Department for
Business, Energy
& Industrial Strategy

OFFSHORE OIL & GAS LICENSING

32ND SEAWARD ROUND

Habitats Regulations Assessment

Appropriate Assessment: Southern North Sea

July 2020

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Contents

1 Introduction

1.1 Background and purpose

The plan/programme covering this seaward licensing round has been subject to a Strategic Environmental Assessment (OESEA3), completed in July 2016. 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. The SEA Environmental Report was subject to an 8-week public consultation period, and a post-consultation report summarising comments and factual responses was produced as an input to the decision to adopt the plan/programme. This decision has allowed the Oil & Gas Authority (OGA) to progress further seaward oil and gas licensing rounds. On 11th July 2019, the OGA invited applications for licences relating to 796 Blocks in a 32nd Seaward Licensing Round covering mature areas of the UK Continental Shelf (UKCS), and applications were received for licences covering 234 Blocks/part Blocks.

The *Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001* (as amended) implement the requirements of Articles 6(3) and 6(4) of the Habitats Directive with respect to oil and gas activities in UK territorial waters and on the UK Continental Shelf. The *Conservation of Offshore Marine Habitats and Species Regulations 2017* cover other relevant activities in offshore waters (i.e. excluding territorial waters). Within territorial waters, the Habitats Directive is transposed into UK law via 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 European (Natura 2000[1]) sites, to comply with its obligations under the relevant regulations, the Department for Business, Energy and Industrial Strategy[2] (BEIS) is undertaking a Habitats Regulations Assessment (HRA). To comply with obligations under the *Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001* (as amended), in autumn 2019, the Secretary of State undertook a screening assessment to determine whether the award of any of the Blocks offered would be

[1] This includes Special Areas of Conservation (SAC) and Special Protection Areas (SPA), and potential sites for which there is adequate information on which to base an assessment.
[2] Note that while certain licensing and regulatory functions were passed to the OGA (a government company wholly owned by the Secretary of State for BEIS) on 1 October 2016, environmental regulatory functions are retained by BEIS, and are administered by the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED).

likely to have a significant effect on a relevant site, either individually or in combination[3] with other plans or projects (BEIS 2019a). In doing so, the Department has applied the Habitats Directive test[4] (elucidated by the European Court of Justice (ECJ) in the case of Waddenzee (Case C-127/02)[5]) 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 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 796 Blocks offered. The screening identified 239 whole or part Blocks as requiring further assessment prior to the OGA making decisions on whether to grant licences (BEIS 2019a). Following the closing date for 32nd Seaward Round applications, and the publication of the screening document, 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 82 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
- Central North Sea

[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).
[4] See Article 6(3) of the Habitats Directive.
[5] Also see the Advocate General's Opinion in the 'Sweetman' case (Case C-258/11), which confirms those principles set out in the Waddenzee judgement.

- West of Shetland

1.2.1 Southern North Sea Blocks

The relevant southern North Sea Blocks applied for in the 32nd 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

36/30b	42/5b	42/7b	42/13b	42/17	42/18	42/19	42/20b	42/22	42/23
42/27	42/28e	42/28g	42/28h	42/29b	43/1	43/11	43/12b	43/13a	43/14c
43/19a	43/20	43/25	43/26b	43/27b	43/29	43/30	44/16	44/17	44/18b
44/19b	44/21	44/22	44/23a	44/23b	44/25	44/26	44/28	44/29a	44/30b
47/2b	47/3g	47/3i	47/15b	48/4	48/5	48/9	48/12g	48/13c	48/14b
48/14c	48/15c	48/17e	48/18e	48/19d	48/23d	48/24c	49/1	49/2	49/3
49/4e	49/6c	49/8b	49/9b	49/9e	49/11c	49/12d	49/13	49/14a	49/16b
49/17b	49/21e	49/22b							

1.3 Relevant Natura 2000 sites

The screening assessment identified the relevant Natura 2000 sites and related Blocks requiring further assessment in the southern North Sea (refer to Appendix B of BEIS 2019a). Following a reconsideration of the Blocks and sites screened in against those Blocks applied for, eleven Natura 2000 sites in parts of the southern North Sea were identified as requiring further assessment in relation to 73 Blocks (Table 1.2 and Figure 1.1).

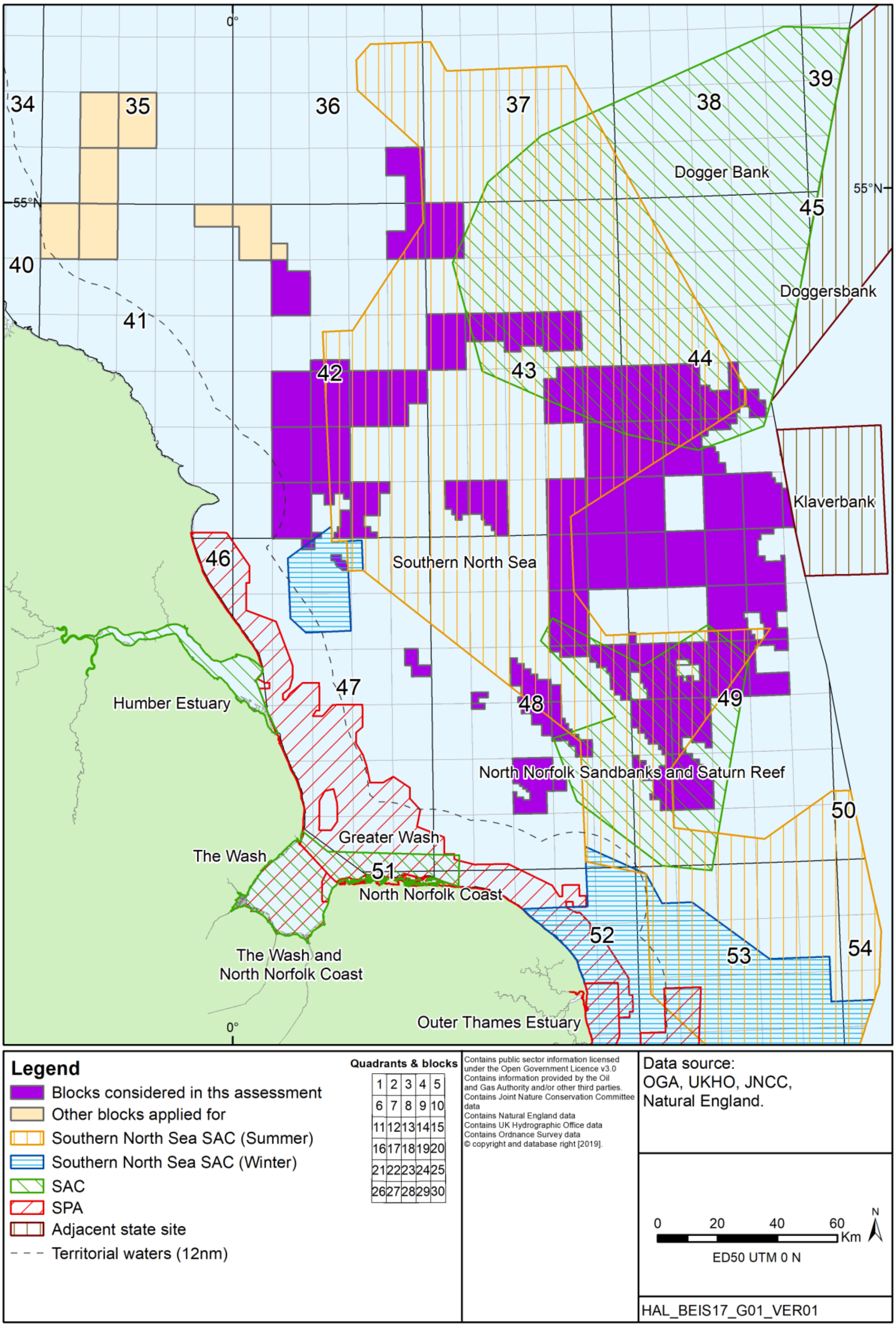
Table 1.2: Relevant sites requiring further assessment

Relevant site Features	Relevant Blocks applied for	Sources of potential effect
SPAs		
Greater Wash SPA Over winter: Red-throated diver, common scoter	42/27	Underwater noise: deep geological seismic survey, rig site survey, VSP, conductor piling, drilling, vessel & rig movements
The Wash SPA Over winter: Common scoter, goldeneye, waterbird assemblage (cormorant, eider, little grebe)	42/27	Underwater noise: deep geological seismic survey, rig site survey, VSP, conductor piling, drilling, vessel & rig movements

Relevant site Features	Relevant Blocks applied for	Sources of potential effect
North Norfolk Coast SPA Over winter: waterbird assemblage (common scoter)	42/27	Underwater noise: deep geological seismic survey, rig site survey, VSP, conductor piling, drilling, vessel & rig movements
Outer Thames Estuary SPA Over winter: Red-throated diver	42/27	Underwater noise: deep geological seismic survey, rig site survey, VSP, conductor piling, drilling, vessel & rig movements
SACs		
Southern North Sea SAC Annex II species: harbour porpoise	36/30b, 42/5b, 42/7b, 42/13b, 42/17, 42/18, 42/19, 42/20b, 42/22, 42/23, 42/27, 42/28e, 42/28g, 42/28h, 42/29b, 43/1, 43/11, 43/12b, 43/13a, 43/14c, 43/19a, 43/20, 43/25, 43/26b, 43/27b, 43/29, 43/30, 44/16, 44/17, 44/18b, 44/19b, 44/21, 44/22, 44/23a, 44/23b, 44/26, 47/2b, 47/3g, 47/3i, 47/15b, 48/4, 48/5, 48/9, 48/12g, 48/13c, 48/14b, 48/14c, 48/15c, 48/17e, 48/18e, 48/19d, 48/23d, 48/24c, 49/6c, 49/8b, 49/9b, 49/9e, 49/11c, 49/12d, 49/13, 49/14a, 49/16b, 49/17b, 49/21e, 49/22b	Physical disturbance and drilling: rig siting, drilling discharges
	36/30b, 42/5b, 42/7b, 42/13b, 42/17, 42/18, 42/19, 42/20b, 42/22, 42/23, 42/27, 42/28e, 42/28g, 42/28h, 42/29b, 43/1, 43/11, 43/12b, 43/13a, 43/14c, 43/19a, 43/20, 43/25, 43/26b, 43/27b, 43/29, 43/30, 44/16, 44/17, 44/18b, 44/19b, 44/21, 44/22, 44/23a, 44/23b, 44/26, 44/28, 47/2b, 47/3g, 47/3i, 47/15b, 48/4, 48/5, 48/9, 48/12g, 48/13c, 48/14b, 48/14c, 48/15c, 48/17e, 48/18e, 48/19d, 48/23d, 48/24c, 49/1, 49/2, 49/3, 49/4e, 49/6c, 49/8b, 49/9b, 49/9e, 49/11c, 49/12d, 49/13, 49/14a, 49/16b, 49/17b, 49/21e, 49/22b	Underwater noise: deep geological seismic survey, rig site survey, VSP, conductor piling, drilling, vessel & rig movements
Dogger Bank SAC Annex I habitat: sandbanks which are slightly covered by sea water all the time	42/5b, 43/1, 43/11, 43/12b, 43/13a, 43/14c, 43/19a, 43/20, 43/25, 44/16, 44/17, 44/18b, 44/19b, 44/21, 44/22, 44/23a, 44/23b, 44/25, 44/28	Physical disturbance and drilling: rig siting, drilling discharges
Doggersbank SAC (Netherlands) Annex I habitat: sandbanks which are slightly covered by sea water all the time Annex II species: grey seal, harbour seal, harbour porpoise	44/19b	Physical disturbance and drilling: rig siting, drilling discharges
	44/18b, 44/19b, 44/23a	Underwater noise: rig site survey, VSP, conductor piling, drilling, vessel & rig movements
Klaverbank SAC (Netherlands) Annex I habitat: reefs	44/19b, 44/25, 44/29a, 44/30b, 49/4e, 49/9b	Physical disturbance and drilling: rig siting, drilling discharges

Relevant site Features	Relevant Blocks applied for	Sources of potential effect
Annex II species: grey seal, harbour seal, harbour porpoise	44/18b, 44/23a, 44/25, 44/28, 44/29a, 44/30b, 49/4e, 49/9b	Underwater noise: rig site survey, VSP, conductor piling, drilling, vessel & rig movements
Humber Estuary SAC Annex I habitats: estuaries, mudflats and sandflats, sandbanks, saltmarsh and salt meadows, coastal lagoons, coastal dunes Annex II species: grey seal	42/18, 42/19, 42/20b, 42/22, 42/23, 42/27, 42/28e, 42/28g, 42/28h, 42/29b, 47/2b, 47/3g, 47/3i	Physical disturbance and drilling: rig siting, drilling discharges
	42/18, 42/19, 42/20b, 42/22, 42/23, 42/27, 42/28e, 42/28g, 42/28h, 42/29b, 47/2b, 47/3g, 47/3i	Underwater noise: deep geological seismic survey, rig site survey, VSP, conductor piling, drilling, vessel & rig movements
The Wash and North Norfolk Coast SAC Annex I habitats: mudflats and sandflats, inlets and bays, reefs, saltmarsh and salt meadows, coastal lagoons Annex II species: harbour seal	47/15b, 48/12g, 48/13c, 48/17e, 48/18e, 48/23d	Physical disturbance and drilling: rig siting, drilling discharges
	47/15b, 48/12g, 48/13c, 48/17e, 48/18e, 48/23d	Underwater noise: rig site survey, VSP, conductor piling, drilling, vessel & rig movements
North Norfolk Sandbanks and Saturn Reef SAC Annex I habitats: sandbanks which are slightly covered by sea water all the time, reefs	48/4, 48/9, 48/13c, 48/14b, 48/14c, 48/15c, 48/18e, 48/19d, 48/23d, 48/24c, 49/6c, 49/8b, 49/9b, 49/9e, 49/11c, 49/12d, 49/13, 49/14a, 49/16b, 49/17b, 49/21e, 49/22b	Physical disturbance and drilling: rig siting, drilling discharges

Figure 1.1: Blocks and sites relevant to this Appropriate Assessment



1.4 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 European 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, a draft of the AA document was subject to consultation with appropriate nature conservation bodies and the public (via Consultation pages of the gov.uk website) and has been 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 UK Continental Shelf (UKCS) are vested in the Crown and the *Petroleum Act 1998* (as amended) gives the OGA 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 AA under Article 6(3) of the Habitats Directive (Directive 92/43/EC).

Several sub-types of Seaward Production Licence (Traditional, Frontier and Promote) were replaced after the 28th Round by the single "Innovate" licence[6]. 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. 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 OGA. 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 OGA and the applicant.

[6] *The Petroleum and Offshore Gas Storage and Unloading Licensing (Amendment) Regulations 2017* amend the Model Clauses to be incorporated in Seaward Production Licences.

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. Failure to complete the work agreed in a Phase, or to commit to the next Phase means the licence ceases, unless the term has been extended by the OGA.

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 OGA (in consultation with the Offshore Safety Directive Regulator)[7] through written submissions before licences are awarded[8].

As part of these written submissions operators must demonstrate that they have the relevant safety and environmental capabilities to undertake the proposed work programme (e.g. company environmental policies, awareness of statutory safety and environment provisions, and has environmental management systems). Where full details cannot be provided via the written submissions at the application stage, licensees must provide supplementary submissions that address any outstanding environmental and safety 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 OGA with details of work programmes they propose in the Initial Term. These work programmes are considered along with a range of other factors by the OGA 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 three levels of drilling commitment:

- A Firm Drilling Commitment is a commitment to the OGA to drill a well. Firm drilling commitments are preferred on the basis that, if there were no such commitment, the OGA

[7] The Offshore Safety Directive Regulator is the Competent Authority for the purposes of the Offshore Safety Directive comprising OPRED and the Health and Safety Executive (HSE) working in partnership.
[8] Refer to OGA technical guidance and safety and environmental guidance on applications for the 32nd Round at: https://www.ogauthority.co.uk/licensing-consents/licensing-rounds/

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 Contingent Drilling Commitment is also a commitment to the OGA to drill a well, but it includes specific provision for the OGA to waive the commitment in light of further technical information.
- A Drill or Drop (D/D) Drilling Commitment is a conditional commitment with the proviso (unless otherwise decided by the OGA) that the licence is relinquished if a well is not drilled.

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 OGA general guidance[9] makes it clear that an award of a 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 2.2 provides an overview of the plan process associated with the 32nd Seaward Licensing Round and the various environmental assessments including HRA. Offshore activities such as drilling are subject to relevant activity specific environmental assessments by the Department (see Figure 2.3), and there are other regulatory provisions exercised by the Offshore Safety Directive 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.

