Department for Energy Security & Net Zero

Offshore Oil & Gas Licensing

33rd Seaward Round

Habitats Regulations Assessment

Draft Appropriate Assessment: Eastern Irish Sea

July 2023

Contents

1 Introduction

1.1 Background and purpose

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

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

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

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

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

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

1.2 Relevant Blocks

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

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

1.2.1 Eastern Irish Sea Blocks

The relevant Blocks applied for in the 33rd Round and considered in this assessment are 110/3b and 113/27c (Table 1.1), and are shown in Figure 1.1.

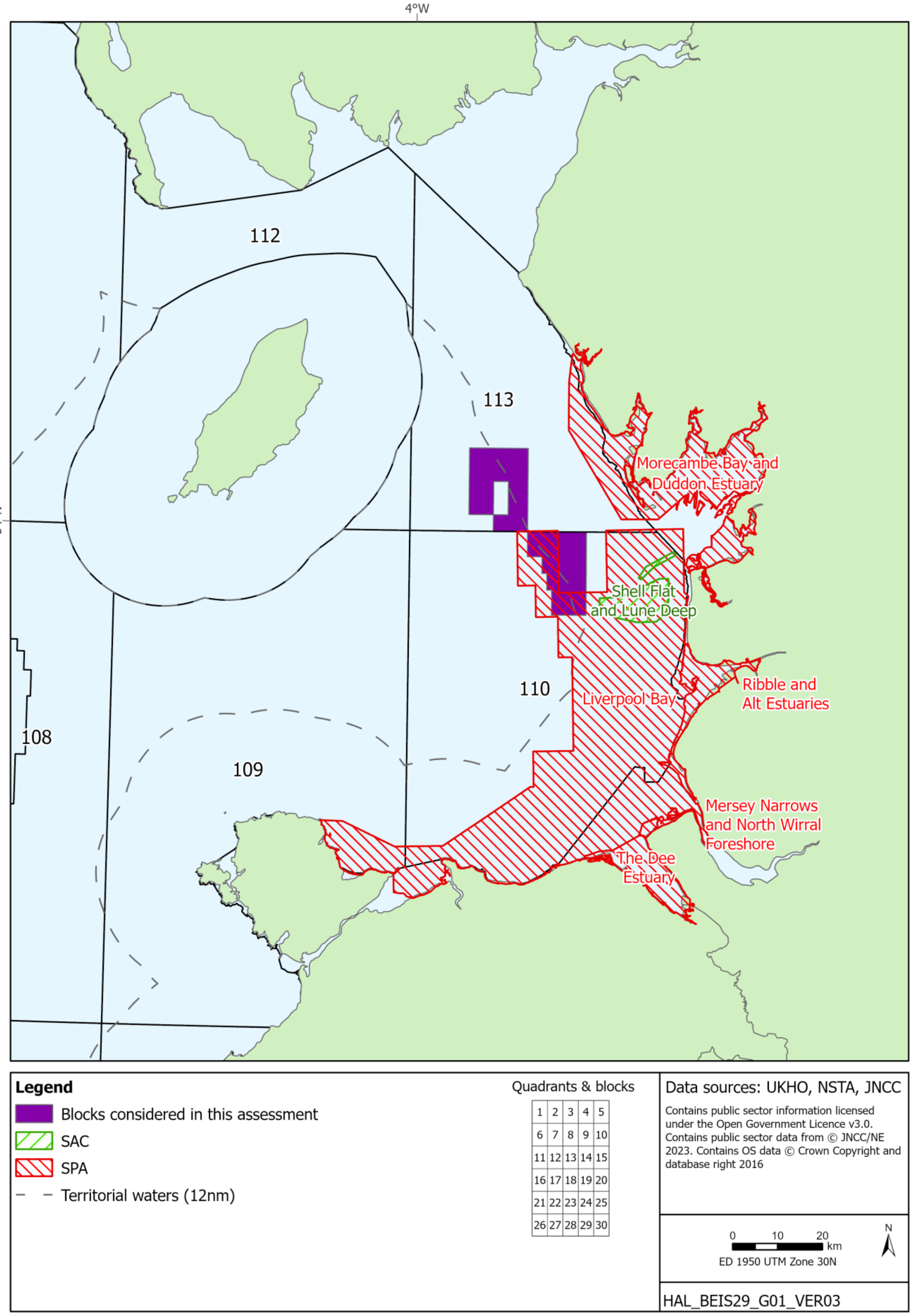
[4] See, in particular, the European Court of Justice case of Waddenzee (C-127/02). At the time of this assessment, this remains relevant to interpretation of the UK's legislation as retained EU case law under the *European Union (Withdrawal) Act 2018*.

Table 1.1: Relevant sites requiring further assessment

Relevant site Features	Relevant Blocks applied for	Sources of potential effect
SPAs		
Liverpool Bay Breeding: little tern, common tern Over winter: red-throated diver, little gull, common scoter. Wintering waterbird assemblage, including the named assemblage features, red-breasted merganser and great cormorant	110/3b, 113/27c	Physical disturbance and drilling: rig siting, drilling discharges
Over winter: red-throated diver, common scoter. Wintering waterbird assemblage		Underwater noise: deep geological seismic survey, rig site survey, VSP, conductor piling, drilling, vessel & rig movements
Ribble and Alt Estuaries[1] common tern	110/3b, 113/27c	Physical disturbance and drilling: rig siting, drilling discharges
Mersey Narrows and North Wirral Foreshore[1] common tern	110/3b, 113/27c	Physical disturbance and drilling: rig siting, drilling discharges
The Dee Estuary[1] common tern, little tern	110/3b, 113/27c	Physical disturbance and drilling: rig siting, drilling discharges
Morecambe Bay and Duddon Estuary Breeding: common tern, sandwich tern, little tern Over winter: whooper swan, little egret, golden plover, ruff, bar-tailed godwit, Mediterranean gull, lesser black-backed gull, herring gull; On passage: pink-footed goose, shelduck, oystercatcher, ringed plover, grey plover, knot, sanderling, dunlin, black-tailed godwit, curlew, pintail, turnstone, redshank, lesser black-backed gull. Seabird and waterbird assemblage all year round	110/3b, 113/27c	Physical disturbance and drilling: rig siting, drilling discharges
SACs		
Shell Flat and Lune Deep Annex I habitat: reefs	110/3b	Physical disturbance and drilling: rig siting, drilling discharges

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

Figure 1.1: Blocks and sites relevant to this Appropriate Assessment



1.3 Assessment overview

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

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

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

2 Licensing and potential activities

2.1 Licensing

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

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

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

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

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

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

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

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

2.2 Activities that could follow licensing

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

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

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

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

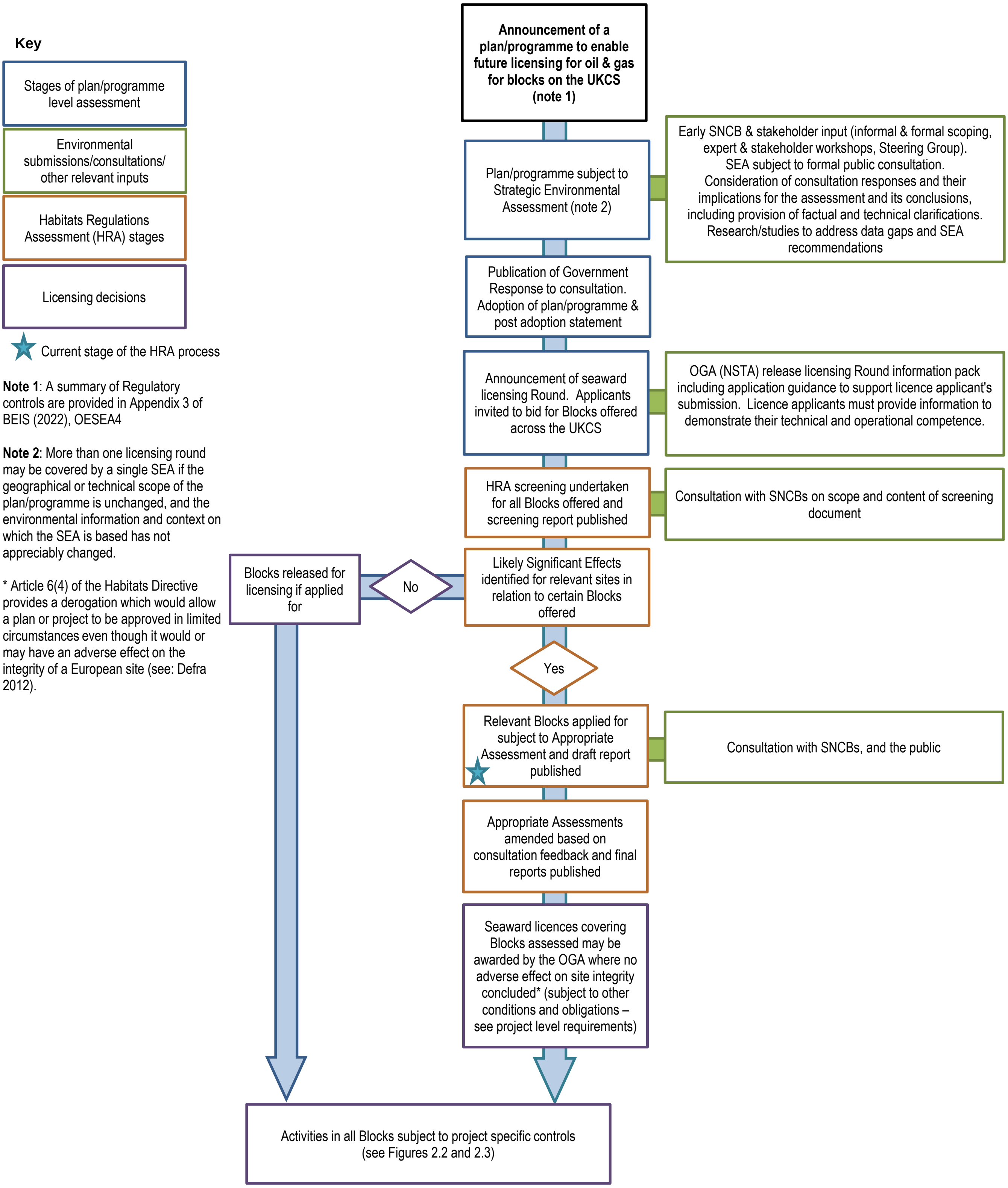
Note that Drill or Drop and Contingent work programmes (subject to further studies by the licensees) will probably result in a well being drilled in less than 50% of the cases.

