East Marine Plan policy CAB1), with protection materials used strategically at cable/pipeline crossings or should there be difficulties achieving burial depth due to the nature of the shallow geology. The current timelines for project proposals (Table 5.3, Figure 5.4) indicate the potential for temporal overlap with 33rd Round activity, subject to the issue of licences and the timing of individual work programme activities. There is significant overlap with Round 4 preferred projects, however as these are at the pre-application stage of planning, it is unlikely that there would be overlap with 33rd round activities. Despite the limited potential for spatial overlap, there is the potential for incremental physical effects which are discussed below. Early engagement between any seaward oil and gas licence holder and wind farm developer can help to avoid spatial conflict, and applicants taking part in the 33rd licensing round were made aware of such relevant Crown Estate interests through links to offshore activity maps[96].

The HRA for The Crown Estate's Round 4 wind leasing[97] concluded that adverse effects on site integrity could not be discounted for Dogger Bank SAC in relation to habitat loss and damage from preferred projects 1 and 2, which are almost entirely within the SAC. This was due to the long-term (~60 years) impact on the habitat extent and distribution, the limited expected potential to recover, and the current site condition which is considered to be unfavourable. Additionally, a number of other wind farms, including Dogger Bank A, B, C and Sofia, are located within the Dogger Bank SAC, with a more limited coverage of gas field infrastructure (most subject to decommissioning, see Figure 5.5) to the south of the site[98]. The HRA for Round 4 wind leasing covered potential compensation measures for Dogger Bank including: the removal of structures which are contributing to the unfavourable status of the sandbank feature (e.g. oil and gas pipelines and related protection materials), debris removal and habitat restoration either within Dogger Bank SAC or other sandbank sites across the National Site Network (though both lacking confidence as to their viability at this stage) and reduction of pressures from other activities (noting the only realistic option was considered to be removal of demersal fishing pressure, acknowledging this would need to add to the existing MMO measures noted above). The extension of the site to include more Annex I sandbank habitat was also considered, though there was general lack of support for this. Despite the potential limitations of the compensatory measures proposed, the preferred projects were not discounted at this stage. Once firm project proposals are known, existing statutory and planning processes allow for further consideration of interactions between carbon storage and

[96] https://opendata-thecrownestate.opendata.arcgis.com/
[97] https://www.marinedataexchange.co.uk/details/3582/2022-the-crown-estate-2020-offshore-wind-round-4-plan-habitats-regulations-assessment/
[98] A scoping opinion has been sought from the Planning Inspectorate for Dogger Bank D, which is a proposed 1.8GW wind farm projected located to the east of Dogger Bank C. An application for the project is not expected until later 2024 and it is considered to be too early in its consenting process to consider in any detail at this stage.

other activities and, where applicable, this would be subject to project level HRA which would include in-combination assessment.

In addition to Round 4, The Crown Estate also undertook an HRA covering a number of wind farm extensions, which was concluded in 2019. Likely significant effects were determined for projects in relation to effects on the Annex I habitat of the Wash and North Norfolk Coast SAC and, North Norfolk Sandbanks and Saturn Reef SAC. For each of the sites, conclusions of no adverse effect were determined, including in-combination, through the adoption of a Cable Route Protocol as part of plan-level mitigation, in addition to not awarding rights to the Race Bank extension project[99]. The Cable Route Protocol contains requirements for offshore wind developers in the planning of offshore export cable routes, compliance for which is secured through offshore wind agreements for lease. An adverse effect on site integrity was concluded for the Wash and North Norfolk Coast SAC and the North Norfolk Sandbanks and Saturn Reef SAC in relation to Hornsea Project Three, specifically in relation to habitat loss and modification associated with cable protection. A Sandbank Implementation Plan was submitted as part of the planning process for the project which sets out mitigation and compensation measures, in keeping with its Development Consent Order (DCO) requirements, and was approved in April 2022. With regards to temporary effects to Annex I sandbank, in relation to Haisborough Hammond and Winterton SAC, it was concluded in the HRAs for Norfolk Boreas and Norfolk Vanguard that adverse effects of sandbank levelling, cable installation and repairs, could be excluded for the projects alone and in-combination.