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

[9] https://www.ogauthority.co.uk/media/5888/general-guidance-32nd-seaward-licensing-round-june-2019.pdf

Figure 2.2: Stages of plan level environmental assessment

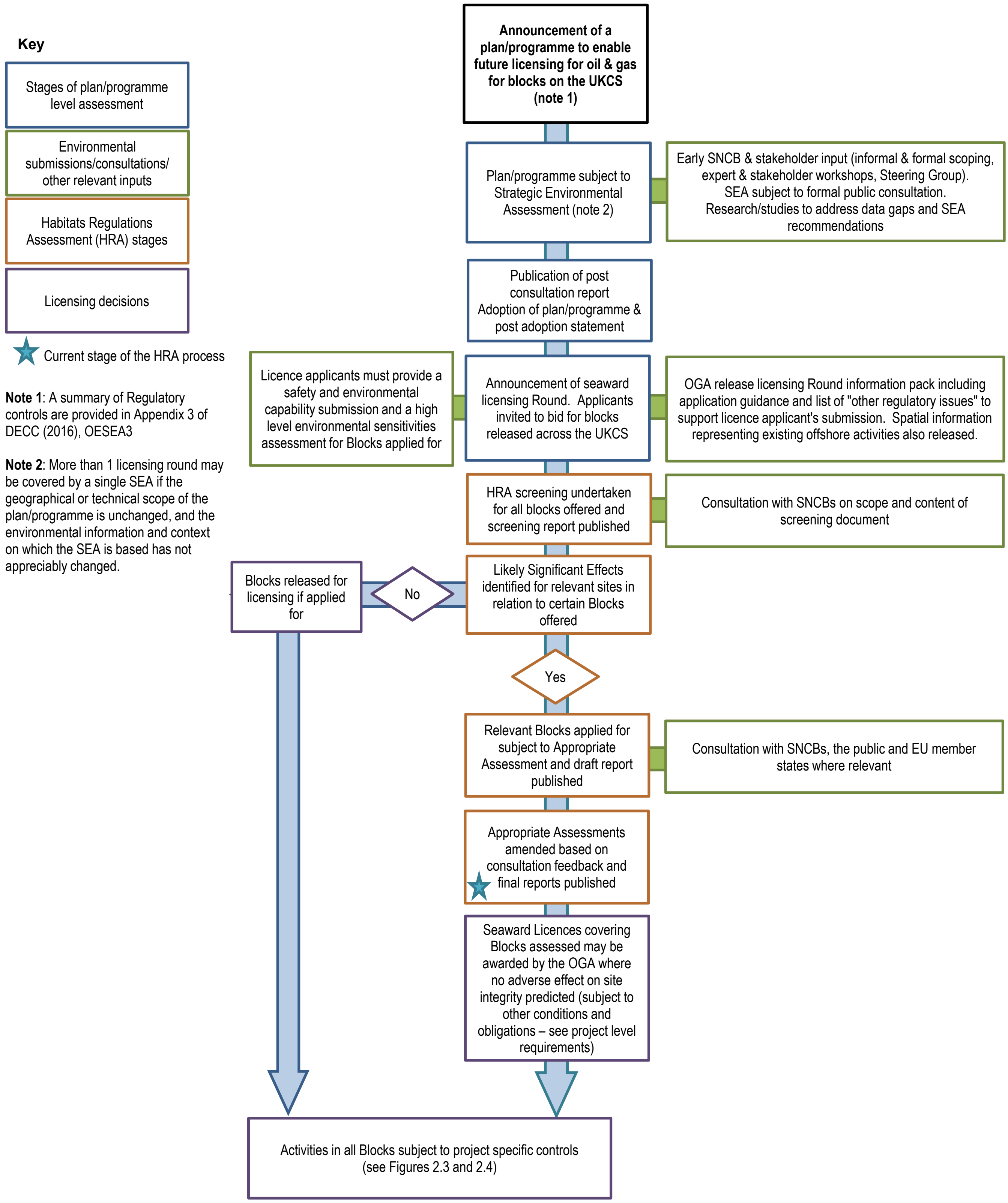
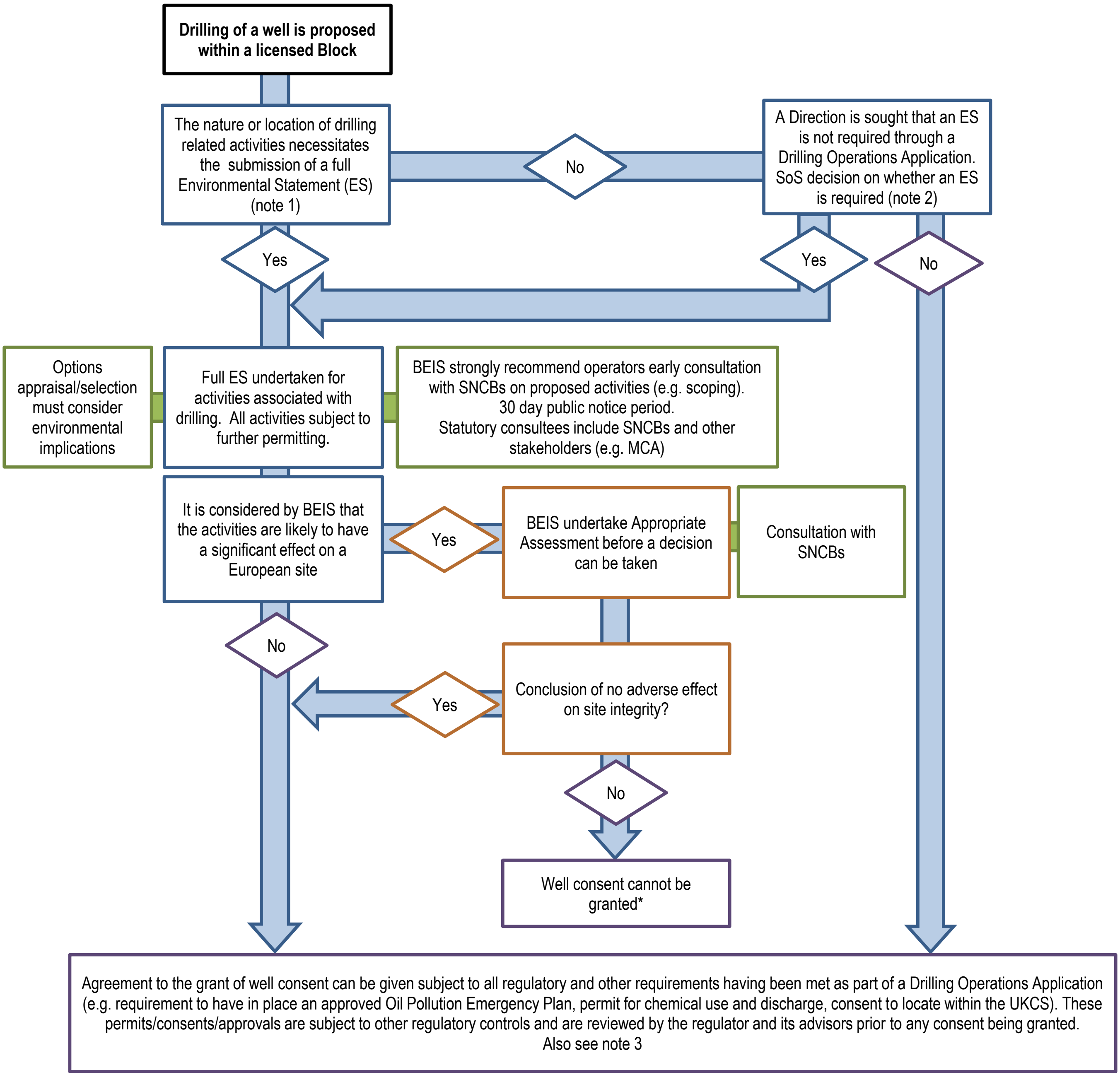
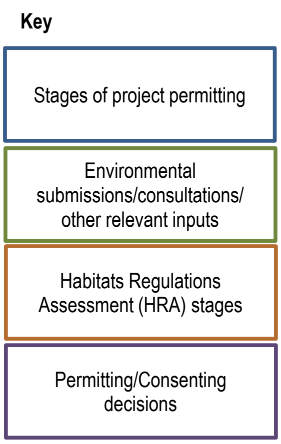


Figure 2.3: High level overview of exploration drilling environmental requirements





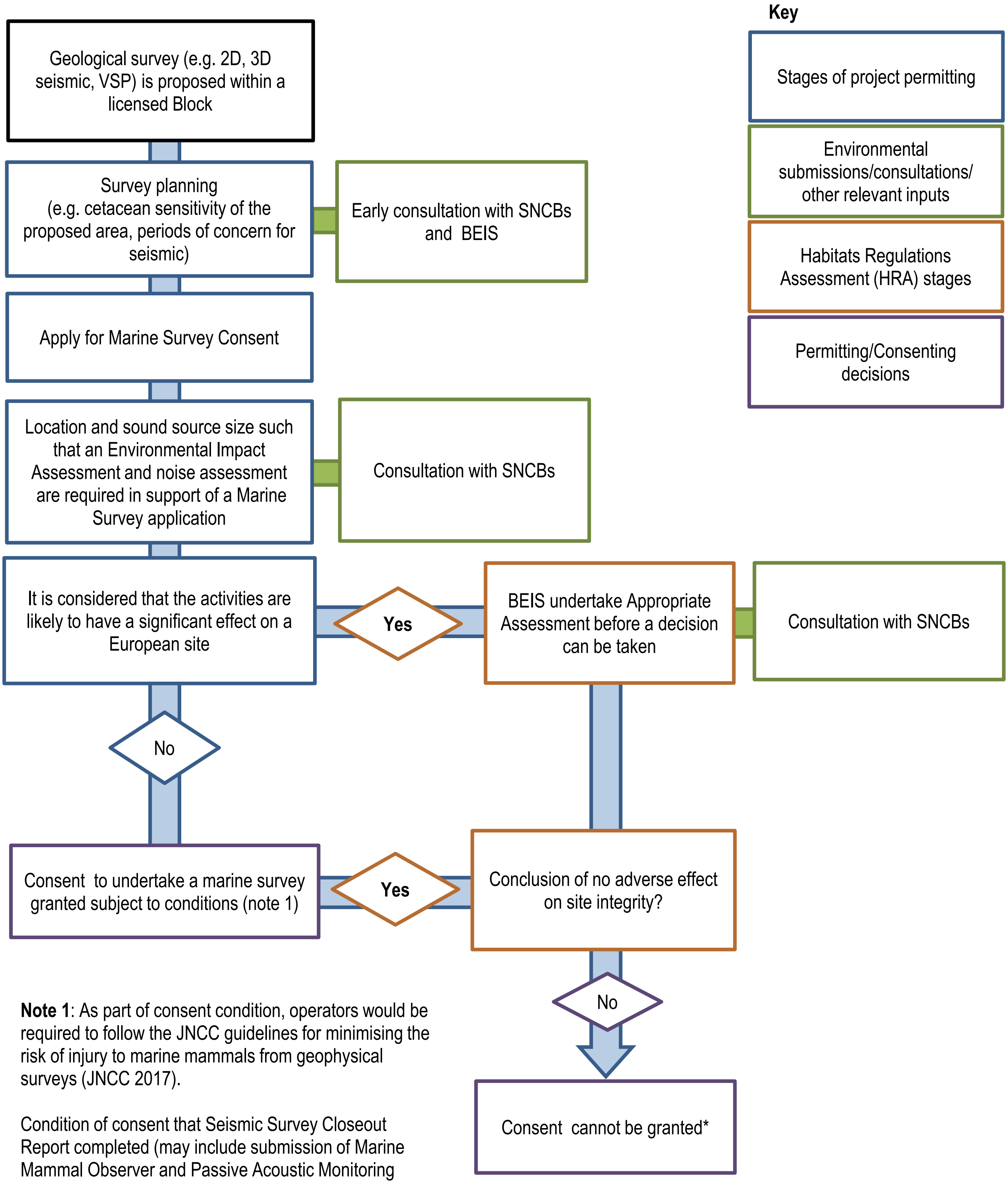
Note 1: See BEIS (2020). The Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (as amended) – a guide.

Note 2: Early consultation between BEIS 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 2.4: 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).

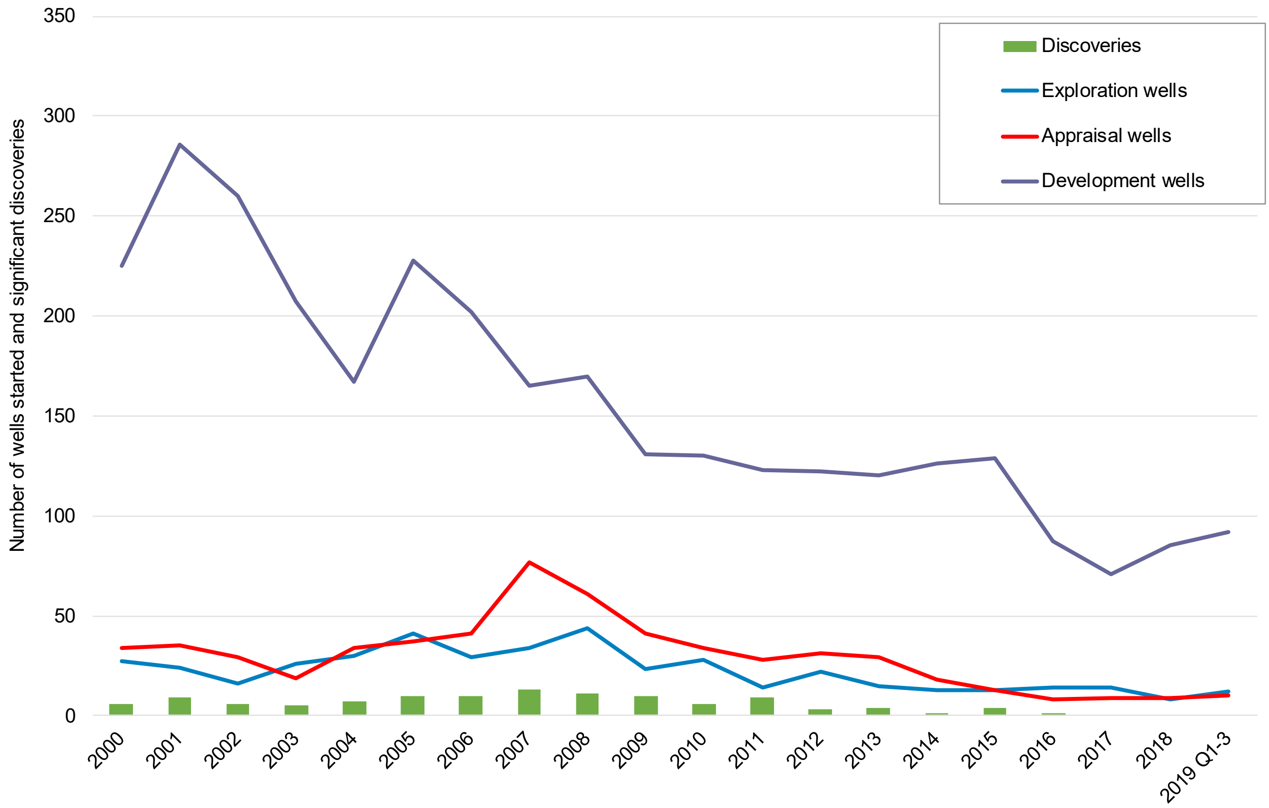
Condition of consent that Seismic Survey Closeout Report completed (may include submission of Marine Mammal Observer and Passive Acoustic Monitoring reports)

* 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 OGA 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 2.1 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 2.1: UKCS Exploration, appraisal & development wells, and significant discoveries since 2000



Note: "significant" generally refers to the flow rates that were achieved (or would have been reached) in well tests (15 mmcfgd or 1000 BOPD) and does not indicate commercial potential of the discovery. Source: OGA Drilling Activity (October 2019), 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, of the 40 current projects identified by the OGA's Project Pathfinder (as of 13th December 2019)[10], 20 are planned as subsea tie-backs to existing infrastructure, 4 involve new stand-alone production platforms and 4 are likely to be developed via Floating Production, Storage and Offloading (FPSO) facilities. The final form of development for many of the remaining projects is not decided, with some undergoing re-evaluation of development options but some are likely to be subsea tie-backs. Figure 2.1 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 screening criteria described in Section 4 are applicable to the potential effects of development well drilling within any of the 32nd Round Blocks.

2.2.2 32nd Round activities considered by the HRA

The nature, extent and timescale of development, if any, which may ultimately result from the licensing of 32nd 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. 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. In this way the opinion of the Advocate General in ECJ case C-6/04, on the effects on Natura sites, "*must be assessed at every relevant stage of the procedure to the extent possible on the basis of the precision of the plan. This assessment is to be updated with increasing specificity in subsequent stages of the procedure"* is addressed. 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 would be 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 OGA 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

[10] https://itportal.ogauthority.co.uk/eng/fox/path/PATH_REPORTS/pdf

every Block applied for, although seismic survey may cover parts of several or all Blocks comprising a single licence.

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

Relevant Blocks	Obtain[11] and/or reprocess 2D or 3D seismic data	Shoot 3D seismic	Drill or drop well/contingent well	Second Term
36/30b	-	✓	✓	-
42/5b	-	✓	✓	-
42/7b	-	-	✓	-
42/13b	-	-	✓	-
42/17	-	-	✓	-
42/18	-	-	✓	-
42/19	-	-	✓	-
42/20b	-	-	✓	-
42/22	-	-	✓	-
42/23	-	-	✓	-
42/27	-	✓	✓	-
42/28e	-	✓	✓	-
42/28g	-	-	✓	-
42/28h	-	-	✓	-
42/29b	-	✓	✓	-
43/1	-	✓	✓	-
43/11	-	✓	✓	-
43/12b	-	✓	✓	-
43/13a	-	✓	✓	-
43/14c	-	-	✓	-
43/19a	-	✓	✓	-
43/20	-	✓	✓	-
43/25	-	✓	✓	-
43/26b	-	-	✓	-
43/27b	-	-	✓	-
43/29	-	✓	✓	-
43/30	-	✓	✓	-
44/16	-	-	✓	-
44/17	-	-	✓	-
44/18b	-	-	-	✓
44/19b	-	-	✓	-
44/21	-	-	-	✓
44/22	-	-	-	✓
44/23a	-	-	-	✓
44/23b	-	-	✓	-
44/25	-	-	✓	-

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

Relevant Blocks	Obtain[11] and/or reprocess 2D or 3D seismic data	Shoot 3D seismic	Drill or drop well/contingent well	Second Term
44/26	-	-	✓	-
44/28	-	-	-	✓
44/29a	-	-	✓	-
44/30b	-	-	✓	-
47/2b	-	✓	✓	-
47/3g	-	✓	✓	-
47/3i	-	-	Firm well	-
47/15b	-	-	-	✓
48/4	-	✓	✓	-
48/5	-	✓	✓	-
48/9	-	-	✓	-
48/12g	-	✓	✓	
48/13c	-	-	✓	-
48/14b	-	-	✓	-
48/14c	-	-	✓	-
48/15c	-	✓	✓	-
48/17e	-	✓	✓	
48/18e	-	-	✓	-
48/19d	-	-	✓	-
48/23d	-	-	✓	-
48/24c	-	-	✓	-
49/1	-	-	✓	-
49/2	-	-	✓	-
49/3	-	-	✓	-
49/4e	-	-	✓	-
49/6c	-	-	-	✓
49/8b	-	-	✓	-
49/9b	-	-	✓	-
49/9e	-	-	✓	-
49/11c	-	-	-	✓
49/12d	-	-	-	✓
49/13	-	-	✓	-
49/14a	-	-	✓	-
49/16b	-	✓	✓	-
49/17b	-	-	-	✓
49/21e	-	-	✓	-
49/22b	-	-	-	✓

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 12 km 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 3,000-8,000 in^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 production 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 18 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.
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	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

Potential activity	Description	Assumptions used for assessment
	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 through halites or water reactive shales, would require onshore disposal or treatment offshore to the required standards prior to discharge.	well location covering an area in the order of 0.8km^2 (refer to Section 4.2 for supporting information).
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 the North Sea, the diameter of the conductor pipe for exploration wells is typically 26" or 30" (<1m), which is considerably smaller than the monopiles used for offshore wind farm foundations (>3.5m diameter), and 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.	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.
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 several 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).
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	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
	used on site surveys and some Vertical Seismic Profiling (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).	
Well evaluation (e.g. Vertical Seismic Profiling)	Sometimes conducted to assist with well evaluation by linking rock strata encountered in drilling to seismic survey data. A seismic source (airgun array, typically with a source size around 500 in^3 and with a maximum of 1,200 in^3, Stone 2015) is deployed from the rig, and measurements are made using a series of geophones deployed inside the wellbore.	VSP surveys are of short duration (one or two days at most).

2.3 Existing regulatory requirements and controls

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

2.3.1 Physical disturbance and drilling

The routine sources of potential physical disturbance and drilling effects associated with exploration are assessed and controlled through a range of regulatory processes, such as Environmental Impact Assessment (EIA) under the *Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999* (as amended) as part of the Drilling Operations Application through the Portal Environmental Tracking System and, where relevant, HRA to inform decisions on those applications[12].

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)[13]. 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 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 DECC 2016, 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 mandatory 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 which would be expected to have a significant negative impact would not be permitted.

[12] https://www.gov.uk/guidance/oil-and-gas-offshore-environmental-legislation
[13] See BEIS (2020a). The Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (as amended) – a guide.

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. Applications are made through the Department's Portal Environmental Tracking System using a standalone Master Application Template (MAT) and appropriate Subsidiary Application Template (SAT). Regarding noise thresholds to be used as part of any assessment, applicants are encouraged to seek the advice of relevant SNCB(s) (JNCC 2017b) in addition to referring to European Protected Species (EPS) guidance (JNCC 2010). Applicants should be aware of recent research in the field of marine mammal acoustics, including the development of a new set of criteria for injury (NMFS 2018, referred to as NOAA thresholds), which were recently adopted as updated criteria thresholds in the peer-reviewed literature (Southall *et al*. 2019).