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

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

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

Figure 2.1: Stages of plan level environmental assessment

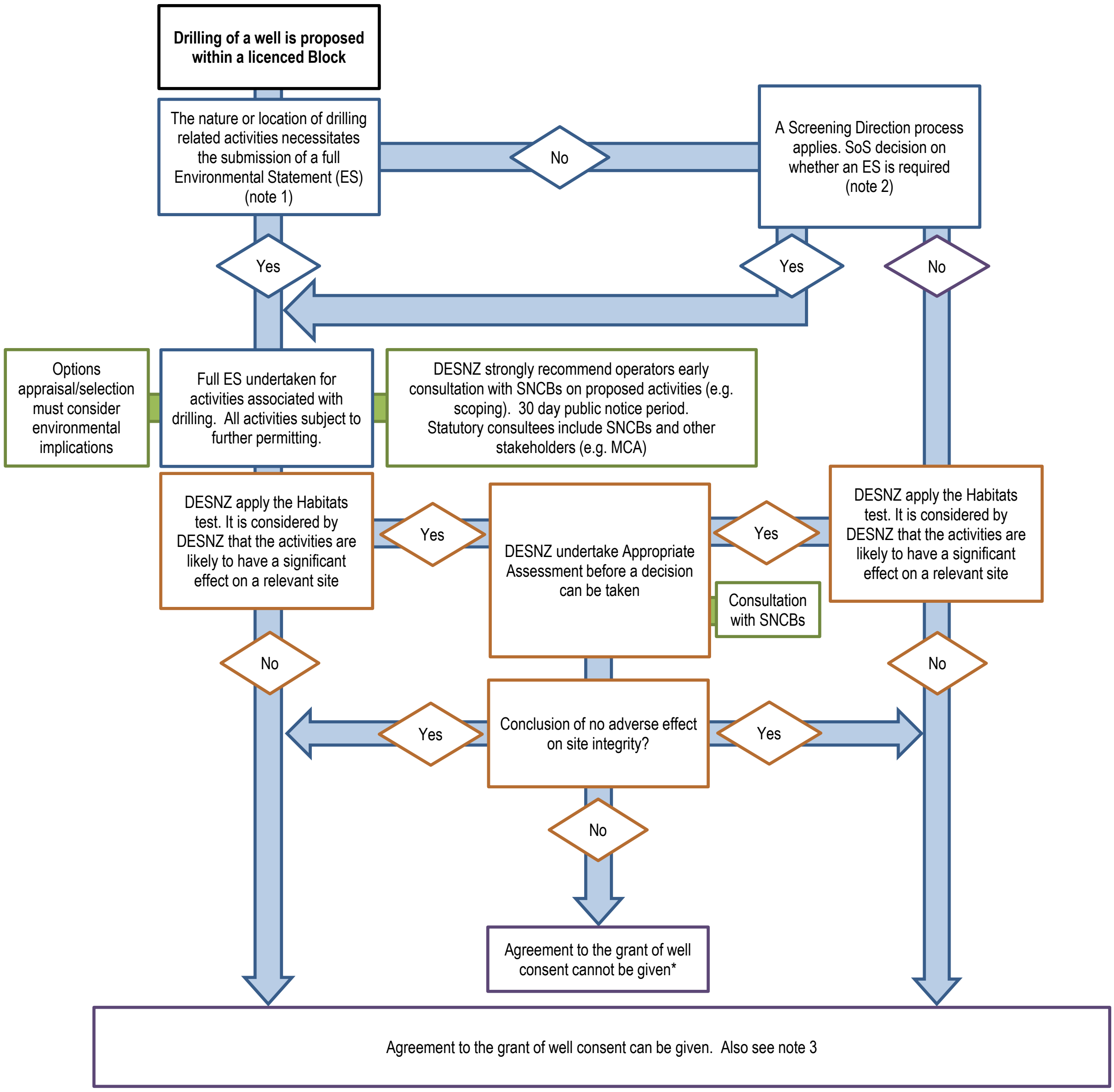


Note 1: A summary of Regulatory controls are provided in Appendix 3 of BEIS (2022), OESEA4

Note 2: More than one licensing round may be covered by a single SEA if the geographical or technical scope of the plan/programme is unchanged, and the environmental information and context on which the SEA is based has not appreciably changed.

* 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 2.2: High level overview of exploration drilling environmental requirements



Key

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

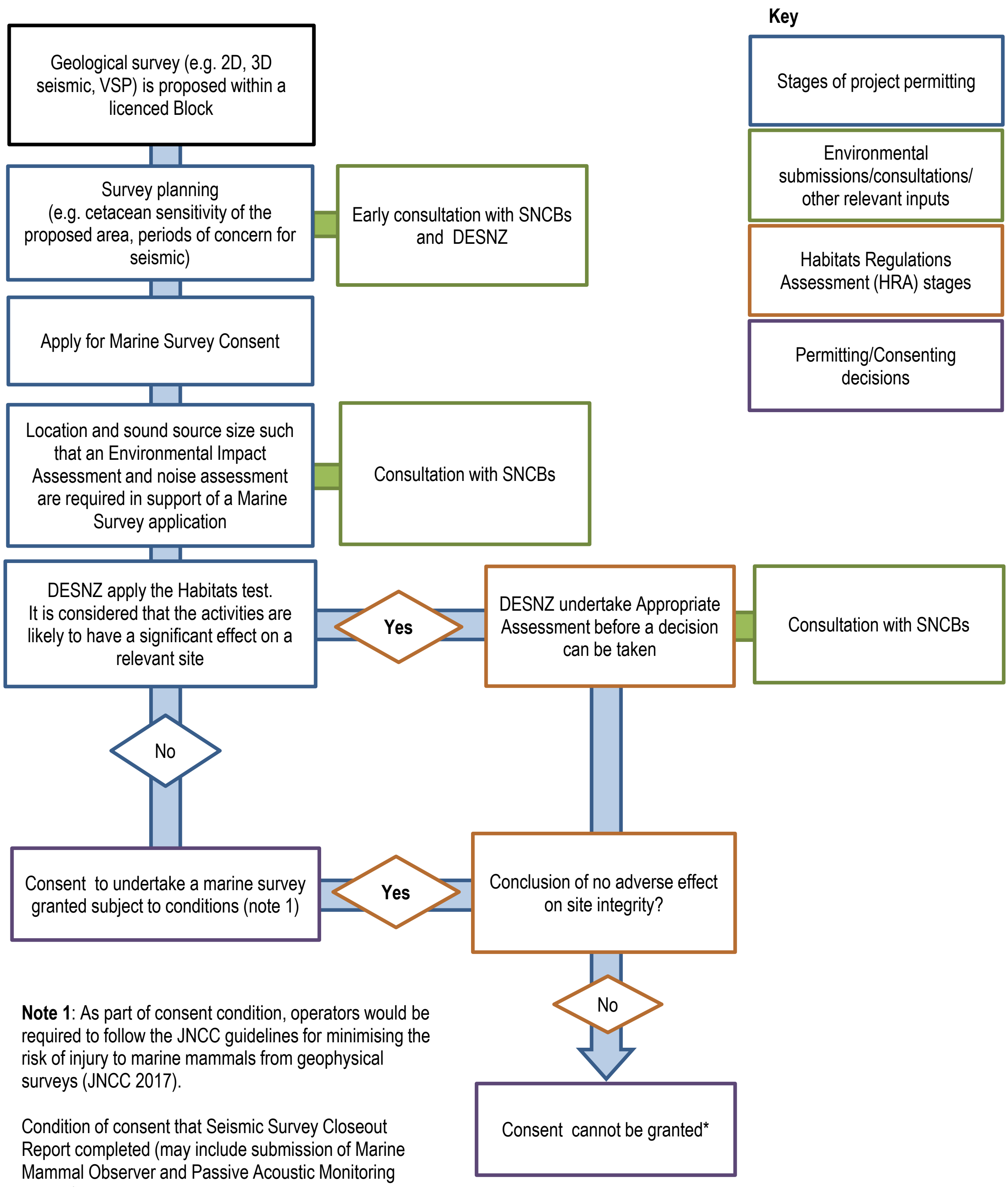
Note 1: See BEIS (2022). The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 – A Guide.