It was concluded in Section 5.2.1 that alone, the licensing of certain Blocks would not result in an adverse effect on the integrity of the Dogger Bank SAC (37/27, 44/17, 43/2b, 43/3b, 43/4b, 44/13, 44/19b, 43/20c, 43/9, 44/18a, 44/23a, 43/25, 44/16, 44/22, 43/14, 44/21, 43/12a, 43/18, 43/13, 43/19d, 43/17), North Norfolk Sandbanks and Saturn Reef SAC (48/10, 48/14d, 48/15b, 48/20c, 48/24, 48/25d, 49/11b, 49/16d, 49/21b, 49/21d, 49/26b, 53/2c), Inner Dowsing, Race Bank and North Ridge SAC (47/20, 48/21) and Haisborough, Hammond and Winterton SAC (48/28b, 48/30c, 49/26b, 52/5c, 53/2c) as, subject to mitigation, there would be no permanent change in the structure or extent and distribution of the Annex I sandbanks habitat from exploration/appraisal activities. As noted in Section 5.2.2, mitigation will be required to avoid the placement of rig stabilisation materials that would represent a permanent change to the habitat. It is considered that the minor and short-term disturbance generated by exploration/appraisal drilling, should this occur in the above sites, will not result in adverse in-combination effects with other plans or programmes, when considered in the context of the mitigation already set out in Section 5.2.1, which is, that should rig stabilisation be required, removable methods must be used, subject to technical and safety considerations. As noted in Section 2.1, the issue of a licence does not confer any consent to undertake activities which will be subject to separate project-level consenting including, where appropriate, HRA. There is the opportunity at that stage to identify mitigation to avoid adverse impacts on site integrity. If mitigation cannot be identified, and a conclusion of adverse effect must be made at that stage, consent will not be granted.

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, however given the relatively shallow water depths (generally <50m), moderate tidal currents and potential for storm wave base interactions

[99] https://www.marinedataexchange.co.uk/details/628/2019-the-crown-estate-2017-offshore-wind-extensions-plan-habitats-regulations-assessment-hra/

across the areas applied for (e.g. Klein *et al.* 1999), accumulations of cuttings piles are not considered likely from exploration activity (see Section 5.2) or in-combination with other exploration and development wells associated with gas production or carbon dioxide storage. Additionally, 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), which the UK Marine Strategy[100] has identified as relevant measures contributing to managing discharges. Discharges are considered unlikely to be detectable and to have negligible in-combination effect (BEIS 2022).

Advice on operations for the Dogger Bank SAC, Haisborough, Hammond and Winterton SAC, North Norfolk Sandbanks and Saturn Reef SAC, Inner Dowsing, Race Bank and North Ridge and Southern North Sea SAC (see Sections 5.2 and 5.3) identify that the sites are sensitive to commercial fisheries, though for the latter, the focus is harbour porpoise bycatch and removal of prey species. It is not regarded that the nature and scale of exploration/appraisal activities would result in a significant in-combination effect with porpoise bycatch. Physical disturbance related pressures from fisheries for which the other sites have been assessed as sensitive are relevant for those sources of effect from 33rd Round activities (noted in Section 4.2 and assessed in Section 5.2), and the potential for in-combination effects with fisheries are considered below.

Fishing, and particularly bottom trawling, have historically contributed to seabed disturbance over extensive areas and was identified as an ongoing issue in the UK assessment of good environmental status[101]. 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. A number of byelaws have recently been imposed on conservation sites which effectively prohibit the use of certain gears in all or part of certain SACs, including the Dogger Bank SAC and Inner Dowsing, Race Bank and North Ridge SAC[102]. Additionally, it is noted that the MMO are pursuing further fisheries restrictions through bylaws for certain conservation sites/features[103], which were subject to a call for evidence[104]; of relevance to this assessment are the North Norfolk Sandbanks and Saturn Reef SAC and Haisborough, Hammond and Winterton SAC. Unlike the bylaws for Dogger Bank SAC and Inner Dowsing, Race Bank and North Ridge SAC, those for Inner Dowsing, Race Bank and North Ridge and North Norfolk Sandbanks and Saturn Reef do not specify areas of sandbank within which bottom towed gear is prohibited. The proposed bylaws prohibit such fishing in areas which are primarily to be managed as Annex I reef, with some overlap with the Annex I sandbank features[105]. While there is limited information on the timescale under which the fisheries management measures could lead to a change in the