The Department consults the relevant statutory consultees on the consent applications for advice and a decision on whether to grant consent is only made after careful consideration of their comments. Statutory consultees 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. The SNCBs (JNCC, Natural England and DAERA) have recently published guidance for assessing the significance of noise disturbance against conservation objectives of harbour porpoise SACs (JNCC *et al*. 2020). This has been developed through several years of inter-agency work and stakeholder discussion, including a period of consultation on draft guidance in February/March 2020. Key elements of the guidance include recommended effective deterrence ranges (EDRs) to estimate temporary habitat loss from different noise-generating activities, coupled with a definition of significant disturbance that is based on daily and seasonal spatial thresholds of porpoise exclusion. Any plan or project which, individually or in combination, could breach these area/time thresholds could be deemed to have an adverse effect on site integrity, necessitating noise management measures such as adjustment of activity schedules, the use of alternative technologies and noise abatement. Following receipt of the guidance, the Department (OPRED) is working on an implementation approach for industry, including preparing and publishing a policy statement. The Department (OPRED) are also engaging with the SNCBs and the relevant Southern North Sea (SNS) Regulators on implementation of the guidance[14]. In the intervening period, there is no expectation from the Department that this guidance is applied to applications involving mobile noise sources, for example geological survey applications, but it

[14] https://www.gov.uk/guidance/oil-and-gas-offshore-environmental-legislation#sncb-noise-guidance

is advised that the guidance is appropriate to apply to specific activities, namely piling and unexploded ordnance detonation.

It is a condition of consents issued under Regulation 4 of the *Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001* (as amended) for oil and gas related 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*[15]. The updated JNCC guidelines (2017b) 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 have been highlighted with respect to seismic survey and fish spawning (see Section 2 of OGA's Other Regulatory Issues[16] which accompanied the 32nd Round offer) which licensees should take account of. Licensees should also be aware that it may influence the Department's decision whether or not to approve particular activities.

[15] 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.
[16] https://www.ogauthority.co.uk/media/5883/other-regulatory-issues-july-2019.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 European 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 used the clarification of the tests set out in the Habitats Directive in line with the ruling of the ECJ in the *Waddenzee* case (Case C-127/02), 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, in the Commission's guidance and clarified by the courts (Cairngorms judicial review case[17]) 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

[17] World Wild Life Fund & Others, Re application for judicial review of decisions relating to the protection of European Sites at Cairngorm Mountain, by Aviemore and proposals for construction of a funicular railway thereon.

in Article 1 of the Directive (JNCC 2002). As clarified by the European Commission (2019), 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 a site only in a visual sense or only with respect to habitat types or species other than those listed in Annex I or Annex II. In such cases, the effects do not amount to an adverse effect for purposes of Article 6(3) of the Habitats Directive, 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 2019), 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 and 2016, and the review of OESEA3 in BEIS 2018) 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.

In recent years, significant 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, 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 (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 and gas exploration activity, for which the site features are regarded to be 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[18]. Whilst the matrices provided as part of the advice are informative and note relevant pressures associated with hydrocarbon exploration, 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

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

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 oil and gas exploration from successive Offshore Energy SEAs and the review of the OESEA3 Environmental Report (BEIS 2018) covers the range of pressures identified in the advice for the relevant sites (as summarised in Sections 4.2-4.3) and has therefore been used to underpin the assessment against site-specific information. It is noted that, existing controls are in place for many relevant pressures (e.g. hydrocarbon & PAH 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 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 Natura 2000 site 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 Natura 2000 sites to be subject to further assessment are located (Table 1.2, Figure 1.1).

4.2 Physical disturbance and drilling effects

The pressures[19] which may result from exploration activities and cause physical disturbance and drilling effects on relevant Natura 2000 sites assessed in Section 5.2 are described below with respect to rig siting, drilling discharges and other effects.

4.2.1 Rig siting

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

Jack-up rigs, normally used in shallower water (<120m), leave three or four seabed depressions from the feet of the rig (the spud cans) 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 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 associated with the drilling of a previous well in 2006 (no information on the depths of the depressions was

[19] Relevant pressures identified from advice on operations for sites and JNCC PAD (2018).

provided). The well site was in water depth of *ca*. 70m, 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). 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 response of benthic macrofauna to physical disturbance has been well characterised in peer-reviewed literature, with increases in abundance of small opportunistic fauna and decreases in larger more specialised fauna (Eagle & Rees 1973, Newell *et al*. 1998, van Dalfsen *et al*. 2000, Dernie *et al*. 2003).

Habitat recovery from temporary disturbance will depend primarily on re-mobilisation of sediments by current shear (as reviewed by Newell *et al*. 1998, Foden *et al.* 2009). Subsequent benthic population recovery takes place through a combination of migration, re-distribution and larval settlement. On the basis that seabed disturbance is qualitatively similar to the effects of wave action from severe storms, in most of the shallower parts of the UKCS, sand and gravel habitat recovery will be relatively rapid (1-5 years) (van Dalfsen *et al.* 2000, Newell & Woodcock 2013).

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, however this is not typical. In soft sediments, rock deposits may cover existing sediments resulting in a physical change of seabed type. The introduction of rock into an area with a seabed of sand and/or gravel can in theory provide “stepping stones” which might facilitate biological colonisation including by non-indigenous species by allowing species with short lived larvae to spread to areas where previously they were effectively excluded. On the UK continental shelf natural “stepping stones” are already 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 INSITE24 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 potential for biological connectivity between structures in the North Sea, but this has not been validated by empirical data (ISAB 2018). The Department is supporting Phase 2 of the INSITE research, which aims to tackle gaps in understanding of the role of man-made structures in marine ecosystems. Key areas to be investigated in the second phase include enhancing the understanding of the larval biology of ecologically significant biofouling species, the contribution of man-made structures as artificial reefs, and approaches to the monitoring and environmental assessment of drill cuttings piles, renewable energy installation footings, and cables.

Introduction or spread of invasive 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[20]. The Convention includes Regulations with specified technical standards and requirements (IMO Globallast website[21]). Further, oil and gas 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.

4.2.2 Drilling discharges

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 pressures described in this section relate to physical ones associated with the discharge and settlement of cuttings during exploration well drilling rather than potential chemical pressures (described below). Water-based mud cuttings are typically discharged at, or relatively close to the 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. Surface hole cuttings are derived from shallow geological formations and a proportion will be similar to surficial sediments in composition and

[20] 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
[21] http://archive.iwlearn.net/globallast.imo.org/the-bwmc-and-its-guidelines/index.html

characteristics. Dispersion of mud and cuttings is influenced by various factors, including particle size distribution and density, vertical and horizontal turbulence, current flows and water depth. In contrast to historic oil-based mud discharges, potential smothering effects due to the discharge of cuttings drilled with water based muds (WBM) are usually subtle or undetectable, although the presence of drilling material at the seabed is often detectable close to the drilling location (<500m). In areas of shallow water (<50m) and strong currents (e.g. southern North Sea), the cuttings are rapidly dispersed (Breuer *et al*. 1999).

Modelling of WBM cuttings discharges in the southern North Sea for an exploration well in Block 44/19b in *ca*. 27m water depth (Tullow Oil UK 2010), indicated that most of the material would be deposited within 1km of the well location. Cuttings deposition decreased away from the well with <400mm thickness predicted within the first 4m of the well, falling to ~10mm covering a 140m x 65m area. Beyond this, cuttings deposition was predicted to be less than 1mm thick. It was expected that all the cuttings would become mixed with the natural sediments and eventually disperse due to the strong tidal and wave generated currents in the area.

The extent and potential impact of drilling discharges have been reviewed in successive SEAs, OESEA, OESEA2 and OESEA3 (DECC 2009, 2011 and 2016, respectively, also see BEIS 2018).

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).

After installation of 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), although this is only likely to be temporary in the southern North Sea).

Contamination[22]

The past discharge to sea of drill cuttings contaminated with oil-based drill mud (OBM) resulted in well documented acute and chronic effects at the seabed (e.g. Davies *et al.* 1989, Olsgard & Gray 1995, Daan & Mulder 1996). These effects resulted from the interplay of a variety of factors of which direct toxicity (when diesel based muds were used) or secondary toxicity as a consequence of organic enrichment (from hydrogen sulphide produced by bacteria under anaerobic conditions) were probably the most important. Through OSPAR and other actions, the discharge of oil-based and other organic phase fluid contaminated material is now effectively banned. The "legacy" effects of contaminated sediments on the UKCS resulting from OBM discharges have been the subject of joint industry work (UKOOA 2002) and reporting to OSPAR.

The UK Government/Industry Environmental Monitoring Committee has reviewed UK offshore oil and gas monitoring requirements with an aim to ensure that adequate data is available on the environmental quality status in areas of operations for permitting assurance and to meet the UK's international commitments to report on UK oil industry effects. This strategy has been implemented since 2004 and has included regional studies in various parts of the North Sea, and surveys around specific single and multi-well sites. The most recent survey was undertaken as part of the Department's SEA monitoring with a survey in the Fladen Ground in late 2015 (see Appendix 1b of OESEA3).

Overall, there are positive indications of recovery of sediments and communities in both the Fladen Ground and East Shetland Basin from the historic effects of oil-based mud discharges. The total PAH and total n-alkane concentrations in Fladen Ground sediments were all lower in 2001 than in 1989 and are now at levels which are considered below 'background'. The results of the most recent Fladen Ground survey confirm this general pattern of recovery.

In contrast to historic oil based mud discharges[23], effects on seabed fauna resulting from the discharge of cuttings drilled with water based muds (WBM) and of the excess and spent mud itself are usually subtle or undetectable (e.g. Cranmer 1988, Neff *et al*. 1989, Hyland *et al*. 1994, Daan & Mulder 1996, Currie & Isaacs 2005, OSPAR 2009, Bakke *et al.* 2013, DeBlois *et al.* 2014, Aagaard-Sørensen *et al.* 2018). Considerable data 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 (see above).

[22] Including contamination from transition elements and organo-metals, hydrocarbons and PAHs, synthetic compounds and the introduction of other substances (solid, liquid or gas).

[23] 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.

OSPAR (2009) concluded that the discharge of water-based muds and drill cuttings may cause some smothering in the near vicinity of the well location. The impacts from such discharges are localised and transient but may be of concern in areas with sensitive benthic fauna, for example corals and sponges. Field experiments on the effects of water-based drill cuttings on benthos by Trannum *et al*. (2011) found after 6 months 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 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 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).

4.2.3 Other effects

Collisions 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 by ships, especially by fast-moving ferries, but smaller cetacean species and seals can also suffer 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[24] indicates that post-

[24] http://archive.jncc.gov.uk/pdf/SNorthSea_ConsAdvice.pdf

mortem investigations of harbour porpoise deaths have revealed death caused by trauma (potentially linked with vessel strikes) is not currently considered a significant risk.

4.3 Underwater noise effects

The current level of understanding of sources, measurement, propagation, ecological effects and potential mitigation of 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). 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

Of those oil and gas activities that generate underwater sound, deep geological seismic surveys (2D and 3D) are of primary concern due to the high amplitude, low frequency and impulsive nature of the sound produced 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. As detailed in Section 2.2.2 some work programmes relating to the Blocks applied for in the 32nd Round include the intention to conduct a 3D seismic survey.

In addition to seismic surveys, relevant sources of impulsive sound are restricted to the smaller volume air-guns and sub-bottom profilers (SBPs) used in high-resolution geophysical surveys (HRGS, e.g. rig site surveys) and well evaluation (i.e. Vertical Seismic Profiling, VSP), and also from occasional conductor-piling during drilling (see Table 2.2).

Sources such as pinger, chirped or parametric SBPs, along with other sources used in HRGS such as side-scan sonar and multi-beam echosounders (MBES), produce a computer-controlled frequency-amplitude modulated (F/AM) periodic waveforms. These waveforms do not exhibit the same steep rise time characteristic of airguns, sparkers or boomers, and therefore the potential for physical injury is less. Additionally, these sources are more directional and have dominant frequencies higher than those of air guns[25] such that, even at high source levels, sound levels outside the main beam would be much reduced, and for high-frequency sources such as MBES and side-scan sonar, be subject to high levels of frequency-

[25] 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 2017b).

dependent absorption[26]. SBPs of the 'boomer' and 'sparker' type do generate a true broadband pulsed waveform of low frequency, although the peak pressures produced by these small devices are considerably lower than those generated by airguns. Two studies commissioned by the US Bureau of Ocean Energy Management investigated sound generated by equipment commonly used in HRGS. Calibrated source levels were measured under controlled conditions in a test tank (Crocker & Fratantonio 2016, Crocker *et al*. 2019); acoustic characteristics of several example pieces of equipment 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 (dB re 1µPa@1m)[1]		Approximate frequency range of dominant energy (kHz)	-3dB beam width (degrees); across track
		$SPL_{peak-peak}$	SEL		
Delta Sparker	SBP 'sparker'; impulse	206-225	163-185	0.3 - 1.5	n/a
Applied Acoustics 251	SBP 'boomer' (single plate); impulse	208-216	166-174	3 - 5	49-76
EdgeTech 512i	SBP 'chirper'; FM chirp	176-191	145-160	1 - 9	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). Unfortunately, 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. A further project to calibrate these measures and provide an expanded assessment of propagation commenced in 2019. Despite these caveats, 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 sparker SBPs tested showed slightly greater propagation, as would be expected from the lower-frequency and less directional impulsive signals these

[26] For example, the absorption coefficient alone in seawater is approximately -36dB/km at 100kHz, rising to -61dB at 200kHz (Lurton 2016).

devices produce. The greatest propagation was generally observed at the deepest test site (100m water depth) from sources generating low frequencies (<10kHz); by contrast, at 100m water depth, some of the highest frequency sources (>50kHz) experienced such attenuation that they were only weakly detectable or undetected by recording equipment. While recognising that these results require refining, preliminary evidence suggests that SBPs and other HRGS sources generate a very limited sound field in the marine environment, which is of a much lower magnitude than those generated by seismic airgun arrays, and therefore has a very low potential for significant disturbance of sensitive marine fauna. It is noted that JNCC encourage studies to provide evidence to support this assertion, and, until further information becomes available, are advising the use of a precautionary 5km marine mammal deterrence radius in assessments of potential effects of SBPs and other HRGS sources (e.g. JNCC *et al*. 2020).

Direct measurements of underwater sound generated during conductor piling are limited, although the evidence which does exist supports the assertion that the low hammer energies and pile diameters relative to the piling of monopiles for offshore wind foundations results in much lower amplitude underwater noise. 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 in 365m water depth off southern California. 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 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 $1\mu Pa^2 \cdot s$), reducing to 149-155dB re 1μPa at 400m from source and 20m water depth (SEL = 143-147dB re $1\mu Pa^2 \cdot s$).

Drilling operations and support vessel traffic are sources of continuous noise (non-impulsive) of comparable amplitude and 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). 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).

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 changes, physical injury and mortality. While generally the severity of effects tends to increase with increasing exposure to noise, it is important to draw a distinction between effects from physical (including auditory) injury and those from behavioural disturbance. In addition to direct effects, indirect effects may also occur, for example via effects on prey species, complicating the overall assessment of significant effects. Marine mammals, and in particular the harbour porpoise, are regarded as the most sensitive to acoustic disturbance 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 latest 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 recently 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, current mitigation measures as described in JNCC guidelines[27] are thought sufficient in minimising the risk of injury to negligible levels for the marine mammal species of relevance in this AA (harbour porpoise and seals). As JNCC guidelines (see Section 2.3.2) are required to be followed as part of any consent with regard to geophysical surveys across the UKCS, the risk of injury to marine mammals is not considered further.

With respect to disturbance, it has proved much more difficult to establish broadly applicable threshold criteria based on exposure alone; this is largely due to the inherent complexity of animal behaviour where the same sound level is likely to elicit different responses depending on an individual's behavioural context and exposure history. 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[28]. This is to highlight that a disturbance offence is unlikely to occur

[27] JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys, August 2017 (JNCC 2017b).
[28] See Table 4 (p450) of Southall *et al.* (2007) for a full description of response scores.

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.

Evidence of the effects of seismic surveys on odontocetes and pinnipeds is limited but of note are studies carried out in the Moray Firth observing responses to a 10-day 2D seismic survey (Thompson *et al.* 2013a). The 2D seismic survey took place in September 2011 and exposed a 200km^2 area to noise throughout that period; peak-to-peak source levels generated by the 470in^3 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 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 impacted 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).

More recently, the effects of a large 3D seismic survey conducted in the Danish sector of the North Sea on harbour porpoise echolocation activity were examined (Sarnocińska *et al*. 2020). The source comprised a 3,570in^3 airgun array and the survey lasted 103 days, with seismic survey activity occurring on all but 17 days, covering an area of 1,121km^2. Acoustic loggers were deployed inside and adjacent to the seismic survey area, before, during and after the survey over a total duration of 9 months. Three different measures of porpoise activity showed a dose-response effect, with the lowest activity closest to the source vessel, and activity increasing up to a range of 8-12km, beyond which baseline acoustic activity was attained and no general displacement could be detected compared to reference stations at 15km from the seismic activity. The lowest porpoise acoustic activity was recorded at SELs for a single pulse of 155dB re 1 μPa^{2}s - a similar level to that estimated by Thompson *et al*. (2013) at distances where harbour porpoise detections were reduced. Also similar to Pirotta *et al*. (2014) and Thompson *et al.* (2013a), the study found no long-term and large-scale displacements of porpoises throughout the survey. The authors note that it is not known whether the same animals remained in the area during the survey or if displaced animals were continuously replaced by new animals moving into the area.

The OESEA3 (DECC 2016) concluded that 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 a 10km Effective Deterrence Radius (EDR) suggested by the SNCBs in their joint response to the 31st Round draft AA, March 2019), resulting in changes in distribution and a reduction of foraging activity but the effect is expected to be short-lived. Recently published guidance (JNCC *et al*. 2020) advises a minimum EDR of 12km for seismic (airgun) surveys when assessing the significance of noise disturbance against conservation objectives of harbour porpoise SACs, citing Thompson *et al*. (2013a) and Sarnocińska *et al*. (2020) as key sources of evidence for this distance. The precautionary criterion applied during initial Block screening (15km) 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 (relevant differences between the noise pulses are described by Sarnocińska *et al.* (2020)) and for assessing in-combination effects with wind farms currently planned or under construction across the North Sea. Empirical studies during the construction of offshore wind farms (OWFs) in the North and Baltic Seas (Carstensen *et al*. 2006, Tougaard *et al*. 2009, Brandt *et al*. 2011, 2018, Dähne *et al.* 2013) 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 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; however, once piling ceases, harbour porpoises are expected to return readily (hours to days) (DECC 2016). Sarnocińska *et al.* (2020) noted that the difference in response to piling and seismic survey, may in part be related to the difference between moving and stationary sound sources.

Graham *et al*. (2019) provide evidence of harbour porpoise behavioural responses to pile-driving during construction of the Beatrice offshore 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 results of the study suggest that response levels were increased with ADD use.

The Beatrice OWF pin-pile installation involved approximately twice the pile diameter and hammer energy of that typical of the piling of well conductors/subsea infrastructure. The associated findings of 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.

At Horns Rev wind farm, off the Danish North Sea coast, a study using 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 shown to be temporary, with seals returning to their non-piling distribution within two hours of the cessation of piling.

With regard to conductor piling, the low hammer energy, narrow diameter of pipes and short duration of piling relative to those for offshore wind farms, 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. These studies are cited in recent SNCB guidance for harbour porpoise SACs, which advise the use of a 15km EDR in assessments of the effects of conductor piling (JNCC *et al*. 2020).