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

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

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

Figure 2.3: High level overview of seismic survey environmental requirements



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

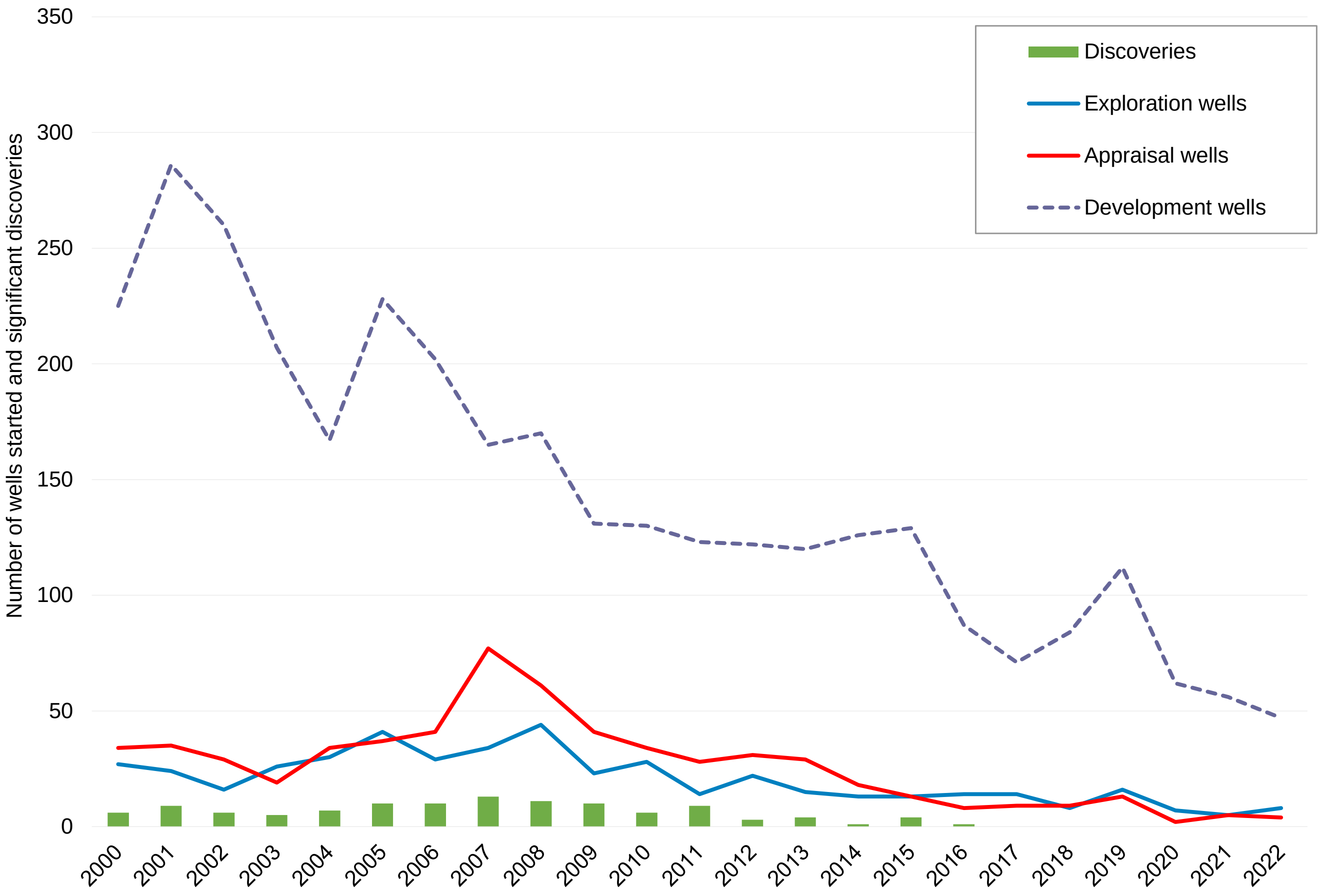
Condition of consent that Seismic Survey Closeout Report completed (may include submission of Marine Mammal Observer and Passive Acoustic Monitoring reports)

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

2.2.1 Likely scale of activity

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

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



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

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

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

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

2.2.2 33rd Round activities considered in this HRA

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

Potential accidental events, including spills, are not considered in the AA as they are not part of the work plan. Measures to prevent accidental events, response plans and potential impacts in the receiving environment are 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 NSTA are shown in Table 2.1.

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

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

Block	Obtain[11] and/or reprocess 2D or 3D seismic data	Shoot 3D seismic	Drill or drop well/contingent well	Second Term
110/3b	-	-	-	✓[1]
113/27c	✓	-	✓	-

Note: [1]this application proposes only desk studies

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

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

Table 2.2: Potential activities and assessment assumptions

Potential activity	Description	Assumptions used for assessment
Initial Term Phase C: Drilling and well evaluation		
Rig tow out & de-mobilisation	Mobile rigs are towed to and from the well site typically by 2-3 anchor handling vessels.	The physical presence of a rig and related tugs during tow in/out is both short (a number of days depending on initial location of rig) and transient.
Rig placement/ anchoring	Jack-up rigs are used in shallower waters (normally <120m) and jacking the rig legs to the seabed supports the drilling deck. Each of the rig legs terminates in a spud-can (base plate) to prevent excessive sinking into the seabed. Unlike semi-submersible rigs, jack-up rigs do not require anchors to maintain station, and these are not typically deployed for exploration activities, with positioning achieved using several tugs, with station being maintained by contact of the rig spudcans with the seabed. Anchors may be deployed to achieve precision siting over fixed installations or manifolds at injection facilities, which are not considered in this assessment.	It is assumed that jack-up rigs will be three or four-legged rigs with 20m diameter spudcans with an approximate seabed footprint of 0.001km^2 within a radius of *ca*. 50m of the rig centre. For the assessment it is assumed that effects may occur within 500m of a jack-up rig which would take account of any additional rig stabilisation (rock placement) footprint. A short review of 20 Environmental Statements, which included drilling operations in the southern North Sea since 2007 (specifically in quadrants 42, 43, 44, 47, 48, 49 and 53) indicated that rig stabilisation was either not considered necessary and/or assessed as a worst-case contingency option. Where figures were presented, the spatial scale of potential rock placement operations was estimated at between 0.001-0.004km^2 per rig siting. Mud mats are routinely used in offshore oil & gas and offshore wind infrastructure. In particular they tend to be used below templates and pipeline end manifolds to control vertical and lateral movements of the structures, and also on the footings of jacket-type structures to provide on-bottom stability prior to the installation of piles, particularly on soft sediments (Dunne & Martin 2017, IFC 2021, Shell 2022, Ørsted 2022). Mud mats are generally made from steel, and are used to distribute the weight of the overlying infrastructure to prevent sinking into the sediment but also control lateral movements (Dunne & Martin 2017). Mud mats are also used for jack-up rig drilling (Stewart 2007) as an alternative to rock placement, though examples are fewer than for fixed infrastructure. Mud mats, if used, would be expected to be removed as part of the overall drilling programme, and would therefore, be only a temporary feature which would be permanently removed on completion of the work programme.
Marine discharges	Typically around 1,000 tonnes of cuttings (primarily rock chippings) result from drilling an exploration well. Water-based mud cuttings are typically discharged at, or relatively close to sea surface during	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