[100] 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.
[101] https://consult.defra.gov.uk/marine/updated-uk-marine-strategy-part-one/supporting_documents/UKmarinestrategypart1consultdocumentfinal.pdf
[102] https://www.gov.uk/government/publications/the-inner-dowsing-race-bank-and-north-ridge-special-area-of-conservation-specified-areas-prohibited-fishing-gears-byelaw-2022, https://www.gov.uk/government/publications/the-dogger-bank-special-area-of-conservation-specified-area-bottom-towed-fishing-gear-byelaw-2022
[103] https://consult.defra.gov.uk/mmo/stage-2-formal-consultation/
[104] https://www.gov.uk/guidance/marine-conservation-byelaws#new-mmo-byelaws https://consult.defra.gov.uk/mmo/call-for-evidence-stage-2/
[105] https://consult.defra.gov.uk/mmo/stage-2-formal-consultation/supporting_documents/DRAFT%20Marine%20Protected%20Areas%20Bottom%20Towed%20Fishing%20Gear%20Byelaw%202023.pdf

condition of the features of the site, recovery would be expected in the coming years, in particular for the reef features, with less certainty about the sandbanks for these sites.

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. When any surface structure (fixed and floating installations) used for exploration/appraisal 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 exploration (both spatially and temporally), significant incremental effects following the licensing of the 33rd Round Blocks are not predicted.

Marine aggregate extraction areas, relevant sites and Blocks applied for are shown in Figure 5.4. Blocks 43/17, 47/20, 48/16 and 48/17d overlap licensed aggregate extraction production areas in the southern North Sea. As noted in Table 5.3, dredging intensity over these areas has been generally low to medium in recent years (TCE & BMAPA 2022, also see TCE & BMAPA 2018), however, none of the aggregate areas are located within a site which is subject this Appropriate Assessment and also overlap a relevant Block. Additionally, two areas of relevance to the Greater Wash SPA (covered by Area 2103) may be offered exploration and option agreements, subject to HRA, in the 2021/2022 aggregates leasing round[106], though these do not overlap any Block applied for. Analogous to the advice provided in relation to offshore wind farms, applicants should contact the relevant aggregate companies in order that any proposed activity is undertaken in co-operation with the relevant lease or licence holders. In-combination impacts which could lead to adverse effects on the integrity of sites considered in this AA, are not anticipated.

5.4.2 Physical presence

Physical presence of offshore infrastructure and support activities may potentially cause behavioural responses in fish, birds, and marine mammals (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) and because the majority are at a substantial distance offshore; rigs used for carbon dioxide storage exploration/appraisal will be of the same type as those used in oil and gas exploration. The larger numbers of individual surface or submerged structures associated with offshore wind developments, the presence of rotating turbine blades and considerations of their location and spatial distribution (e.g. in relation to coastal breeding or wintering locations for waterbirds and important areas for marine mammals), indicate a higher potential for physical presence effects.

Potential displacement and barrier effects, particularly for birds, have been an important consideration at the project level for the large offshore wind developments that are planned for the area of the southern North Sea (Figure 5.4) and formed an important part of associated HRAs. Additional in-combination physical presence effects are possible with proposed wind farm project extensions and/or any projects arising from Round 4 of wind leasing. As noted

[106] https://www.thecrownestate.co.uk/en-gb/media-and-insights/news/2022-the-crown-estate-confirms-areas-selected-for-202122-marine-aggregates-tender-round/

above, plan level HRA has been completed for both the extension projects and Round 4 preferred projects, and any subsequent projects will be subject to their own HRA processes. One of the major concerns relating to sites considered in this assessment, and in particular for Flamborough and Filey Coast SPA (note this site was not screened into this AA), is seabird mortality related to collision risk with turbines, and displacement of species (mainly auks including razorbill and guillemot). With regards to the former, advice on operations for the site, while noting the qualifying interests are sensitive to, *collision above the water with static or moving objects not naturally found in the marine environment (e.g., boats, machinery, and structures)*, indicate that exploration activities pose a low risk, and the temporary presence of a rig is not considered to be likely to act in-combination with operating wind farms such that it would lead to significant disturbance of birds and related mortality.