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. The latest OESEA (DECC 2016) concluded that effects are negligible but with a high level of uncertainty. Recent investigation of the source levels of a variety of high-resolution geophysical survey sources (Crocker & Fratantonio 2016, Crocker *et al*. 2019, see Section 4.3.1), combined with preliminary results of emitted sound fields, have provided evidence to support the conclusion of very low risk of significant effects from such 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). The SNCB guidance for harbour porpoise SACs, advises the use of a 5km EDR in assessments of the effects of other geophysical (non-airgun) acoustic surveys - a distance they acknowledge to likely be conservative (JNCC *et al*. 2020).

The presence and/or movement of vessels from and within Blocks during exploration and appraisal activities could also potentially disturb marine mammals foraging within or close to designated or potential SACs for which they are a qualifying feature. Reported responses include avoidance, interrupted foraging behaviour, changes in swimming speed, direction and surfacing patterns, alteration of the intensity and frequency of calls (review in Erbe *et al*. 2019). Chronic exposure has also been linked to an increase in stress-related hormones (Rolland *et al.* 2012). 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. Statistical analyses showed that higher levels of medium- to high-frequency components of vessel noise (250Hz to 63kHz octave bands) significantly increase the probability of porpoising. By contrast, there was no significant relationship between porpoising behaviour and low-frequency components of vessel noise (≤125Hz) or the presence of pulses from echo-sounders on the vessels (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 levels of noise (coinciding with the passage of 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 96dB re 1 μPa (16 kHz third-octave band, Wisniewska *et al*. 2018).

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 in 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 an inverse 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 commissioned project “Mapping UK shipping density and routes from AIS” (MMO 2014b) and the 2015 national dataset of marine vessel traffic[29] provides relevant shipping density information. 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 the Humber Estuary SAC and the Wash and North Norfolk Coast SAC.

Fish

Many species of fish are highly sensitive to sound and vibration, and broadly applicable sound exposure criteria have 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 Carroll *et al.* 2017). 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), although a similar number of studies have reported no effects on catches or abundance, or conflicting results (Carroll *et al*. 2017). 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). Hence, their ability 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 (Hawkins & Johnstone 1978, cited by Gill & Bartlett 2010). A recent 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 (Mickle *et al*. 2019).

In addition to considering direct effects on fish as qualifying features of Natura 2000 sites, fish also form important prey items of seabird, marine mammal and fish qualifying features. Example fish species of known importance to both diving seabirds and marine mammals in the southern North Sea include sandeels, small 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. Atlantic mackerel also lack a swim bladder and detect sound primarily through particle motion. Exposure of mackerel in a net pen to sounds from a 90in^3 airgun showed an increase in school cohesion but no sudden behavioural responses to a gradually escalating received level as the source vessel approached (Doksæter *et al*. 2017).

[29] https://data.gov.uk/dataset/b7ae1346-7885-4e2d-aedf-c08a37d829ee/vessel-density-grid-2015

By contrast, herring are considered hearing specialists, detecting a broader frequency range than many species. Sprat are assumed to have similar sensitivities to herring due to their comparable morphology, although studies on this species are lacking. Observed responses of herring to underwater noise vary; for example, Peña *et al*. (2013) did not observe any changes in swimming speed, direction, or school size as a 3D seismic vessel slowly approached schools of feeding herring from a distance of 27km to 2km; conversely, Slotte *et al*. (2004) observed herring and other mesopelagic fish to be distributed at greater depth during periods of seismic shooting than non-shooting, and a reduced density within the survey area. Evidence for and against avoidance of approaching vessels by herring has been reported (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.

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. Existing studies do not yield completely coherent results but suggest that fish could stop foraging and move down in the water column. Such temporary displacement and/or altered feeding behaviour are likely to be responsible for the reduced catches reported in some circumstances. 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. 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 dive 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; of these, two species are qualifying features of sites in the southern North Sea region which this AA addresses: red-throated diver and common scoter.

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 al.* 2019). Therefore, the potential for acute trauma to diving birds from seismic survey is considered to be very low.

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

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

Note: Includes species which are known to engage in pursuit diving or benthic feeding in marine, coastal and estuarine waters at least during part of the year. Species in ***bold*** *are those of relevance to the sites and Blocks considered within this AA.*

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, gannet and puffin 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 >3-4kHz (Crowell e*t al.* 2015; Mooney *et al*. 2019). 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. However, the use of underwater sound by diving birds is unknown; underwater vocalisations associated with feeding reported for penguins are the first record of underwater sound emission from any diving bird (Thiebault *et al*. 2019). 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. A study investigated 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 thick-billed murre (Brünnich's guillemot), along with kittiwake and fulmar. 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 bordered the closest boundary of the seismic survey; during shooting, their distribution shifted away from the survey area, with areas of higher use at least 15km distant to the closest survey line. However, insufficient information was provided on the spatio-temporal distribution of seismic shooting or penguin distribution to estimate a deterrence radius. It was reported that penguins quickly reverted to normal foraging behaviour after cessation of seismic survey activities, suggesting a relatively short-term influence of seismic survey activity on these birds' behaviour and/or that of their prey (Pichegru *et al*. 2017).

These 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. While there is some evidence of noise-induced changes in the distribution and behaviour of diving birds in response to impulsive underwater noise, these have been temporary and may be a direct disturbance or reflect a change in fish distribution during that period (possibly as a result of seismic activities).

5 Assessment

The screening process (BEIS 2019a) 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 32nd Round. A number of these Blocks have been applied for (see Section 1.2) and the further assessment of licensing of these Blocks on relevant Natura 2000 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 32nd Round Southern North Sea 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. The harbour porpoise is protected in European waters under the provisions of Article 12 of the Habitats Directive and within the UK its conservation status is favourable[30]. 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 2015). 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 support persistently higher densities during the winter (see Figures 5.1 and 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

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[30] JNCC (2013). Species conservation status reports. Third Report by the United Kingdom under Article 17 of the EU Habitats Directive. Joint Nature Conservation Committee, Peterborough. http://jncc.defra.gov.uk/page-6564 (accessed August 2015).

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[31]. The conservation objectives[32] indicate that the 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.* 2017) as part of SCANS-III (345,000, CV = 0.18), which is similar to the 2005 estimate (335,000 CV = 0.22).

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

[31] http://jncc.defra.gov.uk/pdf/SouthernNorthSeaSelectionAssessmentDocument.pdf
[32] http://archive.jncc.gov.uk/pdf/SNorthSea_ConsAdvice.pdf

unfavourable (Eggleton *et al.* 2017), such that the SACO for the Dogger Bank SAC[33] advises that the site feature extent and distribution, and structure and function should be restored, while supporting processes be maintained.

Doggersbank SAC & Klaverbank SAC (Netherlands)

A profile of the habitat type associated with the Dutch Doggersbank SAC site is not yet available[34] but it is a continuation of the UK Dogger Bank SAC and contains similar habitat types[35]. Similarly, a profile of the reef habitat of the Dutch Klaverbank SAC is also not yet available[36]. Both sites have grey and harbour seal and harbour porpoise listed as qualifying features although this reflects that animals range throughout the Dutch EEZ rather than the sites having special significance as reproduction sites, foraging sites 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 was screened in for further assessment of the site's grey seal qualifying feature and its offshore distribution relevant to a number of Blocks. 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 2018 breeding season (SCOS 2018, Lincolnshire Wildlife Trust[37]). 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 the past 3 years (*ca.* 8.5% p.a., 2014-2016 compared to 22% p.a., 2010-2014), perhaps an early indication it is approaching a carrying capacity (SCOS 2018). Tagging

[33] http://archive.jncc.gov.uk/pdf/DoggerBank_SACO_v1_0.pdf
[34] https://www.noordzeeloket.nl/en/policy/noordzee-natura-2000/gebieden/doggersbank/dogger-bank/habitattype/
[35] http://www.emodnet-seabedhabitats.eu
[36] https://www.noordzeeloket.nl/en/policy/noordzee-natura-2000/gebieden/klaverbank/cleaver-bank/habitattype/
[37] Lincolnshire Wildlife Trust website: http://www.lincstrust.org.uk/donna-nook/weekly-update

studies show that grey seals use offshore areas (up to 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) 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 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.

The Wash and North Norfolk Coast SAC

Similarly, The Wash and North Norfolk Coast SAC was screened in for further assessment of its harbour seal qualifying feature and its offshore distribution relevant to a number of Blocks. 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 slightly since 2015 with 3,210 adults in The Wash and 399 at Blakeney Point in 2017 (SCOS 2018).

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.

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[38]. 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).

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. 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[39].

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 number of bird species including common scoter and goldeneye. Other relevant diving species which are part of the non-breeding waterbird assemblage include cormorant, eider and little grebe[40].

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[38] http://jncc.defra.gov.uk/page-6537

[39] 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

[40] https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9008021&SiteName=wash&SiteNameDisplay=The%20Wash%20SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=21&HasCA=1

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 is 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[41], with common scoter a component of the waterfowl assemblage[42]. 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[43].

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[44]. 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)[45]. 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.

41 https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9009031&SiteName=north%20norfolk&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&HasCA=1&NumMarineSeasonality=11&SiteNameDisplay=North%20Norfolk%20Coast%20SPA

42 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

43 https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9009031&SiteName=north%20norfolk&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&HasCA=1&NumMarineSeasonality=11&SiteNameDisplay=North%20Norfolk%20Coast%20SPA

44 http://archive.jncc.gov.uk/page-7249

45 http://archive.jncc.gov.uk/pdf/ThamesSPAConsObsVersion3%207%20Mar2013FINAL.pdf

5.2 Assessment of physical disturbance and drilling effects

5.2.1 Blocks and sites to be assessed

The nature and extent of potential physical disturbance and drilling effects are summarised in Section 4.2. On the basis of this information, in conjunction with the locations of Southern North Sea Blocks applied for in the 32nd Round and the sites with relevant qualifying features, potential likely significant effects are considered to remain for 73 Blocks (or part Blocks), in respect of seven sites (Figure 5.1) which are assessed below.

5.2.2 Implications for site integrity of relevant sites

The conservation objectives of relevant sites and information relating to site selection and advice on operations have been considered against the work programmes for the Blocks 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 here.

Figure 5.1: Sites and Blocks to be subject to further assessment for physical disturbance and drilling effects

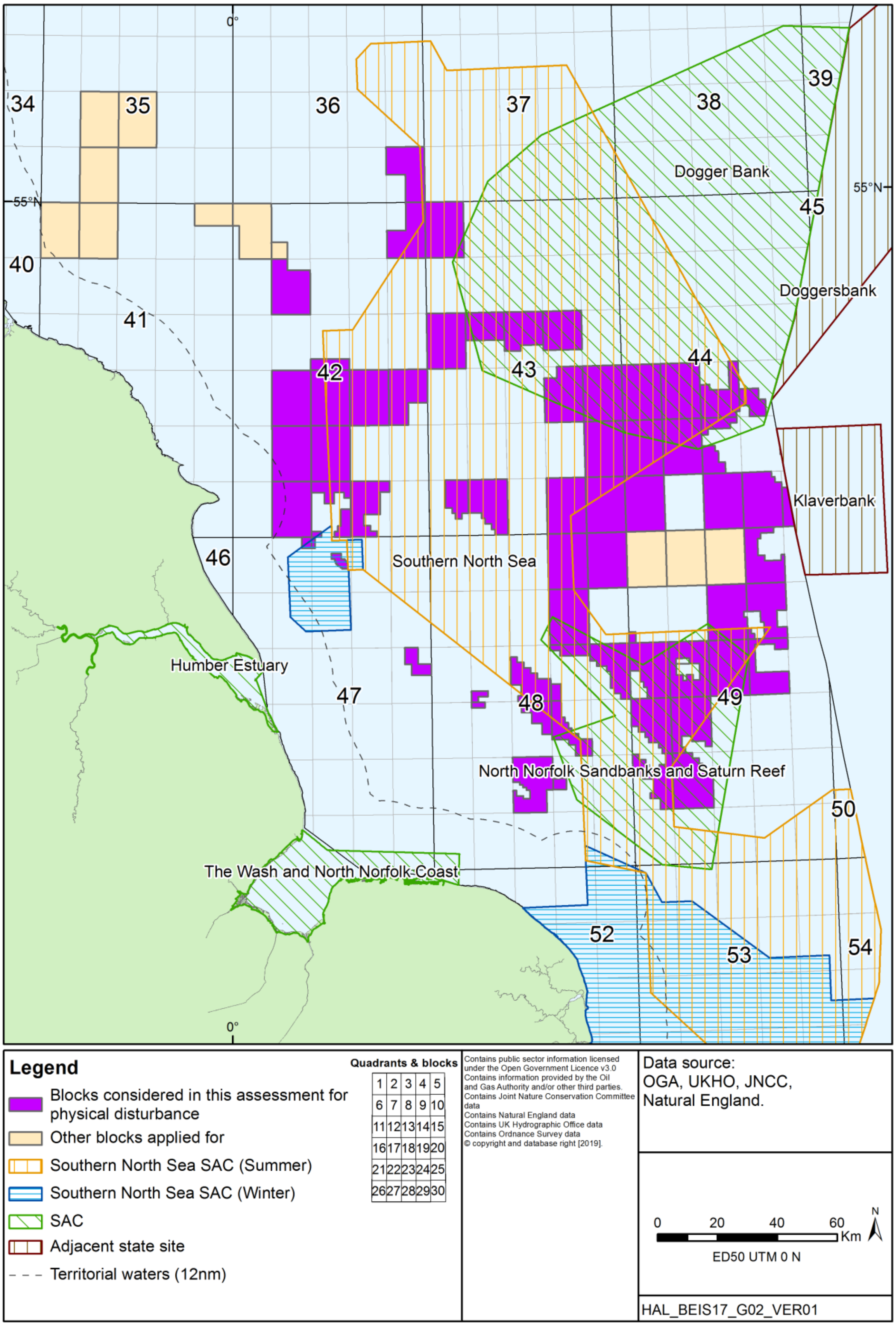


Table 5.1: Consideration of potential physical disturbance and drilling effects and relevant site conservation objectives

Southern North Sea SAC
Site information
Area (ha): 3,695,054 **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 for physical disturbance and drilling effects
36/30b, 42/5b, 42/7b, 42/13b, 42/17, 42/18, 42/19, 42/20b, 42/22, 42/23, 42/27, 42/28e, 42/28g, 42/28h, 42/29b, 43/1, 43/11, 43/12b, 43/13a, 43/14c, 43/19a, 43/20, 43/25, 43/26b, 43/27b, 43/29, 43/30, 44/16, 44/17, 44/18b, 44/19b, 44/21, 44/22, 44/23a, 44/23b, 44/26, 47/2b, 47/3g, 47/3i, 47/15b, 48/4, 48/5, 48/9, 48/12g, 48/13c, 48/14b, 48/14c, 48/15c, 48/17e, 48/18e, 48/19d, 48/23d, 48/24c, 49/6c, 49/8b, 49/9b, 49/9e, 49/11c, 49/12d, 49/13, 49/14a, 49/16b, 49/17b, 49/21e, 49/22b
Assessment of effects on site integrity
Rig siting ***(Relevant pressures:*** *No relevant pressures identified[46]. 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 type))[47]* The delineation of the Southern North Sea 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)[48]. 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 42/7b, 42/17, 42/22, 42/27, 47/15b, 48/5, 48/12g, 48/17e, 48/23d and 48/24c are outside of the site boundary and given the assumed distance from a jack-up rig within which effects may occur (500m, see Table 2.2), rig installation will not significantly impact the extent and distribution of the qualifying habitat. Blocks 36/30b, 42/5b, 42/23, 43/30, 44/19b, 44/22, 44/26, 44/23a, 44/23b, 48/18e, 49/8b, 49/9b, 49/14a and 49/22b 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 that are partly or wholly within the site, 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%). 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 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.

[46] http://jncc.defra.gov.uk/pdf/SNorthSea_ConsAdvice.pdf
[47] Relevant pressures were identified based on those from the JNCC pressures-activities database which could potentially impact the supporting habitats (sand/gravel), informed by the conservation advice package for the Dogger Bank SAC which overlaps with the SCI over a number of Southern North Sea Blocks.
[48] http://jncc.defra.gov.uk/pdf/SouthernNorthSeaSelectionAssessmentDocument.pdf

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 5.2.3), allowing the conclusion that the site conservation objectives will not be undermined and there will be no adverse effect on site integrity.

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 42/7b, 42/17, 42/22, 42/27, 47/15b, 48/5, 48/12g, 48/17e, 48/23d and 48/24c are outside of the site boundary and therefore drilling discharges will not significantly impact the extent and distribution of supporting habitats. Blocks 36/30b, 42/5b, 42/23, 43/30, 44/19b, 44/22, 44/26, 44/23a, 44/23b, 48/18e, 49/8b, 49/9b, 49/14a and 49/22b have significant areas outside the site boundaries in which drilling would be possible, and therefore impacts on supporting habitats could be largely avoided. For the Blocks that are partly or wholly within the site, 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. 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 the 41 Blocks entirely or largely within the site are localised and temporary, and unlikely to overlap between Blocks 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 41 Blocks (an improbable worst-case scenario that all 41 wells are drilled) is estimated at 33km^2 (<0.1% 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 5.2.3) will ensure that site conservation objectives are not undermined. Section 5.4 provides a consideration of potential Block activities in-combination with other relevant plans and projects.

Dogger Bank SAC

Site information

Area (ha): 1,233,115
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[49].
Relevant Blocks for physical disturbance and drilling effects
42/5b, 43/1, 43/11, 43/12b, 43/13a, 43/14c, 43/19a, 43/20, 43/25, 44/16, 44/17, 44/18b, 44/19b, 44/21, 44/22, 44/23a, 44/23b, 44/25, 44/28
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[50] by the placement of spud cans as part of rig siting. Blocks 42/5b and 43/11 are outside of the site boundary and given the assumed distance from a jack-up rig within which effects may occur (500m, see Table 2.2), rig installation will not significantly impact the extent and distribution of the qualifying habitat. Blocks 43/1, 43/25, 44/21, 44/22 and 44/23b have significant areas outside the site boundaries in which rig siting would be possible, and therefore interaction with the qualifying features could be avoided. With respect to the remaining Blocks that are largely within the site, 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 0.006%), 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 nature and the energetic nature of the environment. 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 5.2.3), which will ensure that 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. 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. The Dogger Bank SACO (2018) indicates that introduced substrates, such as rock placement, normally consisting of gravel or pebbles have been deposited onto the seabed although it is not clear how much of the material there is within the site, 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 within the site to minimise further impact on feature extent and distribution, and associated changes in biological communities. 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). Moreover, further mitigation measures are available which include use of removable mud mats or anti-scour mats as an alternative to rock placement (Section 5.2.3), allowing the conclusion that the site conservation objectives will not be undermined and there will be no adverse effect on site integrity. 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. 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 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

[49] http://archive.jncc.gov.uk/pdf/DoggerBank_SACO_v1_0.pdf
[50] http://jncc.defra.gov.uk/docs/DoggerBank_AoO_Workbook_v1_0.xlsx

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 to Blocks 42/5b and 43/11 which are beyond this distance, or Blocks 43/1, 43/25, 44/21, 44/22 and 44/23b which have significant areas outside the site boundaries in which drilling will be possible, drilling discharges will not significantly impact the extent and distribution or the structure and function of the qualifying habitat. For the Blocks 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. Therefore, site conservation objectives will not be undermined. The advice on operations indicates that the qualifying feature is not sensitive or there is insufficient evidence on the contamination pressures listed above and described in Section 4.2.3. 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 in Blocks 43/12b, 43/13a, 43/14c, 43/19a, 43/20, 44/16, 44/17, 44/18b, 44/19b, 44/23a, 44/25 and 44/28 (i.e. those Blocks entirely or largely within the site) will be localised and temporary, and unlikely to overlap between Blocks either spatially or temporally. Given the indicative work programmes, the combined spatial footprint within which physical disturbance and drilling effects could occur (within 500m of the rig/well location) across the 12 Blocks (a worst case scenario of 12 drill or drop wells) is estimated at 9.6km^2 (0.08% of the site). However, the temporary nature of the disturbance, energetic nature of the environment, required controls and available mitigation (Sections 2.3.1 and 5.2.3), will ensure that site conservation objectives are not undermined. Section 5.4 provides a consideration of potential Block activities in-combination with other relevant plans and projects.
Doggersbank SAC (Netherlands)
Site information
Area (ha): 473,500 **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 for physical disturbance and drilling effects
44/19b
Assessment of effects on site integrity
Rig siting Block 44/19b is 2km from the site boundary and given the assumed distance from a jack-up rig within which effects may occur (500m, see Table 2.2), rig installation will not significantly impact the extent and quality of the sandbank habitat. 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, with respect to Block 44/19b which is 2km from the site boundary, drilling discharges will not significantly impact the extent and quality of the sandbank habitat. Therefore, 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 applied that is of relevance to the site. Section 5.4 provides a consideration of potential Block activities in-combination with other relevant plans and projects.