Potential activity	Description	Assumptions used for assessment
	"closed drilling" (i.e. when steel casing in the well bore and a riser to the rig are in place), whereas surface hole cuttings are normally discharged at seabed during "open-hole" drilling. Use of oil based mud systems, for example in highly deviated sections or in drilling water reactive shales, would require onshore disposal or treatment offshore to the required standards prior to discharge. Typical chemical use and discharge for an exploration well includes cements which are used to fix casings and liners into place inside the well, with the vast majority retained downhole and not discharged to the marine environment. Brines and clean up chemicals, designed to remove mud and cuttings traces from the well bore, and other chemicals such as rig washes, hydraulic fluids and pipe dopes, are essential during drilling programmes.	500m of the well location covering an area in the order of 0.8km^2 (refer to Section 4.2 for supporting information). Typically, the majority of chemicals used and discharged are either PLONOR (Pose Little or No Risk to the Environment) or have a risk assessment banding of E or Gold and contain no additional warnings (i.e. they do not contain components which have been identified for substitution, for example due to toxicity, biodegradation, bioaccumulation). Chemicals are risk assessed prior to their use and discharge offshore, with those chemicals identified with warnings and/or a poorer environmental profile, requiring additional justification in order to obtain approval. Effects from chemical discharge will typically be localised to the well area.
Conductor piling	Well surface holes are usually drilled "open-hole" with the conductor subsequently inserted and cemented in place to provide a stable hole through which the lower well sections are drilled. Where the nature of the seabed sediment and shallow geological formations are such that they would not support a stable open-hole (i.e. risking collapse), the conductor may be driven into the sediments. In North Sea exploration wells, the diameter of the conductor pipe is usually 26" or 30" (<1m), which is considerably smaller than the monopiles used for offshore wind farm foundations (>3.5m diameter), and therefore require less hammer energy and generate noise of a considerably lower amplitude. For example, hammer energies to set conductor pipes are in the order of 90-270kJ (see: Matthews 2014, Intermoor website), compared to energies of up to 3,000kJ in the installation of piles at some southern North Sea offshore wind farm sites. Direct measurements of underwater sound generated during conductor piling are limited. Jiang *et al.* (2015) monitored conductor piling operations at a jack-up rig in the central North Sea in 48m water depth and found peak sound pressure levels (L_{pk}) not to exceed 156dB re 1 µPa at 750m (the closest measurement to source) and declining with distance. Peak frequency was around 200Hz, dropping off rapidly above 1kHz; hammering was undertaken at a stable power level of 85 ±5 kJ but the pile diameter was not specified (Jiang *et al.* 2015). MacGillivray (2018) reported underwater noise measurements during the piling of six 26"	The need to pile conductors is well-specific and is not routine. It is anticipated that a conductor piling event would last between 4-6 hours, during which time impulses sound would be generated primarily in the range of 100-1,000Hz, with each impulse of a sound pressure level of approximately 150dB re 1µPa at 500m from the source.

Potential activity	Description	Assumptions used for assessment
	conductors at a platform, six miles offshore of southern California in 365m water depth. After initially penetrating the seabed under its own weight, each conductor was driven approximately 40m further into the seabed (silty-clay and clayey-silt) with hammer energies that increased from 31 ±7 kJ per strike at the start of driving to 59 ±7 kJ per strike. Between 2.5-3 hours of active piling was required per conductor. Sound levels were recorded by fixed hydrophones positioned at distances of 10-1,475m from the source and in water depths of 20-370m, and by a vessel-towed hydrophone. The majority of sound energy was between 100-1,000Hz, with peak sound levels around 400Hz. Broadband sound pressure levels recorded at 10m from source and 25m water depth were between 180-190dB re 1µPa (SEL = 173-176dB re 1µPa·s), reducing to 149-155dB re 1µPa at 400m from source and 20m water depth (SEL = 143-147dB re 1µPa·s).	
Rig site survey	Rig site surveys are undertaken to identify seabed and subsurface hazards to drilling, such as wrecks and the presence of shallow gas. The surveys use a range of techniques, including multibeam and side scan sonar, sub-bottom profiler, magnetometer and high-resolution seismic involving a much smaller source (mini-gun or four airgun cluster of 160 in^3) and a much shorter hydrophone streamer. Arrays used on site surveys and some Vertical Seismic Profiling (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).	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.
Rig/vessel presence and movement	On site, the rig is supported by supply and standby vessels, and helicopters are used for personnel transfer.	Supply vessels typically make 2-3 supply trips per week between rig and shore. Helicopter trips to transfer personnel to and from the rig are typically made 2-3 times a week. A review of Environmental Statements for exploratory drilling suggests that the rig could be on location for, on average, up to 10 weeks. Support and supply vessels (50-100m in length) are expected to have broadband source levels in the range 165-180dB re 1µPa@1m, with the majority of energy below 1kHz (OSPAR 2009). Additionally, the use of thrusters for dynamic positioning has been reported to result in increased sound generation (>10dB) when compared to the same vessel in transit (Rutenko & Ushchipovskii 2015).

Potential activity	Description	Assumptions used for assessment
Well evaluation (e.g. Vertical Seismic Profiling)	Sometimes conducted to assist with well evaluation by linking rock strata encountered in drilling to seismic survey data. A seismic source (airgun array, typically with a source size around 500 in^3 and with a maximum of 1,200 in^3, Stone 2015) is deployed from the rig, and measurements are made using a series of geophones deployed inside the wellbore.	VSP surveys are of short duration (one or two days at most).

2.3 Existing regulatory requirements and controls

The AA assumes that the high-level controls described below are applied as standard to activities since they are legislative requirements. These are distinct from further control measures which may be identified and employed to avoid likely significant effects on relevant sites. These further control measures are identified in Sections 5.2.1 and 5.3.1 with reference to the two main sources of effect identified.

2.3.1 Physical disturbance and drilling effects

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

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

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

2.3.2 Underwater noise effects

Controls are in place to cover all significant noise generating activities on the UKCS, including geophysical surveying. Seismic surveys (including VSP and high-resolution site surveys), sub-bottom profile surveys and shallow drilling activities require an application for consent under the *Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001* (as amended) and cannot proceed without consent. These applications are supported by an EIA, which includes a noise assessment. Regarding noise thresholds to be used as part of any assessment, applicants are encouraged to seek the advice of relevant SNCB(s) (JNCC 2017) in addition to referring to European Protected Species (EPS) guidance (JNCC 2010). Applicants should be aware of recent research development in the field of marine mammal acoustics, including the development of a new set of criteria for injury (Southall *et al*. 2019).

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

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

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

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

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

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

3 Appropriate assessment process

3.1 Process

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

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

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

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

3.2 Site integrity

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

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

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

3.3 Assessment of effects on site integrity

The assessment has been undertaken in accordance with the European Commission Guidance (EC 2019) and with reference to other guidance, reports and policy, including the Habitats Regulations Guidance Notes (English Nature 1997, Defra 2012, SEERAD 2000), SNH (2015), the National Planning Policy Framework (MHCLG 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, 2016, BEIS 2022) and other literature. Recent operator Environmental Statements for offshore exploration and appraisal activities on the UKCS have also been reviewed, providing, for example, a more specific indication of the range of spatial footprints associated with relevant drilling activities to inform the further consideration of those sites where physical disturbance and drilling effects may be considered likely.

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

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

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

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

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

4.2 Physical disturbance and drilling effects

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

- Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion from jack-up drilling rig spud can placement[18] (see Section 4.2.1)
- Abrasion/disturbance of the substrate on the surface of the seabed and smothering/siltation rate change through the discharge of surface hole cuttings around the well, placement of wellhead assembly, and by settlement of drill cuttings onto the seabed following discharge near sea surface (see Section 4.2.2)
- Physical change to another seabed type through rock placement around jack-up legs for rig stabilisation (see Section 4.2.3)
- Contamination (see Section 4.2.4)
- Introduction or spread of non-indigenous species (see Section 4.2.5)
- Visual disturbance (and underwater noise, covered in Section 4.2.6), introduction of light and collision associated with the presence and movement of vessels causing displacement of sensitive receptors (see Section 4.4.6)
- Collisions above or below water with static or moving objects (see Section 4.2.7)

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

Jack-up rigs, normally used in shallower water (<120m), leave three or four seabed depressions from the feet of the rig (the spudcans) of around 15-20m in diameter. The form of the footprint depends on factors such as the spudcan shape, the soil conditions, the footing penetration and methods of extraction, with the local sedimentary regime affecting the longevity of the footprint (HSE 2004). For example, side scan survey data from a 2011

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

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

The drilling of the surface hole of a well and installation of the conductor will result in highly localised changes to the substrate below the surface of the seabed, for example, a typical conductor may have a diameter of 26 inches. Following drilling, exploration wells are typically plugged and abandoned with the casing being removed to approximately 3m below the seabed. As noted above in relation to depressions from jack-up rig rigs, some natural infilling and recovery of the seabed would be expected following conductor removal, subject to local hydrodynamic conditions.