For the Southern North Sea SAC, shipping is noted to be a source of pressures including underwater noise (see Section 5.3) and death or injury by collision, with the latter not being considered a significant risk that requires management (JNCC 2016).

Disturbance of red-throated diver and common scoter associated with the Greater Wash SPA is possible both in relation to support vessel movements and the presence of a drilling rig in a number of Blocks (see Section 5.2). Any sensitivity is limited to the winter months and may be avoided if activities take place outside of this period. As noted in Section 5.2.2, JNCC/NE advise that displacement buffers of 2km and 2.5km are applied at the project level for the assessment of effects of vessel traffic on red-throated diver and common scoter respectively, and any displacement taking place as a result of 33rd Round activities could be of this scale. A number of wind farms in or partly within the Greater Wash SPA including Humber Gateway, Westermost Rough, Race Bank, Lincs, Lynn and Inner Dowsing, are likely to present some form of displacement to divers within the Greater Wash SPA, though the scale of this displacement is not certain (see Section 4.2.3) as is any population level effect (see Section 5.2 and Vilela *et al.* 2022). There are established vessel approaches and anchorages associated with The Wash and the Humber, and routes between these and other ports in the UK and Europe, and offshore oil and gas infrastructure, which likely represent a baseline level of disturbance in advance of the Greater Wash SPA being designated, with some additional disturbance since then associated with wind farm operation and maintenance traffic. Vessel traffic in these routes is moderate to high (Figure 5.6), and the increment of two to three vessels per week is unlikely to represent a significant in-combination level of effect. 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 1.2). The installation of Viking Link involved a cable lay barge or vessel activity in the nearshore and through the Greater Wash SPA, though as the first 51km of the cable was installed in summer 2021, with some post-cable lay works completed by October 2021, any in-combination disturbance related effects with the siting of a drilling rig in the relevant blocks is not considered possible. The Outer Thames Estuary SPA was screened in for consideration by association with the Greater Wash SPA and the likelihood that birds move between these areas, however, the focus is on the potential for adverse effects on birds in the Greater Wash SPA. 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 1.2).

5.4.3 Underwater noise effects

A number of projects are relevant to the consideration of in-combination effects with activities which may follow the licensing of the Blocks applied for (Table 5.3). The associated activities can generate noise levels with the potential to result in disturbance or injury to animals associated with relevant sites (see BEIS 2022).

Of most relevance to the Blocks being considered are a series of Round 3, Round 4, and Round 2 extension wind farms. While the operation, maintenance and decommissioning of offshore wind energy developments will introduce noise into the marine environment, these are typically of low intensity compared to installation. The greatest noise levels arise during the construction phase, and it is these which have the greatest potential for acoustic disturbance effects (see BEIS 2022). Pile-driving of mono-pile foundations or pin piles used in jacket-type foundations is the principal source of construction noise, which will be qualitatively similar to pile-driving noise resulting from harbour works, bridge construction and oil and gas platform installation. Mono-pile foundations are the most commonly used for offshore wind farm developments in the southern North Sea to date (including in the studies looking at the effect of wind farm construction on harbour porpoise behaviour, as discussed in Section 4.3.2). The final selection of foundation type is uncertain for some developments as this will be subject to detailed design, though for those consented wind farms, it is highly likely that monopiles will be used.

Of those wind farms listed in Table 5.3, the Dogger Bank A and B and Sofia developments and Hornsea Project Three are scheduled for construction from 2023, with a number of other projects including Hornsea Projects Three and Four, Norfolk Vanguard and Boreas, and the Dudgeon and Sheringham extension projects, have the potential to be constructed from 2025 onwards, subject to some of these receiving Development Consent Orders (see Section 2.5 and Appendix 1h of BEIS 2022[107]). A number of developments are in the pre-application stage, including those identified through the Round 4 leasing process, and the timing of their construction is subject to a high degree of uncertainty. These projects, if executed, are expected to result in temporary changes in harbour porpoise distribution and a reduction of foraging activity for those individuals within the impacted area, during construction. However, assessment of the integrity of the site must be undertaken with respect to the site contributing to maintaining the Favourable Conservation Status of the wider harbour porpoise population. It follows that projects across the whole North Sea Management Unit are therefore also relevant.