Klaverbank SAC (Netherlands)
Site information
Area (ha): 153,900 **Relevant qualifying features:** Reefs, 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 for physical disturbance and drilling effects
44/19b, 44/25, 44/29a, 44/30b, 49/4e, 49/9b
Assessment of effects on site integrity
Rig siting All of the relevant Blocks are outside of the site boundary and only 44/30b is immediately adjacent to the site. Given the assumed distance from a jack-up rig within which effects may occur (500m, see Table 2.2), rig installation will not significantly impact the extent and quality of the reef habitat. 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, with respect to all of the relevant Blocks, drilling discharges will not significantly impact the extent and quality of the reef habitat. Therefore, drilling discharges will not adversely affect site integrity. **Other effects** N/A **In-combination effects** No intra-plan in-combination effects likely given that all of the relevant Blocks applied for are outside of the site. Section 5.4 provides a consideration of potential Block activities in-combination with other relevant plans and projects.
Humber Estuary SAC
Site information
Area (ha): 36,657 **Relevant qualifying features:** Grey seal. See Natural England guidance for details of qualifying features[51]. **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.

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

Attributes and related targets have been set for the site features which are presented in the site SACO[52]. Advice on seasonality for the site indicates year-round grey seal presence at the site.
Relevant Blocks for physical disturbance and drilling effects
42/18, 42/19, 42/20b, 42/22, 42/23, 42/27, 42/28e, 42/28g, 42/28h, 42/29b, 47/2b, 47/3g, 47/3i
Assessment of effects on site integrity
There are no Blocks applied for in the 32nd Round which lie within 10km of the boundary of the Humber Estuary SAC. All relevant Blocks considered here for potential physical disturbance and drilling effects were screened-in during the Stage 1 HRA Screening (BEIS 2019a) on the basis of either overlapping or being immediately adjacent to an area of higher relative density of grey seals extending from the Humber Estuary (defined as grid cells of ≥10-50 seals per 5x5km). **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)* The Blocks have been screened in as they areas of moderate to high grey seal usage (see Section 5.1) and 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 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 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)* With respect to the moderate to high grey seal usage of the relevant Blocks, the maximum spatial footprint within which smothering by drilling discharges may occur (0.8km^2) is small and 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 habitats of this qualifying species. The small scale and temporary nature of the potential physical damage, 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** With respect to grey seal supporting habitats outside of the site, intra-plan in-combination effects are possible although spatial footprints associated with rig installation and drilling discharges in Blocks 42/18, 42/19, 42/20b, 42/22, 42/23, 42/27, 42/28e, 42/28g, 42/28h, 42/29b, 47/2b, 47/3g and 47/3i are localised and temporary, and unlikely to overlap between Blocks either spatially or temporally. Given the indicative work programmes, the combined spatial footprint within which physical disturbance and drilling effects could occur (within 500m of the rig/well location) across the 13 Blocks (a worst case scenario of 12 drill or drop wells and one Firm well proposed for 47/3i) is estimated at 10.4km^2. However, given that the Blocks are over 40km from the site, the temporary and localised nature of the disturbance and the environmental conditions, site conservation objectives will not be

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

undermined. Section 5.4 provides a consideration of potential Block activities in-combination with other relevant plans and projects.
The Wash and North Norfolk Coast SAC
Site information
Area (ha): 107,761 **Relevant qualifying features:** Harbour seal. See Natural England guidance for details of qualifying features[53]. **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[54]. Advice on seasonality for the site indicates year-round grey seal presence at the site.
Relevant Blocks for physical disturbance and drilling effects
47/15b, 48/12g, 48/13c, 48/17e, 48/18e, 48/23d
Assessment of effects on site integrity
There are no Blocks applied for in the 32nd Round which lie within 10km of the boundary of The Wash and North Norfolk Coast SAC. All relevant Blocks considered here for potential physical disturbance and drilling effects were screened-in during the Stage 1 HRA Screening (BEIS 2019a) on the basis of either overlapping or being immediately adjacent to an area of higher relative density of harbour seals extending from The Wash (defined as grid cells of ≥10-50 seals per 5x5km). **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)* The Blocks have been screened in as they are areas of moderate to high harbour seal usage (see Section 5.1) and 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 jack-up rig siting is small (0.8km^2) and recovery from physical damage of the scale associated with rig placement is expected to be rapid. The small scale and temporary nature of the potential physical damage 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**

53 https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK0017075&SiteName=&countyCode=&responsiblePerson=&unitId=&SeaArea=&IFCAArea=&HasCA=1&NumMarineSeasonality=2&SiteNameDisplay=The%20Wash%20and%20North%20Norfolk%20Coast%20SAC

54 https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK0017075&SiteName=&SiteNameDisplay=The+Wash+and+North+Norfolk+Coast+SAC&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=2

(***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)* With respect to the moderate to high harbour seal usage of the Blocks, the maximum spatial footprint within which smothering by drilling discharges may occur (0.8km^2) is small and 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 habitats of this qualifying species. The small scale and temporary nature of the potential physical damage, 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** With respect to harbour seal supporting habitats outside of the site, intra-plan in-combination effects are possible although spatial footprints associated with rig installation and drilling discharges in Blocks 47/15b, 48/12g, 48/13c, 48/17e, 48/18e and 48/23d are localised and temporary, and unlikely to overlap between Blocks either spatially or temporally. Given the indicative work programmes, the combined spatial footprint within which physical disturbance and drilling effects could occur (within 500m of the rig/well location) across the six Blocks (a worst case scenario of six drill or drop wells which includes Block 47/15b which is proposed to go straight to Second Term) is estimated at 4.8km^2. However, given that the Blocks are over 20km from the site, the temporary and localised nature of the disturbance and the energetic nature of the environment, site conservation objectives will not be undermined. Section 5.4 provides a consideration of potential Block activities in-combination with other relevant plans and projects.
North Norfolk Sandbanks and Saturn Reef SAC
Site information
Area (ha): 360,341 **Relevant qualifying features:** Sandbanks, 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[55].
Relevant Blocks for physical disturbance and drilling effects
48/4, 48/9, 48/13c, 48/14b, 48/14c, 48/15c, 48/18e, 48/19d, 48/23d, 48/24c, 49/6c, 49/8b, 49/9b, 49/9e, 49/11c, 49/12d, 49/13, 49/14a, 49/16b, 49/17b, 49/21e, 49/22b
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)* Both the sandbank and reef qualifying features are sensitive to penetration and/or disturbance of the seabed surface and subsurface[56] by the placement of spud cans as part of rig siting. Blocks 48/4, 48/13c, 48/14c, 48/18e, 48/23d, 48/24c, 49/6c, 49/9b, 49/9e and 49/14a are outside of the site boundary and given the assumed distance from a jack-up rig within which effects may occur (500m, see Table 2.2), rig installation will not significantly impact the extent and distribution of the qualifying habitats. Blocks 48/9, 48/19d and 49/8b have significant areas outside the site boundaries in which rig siting would be possible, and therefore interaction with the qualifying features

[55] http://archive.jncc.gov.uk/pdf/NNSSR_SACO_v1_0.pdf
[56] http://jncc.defra.gov.uk/docs/NNSSR_AoO_Workbook_v1_0.xlsx

could be avoided. With respect to the remaining Blocks that are largely within the site, 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%). Recovery from physical disturbance of the scale associated with rig placement is expected to be rapid given the dynamic nature of the site. Moreover, further mitigation measures are available (e.g. rig siting to ensure sensitive seabed surface features are avoided, see Section 5.2.3), and will be required, where appropriate, to ensure that 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 type (but only with respect to pipelines which are not part of this AA). The SACO[57] notes that the deposition of material (rock) may lead to a persistent change in substrate which is not suitable habitat for characterising sandbank communities. They 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. Of note is that 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 (3,603.4km^2). Moreover, further mitigation measures are available which include the use of removable mud mats or anti-scour mats as an alternative to rock placement (Section 5.2.3) and 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 4.2.3, 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 SNS.

It is assumed that effects relating to drilling discharges occur within 500m of the well location (Table 2.2). Therefore with respect to Blocks 48/4, 48/13c, 48/14c, 48/18e, 48/23d, 48/24c, 49/6c, 49/9b, 49/9e and 49/14a which are beyond this distance, or Blocks 48/9, 48/19d and 49/8b which have significant areas outside the site boundaries in which drilling will be possible, drilling discharges will not significantly impact the extent and distribution or the structure and function of the qualifying habitat. With respect to the other Blocks which are partly or wholly 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) and given the site's dynamic nature, redistribution of drilling discharges and recovery from smothering would be rapid. 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

[57] http://jncc.defra.gov.uk/pdf/NNSSR_SACO_v1_0.pdf

Intra-plan in-combination effects are possible although spatial footprints associated with rig installation and drilling discharges in Blocks 48/9, 48/14b, 48/15c, 48/19d, 49/8b, 49/11c, 49/12d, 49/13, 49/16b, 49/17b, 49/21e and 49/22b (i.e. those Blocks entirely or largely within the site) are localised and temporary, and unlikely to overlap between Blocks either spatially or temporally. Given the indicative work programmes, the combined spatial footprint within which physical disturbance and drilling effects could occur (within 500m of the rig/well location) across the 12 Blocks (a worst case scenario of 12 drill or drop wells which includes 4 Blocks where proposed to go straight to Second Term) is estimated at 9.6km^2 (0.3% of the site). However, the localised and temporary nature of the disturbance and available mitigation (Sections 2.3.1 and 5.2.3), will ensure that site conservation objectives are not undermined. Section 5.4 provides a consideration of potential Block activities in-combination with other relevant plans and projects.

5.2.3 Further mitigation measures

Further mitigation measures are available which are identified through the EIA process and operator's environmental management 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[58].

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.

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

[58] Whether within or outside an SAC, rig site survey typically includes a consideration of the presence of, amongst other sensitivities, Annex I habitats.

5.2.4 Conclusions

Likely significant effects identified with regards to physical damage to the seabed, drilling discharges and other effects (see Section 5.2.2) when considered along with project-level mitigation (Section 5.2.3) and relevant activity permitting requirements (see Section 2.3.1and other measures in Section 5.2.3), will not have an adverse effect on the integrity of the Natura 2000 sites considered in this assessment. At the project level, there is a legal framework through the implementation of the EIA Regulations[59] and the Habitats Directive, to ensure that there are no adverse effects on the integrity of Natura 2000 sites. 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.

Taking into account the information presented above, it is concluded that activities arising from the licensing of those Blocks listed in Table 5.1, in so far as they may generate physical disturbance and drilling effects, will not cause an adverse effect on the integrity of the relevant sites identified. Following award of any licence, consent for offshore activities will not be granted unless the operator can demonstrate that the proposed activities will not have an adverse effect on the integrity of relevant sites.

[59] The *Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (as amended)*

5.3 Assessment of underwater noise effects

5.3.1 Blocks and sites to be assessed

The nature and extent of potential underwater noise effects are summarised in Section 4.3. On the basis of this information, in conjunction with the location of Blocks applied for in the 32nd Round and the location of sites with relevant qualifying features, potential likely significant effects are considered to remain for 73 Blocks (or part Blocks), in respect of nine sites (Figure 5.2). Descriptions of nine of these sites and their qualifying features, most of which are also assessed for physical and drilling effects, are provided earlier in Section 5.1. Qualifying features of relevance to underwater noise effects are noted below in Table 5.2.

5.3.2 Implications for site integrity of relevant sites

The site conservation objectives and other relevant information relating to site selection and advice on operations has been considered against indicative Block work programmes (see Section 2.2.1) to determine whether they could adversely affect site integrity, i.e. impacts the site features, either directly or indirectly, and result in altering the ecological structure and functioning of the site and/or affects the ability of the site to meet its conservation objectives. The results are given in Table 5.2 below. In terms of mitigation, all mandatory requirements (as given in Section 2.3.2) are assumed to be in place as a standard for all activities assessed at this stage.

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

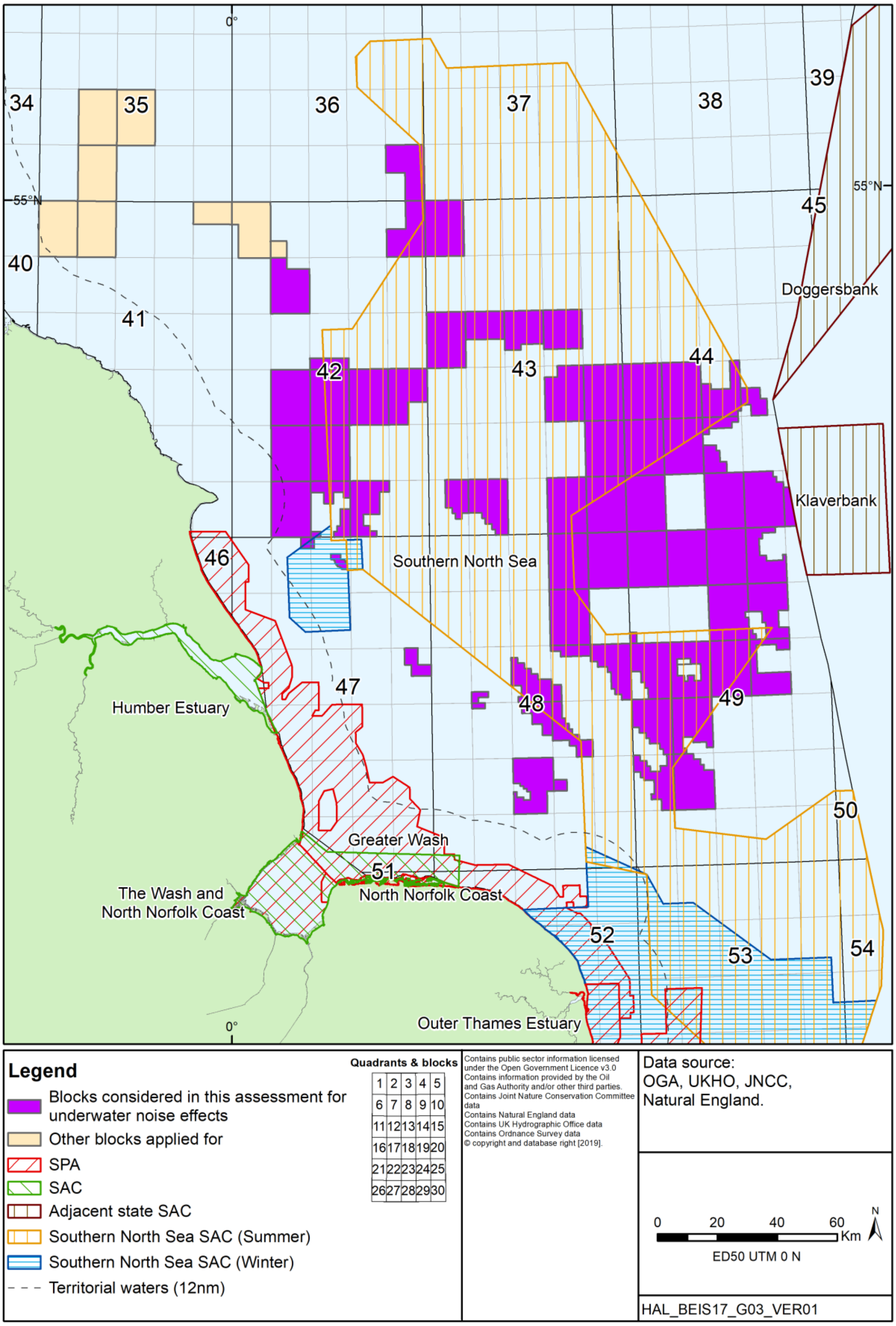


Table 5.2: Consideration of potential underwater noise effects and relevant site conservation objectives

Greater Wash SPA
Site information
Area (ha): 353,578 **Relevant qualifying features:** Overwintering red-throated diver and common scoter. See JNCC site information centre for details of qualifying features[60]. **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.
Relevant Blocks for underwater noise effects
Direct: 42/27 **Indirect:** None
Assessment of effects on site integrity
Block 42/27 is 13km from the northeast site boundary. The application relating to the Block includes a work programme to shoot 3D seismic. **Impulsive noise (2D/3D seismic survey, rig site survey, VSP, conductor piling)** *(**Relevant pressures:** underwater noise change, vibration)* Red-throated diver are widespread throughout the site and in the northeast modelled densities are *ca*. 0.5-0.6 birds/km^2. Surveys suggest that common scoter are concentrated off the mouth of The Wash and a small area around Winterton-on-Sea (Lawson *et al*. 2016), which are all >15km from the relevant Block. Given: (i) the distribution of red-throated diver within the site relative to the relevant Block; (ii) the evidence (albeit limited) of low hearing sensitivity and a lack of reported injury or disturbance effects; and (iii) the likely avoidance of the physical presence of survey vessel(s) and airguns, the risk of injury or significant disturbance is very low. Negative indirect effects of seismic survey activities on qualifying features may arise through effects on prey species, primarily small fish such as gadoids, sprat, herring and sandeel, if these prey are subject to injury or disturbance which reduce their availability to qualifying seabirds. 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 Block 42/27 are not anticipated to result in significant effects on the food resources of the qualifying seabird 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, it is concluded that these activities, in any of the relevant Blocks, will not result in an adverse effect on the integrity of the site or its source colony sites. **Continuous noise (drilling, vessel & rig movements)** *(**Relevant pressures:** underwater noise change, vibration)*

[60] http://archive.jncc.gov.uk/page-7585

No significant effects on red-throated divers 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 physical injury and no evidence of significant disturbance.

In-combination effects
Intra-plan in-combination underwater noise effects are considered highly unlikely given the low potential for effects identified above and that Block 42/27 is the only Block applied that is of relevance and is 13km from the site. Section 5.4 provides a consideration of potential Block activities in-combination with other relevant plans and projects.

The Wash SPA

Site information

Area (ha): 62,212
Relevant qualifying features: Over wintering common scoter, goldeneye, waterbird assemblage (cormorant, eider, little grebe). See Natural England guidance for further details[61].

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.

Relevant Blocks for underwater noise effects

Direct: None
Indirect: 42/27

Assessment of effects on site integrity

Block 42/27 is over 100km from the site boundary. The site and Block were screened in for appropriate assessment due to the site's link with the Greater Wash SPA which is contiguous with the site and provides foraging grounds for some of the SPA's qualifying features. The application relating to the Block includes a work programme to shoot 3D seismic.