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

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

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

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

Relevant information on the recovery of benthic habitats to smothering mainly comes from studies of dredge disposal areas (see Newell *at al.* 1998). Recovery following disposal occurs through a mixture of vertical migration of buried fauna, together with sideways migration into the area from the edges, and settlement of new larvae from the plankton. The community recolonising a disturbed area is likely to differ from that which existed prior to construction. Opportunistic species will tend to dominate initially and on occasion, introduced and invasive species may then exploit the disturbed site (Bulleri & Chapman 2010). Harvey *et al.* (1998) suggest that it may take more than two years for a community to return to a closer resemblance of its original state (although if long lived species were present this could be much longer). Shallow water (<20m) habitats in wave or current exposed regimes, with unconsolidated fine grained sediments have a high rate of natural disturbance and the characteristic benthic species are adapted to this. Species tend to be short lived and rapid reproducers and it is generally accepted that they recover from disturbance within months. By contrast a stable sand and gravel habitat in deeper water is believed to take years to recover (see Newell *et al.* 1998, Foden *et al*. 2009). Changes in water quality from increased suspended sediment loads are noted as a pressure relevant to exploration drilling[19], though is justified in relation to vessel use in shallow waters and in ports rather than drilling activities themselves. While drilling activities may results in enhanced turbidity, e.g. from cuttings discharge, these are widely and quickly dispersed and are not likely to impact, for example, shallow plunge diving birds such as terns.

4.2.3 Physical change to another seabed type

As noted, there may be a requirement for jack-up rig stabilisation (e.g. rock placement or use of mud mats) depending on local seabed conditions, but this is not typical. In soft sediments, rock deposits may cover existing sediments resulting in a physical change of seabed type, and related habitat loss, which in the context of HRA, could lead to a reduction in feature extent that would need to be considered in relation to the site's conservation objectives and conservation status. The introduction of rock into an area with a seabed of sand and/or gravel can in theory provide "stepping stones" which might facilitate biological colonisation including by non-indigenous species by allowing species with short lived larvae to spread to areas where previously they were effectively excluded. On the UKCS, natural "stepping stones" are widespread and numerous for example in the form of rock outcrops, glacial dropstones and moraines, relicts of periglacial water flows, accumulations of large mollusc shells, carbonate cemented rock etc., and these are often revealed in rig site and other (e.g. pipeline route) surveys. The potential for man-made structures to act as stepping stones in the North Sea and the impact of their removal during decommissioning is being investigated as part of the INSITE[20] programme. Phase 1 projects (2015-2017) are now complete; those of relevance suggest that man-made structures may influence benthic community structure and function but only on a limited spatial scale. Modelling indicates the strong potential for biological connectivity between structures in the North Sea (e.g. Henry *et al.* 2018, Mayorga-Adame *et al.* 2022), but this has not been validated by empirical data (ISAB 2018). Phase 2 of the INSITE research aimed to tackle gaps in understanding of the role of man-made structures in marine ecosystems and results from this phase of the work were recently summarised in a series of

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

webinars[21]. An additional project has been commissioned to provide a synthesis of evidence relating to man-made structures in the marine environment, building on phases 1 and 2 of the INSITE programme, is also due to complete in the same timeframe as Phase 2[22].

4.2.4 Contamination[23]

In contrast to historic oil based mud (OBM) discharges[24], effects on seabed fauna resulting from the discharge of cuttings drilled with water based muds (WBM) and of the excess and spent mud itself are usually subtle or undetectable. Although the presence of drilling material at the seabed close to the drilling location (<500m) is often detectable chemically (e.g. Cranmer 1988, Neff *et al.* 1989, Hyland *et al.* 1994, Daan & Mulder 1996, Currie & Isaacs 2005, OSPAR 2009, Bakke *et al.* 2013). Recent studies (e.g. Aagaard-Sørensen *et al.* 2018, Junttila *et al.* 2018, Dijkstra *et al.* 2020, Gillett *et al.* 2020, Nguyen *et al.* 2021) have investigated the spread and effects of WBM discharges on various aspects of seabed ecology including those not typically included in benthic monitoring programmes; the results indicate that, where effects were detected, they were of small spatial scale and relatively short duration. Analysis of UKBenthos data (Henry *et al.* 2017) for 19 installations spanning the northern, central and southern North Sea, suggested strong benthic responses for 12 structures, with 10 having their maximum ecological footprint within 1km of the discharge, and the remaining two within 1.2km, with recovery time varying between zero years (i.e. no effect) to between 6.8 and 8.3 years. The datasets largely reflected the effects of discharged OBM rather than WBMs, and the authors could not disentangle the effects of OBMs and WBMs in terms of persistence with the available data.

Considerable data from oil and gas activities has been gathered from the North Sea and other production areas, indicating that localised physical effects are the dominant mechanism of ecological disturbance where water-based mud and cuttings are discharged. Modelling of WBM cutting discharges has indicated that deposition of material is generally thin and quickly reduces away from the well. Jones *et al.* (2006, 2012) compared pre- and post-drilling ROV surveys of a West of Shetland exploration well in Block 206/1a in *ca*. 600m water depth and documented physical smothering effects within 100m of the well (note that this is over 400m deeper than any of the areas on offer in this round). Outside the area of smothering, fine sediment was visible on the seafloor up to at least 250m from the well. After three years, there was significant reduction of cuttings material visible particularly in the areas with relatively low initial deposition (Jones *et al*. 2012). The area with complete cuttings cover had reduced from 90m to 40m from the drilling location, and faunal density within 100m of the well had increased considerably and was no longer significantly different from conditions further away. The use of a ROV has also allowed the detection of small scale changes in benthic fauna in the immediate vicinity of a wellbore in the Norwegian sector of the North Sea, for example Hughes *et al.* (2010) found declines of the density of sea urchin *Gracilechinus acutus* within 50m of a well; such effects are considered temporary and negligible.

OSPAR (2009) concluded that the discharge of water-based muds and drill cuttings may cause some smothering in the near vicinity of the well location. The impacts from such discharges are localised and transient, but may be of concern in areas with sensitive benthic fauna, for

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

example corals and sponges. Field experiments on the effects of water-based drill cuttings on benthos by Trannum *et al*. (2011) treated two “fine” and “coarse” sediment samples with water-based drill cuttings and placed these in water depths of 27-37m. After six months there were only minor differences in faunal composition between the controls and those treated with drill cuttings. This corresponds with the results of field studies where complete recovery was recorded within 1-2 years after deposition of water-based drill cuttings (Daan & Mulder 1996, Currie & Isaacs 2005).

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

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

4.2.5 Introduction or spread of non-indigenous species

Through the transport and discharge of vessel ballast waters (and associated sediment), and to a lesser extent fouling organisms on vessel/rig hulls, non-native species may be introduced to the marine environment. Should these introduced species survive and form established breeding populations, they can result in negative effects on the environment. These include: displacing native species by preying on them or out-competing them for resources; irreversible genetic pollution through hybridisation with native species, and increased occurrence of harmful algal blooms (as reviewed in Nentwig 2007). The economic repercussions of these ecological effects can also be significant (see IPIECA & OGP 2010, Lush *et al*. 2015, Nentwig 2007). In response to these risks, a number of technical measures have been proposed such as the use of ultraviolet radiation to treat ballast water or procedural measures such as a mid-ocean exchange of ballast water (the most common mitigation against introductions of non-native species). Management of ballast waters is addressed by the International Maritime Organisation (IMO) through the International Convention for the Control and Management of Ships Ballast Water & Sediments, which entered into force in 2017[25]. The Convention includes Regulations with specified technical standards and requirements (IMO Globallast website[26]). Further, oil and gas exploration and appraisal activity is unlikely to change the risk of the introduction of non-native species as the vessels typically operate in a geographically localised area (e.g. rigs may move between the Irish Sea and North Sea), and the risk from hull fouling is low, given the geographical working region and scraping of hulls for regular inspection.

4.2.6 Visual disturbance

The Blocks offered may support important numbers of birds at certain times of the year including overwintering birds and those foraging from coastal SPAs. Therefore, the presence and/or movement of vessels and aircraft from and within 33rd Round licence blocks during exploration and appraisal activities could temporarily disturb birds from relevant SPA sites. In areas where helicopter transits are regular, a degree of habituation to disturbance amongst some birds has been reported (see Smit & Visser 1993). The anticipated level of helicopter traffic associated with exploration/appraisal drilling activity (2-3 trips per week, see Table 2.2) is likely to be insignificant in the context of existing helicopter, military and civilian aircraft activity levels.