While progress is being made in estimating population-level effects of disturbance on marine mammals, the degree of uncertainty in extrapolating from individual empirical observations to modelled population estimates is still high. In particular, there remains very limited empirical data to support quantification of the links between physiological and behavioural changes (e.g. hearing loss, displacement) and changes in vital rates (e.g. survival, fertility), although updates to expert elicited values in iPCoD are noted (Booth & Heinis 2018, Booth *et al*. 2019). It has not yet been possible to establish criteria for determining limits of acceptable cumulative impact at the UK or EU level, but the collation of data through the Marine Noise Registry (https://mnr.jncc.gov.uk/) has been an important first-step. The Department is cognisant of the ongoing efforts to implement the UK's Marine Strategy and will review the results of the ongoing process closely with respect to the consenting of relevant activities which may result

[107] Also see: RenewableUK Offshore Wind Project Timelines 2022: https://www.renewableuk.com/store/viewproduct.aspx?id=21259338

from future licensing, as well as other activities which generate noise in the marine environment.

A review of consents HRA was undertaken for six OWFs in relation to the Southern North Sea SAC, which included those which had not yet commenced operations or had HRAs undertaken in advance of the site being classified (Dudgeon, Greater Gabbard, Galloper, Hornsea Two, Dogger Bank A and B, Dogger Bank C and Sofia). This review augmented those HRAs already undertaken for these projects, specifically considering effects in relation the Southern North Sea SAC alone and in-combination with other projects, including those other OWFs of relevance to the wider site, and oil and gas activities. The HRA concluded that while the OWF projects assessed have the potential to generate likely significant effects for the site, adverse effects on site integrity will not occur alone or in-combination with other plans or projects (including that of existing oil and gas activities such as drilling and seismic survey), subject to mitigation measures secured through relevant Development Consent Orders and deemed Marine Licences (including a Site Integrity Plan)[108].

Significant in-combination underwater noise effects on the harbour porpoise feature of the Southern North Sea SAC are considered to be unlikely given the spatially limited, temporary nature and limited scale of noise generating activity associated with the exploration/appraisal activities associated with Blocks applied for (see Section 5.3), and that there is significant scope to avoid concurrent OWF construction and exploration well site survey activity either through dialogue with relevant leaseholders or by virtue of wind farm construction timelines, and through measures such as the SNS Activity Tracker (see below). Piling can be detrimental to seismic data collection, and these activities would not therefore be undertaken concurrently in close proximity. In addition to piling, unexploded ordnance (UXO) is commonly disposed of during offshore wind farm installation[109]. UXO detonations have the potential to cause significant injury or death to marine mammals (Robinson *et al.* 2022) and project developers are bound by health and safety legislation to manage and reduce this risk, though low order techniques are available (e.g. Robinson *et al.* 2020) for which the department and a number of other UK Government and Devolved administration departments have published recommendations in the form of a joint interim position statement[110].

The recent SNCB guidance on assessing the significance of noise disturbance against conservation objectives of harbour porpoise SACs (JNCC *et al*. 2020) presents thresholds for daily and seasonal disturbance as a proportion of the site from which harbour porpoise may be excluded. This gives a mechanism for assessing the potential in-combination effects of low frequency impulsive noise on the Southern North Sea SAC across multiple sources and industries. For example, in-combination effects with further wind farm construction of relevance to the site, in the context of the disturbance thresholds, can be partly addressed through the Site Integrity Plans required for certain offshore wind farms, where a baseline of activities that may act in-combination with wind farm activities to breach the thresholds must be maintained. The use of the guidance to consider in-combination effects in this Appropriate Assessment is limited by uncertainty in the extent, location and timing of activities which may follow licensing of any of the Blocks applied for, noting the potential duration of the Initial Term (up to six years) relative to the duration of noise producing activities (Table 2.2), and also the relative uncertainty in the location and timing of other noise producing activities which could