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

As indicated above, the distribution of common scoter within the Greater Wash SPA is concentrated primarily off the mouth of The Wash. The distribution of the other relevant species is primarily coastal within the boundaries of The Wash SPA or neighbouring sites such as North Norfolk Coast SPA. Given: (i) the distance of the site from the Block and the distribution of relevant qualifying features primarily within or close to the site; (ii) the evidence (albeit limited) of low hearing sensitivity and a lack of reported injury or disturbance effects; and (iii) the likely avoidance of the physical presence of survey vessel(s) and airguns, the risk of mortality, injury or significant disturbance is very low.

Given the distance of the Block from the site, any underwater noise effects on prey species, primarily benthic invertebrates are not anticipated to result in significant effects on the food resources of the qualifying seabird 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

61 https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9008021&SiteName=the%20wash&SiteNameDisplay=The%20Wash%20SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=21&HasCA=1

impulsive noise such as VSP, rig site survey and conductor piling, it is concluded that these activities, in any of the relevant Blocks, will not result in an adverse effect on the integrity of the site or its source colony sites.

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

No significant effects on relevant qualifying features 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 physical injury and no evidence of significant disturbance.

In-combination effects
Intra-plan in-combination underwater noise effects are considered highly unlikely given the low potential for effects identified above and that Block 42/27 is the only Block applied that is of relevance and is over 100km from the site. Section 5.4 provides a consideration of potential Block activities in-combination with other relevant plans and projects.

The North Norfolk Coast SPA

Site information

Area (ha): 7,887
Relevant qualifying features: Over wintering common scoter (part of waterbird assemblage). See Natural England guidance for further details[62].

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.

Relevant Blocks for underwater noise effects

Direct: None
Indirect: 42/27

Assessment of effects on site integrity

Block 42/27 is over 115km from the site boundary. The site and Block were screened in for appropriate assessment due to the site's link with the Greater Wash SPA which is contiguous with the site and provides foraging grounds for some of the SPA's qualifying features. The application relating to the Block includes a work programme to shoot 3D seismic.

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

The distribution of common scoter within the Greater Wash SPA is concentrated primarily off the mouth of The Wash and along the north Norfolk Coast SPA. Given: (i) the distance of the site from the Block and the distribution of the relevant qualifying feature primarily within or close to the site; (ii) the evidence (albeit limited) of low hearing sensitivity and a lack of reported injury or disturbance effects; and (iii) the likely avoidance of the physical presence of survey vessel(s) and airguns, the risk of mortality, injury or significant disturbance is very low.

Given the distance of the Block from the site, any underwater noise effects on prey species, primarily benthic invertebrates are not anticipated to result in significant effects on the food resources of the qualifying seabird features.

62 https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9009031&SiteName=north%20norfolk%20coast&SiteNameDisplay=North%20Norfolk%20Coast%20SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=11&HasCA=1

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, it is concluded that these activities, in any of the relevant Blocks, will not result in an adverse effect on the integrity of the site or its source colony sites.

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

No significant effects on relevant qualifying features 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 physical injury and no evidence of significant disturbance.

In-combination effects
Intra-plan in-combination underwater noise effects are considered highly unlikely given the low potential for effects identified above and that Block 42/27 is the only Block applied that is of relevance and is over 115km from the site. Section 5.4 provides a consideration of potential Block activities in-combination with other relevant plans and projects.

Outer Thames Estuary SPA

Site information

Area (ha): 392,452
Relevant qualifying features: Overwintering red-throated diver. See Natural England guidance for further details[63].
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.

Relevant Blocks for underwater noise effects

Direct: None
Indirect: 42/27

Assessment of effects on site integrity

Block 42/27 is 175km from the site boundary. The site and Block were screened in for appropriate assessment due to the site's link with the Greater Wash SPA which is contiguous with the site and the qualifying feature is likely to move between the two sites. The application relating to the Block includes a work programme to shoot 3D seismic.

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

As indicated, there is likely to be a degree of movement of red-throated diver between the Outer Thames Estuary SPA and the Greater Wash SPA. However, given: (i) the distance of the site relative to the relevant Block; (ii) the evidence (albeit limited) of low hearing sensitivity and a lack of reported injury or disturbance effects; and (iii) the likely avoidance of the physical presence of survey vessel(s) and airguns, the risk of mortality, injury or significant disturbance is very low.

63 https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9020309&SiteName=outer%20thames&SiteNameDisplay=Outer%20Thames%20Estuary%20SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=3&HasCA=1

Given the distance of the Block from the site, any underwater noise effects on prey species, primarily small fish such as gadoids, sprat, herring and sandeel, are not anticipated to result in significant effects on the food resources of the qualifying seabird 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, it is concluded that these activities, in any of the relevant Blocks, will not result in an adverse effect on the integrity of the site or its source colony sites.

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

No significant effects on red-throated divers 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 physical injury and no evidence of significant disturbance.

In-combination effects
Intra-plan in-combination underwater noise effects are considered highly unlikely given the low potential for effects identified above and that Block 42/27 is the only Block applied that is of relevance and is 175km from the site. Section 5.4 provides a consideration of potential Block activities in-combination with other relevant plans and projects.

Southern North Sea SAC

Site information

Area (ha): 3,695,054
Relevant qualifying features: Harbour porpoise
Conservation objectives: See Table 5.1 above.

Relevant Blocks for underwater noise effects

36/30b, 42/5b, 42/7b, 42/13b, 42/17, 42/18, 42/19, 42/20b, 42/22, 42/23, 42/27, 42/28e, 42/28g, 42/28h, 42/29b, 43/1, 43/11, 43/12b, 43/13a, 43/14c, 43/19a, 43/20, 43/25, 43/26b, 43/27b, 43/29, 43/30, 44/16, 44/17, 44/18b, 44/19b, 44/21, 44/22, 44/23a, 44/23b, 44/26, 44/28, 47/2b, 47/3g, 47/3i, 47/15b, 48/4, 48/5, 48/9, 48/12g, 48/13c, 48/14b, 48/14c, 48/15c, 48/17e, 48/18e, 48/19d, 48/23d, 48/24c, 49/1, 49/2, 49/3, 49/4e, 49/6c, 49/8b, 49/9b, 49/9e, 49/11c, 49/12d, 49/13, 49/14a, 49/16b, 49/17b, 49/21e, 49/22b

Assessment of effects on site integrity

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

New 3D seismic surveys have been proposed in the work programmes for Blocks 36/30b, 42/5b, 42/27, 42/28e, 42/29b, 43/1, 43/11, 43/12b, 43/13a, 43/19a, 43/20, 43/25, 43/29, 43/30, 47/2b, 47/3g, 48/4, 48/5, 48/9, 48/15c and 49/16b.

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 is would be of shorter duration, 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 Blocks 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 5.3.3), 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 recent SNCB guidance on spatio-temporal thresholds for noise disturbance within the SAC, should a seismic survey take place wholly within the boundaries of the summer portion of the SAC (such surveys typically occur between Apr-Sep), an approximate conservative estimate of the proportion of the relevant area from which harbour porpoise may be disturbed is 9.4%[64]. 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 2019c, 2020) estimate 4.5-6.4% average seasonal (summer) disturbance[65], 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 Blocks 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 5.3.3) 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
The number of 3D seismic surveys undertaken within 15km of the SAC between 2001 and 2019 has ranged between zero and five surveys per year (cumulative coverage of approximately 19,057km^2 over 25 surveys, an average of 1.3 surveys per year covering 1,003km^2). The greatest survey coverage during this period was in 2012 and 2013, within which an area of up to 9,020km^2 was covered across five and four surveys, respectively. Since 2015, one 3D survey (513km^2) was undertaken in 2019. Similarly, 2D seismic surveys have also been conducted and between 2001 and 2019 have ranged between one and four surveys per year (cumulative survey length of approximately 20,032km over 15 surveys, an average of 0.8 surveys per year covering 1,054km). The greatest survey coverage during this period was in 2015, within which 4,524km was covered as part of the OGA regional survey of the Mid-North Sea High area. Since then, single surveys in 2018 and 2019 have covered

[64] 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 2,540km^2, which is 9.4% of the summer SAC area. These estimates are comparable to values of 7.9% and 8.7% (summer area, noting the latter used a 10km EDR) estimated in recent HRAs for two different planned seismic surveys with partial overlap with the Southern North Sea SAC (BEIS 2019c, 2020).
[65] Based on likely worst-case scenarios of 122-134 total days of disturbance during the survey.

1,220km and 32km respectively. For the purposes of this AA, twenty-one Blocks within 15km of the site have work programmes which propose 3D seismic survey. However, work programmes are likely to cover multiple Blocks and the total number of surveys undertaken is likely to fall within the range described above. 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 5.3.3) 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.
Doggersbank SAC (Netherlands)
Site information
Area (ha): 473,500 **Relevant qualifying features:** Grey seal, harbour seal, harbour porpoise. **Conservation objectives:** See Table 5.1 above.
Relevant Blocks for underwater noise effects
44/18b, 44/19b, 44/23a
Assessment of effects on site integrity
Impulsive noise (rig site survey, VSP, conductor piling) *(**Relevant pressures:** underwater noise change, vibration)* No new seismic surveys are proposed by the work programmes for Blocks 44/19b, 44/18b and 44/23a which are 2, 11 and 13km respectively from the site boundary. Therefore, potential sources of impulsive noise with respect to these Blocks relate primarily to rig site survey, VSP and conductor piling. There would be very limited propagation of noise from activities such as rig site surveys and VSP into the site. For these activities, which would generate the highest amplitude noise of any activities associated with the proposed work programme, 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, from the periphery of the site. Such effects is 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. As such, no adverse effects on the integrity of the site are expected. Negative indirect effects of rig site survey and VSP 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. 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 relevant 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 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 from the site boundary, 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 5.3.3) 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 32nd Round activities which could take place in the Blocks. Section 5.4 provides a consideration of potential Block activities in-combination with other relevant plans and projects.

Klaverbank SAC (Netherlands)

Site information

Area (ha): 153,900
Relevant qualifying features: Grey seal, harbour seal, harbour porpoise.
Conservation objectives: See Table 5.1 above.

Relevant Blocks for underwater noise effects

44/18b, 44/23a, 44/25, 44/28, 44/29a, 44/30b, 49/4e, 49/9b

Assessment of effects on site integrity

Impulsive noise (rig site survey, VSP, conductor piling)
*(**Relevant pressures:** underwater noise change, vibration)*

No new 3D seismic surveys are proposed by the work programmes for any of the relevant Blocks which adjoin the site (44/25, 44/30b) or range between 2km (44/29a) to 14km (44/28) distant from the site boundary. Therefore, potential sources of impulsive noise with respect to these Blocks relate primarily to rig site survey, VSP and conductor piling.

There would be very limited propagation of noise from activities such as rig site surveys and VSP into the site. For these activities, which would generate the highest amplitude noise of any activities associated with the proposed work programme, 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, from the periphery of the site. Such effects is 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. As such, no adverse effects on the integrity of the site are expected.

Negative indirect effects of rig site survey and VSP 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 relevant 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 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 from the site boundary, 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 5.3.3) 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 32nd Round activities which could take place in the Blocks. Section 5.4 provides a consideration of potential Block activities in-combination with other relevant plans and projects.

Humber Estuary SAC
Site information
Area (ha): 36,657 **Relevant qualifying features:** Grey seal. **Conservation objectives:** See Table 5.1 above.
Relevant Blocks for underwater noise effects
42/18, 42/19, 42/20b, 42/22, 42/23, 42/27, 42/28e, 42/28g, 42/28h, 42/29b, 47/2b, 47/3g, 47/3i
Assessment of effects on site integrity

There are no Blocks applied for in the 32nd Round which lie within 15km of the boundary of the Humber Estuary SAC. All relevant Blocks considered here for potential underwater noise effects were screened-in during the Stage 1 HRA Screening (BEIS 2019a) on the basis of either overlapping or being immediately adjacent to an area of higher relative density of grey seals extending from the Humber Estuary (defined as grid cells of ≥10-50 seals per 5x5km). While river and sea lamprey are also qualifying features of the Humber Estuary SAC and potentially sensitive to underwater noise effects, their distribution in marine habitats is largely restricted to estuaries and nearshore coastal waters (Silva *et al.* 2014); subsequently, these features are not assessed for any Blocks located beyond the 15km screening criteria.

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

Seismic surveys are proposed for Blocks 42/27, 42/28e, 42/29b, 47/2b and 47/3g which are all over 40km from the site. At-sea distribution modelling suggests that the relevant Blocks are outwith the areas of highest grey seal density occurring around the mouth of the Humber Estuary close to the site, and areas to the north-east (although Block 42/29b partly overlaps with one of these areas). Considering the distance of the Blocks from the site and location of the breeding colony at Donna Nook, there would be limited propagation of noise from activities such as 3D seismic survey, 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. For these activities, 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 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.

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 Blocks are not anticipated to result in significant effects on the food resources of the grey 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 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 Blocks (moderate to very high)[66], 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 5.3.3) 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 32nd Round activities which could take place in the Blocks. Section 5.4 provides a consideration of potential Block activities in-combination with other relevant plans and projects.

The Wash and North Norfolk Coast SAC
Site information
Area (ha): 107,761 **Relevant qualifying features:** Harbour seal. **Conservation objectives:** See Table 5.1 above.
Relevant Blocks for underwater noise effects
47/15b, 48/12g, 48/13c, 48/17e, 48/18e, 48/23d
Assessment of effects on site integrity

There are no Blocks applied for in the 32nd Round which lie within 15km of the boundary of The Wash and North Norfolk Coast SAC. All relevant Blocks considered here for potential underwater noise effects were screened-in during the Stage 1 HRA Screening (BEIS 2019a) on the basis of either overlapping or being immediately adjacent to an area of higher relative density of harbour seals extending from The Wash (defined as grid cells of ≥10-50 seals per 5x5km).

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

No new 3D seismic surveys are proposed by the work programmes for any of the relevant Blocks. Therefore, potential sources of impulsive noise with respect to these Blocks relate primarily to rig site survey, VSP and conductor piling.

At-sea distribution modelling suggests that the relevant Blocks are outwith the areas of highest harbour seal density occurring within The Wash. The Blocks are between 23km (48/23d) and *ca*. 50km (the other relevant Blocks) and harbour seals are known to spend the majority of their time within 50km of the coast (Jones *et al.* 2015). Considering the distance of the Blocks from the site, there would be very limited propagation of noise from activities such as rig site surveys and VSP into the site, although emitted sound fields would overlap an area of assumed foraging habitat occurring at distance from the site. For these activities, 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.

[66] https://www.ogauthority.co.uk/media/1419/29r_shipping_density_table.pdf

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 relevant Blocks are 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 relevant Blocks (moderate to very high with only 48/18 experiencing low 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 seal from potential important areas outside of the site for a significant period of time. Further mitigation measures are also available (Section 5.3.3) 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 32nd Round activities which could take place in the Blocks. Section 5.4 provides a consideration of potential Block activities in-combination with other relevant plans and projects.

5.3.3 Further mitigation measures

The Department require operators to provide sufficient information in the EIA on the potential impact of proposed activities on relevant sites and their qualifying features as well as proposed further mitigation measures in their applications for a relevant consent. Due to the temporary nature of the activities mitigation measures could include activity timing to avoid the most sensitive periods. Operators must demonstrate how seasonal sensitivities have been taken into account when planning operations (see BEIS 2019). 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-generating activities (i.e. other geophysical surveys and impact piling). It is advised that the licensees of the 82 Blocks 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 of the relevant SNCBs in also recommended.

For those Blocks 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.

5.3.4 Conclusion

Although underwater sound generated during project-level activities, specifically seismic surveys, has the potential to injure and disturb individual harbour porpoises and seals, 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 Blocks 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 Blocks 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

5.4.1 Introduction

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 (DECC 2016; see also OSPAR 2000, 2010[67] and BEIS 2018). There are a number of potential interactions between activities that may follow licensing and those existing or planned activities in the southern North Sea, for instance in relation to renewable energy, fishing, shipping and aggregate extraction. These activities are subject to individual permitting or consenting mechanisms or are otherwise managed at a national or international level. The Blocks are located within the North East and East Inshore and Offshore Marine Plan areas. The latter were adopted in June 2014 and the final stage of statutory public consultation on the North East Marine Plans will close April 2020[68]. The plans set out objectives and policies to guide development in the southern North Sea over a 20-year period.

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 Blocks have the potential to be licensed within the same site). The following section considers the potential for in-combination effects with other relevant plans and programmes.

5.4.2 Sources of potential effect

Projects for which potential interactions with operations that could arise from the licensing of 32nd Round Blocks (see Table 1.1) 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; it should be noted that activities scheduled for Q3-Q4 are likely to be complete before any activities associated with the 32nd Round Block licences occur.

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. Round 3) have already been subject to SEA and HRA, and any related projects have been or will be subject to their own individual assessment and HRA processes[69]. Figure 5.3

[67] Note that an intermediate assessment was published by OSPAR in 2017: https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/
[68] https://www.gov.uk/government/collections/north-east-marine-plan
[69] 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. See: https://www.gov.uk/government/consultations/southern-north-sea-review-of-consents-draft-habitats-regulations-assessment-hra

indicates the location of wind farms/wind farm zones in relation to the Blocks subject to this assessment and relevant Natura 2000 sites.

The UK Government believes that the oil & gas and the renewables industry can successfully co-exist, as stated in OGA's Other Regulatory Issues for the 32nd Round, "…*we [(OGA)] 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)*"[70]. Early discussions between the developers will ensure that any potential conflict 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)[71] 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 southern North Sea Blocks (North East Inshore and Offshore) are yet to be finalised, but these are expected to be consistent with those of the East Marine Plans. For example, draft marine plan policies published as part of MMO's final stage of consultation include NE-CO-1 and NE-OG-1/OG-2 with 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.