Physical disturbance of seaduck and other waterbird flocks by vessel and aircraft traffic associated with oil and gas exploration and appraisal is possible, particularly in SPAs established for shy species (e.g. common scoter). Such disturbance can result in repeated disruption of bird feeding, loafing and roosting. Divers and sea ducks have been assessed as being the most sensitive species groups to offshore development and associated boat and helicopter traffic. For example, large flocks of common scoter were observed being put to flight at a distance of 2km from a 35m vessel, though smaller flocks were less sensitive and put to flight at a distance of 1km (Kaiser 2002, also see Schwemmer *et al.* 2011). Larger vessels would be expected to have an even greater disturbance distance (Kaiser *et al.* 2006). Mendel *et al.* (2019) further note behavioural response in red-throated diver within 5km of ships.

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

[25] http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Control-and-Management-of-Ships%27-Ballast-Water-and-Sediments-(BWM).aspx
[26] http://archive.iwlearn.net/globallast.imo.org/the-bwmc-and-its-guidelines/index.html
[27] https://hub.jncc.gov.uk/assets/9aecb87c-80c5-4cfb-9102-39f0228dcc9a

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

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

4.3 Underwater noise effects[28]

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

4.3.1 Noise sources and propagation

For all sources of anthropogenic underwater noise, there is now a reasonable body of evidence to quantify sound levels associated with these activities and to understand the likely propagation of these sounds within the marine environment, even in more complex coastal locations (DECC 2016, BEIS 2022).

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

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

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

Electromechanical sources such as 'pinger' or 'chirper' SBPs, side-scan sonar and multi-beam echosounders (MBES) have narrower beam widths and dominant frequencies much higher than those of air guns[29] such that, even at high amplitudes, the generated sound would be expected to rapidly attenuate and likely not propagate far enough for marine species to be negatively affected by received sound levels. For example, the absorption coefficient alone in seawater is approximately -36dB/km at 100kHz, rising to -61dB at 200kHz (Lurton 2016). SBPs of the 'boomer' and 'sparker' type do generate a true broadband seismic pulse of low frequency, although the peak pressures produced by these small devices are considerably lower than those generated by airguns. Ruppel *et al.* (2022) considered most high-resolution geophysical (HRG) sources, with the exception of seismic sources (e.g. boomers, sparkers), to be intermittent and non-impulsive (although see Hartley Anderson Limited 2020 for commentary on lack of clear definition of impulsiveness). Two studies commissioned by the US Bureau of Ocean Energy Management investigated sound generated by equipment commonly used in high-resolution geophysical surveys, including electromagnetic sources. Calibrated source levels were measured under controlled conditions in a test tank (Crocker & Fratantonio 2016); acoustic characteristics of several example equipment types tested are provided in Table 4.1.

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

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

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

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

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

Despite the caveats on the current open-water test results, it is worth noting some general patterns observed. In all test environments, broadband received levels from all MBES, side-scan sonar and SBP 'chirper' or 'boomer' devices tested were rapidly attenuated with distance from source, with particularly pronounced fall-off for directional sources when the receiver was outside of the source's main beam. Acoustic signals from the SBP 'sparkers' tested showed slightly greater propagation, as would be expected from the lower-frequency impulsive signals these devices produce. The greatest propagation was generally observed at the deepest test site (100m water depth) from sources generating low frequencies (<10kHz) whilst some of the highest frequency sources (>50kHz) experienced such attenuation that they were only weakly detectable or undetected by recording equipment. These preliminary results, combined with the calibrated source measurements in test tanks, suggest that SBPs and other electromechanical sources used in high-resolution geophysical surveys have a very low potential for significant disturbance of sensitive marine fauna. Similarly, Ruppel *et al.* (2022) classified most high resolution geophysical sources (e.g. MBES, SSS, hull-mounted SBP, towed SBP and parametric SBP) in Tier 4, considered unlikely to result in incidental take[30] of marine mammals and therefore termed *de minimis*. Some sparker and boomer systems were considered Tier 3, with characteristics that did not meet the *de minimis* category (e.g. some sparkers) or could not be fully evaluated due to lack of information (e.g. some boomers). In an experiment undertaken at the Energy Island lease area in Danish waters, at water depths of ~35m, Pace *et al.* (2022) recorded a peak frequency of a sparker of between 0.2 and 0.8kHz and source levels (SEL) of up to 156.8dB re 1μPa^{2}s, for a station set at 0m from the source. At 100m, 750 and 2km, the source levels reduced to up to 144.1, 136.6 and 123.3dB re 1μPa^2.

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

Encounters with unexploded ordnance (UXO) from past military conflicts or training are possible almost anywhere across the UKCS, however, they are most frequent in the southern North Sea and eastern Irish Sea. UXO are generally less frequently encountered during exploration activities, and if they are, there is considerable scope to avoid interaction with any

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

suspected device and avoid the need for disposal. To date, clearance of UXO has generally been undertaken by high-order detonation using a charge to destroy the device, but this is a source of loud underwater noise with the potential to generate significant effects for noise sensitive receptors. Alternative "low-order" approaches (e.g. deflagration) which render the UXO safe but without causing it to explode are available, and their use is being encouraged (e.g. see BEIS 2022 and the unexploded ordnance clearance joint interim position statement[31]).

4.3.2 Potential ecological effects

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

Fish

Many species of fish are highly sensitive to sound and vibration and broadly applicable sound exposure criteria have recently been published (Popper *et al.* 2014). Studies investigating fish mortality and organ damage from noise generated during seismic surveys are very limited and results are highly variable, from no effect to long-term auditory damage (reviewed in Popper *et al.* 2014). Slabbekoorn *et al*. (2019) note that there are few good case-studies in the peer-reviewed literature that report on the impact of a seismic survey on the behavioural response of free-ranging fish or the direct impact on local fisheries. Behavioural responses and effects on fishing success ("catchability") have been reported following seismic surveys (Pearson *et al.* 1992, Skalski *et al.* 1992, Engås *et al.* 1996, Wardle *et al*. 2001, Bruce *et al.* 2018). Potential effects on migratory diadromous fish is an area of significant interest for which empirical evidence is still limited, especially as salmonids and eels are sensitive to particle motion (not sound pressure) (Gill & Bartlett 2010). Atlantic salmon *Salmo salar* have been shown through physiological studies to respond to low frequency sounds (below 380Hz), with best hearing at 160Hz (threshold 95 dB re 1 μPa). Harding *et al.* (2016) note a lower sensitivity at 100Hz than previously reported (Hawkins & Johnstone 1978), and greater sensitivity at frequencies of >200Hz, with evidence of some response at 400-800Hz. However, the authors qualify their results with differences in methodological approach, and the use of fish maintained in tanks receiving low frequency ambient sound within the greatest range of sensitivity (<300Hz) for some time in advance of the experiments taking place. The ability of salmon to respond to sound pressure is regarded as relatively poor with a narrow frequency span, a limited ability to discriminate between sounds, and a low overall sensitivity relative to other fish species (Hawkins & Johnstone 1978, cited by Gill & Bartlett 2010, Harding *et al.* 2016). The Mickle *et al*. (2018) study of the hearing ability of sea lamprey (*Petromyzon marinus*) reported that, consistent with fish lacking a swim bladder, sea lamprey showed a limited sensitivity to sound, with juveniles detecting tones of 50-300Hz, but not higher frequencies.

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

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

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

Diving birds

Direct effects from seismic exploration noise on diving birds could potentially occur through physical damage, or through disturbance of normal behaviour, although evidence for such effects is very limited. Unlike other receptor groups, no dedicated reviews on the effects of noise on diving birds have been undertaken; distillations of available evidence can be found in Hartley Anderson Limited (2020), U.S. Department of the Navy (2020) and the DOSITS website[32]. The exposure of shallow plunge-diving or surface-dipping aquatic birds to underwater noise is likely to be negligible due to the very short period of time they spend underwater (U.S. Department of the Navy 2020). Deeper-diving species which spend longer periods of time underwater (e.g. auks) may be most at risk of exposure to high-intensity noise from seismic survey and consequent injury or disturbance, but all species which routinely submerge in pursuit of prey and benthic feeding opportunities (i.e. excluding shallow plunge feeders) may be exposed to anthropogenic noise. A full list of relevant species occurring in the UK is provided in Box 4.1.

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

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.

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

McCauley (1994) inferred from vocalisation ranges that the threshold of perception for low frequency seismic noise in some species (e.g. penguins, considered as a possible proxy for auk species) would be high, hence individuals might be adversely affected only in close proximity to the source. An investigation of seabird abundance in Hudson Strait (Atlantic seaboard of Canada) during seismic surveys over three years (Stemp 1985); comparing periods of shooting and non-shooting, no significant difference was observed in abundance of fulmar, kittiwake and thick-billed murre (Brünnich's guillemot). Pichegru *et al*. (2017) used telemetry data from breeding African penguins to document a shift in foraging distribution concurrent with a 2D seismic survey off South Africa. Pre/post shooting, areas of highest use (indicated by the 50% kernel density distribution) bordered the closest boundary of the survey; during shooting, their distribution shifted away from the survey area, with areas of higher use at least 15km from the closest survey line. However, insufficient information was provided on the spatio-temporal distribution of seismic shooting or penguin distribution to determine an accurate displacement distance. It was reported that penguins quickly reverted to normal foraging behaviour after cessation of seismic activities, suggesting a relatively short-term influence on these birds' behaviour and/or that of their prey (Pichegru *et al*. 2017).