[108] See the related proposed marine licence conditions for the Southern North Sea SAC: https://www.gov.uk/government/consultations/southern-north-sea-sci-proposed-marine-licence-condition
[109] Note that the encounter rate of UXO and its nature is uncertain and disposal operations are subject to separate marine licensing.
[110] https://www.gov.uk/government/publications/marine-environment-unexploded-ordnance-clearance-joint-interim-position-statement/marine-environment-unexploded-ordnance-clearance-joint-interim-position-statement

take place in any season (e.g. piling, wind farm or non-exclusive oil and gas geophysical or seismic survey). The use of the harbour porpoise guidance for comparative purposes in the HRA for the ION 3D seismic survey (BEIS 2021a, BEIS 2021b), illustrates how the guidance can be used at the activity-specific stage to consider the nature and timing of relevant activities in an assessment of in-combination noise effects on a harbour porpoise SAC.

The SAC Noise Management Regulators Working Group, the Department, other southern North Sea regulators and the SNCBs, continue to work together on the implications of the guidance, and in particular, in the area of in-combination effects. Surveys related to oil and gas activities are captured in the UK Energy Portal[111], and the SNS Activity Tracker[112], which assists in the consideration of project level in-combination effects. The Department (with other Government Departments and Regulators) has also recently requested that oil and gas operators who plan to undertake noise producing activities in the upcoming summer season for the site, but for which an application has not yet been made, provide details of their proposals as part of their ongoing commitment to manage impulsive noise within the Southern North Sea SAC, and to understand the potential for in-combination effects[113].

In view of the high level of uncertainty in the nature, scale and timing of potential impulsive noise sources that could occur those Blocks relevant to the Southern North Sea SAC, including relative to the nature and timing of activities with which they could act in-combination, quantitative assessment in relation to the seasonal noise thresholds for the site cannot be undertaken at this stage. Further HRA will be undertaken, as appropriate, once project plans are known, and will allow for a detailed consideration of in-combination effects, and activities will not be permitted if it is concluded that adverse effects cannot be avoided.

The Sheringham Shoal wind farm extension installation or survey activity, and any seismic or geophysical survey activity that could be related to the carbon storage application area SNS Area 3, could act in-combination with 33rd Round Blocks screened in for the Greater Wash SPA, Humber Estuary SAC or The Wash and North Norfolk Coast SAC, however, as noted above, dialogue between operators and wind farm developers, activity timing and assessment once project plans are known will ensure that the conservation objectives of the sites are not undermined and that adverse effects do not occur.

Doggersbank SAC and Klaverbank SAC are not in UK waters, and there is limited oil and gas related activities within these sites, and no planned offshore renewable energy projects. Adverse in-combination effects will not result from 33rd Round activities. The Sheringham Shoal wind farm extension and carbon storage licence provisional award covering SNS Area 3[114] are relevant to the assessment of in-combination noise effects for the Greater Wash SPA (diving birds), Humber Estuary SAC (grey seal) and The Wash and North Norfolk Coast SPA (harbour seal). Sheringham Shoal is presently at the examination phase of the planning process, with a projected timeline for construction, subject to consenting, of 2025-2028. The SNS Area 3 carbon dioxide storage appraisal licence will have an appraisal term of in the region of four to eight years. It is therefore possible that 33rd Round activities could take place within the timeframe of these proposed projects/licence work programmes, and could result in in-combination effects. In view of the length of the initial/appraisal terms of the 33rd Round licences and those of SNS Area 3, and the significant uncertainty about the timing of the

[111] https://itportal.beis.gov.uk/eng/fox/beis/PETS_EXTERNAL_PUBLICATION/main
[112] https://www.gov.uk/guidance/oil-and-gas-offshore-environmental-legislation#offshore-petroleum-activities-conservation-of-habitats-regulations-2001-as-amended
[113] https://www.gov.uk/government/publications/oil-and-gas-opred-communications
[114] https://www.gov.uk/government/consultations/1st-offshore-carbon-dioxide-storage-licensing-round-appropriate-assessment

installation or survey works related to Sheringham Shoal, and also their relative nature, scale, and location, it is considered that a meaningful assessment cannot be undertaken at this time, but that project planning would allow for in-combination effects to be avoided. Like the Southern North Sea SAC, project level HRA must be undertaken, as appropriate, to ensure that adverse in-combination effects do not result from noise-related activity following the 33rd Round, and in particular, impulsive noise from new seismic survey; new seismic is contingent for those Blocks relevant to the Greater Wash SPA and Humber Estuary SAC, e.g. 47/7b, 47/13, 47/14 (see Table 2.1).