[70] OGA 32nd Round Other Regulatory Issues
[71] https://www.thecrownestate.co.uk/en-gb/resources/maps-and-gis-data/

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

Relevant projects	Project summary	Project status/indicative timing	Relevant sites[1]
Offshore Renewables and Interconnectors			
Dogger Bank A (formerly named Creyke Beck A) Dogger Bank B (formerly named Creyke Beck 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. Offshore construction expected from 2021/2022.	Dogger Bank SAC, Southern North Sea SAC
Dogger Bank C (formerly named Dogger Bank Teesside B)	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.	Dogger Bank SAC, Southern North Sea SAC
Sofia (formerly named Dogger Bank Teesside B)	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 platforms. 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, and power was initially exported in February 2019. 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 1,400MW to be generated by 165 wind turbines within an area of 462km^2 and located *ca*. 90km from the Yorkshire coast. The turbines are likely to be fixed to the seabed using monopile foundations. The export cable route shares that of Project One.	Consented. Installation expected from 2020 and operation from 2022.	Southern North Sea SAC
Hornsea Project Three	The wind farm is proposed to have a capacity of up to 2,400MW generated by 160- 300 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.	The wind farm is presently being considered for development consent by the Secretary of State, with a decision due by end December 2020.	Southern North Sea SAC, North Norfolk Sandbanks and Saturn Reef SAC

Relevant projects	Project summary	Project status/indicative timing	Relevant sites[1]
Hornsea Project Four	It is proposed that the wind farm has up to 180 turbines, but the final capacity of the wind farm has not been set, as this will be a function of the final number of turbines to be installed and the individual turbine capacity. Turbines will be installed on fixed foundations yet to be determined. The array is located approximately 65km to the east of Flamborough Head within an area of 846km², 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.	The wind farm is at a pre-application stage, with submission expected in 2020.	Southern North Sea SAC
Dudgeon Extension	The wind farm extension is proposed to have a capacity of 402MW generated by 34 turbines within an area of 105km². Developer proposing a joint development of the Dudgeon and Sheringham Shoal extension projects with a common transmission infrastructure connecting to the grid at Norwich Main substation.	The wind farm is at a pre-application stage, with submission expected in 2021.	Southern North Sea SAC
Sheringham Shoal Extension	The wind farm extension is proposed to have a capacity of 317MW generated by 27 turbines within an area of 93km². See above.	As above.	Southern North Sea SAC
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.	Construction expected from 2020.	Southern North Sea SAC, Greater Wash SPA
Norfolk Vanguard (East and West)	Located 47km (West) and 7km (East) east of the Norfolk coast, the wind farm will feature up to 158 turbines with a combined maximum capacity of 1,800MW across the East and West sites. The development will also feature collector, converter and other platforms. Structure foundations will be either monopile (piled or suction caisson), jacket (piled or suction caisson) or gravity base in design. Export cables will make landfall at Happisburgh South, Norfolk.	Consented. Offshore construction expected mid- to late-2020s.	Southern North Sea SAC
Norfolk Boreas	The proposed project is located 73km east of the Norfolk coast, and immediately north of the Norfolk Vanguard East site. The wind farm is proposed to have up to 180 turbines with a maximum combined capacity of 1,800MW. Turbine foundation types will be either monopile (piled or suction caisson), jacket (piled or suction caisson), gravity base, or tetrabase. It is proposed that export cables will make landfall at Happisburgh South, Norfolk.	Application submitted in July 2019 and currently under examination.	Southern North Sea SAC
East Anglia Three	Located 69km east of the Norfolk coast, the wind farm will feature 100-120 turbines with a combined maximum capacity of 1,400MW, along with collector, converter and other platforms. Turbines may be fixed to the seabed using monopile, multi-leg (jacket), suction caisson or gravity base foundations. Power will be exported to shore via cables making landfall at Bawdsey, Suffolk.	Consented. Offshore construction expected Q4 2021.	Southern North Sea SAC

Relevant projects	Project summary	Project status/indicative timing	Relevant sites[1]
Oil & gas projects			
Sillimanite gas condensate field	The Sillimanite field spans the UK (Block 44/19a) and Netherlands sectors. The field is being developed from a satellite platform in Dutch waters, Block D12-B, located <5km east of the UK-NL median and boundary of the Dogger Bank SAC.	Field Development Plan (FDP) approved February 2020. Currently under construction.	Dogger Bank SAC, Southern North Sea SAC, Doggersbank SAC (Netherlands)
Platypus gas field	Located in Blocks 48/1a and 48/1c, the project is a subsea tie-back to the Cleeton platform. Construction expected in 2020-2021.	FDP has been submitted. Construction planned for 2020-2021.	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), which all propose to re-use the existing Thames export pipeline to Bacton.	FDP has been submitted. Construction planned for 2020-2021.	Southern North Sea SAC, North Norfolk Sandbanks and Saturn Reef SAC
Tolmount	Located in Block 42/28d, the Tolmount gas field development includes a minimal facilities platform and a new gas export pipeline to shore.	Construction, first production expected Q4 2020.	Southern North Sea SAC
Seismic surveys			
ION 3D seismic survey (Southern North Sea)	Planned 3D seismic survey by GX Technology / ION Geophysical Corporation within UKCS quadrants 35, 36, 37, 38, 41, 42, 43 and 44 in the southern North Sea. The survey area covers ca. 13,269km^2 and source airgun array options range from 3,070 to 8,000in^3. The survey was originally planned to last up to 165 days between 1st April and 22nd October 2020.	Consent granted on 9th June for period up to 22nd October. (Likely to be complete prior to any activities associated with 32nd Round Licensing).	Southern North Sea SAC, Dogger Bank SAC, Humber Estuary SAC, Doggersbank SAC (Netherlands)
Oil & gas decommissioning projects			
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.	Decommissioning programmes (DPs) approved April 2020 (Ganymede ZD topsides) and May 2020 (remaining DPs).	Southern North Sea SAC, North Norfolk Sandbanks and Saturn Reef SAC
Caister	The Caister CM platform in 44/23a will be removed to shore for re-use or recycling. The associated sections of pipeline risers attached to the Caister installation will be removed to shore for re-use or recycling.	DP approved March 2020	Southern North Sea SAC

Relevant projects	Project summary	Project status/indicative timing	Relevant sites[1]
Anglia Field	The installations are located in Blocks 48/18b and the export line traverses Blocks 48/19 and 48/20. 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.	DPs approved June 2020	Southern North Sea, North Norfolk Sandbanks and Saturn Reef 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). Installations located in Block 43/19a.	DP approved June 2020	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. Installation located in Block 49/9b.	Draft DP under consideration	Klaverbank SAC (Netherlands)
Hewett Field	Six platforms to be removed and returned to shore. Pipelines and subsea infrastructure to be addressed in a future DP submission.	Draft DP under consideration	Southern North Sea SAC, North Norfolk Sandbanks and Saturn Reef SAC
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. Installation located in Block 48/14a.	Draft DP under consideration	Southern North Sea SAC, North Norfolk Sandbanks and Saturn Reef SAC
A-Fields is a collective term for the Ann, Alison, Annabel subsea tiebacks and the Audrey XW and WD platforms	Topsides and jackets will be removed and transported to shore for recycling. All wells have been plugged and abandoned (2019), and all subsea manifolds will be removed. Buried pipelines will be left in situ except the exposed ends which will be cut and removed. Audrey field located in Blocks 49/11a and 48/15a, tied back fields are in Blocks 49/11a, 48/10a and 49/6a.	DPs approved April 2018	Southern North Sea SAC, North Norfolk Sandbanks and Saturn Reef SAC
Pickerill A& B installations	Installations in Block 48/11b will be removed and transported to shore for recycling.	DP approved September 2019	Southern North Sea SAC
Minke decommissioning programme	Removal to shore of wellhead protection structure in Block 44/24a, buried sections of pipeline to be decommissioned in situ, small surface laid sections to be removed to shore.	DP approved September 2019	Dogger Bank SAC
Schooner	Removal of topsides, jackets and subsea installation in Block 44/26a to shore. Buried pipelines left in situ.	DP approved August 2019	Southern North Sea 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.	DP approved January 2019	Southern North Sea SAC, North Norfolk Sandbanks and Saturn Reef SAC

Relevant projects	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.	DP approved January 2019	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.	DP approved January 2019	Southern North Sea SAC, Dogger Bank SAC
Aggregate areas			
Aggregates production area 483 and 484	These areas are licensed for the extraction of marine aggregates. As part of the wider Humber region, 17.79km^2 were actively dredged in 2017, representing 6.27% of the total licensed area, with 90% of effort in 7.99km^2. Dredging intensity over these areas is considered to be low to moderate.	Active production areas	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/ – accessed 09/07/2020), OGA Oil & Gas Pathfinder current list of projects (https://itportal.ogauthority.co.uk/eng/fox/path/PATH_REPORTS/pdf – accessed 09/07/2020), BEIS Oil & gas: decommissioning of offshore installations and pipelines (https://www.gov.uk/guidance/oil-and-gas-decommissioning-of-offshore-installations-and-pipelines - accessed 09/07/2020), TCE & BMAPA (2018). The area involved – 20th annual report, 20pp.
Notes: 1 – those sites considered to be relevant to 32nd seaward round exploration activities.

Figure 5.3: Location 32nd Round Blocks in relation to other projects

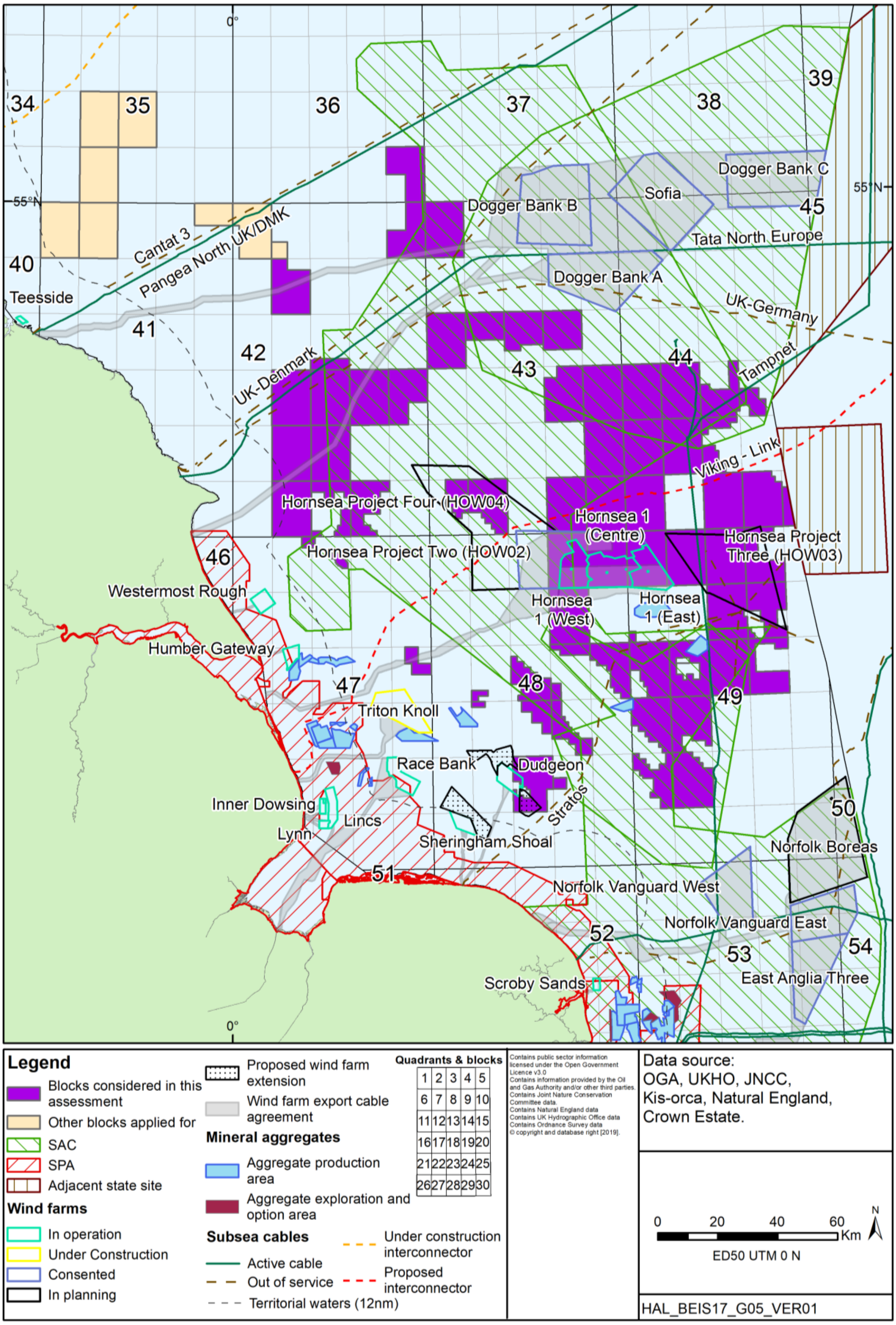
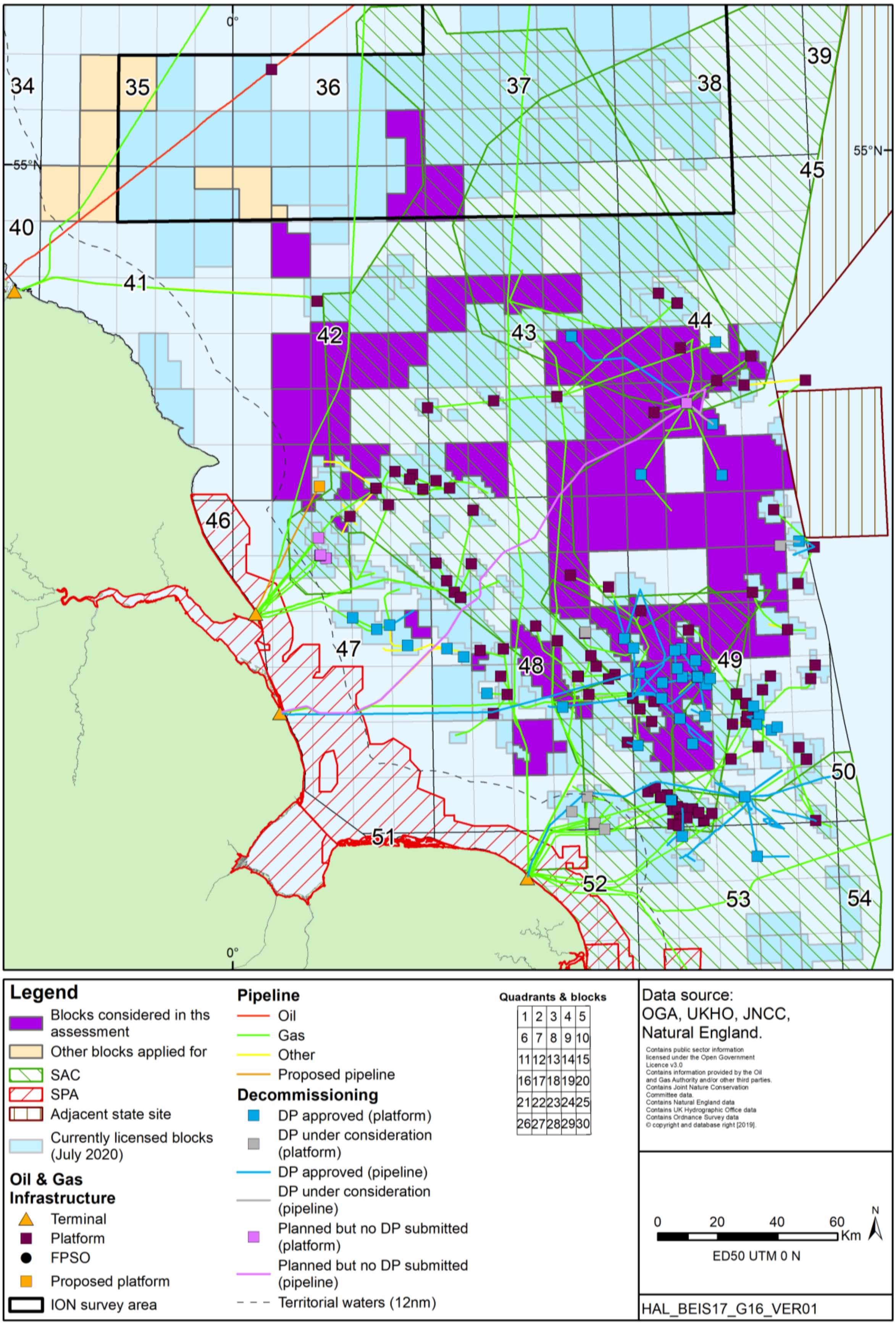


Figure 5.4: Location 32nd Round Blocks in relation to other projects (continued)



5.4.3 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 Natura 2000 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.

Existing or proposed oil & gas projects and CCS lease/licence areas

Though existing oil and gas infrastructure is widespread in the southern North Sea (Figure 5.4), the relative density and footprint of these is small. A review of field development projects (as of February 2020) indicates four development projects for Blocks within the southern North Sea (Blocks 44/19a: Sillimanite, 48/1a, c: Platypus, 48/22b, c and 49/21c: Blythe hub and 42/28d: Tolmount) (see Table 5.3).

There are a number of decommissioning projects presently 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 5.4. These are primarily located in Quadrants 44, 48 and 49 and are partly or entirely relevant to the Southern North Sea SAC, North Norfolk Sandbanks and Saturn Reef 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. These include the York, Murdoch, Hunter and Rita fields and related infrastructure.

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), and levels of activity (e.g. shipping) may not be significantly greater than ongoing operations in the southern North Sea, and will be temporary.

Where appropriate, the Department will undertake Habitats Regulations Assessment 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 and concluded that these would not result in adverse effects on site integrity. As noted above, it is recognised that further decommissioning programmes are likely to come forward in this area of the southern North Sea in coming years, which will be subject to further HRA as appropriate, including in relation to in-combination effects.

Blocks 42/19, 42/20b, 42/29b, 43/22c, 43/26b and 43/27b cover parts of carbon dioxide appraisal and storage licence CS001 and the related AfL (also within the Southern North Sea SAC). The licence and AfL currently have end dates in 2021. Although not developed to date, the technical and economic learning from the CCS Commercialisation Competition, and proximity to existing emissions sources (e.g. the Humber and Teesside regions), means the 5/42 storage site related to this lease/licence remains of high interest to prospective CO_2 storage operators. The government has recently published its revised approach to Carbon

Capture, Usage and Storage (CCUS) through the Clean Growth Strategy, and following the advice of the CCUS Cost Challenge Taskforce (July 2018)[72], published an action plan[73] setting out the next steps government and industry should take to deploy CCUS at scale during the 2030s, subject to costs coming down sufficiently. Both Teesside and the Humber clusters contain significant industrial emitters that could potentially use a southern North Sea storage site, and depending on the outcome of commercial and Government initiatives (e.g. the CCUS Innovation Programme[74]), there is the potential for 5/42 to be used in the coming years.

Given the small and temporary seabed footprint associated with drilling activities which may follow the licensing of 32nd Round Blocks, and those standard and additional mitigation measures set out already in Section 2.2 and 5.2.3, significant in-combination effects associated with those other oil and gas related activities discussed are not expected. Moreover, in view of the length of the initial term, and understanding of the potential scale of CCS activities in the SNS in the coming years, the potential for in-combination effects to occur is considered to be low.

With respect to drilling discharges, previous discharges of WBM cuttings in the UKCS have been shown to disperse rapidly and to have minimal ecological effects (See Section 4.2). Dispersion of further discharges of mud and cuttings could lead to localised accumulation in areas where reduced current allows the particles to accumulate on the seabed, however given the relatively shallow water depths (generally <50m), moderate tidal currents and potential for storm wave base interactions across the area within which Blocks have been applied for (e.g. Klein *et al.* 1999), accumulations of cuttings piles are not considered likely from 32nd Round exploration activity (see Section 5.2) or in-combination with other exploration and development wells associated with extant licences. 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 5.2.3), which the UK Marine Strategy[75] has identified as making an ongoing contribution to managing discharges. Discharges are considered unlikely to be detectable and to have negligible in-combination effect (DECC 2016).

Offshore renewables

OWFs 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, gravity base or possibly tethered foundations) and associated infrastructure such as interconnecting and export cables. 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

[72] https://www.gov.uk/government/publications/delivering-clean-growth-ccus-cost-challenge-taskforce-report
[73] https://www.gov.uk/government/publications/the-uk-carbon-capture-usage-and-storage-ccus-deployment-pathway-an-action-plan
[74] https://www.gov.uk/government/publications/call-for-ccus-innovation/ccus-innovation-programme-selected-projects#negative-co2-emissions-from-full-scale-beccs-utilising-non-amine-ccs-chemistry
[75] https://www.gov.uk/government/publications/marine-strategy-part-three-uk-programme-of-measures

achieving burial depth due to the nature of the shallow geology. The current project timelines for project proposals indicate the potential for interaction with exploration activity as part of the Initial Term of 32nd Round licences (up to 9 years), as construction is proposed to take place within this period. As indicated above, early engagement between any Block licence holder and wind farm developer can help to avoid spatial conflict, and applicants taking part in the 32nd Round were made aware of such relevant Crown Estate interests through links to offshore activity maps[76].