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

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

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

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

5 Assessment

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

5.1 Relevant sites

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

Shell Flat and Lune Deep SAC

The Shell Flat and Lune Deep SAC is characterised by a deep water channel (Lune Deep) and a large sandbank feature (Shell Flat) at the mouth of Morecambe Bay surrounded by shallower areas to the north and south. The reef habitat present in the Lune Deep represents a good example of boulder and bedrock reef with the northern edges of the channel characterised by heavily silted cobble and boulder slopes, subject to strong tidal currents with a dense hydroid and bryozoan turf (Emblow 1992) including the bryozoans *Flustra foliacea* and *Eucratea loricata*, the hydroids *Nemertesia* spp. and *Hydrallmania falcata*, and the erect sponge *Haliclona oculate* (O'Dell *et al.* 2016). It was noted in a recent video survey (O'Dell *et al.* 2016) that the non-native *Molgula manhattensis* was prevalent, however the supplementary advice on conservation objectives[33] notes that there are problems with the taxonomy of this species which may be the native *Molgula socialis*. It further notes that there is no evidence of the site being impacted by non-native species. This unique enclosed deep provides a contrasting habitat to the surrounding muddy communities of the Eastern Irish Mudbelt. Data from a 2004 survey show that the northern flanks of Lune Deep are composed of exposed bedrock with a rugged seabed physiography. In contrast, the southern flank consists of a smooth seabed which is a sink for muddy sands[34]. Habitat distribution maps show the northern flank supporting moderate and exposed circalittoral rock habitats and the southern flank having mixed substrate biotopes with occasional sand influenced habitats (Envision 2015).

The Shell Flat sandbank forms a continuous structure approximately 15km long from east to west. The bank is an example of a banner bank, which are generally only a few kilometres in length with an elongated pear/sickle-shaped form, located in water depths less than 20m. The predicted distribution of sediment types show the Shell Flat to be dominated by slightly gravelly sand on the top of the bank with slightly gravelly muddy sands in the deeper areas. The fine shallower sediments of the bank are occupied by the *Fabulina fabula* and *Magelona mirabilis* biotope with *Abra alba* and *Nucula nitidosa* biotope occurring in the deeper and slightly muddier sediments found on the slopes and in deeper areas of the bank (Envision 2015). Shell

[33] https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK0030376
[34] http://publications.naturalengland.org.uk/file/3275848

Flat is known to provide important habitats for commercial fish species and bird populations and overlaps with the Liverpool Bay SPA. Density estimates of the distribution of qualifying features within the SPA, indicate that the Shell Flat area coincides with high densities of overwintering common scoter in particular (Lawson *et al.* 2016).

The supplementary advice on conservation objectives for the site indicate that for attributes of the site features for which there is evidence (e.g. presence and spatial distribution of biological communities, extent and distribution, non-native species and pathogens, sediment composition and distribution, species composition of component communities, topography, volume, water quality – contaminants) the site features are shown to be in a good condition and/or currently un-impacted by anthropogenic activities. The overall assessment of feature condition for the site[35] is, however, not available.

Liverpool Bay SPA

The Liverpool Bay/Bae Lerpwl SPA is in the east of the Irish Sea, bordering northern England and north Wales, and running as a broad arc from Morecambe Bay to the east coast of Anglesey. The seabed and waters of the site provide an important habitat in the non-breeding season for major concentrations of red-throated divers and sea ducks, notably common scoter, which visit the area to feed on the fish, mollusc and crustacean populations. Annual aerial surveys over winter from 2004-2011 revealed the distribution and abundance of red-throated diver, common scoter and other bird species within the site and adjacent waters (Lawson *et al.* 2016). Red-throated diver were widely distributed throughout the site, with the highest density areas off the north Wales coast, the Wirral, Formby and the mouth of the Ribble Estuary; areas of higher density were also recorded off the Duddon Estuary and south into outer Morecambe Bay. Common scoter were less widely distributed, with two areas of notably high density: off the north Wales coast from Rhos on Sea to the mouth of the Dee estuary, and off Blackpool from Fleetwood south to the mouth of the Ribble Estuary. Peak winter abundance shows large fluctuations between years; mean peak winter abundance estimates across the five years of survey were 1,409 red-throated diver and 57,995 common scoter, in addition to 826 for great cormorant and 160 red-breasted merganser (both named features of the wintering assemblage, representing >1% of the GB population). The site was extended in the north and west in 2017 to include an area identified to support non-breeding little gulls. The highest densities of little gull were consistently located offshore of Blackpool and the Ribble Estuary, close to the 12 nautical mile line (Lawson *et al.* 2016). The site also includes a marine foraging area for terns identified and defined by little terns breeding within The Dee Estuary SPA and the predicted foraging area for common terns breeding within Mersey Narrows & North Wirral Foreshore SPA. These areas add marine habitat extending into the Mersey Estuary, and a small intertidal area abutting the western boundary of The Dee Estuary SPA.

The seabed of the SPA consists of a wide range of mobile sediments. Large areas of muddy sand stretch from Rossall Point to the Ribble Estuary, and sand predominates in the remaining areas, with a concentrated area of gravelly sand off the Mersey Estuary[36]. Tidal currents throughout the Bay are generally weak and this combined with a relatively extended tidal range of 6 to 8m along the Lancashire coastline facilities the deposition of sediments, encouraging mud and sand belts to accumulate.

[35] https://designatedsites.naturalengland.org.uk/Marine/MarineFeatureCondition.aspx?SiteCode=UK0030376
[36] https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9020294

Morecambe Bay and Duddon Estuary SPA

The boundary of the Morecambe Bay and Duddon Estuary SPA was formed in 2017 by the amalgamation of two SPAs (Morecambe Bay SPA and Duddon Estuary SPA); and the addition of a marine foraging area for terns identified and defined by the modelled foraging area for Sandwich terns breeding at Hodbarrow Lagoon. In total, 25 species of waterbirds and seabirds (gulls and terns) are present in qualifying numbers (≥1% of GB/biogeographic population); qualifying assemblages (in any season) of seabirds and waterbirds are present, with the latter including the diving species of eider, goldeneye, red-breasted merganser and great cormorant[37]. While red-throated diver is not listed as a qualifying feature, aerial surveys indicate their presence within the site, particularly off the mouth of the Duddon Estuary.

Morecambe Bay is a large, very shallow, predominantly sandy bay at the confluence of four principal estuaries, the Leven, Kent, Lune and Wyre. The Duddon Estuary is to the north of Morecambe Bay, although directly connected to it by Walney Channel. At low tide vast areas of intertidal sandflats are exposed, with small areas of mudflat, particularly in the upper reaches of the associated estuaries. The sediments of the bay are mobile and support a range of community types, from those typical of open coasts (mobile, well-sorted fine sands), grading through sheltered sandy sediments to low-salinity sands and muds in the upper reaches. Apart from the areas of intertidal flats and subtidal sandbanks, Morecambe Bay supports exceptionally large beds of mussels *Mytilus edulis* on exposed “scars" of boulder and cobble, and small areas of reefs with fucoid algal communities. Of particular note is the rich community of sponges and other associated fauna on tide-swept pebbles and cobbles at the southern end of Walney Channel. Extensive intertidal eelgrass beds are present around Foulney Island and in the south Walney Channel. The Duddon and Ravenglass Estuaries support saltmarsh, intertidal mud and sand communities and sand dune systems with small areas of stony reef.

The common tern feature of Morecambe Bay and Duddon Estuary SPA was retained in the 2017 classification as a matter of Defra policy; the population had declined to be below the selection criteria for the species. Birds were absent from the Foulney Island and South Walney colonies by 2014 (note one AON was observed in 2017), with the counts for common tern at Hodbarrow (average 2015-2019) being 86 individuals, which is considerably lower than the 570 individuals formerly cited in the 1991 Morecambe Bay SPA, and which has been retained to date on the SPA citation.