In addition to those activities which may follow licensing of the areas applied for in the southern North Sea and the other potentially relevant projects listed in Table 5.3, there are a variety of other existing (e.g. gas production, fishing, shipping, military exercise areas, wildlife watching cruises) and planned (e.g. oil and gas exploration and production) 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 cumulative and in-combination effects that, when taken in-combination with the potential number and scale of activities likely to result from the licensing of the areas 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 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[115].

5.4.4 Conclusion

While exploration activity is identified as a pressure to which most of the sites considered in this assessment are sensitive (e.g. from physical effects or underwater noise), with SACO's for some identifying oil and gas infrastructure as contributing to unfavourable feature condition, though this is generally associated with pipelines or platforms which represent long-term or permanent changes to site habitat, which exploration activities would not. Available evidence (see e.g. UKBenthos database, OSPAR 2010 and the 2017 intermediate assessment[116]) for the southern North Sea indicates that past oil and gas activity and discharges has not led to adverse impacts on the integrity of European sites in the area.

Any activities relating to the work programmes will be judged on its own merits and in the context of wider development in the North Sea (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 in the southern North Sea, will not adversely affect the integrity of relevant Sites.

[115] *Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020*

[116] 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 91 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 1.3), 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 a sufficient degree of 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 permanent habitat change to the following sites: Dogger Bank SAC, the North Norfolk Sandbanks and Saturn Reef SAC, Inner Dowsing, Race Bank and North Ridge SAC, and Haisborough, Hammond and Winterton SAC. If a well is proposed within these sites and rig stabilisation is required, removable stabilisation methods must be used, subject to these meeting the technical and safety requirements of rig placement at a particular location. Additionally, in sites with qualifying reef features, rig siting must be informed by recent survey data so that sensitive areas can be avoided. 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
37/27, 44/17, 43/2b, 43/3b, 43/4b, 44/13, 44/19b, 43/20c, 43/9, 44/18a, 44/23a, 43/25, 44/16, 44/22, 43/14, 44/21, 43/12a, 43/18, 43/13, 43/19d, 43/17	Dogger Bank SAC	Sandbanks which are slightly covered by seawater all the time	Where possible, rig siting should take place outside of site boundaries (>500m) to avoid all interaction with the site feature. If there is no alternative to siting the rig inside the site, rig stabilisation must use removable methods to avoid a permanent change to habitat type.

Block applied for	Relevant sites	Relevant feature	Required mitigation
48/10, 48/14d, 48/15b, 48/20c, 48/24, 48/25d, 49/11b, 49/16d, 49/21b, 49/21d, 49/26b, 53/2c	North Norfolk Sandbanks and Saturn Reef SAC	Sandbanks which are slightly covered by seawater all the time Reefs	Where possible, rig siting should take place outside of site boundaries (>500m) to avoid all interaction with the site feature. If there is no alternative to siting the rig inside the site, rig stabilisation must use removable methods to avoid a permanent change to habitat type.
47/20, 48/21	Inner Dowsing, Race Bank and North Ridge SAC	Sandbanks which are slightly covered by seawater all the time Reefs	Where possible, rig siting should take place outside of site boundaries (>500m) to avoid all interaction with the site feature. If there is no alternative to siting the rig inside the site, rig stabilisation must use removable methods to avoid a permanent change to habitat type.
48/28b, 48/30c, 49/26b, 52/5c, 53/2c	Haisborough, Hammond and Winterton SAC	Sandbanks which are slightly covered by seawater all the time Reefs	Where possible, rig siting should take place outside of site boundaries (>500m) to avoid all interaction with the site feature. If there is no alternative to siting the rig inside the site, rig stabilisation must use removable methods to avoid a permanent change to habitat type.
47/7b, 47/13, 47/14, 48/28b	Greater Wash SPA	Red-throated diver, common scoter	Where possible, should activities take place within the site, they should avoid the wintering period (1st November to 31st March inclusive). Where this is not possible, vessels should use established routes and avoid areas of high diver or scoter density.

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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