Sixty-five Blocks were identified on the basis of a potential for likely significant effect in relation to the Southern North Sea SAC, and were considered in Section 5.2.2, and of these a number also coincide with Hornsea project areas One, Two, Three and Four (Figure 5.3), including some which are entirely or almost entirely located within the OWF project areas (43/26b, 48/4, 48/5, and 49/3). The proposed Dogger Bank A and B cable route passes through Blocks 42/18, 42/19, 42/22, 42/23, and that for Sofia passes through Blocks 42/5b and 43/1, all of which are also partly or wholly within the Southern North Sea SAC.

Mitigation may be provided by the ability to locate any drilling rig, if used, outside of the wind farm boundaries or away from cable routes, and/or through dialogue to avoid any conflict of interest, and also to minimise the potential for in-combination effects. Further mitigation is available through activity timing/phasing, such that those sources of physical effect from wind farm installation and operation (e.g. as described in Section 5.4.3 of the OESEA3 Environmental Report, DECC 2016) are not compounded by rig installation – note that the footprint of any drilling rig would be small (approximately 0.001km^2, also see Table 2.2) and temporary, and tidal currents in the shallow southern North Sea are generally such that discharged cuttings are rapidly dispersed. It is therefore not regarded that activity which could take place in the initial term of licences offered as part of the 32nd Round would lead to a physical change significant enough to lead to an adverse effect on site integrity on its own or in-combination with the Hornsea projects, or the cable installation for the Dogger Bank or Sofia projects.

Potential extensions to eight existing offshore wind farm projects were announced by The Crown Estate in October 2018[77], one of which (Dudgeon) is partly within Block 48/23d (see Figure 5.3). The extensions were subject to a plan level HRA undertaken by The Crown Estate, which concluded that seven of the eight projects could progress subject to further site investigation and assessment under the *Planning Act 2008*, but that a cable route protocol would be required to avoid or reduce significant effects from physical disturbance. In addition, individual project-level HRAs are required, to consider effects for example, on red-throated diver, sandwich tern and lesser black-backed gull which could not be considered in detail at the plan level due to the uncertainty about wind farm design details and the scale of impacts. Any

[76] https://opendata-thecrownestate.opendata.arcgis.com/
[77] https://www.thecrownestate.co.uk/en-gb/media-and-insights/news/2018-the-crown-estate-completes-initial-assessment-of-offshore-wind-extension-applications/

subsequent proposal would be subject to project-specific permitting, which would include further HRA as appropriate.

Round 4 of offshore wind commenced in September 2019, with two broad bidding areas (Dogger bank and Eastern Regions) being relevant to this AA. TCE are presently considering which pre-qualified bidders will be eligible to take part in the Invitation to Tender (ITT) process, which is due to take place in the first quarter of 2020. Following the completion of the ITT stage a plan-level HRA will be undertaken, with AfLs being potentially offered in late 2021. In view of the early stage of the process for leasing and project development in the Round 4 areas, the potential for interaction with any activities associated with the Initial Term of any 32nd Round licence is considered to be low, such that no in-combination effects have been identified.

Once firm project proposals are known as part of the Initial or any subsequent Seaward Licencing Term, existing statutory and planning processes allow for further consideration of interactions between other activities and, where applicable, would be subject to project level HRA. Should one or more Blocks be granted a licence within any wind farm zone for which an interaction with a Natura 2000 site has also been established, the in-combination effects of the proposed work programme must be considered as part of any project level HRA. Given the small and temporary seabed footprint associated with drilling activities, significant in-combination effects associated with offshore renewables projects are not expected.

Fisheries

Fishing and particularly bottom trawling has historically contributed to seabed disturbance over extensive areas and was identified as an ongoing issue in the UK initial assessment for MSFD[78], as well as in the updated 2019 assessment[79]. 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. The management of fisheries in relation to Article 6 of the Habitats Directive[80] is fundamentally different to other activities such as offshore energy development, and a revised approach to the management of commercial fisheries in European sites[81] has sought to implement steps to ensure that they are managed in accordance with Article 6.

Advice on operations for the Dogger Bank SAC and Southern North Sea SAC (see Sections 5.2 and 5.3) both 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

78 https://www.gov.uk/government/publications/marine-strategy-part-one-uk-initial-assessment-and-good-environmental-status

79 https://consult.defra.gov.uk/marine/updated-uk-marine-strategy-part-one/supporting_documents/UKmarinestrategypart1consultdocumentfinal.pdf

80 Relevant parts of which have been transposed into Regulation 5 of the *Offshore Petroleum Activities(Conservation of Habitats) Regulations 2001* (as amended).

81 https://www.gov.uk/government/publications/revised-approach-to-the-management-of-commercial-fisheries-in-european-marine-sites-overarching-policy-and-delivery and see https://www.gov.uk/government/publications/marine-protected-areas-strategic-management-table

that the nature and scale of 32nd Round exploration activities would result in a significant in-combination effect with porpoise bycatch. Physical disturbance related pressures from fisheries for which the Dogger Bank has been assessed as sensitive are relevant for those sources of effect from oil and gas exploration activity (noted in Section 4.2 and assessed in Section 5.2), and the potential for in-combination effects with fisheries are considered below.

In relation to specific sites of relevance to this AA, fisheries management proposals for the Dogger Bank were drawn up through the Dogger Bank Steering Group, with stakeholder engagement via the North Sea Regional Advisory Council (now the North Sea Advisory Council). The proposed measures included a number of zones which would be closed for beam trawl, bottom/otter trawl, dredges and semi-pelagic trawl fisheries. A joint management proposal with measures covering those Dogger Bank Natura 2000 sites in UK and adjacent state waters[82] was agreed in early 2017 and was followed by a Joint Recommendation process submission to the European Commission. Following review, the Scientific, Technical and Economic Committee for Fisheries provided advice on the Joint Recommendation to the Commission in 2019[83]. It concluded that the proposed conservation measure in the Dogger Bank represented a positive step forward towards (i) minimising the negative impacts of fishing activities on sand banks which are slightly covered by sea water all time and their biological communities, and (ii) ensuring that fisheries activities avoid the degradation of the marine environment. It further concluded that the proposed measures may contribute towards ensuring that the habitats and species addressed in the recommendation are maintained and restored at favourable conservation status.

While the above reflects the current approach to fisheries management in relation to Marine Protected Areas in English waters, the UK is expected to formally leave the CFP following the Transition Period on its exit from the EU which extends to the end of 2020. The Fisheries White Paper, "Sustainable Fisheries for Future Generations" [84], outlines the UK Government's present vision for how fisheries would be managed when the UK no longer participates in the CFP, which is presently being legislated for under the Fisheries Bill[85].

Whilst fishing may be linked to historical damage to site features, and presents a continuing risk to these, future management measures should limit the potential for in-combination effects with other activities. Effects on sites from exploration activity can be reduced or avoided (see Sections 2.3.1 and 5.2.3), and other oil and gas related activities are subject to statutory environmental impact assessment and where appropriate, HRA.

When an oil and gas surface structure (fixed and floating installations) becomes operational, a safety zone with a radius of 500m is created under the *Petroleum Act 1987* and other activities

[82] See: http://jncc.defra.gov.uk/page-6508 and http://www.nsrac.org/reports/meetings-c/ecowg/spatial-planning-working-group-meeting-4th-july-2016-the-hague/
[83] https://op.europa.eu/en/publication-detail/-/publication/dcbfa22f-e8e2-11e9-9c4e-01aa75ed71a1
[84] See: https://www.gov.uk/government/consultations/fisheries-white-paper-sustainable-fisheries-for-future-generations and also the draft Fisheries Bill: https://services.parliament.uk/bills/2017-19/fisheries.html
[85] https://services.parliament.uk/Bills/2019-20/fisheries.html

are excluded from taking place within the zone, including fisheries. Safety zones apply to mobile drilling rigs and are notified to other users of the sea (e.g. through notices to mariners and Kingfisher charts). In view of the differences in relative scale of physical impacts resulting from trawling and from oil and gas exploration (both spatially and temporally), significant incremental effects from 32nd Round activities are not predicted.

Aggregate extraction

There are a number of licences for the extraction of aggregates held in the southern North Sea, see Figure 5.3 and Table 5.3. In relation to the Blocks considered in this assessment, Blocks 49/12d and 49/16b partly overlap with Crown Estate Production Areas 483 and 484 respectively. Analogous to the advice provided in relation to offshore wind farms, applicants should make contact with the relevant aggregates companies in order that proposed oil and gas activity is undertaken in co-operation with the relevant lease or licence holders. In view of the limited spatial overlap with Blocks applied for, the potential to site rigs away from licence areas, and the nature and scale of physical effects associated with activity which may follow licensing (see Section 5.2), in-combination impacts which could lead to adverse effects on the integrity of sites considered in this AA are not anticipated.

5.4.4 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 2018). 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. 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 5.3) and formed an important part of associated HRAs[86]. Additional in-combination physical presence effects are possible with proposed OWF project extensions and/or any projects arising from Round 4 of wind leasing. Strategic level HRA has been completed[87] of the proposed OWF project extensions, and is proposed in relation to Round 4. No applications for development consent relating to any of the proposed OWF extensions in the southern North Sea have been made, and it is anticipated that HRAs would be undertaken as appropriate when applications are made. For the southern North Sea SAC, shipping is noted to be a source of pressures including underwater noise (see Section

[86] Refer to those HRAs in relation to Dogger Bank Creyke Beck, Dogger Bank Teesside, Hornsea Projects One, Two and Three and related documents on the PINS project pages

[87] https://www.thecrownestate.co.uk/en-gb/media-and-insights/news/2019-28-gw-of-offshore-wind-extension-projects-to-progress-following-completion-of-plan-level-habitats-regulations-assessment/

5.4.5) and death or injury by collision, with the latter not being considered a significant risk that requires management (JNCC 2016). It is not regarded that the temporary addition of a drilling rig (which could be on location for up to 10 weeks) and associated shipping 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).

Shipping densities over the relevant Blocks range from very low to moderate (36/30b, 42/5b, 42/7b, 42/13b, 42/19, 42/20b, 43/1, 43/11, 43/19a, 44/21, 44/22, 44/23a, 44/23b, 44/25, 44/26, 44/28, 44/29a, 44/30b, 47/3g, 47/3i, 47/15b, 48/9, 48/12g, 48/13c, 48/14b, 48/15c, 48/17e, 48/18e, 48/24c, 49/1, 49/2, 49/3, 49/9b, 49/9e, 49/16b, 49/17b) and high to very high (42/17, 42/18, 42/22, 42/23, 42/27, 42/28e, 42/28g, 42/28h, 42/29b, 43/12b, 43/13a, 43/14c, 43/20, 43/25, 43/26b, 43/27b, 43/29, 43/30, 44/16, 44/17, 44/18b, 44/19b, 47/2b, 48/4, 48/5, 48/14c, 48/19d, 48/23d, 49/4e, 49/6c, 49/8b, 49/11c, 49/12d, 49/13, 49/14a, 49/21e, 49/22b). Typical supply visits to rigs while drilling may be in the order of 2 to 3 per week (Table 2.2), and whilst more than doubling weekly average traffic in some of the blocks[88], the in-combination level of traffic remains low. Similarly, the presence of a seismic survey vessel for several days to several weeks would represent a low level, transient addition to existing levels of shipping traffic. Vessel traffic will temporarily increase during OWF construction, particularly for those Blocks which cover parts of OWF zones (Figure 5.3), with low level traffic continuing through their operational phase. Moreover, given that many of the Blocks applied for are within existing mature hydrocarbon basins, helicopters and vessels are likely to use established routes.

Though 32nd Round activities are an incremental source of potential effect in and around OWF project areas, it is anticipated that in-combination effects can be avoided through early engagement with lease holders. The transient nature of exploration drilling and the timing of OWF construction activities are such that any activity associated with the work programmes could be phased in such a way as to avoid in-combination effects from physical presence on any qualifying features of relevant European sites. Such interactions would need to be considered as part of assessments, including in HRA where appropriate, for project-level activity.

5.4.5 Underwater noise

A number of projects are relevant to the consideration of in-combination effects with activities which may follow the licensing of 32nd Round Blocks (see 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 DECC 2016). Here, we focus attention on the harbour porpoise feature of the Southern North Sea SAC, this being the most sensitive feature to underwater noise considered in this AA, and the site with the greatest overlap with 32nd Round Blocks.

Of most relevance to the Blocks being considered are a series of Round 3 and Round 2 extension wind farms. While the operation, maintenance and decommissioning of offshore

[88] Based on 2015 AIS vessel density grid (see: MMO 2014b).

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 DECC 2016). 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 OWF developments in the southern North Sea at present (including in the studies looking at the effect of wind farm construction on harbour porpoise behaviour, as discussed in Section 4.3.2). However, for some proposed developments, sufficient flexibility in foundation type remains in their Development Consent Orders to allow for the potential use of gravity base and even tethered foundations, which would result in less noise on installation. The final selection of foundation type is uncertain for some developments as this will be subject to detailed design.

Of those wind farms listed in Table 5.3, the Dogger Bank A and B and Sofia developments and Hornsea Projects Two and Three are scheduled for construction from 2020 to 2023 (see Section 2.7.4 and Appendix 1h of DECC 2016[89]). A number of other developments are in the pre-application stage. 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. 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.

Several modelling frameworks are being developed and refined to assess population level impacts of acoustic disturbance (e.g. King *et al.* 2015, Nabe-Nielsen *et al*. 2018). The spatially-explicit DEPONS model was used to estimate population-level effects of offshore wind construction on the harbour porpoise at a North Sea-wide scale (Nabe-Neilsen *et al*. 2018). The model included the construction of 65 wind farms within the 15-40m depth range across the southern North Sea, including pile-driving of 3,900 turbine foundations over a ten-year period; the majority of wind farm locations within UK waters fell within the Southern North Sea SAC. Different scenarios were modelled based on different construction schedules and harbour porpoise noise response distances. Results were sensitive to construction schedules, with greater effects anticipated if construction was rapid, offering little recovery time, and if ordered such that the western North Sea was continuously exposed to noise for several years. For all schedules, population effects only became discernible from a baseline undisturbed state when the response distance exceeded 20-50km. It is noted that the anticipated response/displacement distances from seismic surveys would, at a maximum, be considerably less, at ~10km.

[89] Also see: RenewableUK Offshore Wind Project Timelines (June 2018): https://cdn.ymaws.com/www.renewableuk.com/resource/resmgr/luke/RUK18_Offshore_Timeline.pdf

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 recent 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 MSFD and will review the results of the ongoing process closely with respect to the consenting of relevant activities which may result 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)[90].

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 32nd Round Blocks (see Section 5.2), and that there is significant scope to avoid concurrent OWF construction[91] and exploration well site survey activity either through dialogue with relevant leaseholders or by virtue of wind farm construction timelines. Piling can be detrimental to seismic data collection, and these activities would not therefore be undertaken concurrently in close proximity. These considerations and conclusions are also applicable to other relevant sites and features considered in this AA for underwater noise, including diving birds (The Greater Wash SPA, The Wash SPA, The North Norfolk Coast SPA and Outer Thames Estuary SPA), grey and harbour seal features (The Humber Estuary SAC and The Wash and North Norfolk Coast SAC) and SACs of adjacent states; such that adverse in-combination effects on site integrity are not predicted.

[90] 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
[91] Note that the encounter rate of UXO and its nature is uncertain and disposal operations are subject to separate marine licensing.

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 OWF 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 OWFs under MMO's proposed licence conditions[92], where a baseline of activities that may act in-combination with wind farm activities to breach the thresholds must be maintained. The Department do not currently expect this guidance to be applied to industry applications involving mobile noise sources, and its application here is limited by uncertainty in the extent, location and timing of activities which may follow the 32nd Round Licensing. However, its implementation for comparative purposes in the recent HRA for the planned ION 3D seismic survey (BEIS 2020b) illustrates how it 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. It is noted that, in the HRA of the ION survey, daily and seasonal thresholds for disturbance are not exceeded in any scenarios for in-combination effects, which, in addition to the ION seismic survey, includes concurrent UXO detonations (up to 5 per day), platform pin-piling, offshore wind foundation piling, and a pipeline route and rig site survey (BEIS 2020b).

As noted in Section 5.4.2, in keeping with the other regulatory issues for the 32nd Round and relevant marine plan policies, it is expected that early engagement between operators and developers would allow for activities to take place while avoiding potential in-combination effects. Further HRA will be undertaken, where appropriate, at the activity-specific level which will allow for the consideration of the spatial and temporal scope of seismic survey, including in-combination with other relevant projects.

There is the potential for seismic surveys to take place in adjacent Blocks which are not covered by the plan being assessed - refer to the currently licensed Blocks shown in Figure 5.3. For example, the ION 3D seismic survey scheduled for summer-autumn 2020 (see Figure 5.4), the HRA of which concluded that the proposed survey will not have an adverse effect on the integrity of any of the designated sites either alone or in-combination with other plans or projects (BEIS 2020b). The timing, location and scale of other such surveys are unknown and a meaningful assessment of these cannot be made at this time, but they will be subject to activity-specific permitting, including, where appropriate, HRA.

In addition to those activities which may follow licensing of the southern North Sea Blocks and the other potentially relevant projects listed in Table 5.3, there are a variety of other existing (e.g. oil and gas production, fishing, shipping, military exercise areas, wildlife watching cruises) and planned (e.g. oil and gas exploration and production) noise-producing activities in

[92] Note that the consultation outcome both for the Review of Consents and MMO marine licence conditions are yet to be published.

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 likely number and scale of activities likely to result from Block licensing (Section 2.2), would adversely affect the integrity of the relevant sites. This is due to the presence of effective regulatory mechanisms (Section 5.2 and also Appendix 3 of DECC 2016) 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, and this has been strengthened by recent Regulations[93] amending the offshore EIA regime which came into force in May 2017. These reflect Directive 2014/52/EU (amending the EIA Directive) which provides for closer co-ordination between the EIA and Habitats Directives, with a revised Article 3 indicating that biodiversity within EIA should be described and assessed "with particular attention to species and habitats protected under Directive 92/43/EEC and Directive 2009/147/EC".

5.4.6 Conclusions

Available evidence (see e.g. UKBenthos database and OSPAR 2010) 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, and any subsequent development that may occur if site appraisal is successful, will be judged on its own merits and in the context of wider development in the North Sea (i.e. any potential incremental effects). The current controls on terrestrial and marine industrial activities, including oil and gas operations that could follow licensing, can be expected to prevent significant in-combination effects affecting relevant European 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 European sites. Therefore, it is concluded that the in-combination effects from activities arising from the licensing of the relevant 32nd Round Blocks with those from existing and planned activities in the southern North Sea will not adversely affect the integrity of relevant European Sites.

[93] Note that the encounter rate of UXO and its nature is uncertain and disposal operations are subject to separate marine licensing.

[93] *The Offshore Petroleum Production and Pipe-lines (Environmental Impact Assessment and other Miscellaneous Provisions) (Amendment) Regulations 2017*

6 Overall conclusion

Taking account of the evidence and assessment presented above, the report determines that the licensing through the 32nd Licensing Round of the 73 Blocks 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 OGA awarding seaward licences (subject to meeting application requirements) covering those Blocks listed in Table 1.1. This is because there is certainty, within the meaning of the ECJ Judgment in the Waddenzee case, that implementation of the plan will not adversely affect the integrity of relevant European Sites (as described in Section 5), taking account of the mitigation measures that can be imposed through existing permitting mechanisms on the planning and conduct of activities (as described in Section 5.2 and 5.3).

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.

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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