Ribble and Alt Estuaries SPA

The Ribble and Alt Estuaries SPA comprises two estuaries, of which the Ribble Estuary is the larger, together with an extensive area of sandy foreshore along the Sefton Coast. The site consists of extensive sand- and mud-flats and, particularly in the Ribble Estuary, large areas of saltmarsh. There are also areas of coastal grazing marsh located behind the sea embankments. The highest densities of feeding birds are on the muddier substrates of the Ribble, though sandy shores throughout are also used. The saltmarshes and coastal grazing marshes support high densities of grazing and seed-eating wildfowl and these, together with the intertidal sand- and mud-flats, are used as high-tide roosts. Important populations of waterbirds occur in winter, including swans, geese, ducks and waders. The SPA is also of major importance during the spring and autumn migration periods, especially for wader populations moving along the west coast of Britain. The larger expanses of saltmarsh and areas of coastal grazing marsh support breeding birds during the summer, including large concentrations of gulls and terns. These seabirds feed both offshore and inland, outside the

[37] https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9020326

SPA. In total, 21 species of waterbirds and seabirds (gulls and terns) are seasonally present in qualifying numbers (≥1% of GB/biogeographic population); qualifying assemblages of seabirds (breeding) and waterbirds (over-winter) are present, with the latter including the diving species of common scoter and cormorant[38].

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

Mersey Narrows and North Wirral Foreshore SPA

The site was classified in 2013 for waterbird species and breeding/non-breeding common tern, and non-breeding little gull. The site includes extensive intertidal mud and sandflats, distinct areas of rocky shore and small areas of saltmarsh, covering an area of 2,078ha. The intertidal areas provide important feeding areas, and the site includes the Seaforth Nature Reserve which is a high tide roost site, nesting site for common terns, and a feeding area for little gull. Common terns have also been known to nest outside of the site at Langton Dock and Birkenhead docks.

There is evidence that the waterbird assemblage and breeding common tern abundance, and their connectivity with supporting habitats are in a good condition and/or are currently unimpacted by anthropogenic activities, though recreational disturbance to the wintering assemblage is noted as a potential issue. The abundance of non-breeding little gull and bar-tailed godwit are both considered to be in a poor condition or impacted by anthropogenic activities. A target is set to restore the non-breeding populations of bar-tailed godwit and little gull to 3,344 and 213, from recent counts of 1,408 and 53 individuals, respectively. Many other targets do not have a specific status as they lack evidence to demonstrate whether there are impacts.

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

The Dee Estuary SPA

The Dee Estuary was first classified in July 1985, and the boundaries and site features were revised in December 2009. The 2009 classification included the addition of breeding little tern, common tern and Sandwich tern, and wintering teal, grey plover, dunlin, black-tailed godwit and curlew.

The Dee Estuary lies on the border between England and Wales on the north-west coast of Britain, covering an area of 14,292ha. It is a large, funnel-shaped, sheltered estuary, which supports extensive areas of intertidal sand and mudflats and saltmarsh. Where agricultural reclamation has not occurred, the saltmarshes grade into transitional brackish and swamp vegetation on the upper shore. The site is of major importance for waterbirds; during the winter the intertidal flats, saltmarshes and fringing habitats including coastal grazing marsh/fields, provide feeding and roosting sites for internationally important numbers of ducks and waders; in summer the site supports nationally important breeding colonies of two species of tern. The site is also important during migration periods, particularly for wader populations moving along the west coast of Britain and for Sandwich terns post-breeding.

[38] https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9005103

Common terns, little terns and Sandwich terns exploit food resources provided within the estuary, which also provides a staging post for Sandwich terns beginning their autumn migration.

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

5.2 Assessment of physical disturbance and drilling effects

The conservation objectives of relevant sites that could be impacted by physical disturbance and drilling effects, and information relating to site selection and advice on operations have been considered against the activities in the proposed work programmes for the 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.

Figure 5.1: Sites and areas to be subject to further assessment for physical disturbance and drilling effects in the Eastern Irish Sea

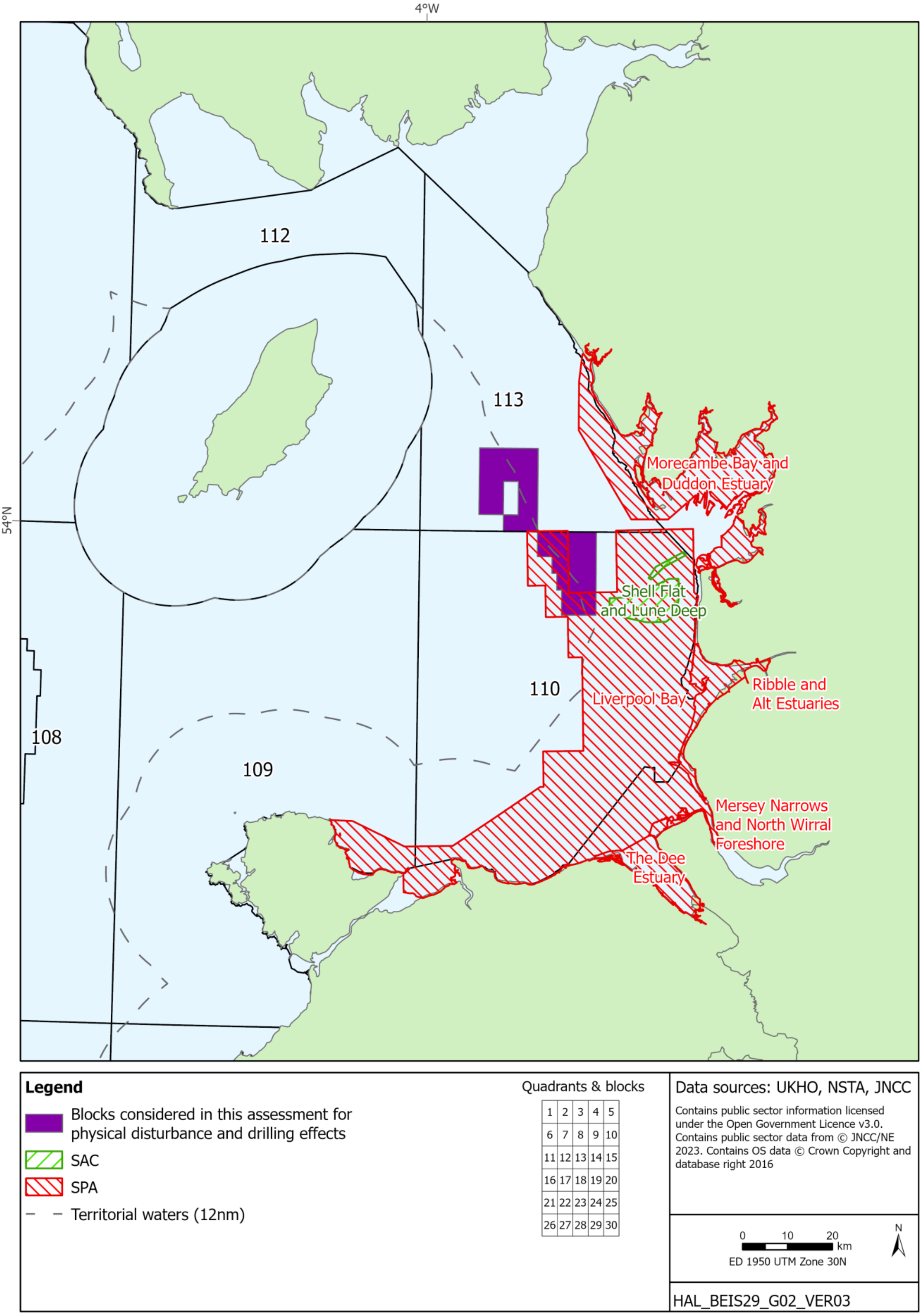


Table 5.1: Consideration of potential physical disturbance and drilling effects and relevant site conservation objectives

Shell Flat and Lune Deep SAC[39]
Site Information
Area (ha/km²): 10,567/105.7 **Relevant qualifying features:** Reefs, Sandbanks which are slightly covered by sea water all the time **Conservation objectives:** The objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the Favourable Conservation Status of its qualifying features, by maintaining or restoring: • the extent and distribution of qualifying natural habitats and habitats of the qualifying species • the structure and function (including typical species) of qualifying natural habitats • the structure and function of the habitats of the qualifying species • the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely • the populations of each of the qualifying species, 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[40].
Relevant Blocks with potential for physical disturbance and drilling effects
110/3b
Activities associated with the proposed work programmes within the relevant licence areas
Drilling up to 1 well involving - siting of rig, drilling discharges
Assessment of effects on site integrity
Rig siting ***Relevant pressures:*** *penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion; physical change (to another seabed/sediment type), introduction or spread of invasive non-indigenous species[41]* The maximum spatial footprint of physical damage associated with jack-up rig siting is small (0.8km²), but the qualifying features are sensitive to disturbance and abrasion pressures. Recovery from physical damage of the scale associated with rig placement would be rapid for Shell Flat in light of typical sandbank communities which are adapted to erosion and accretion; the more stable boulder and bedrock reef of Lune Deep being more sensitive to abrasion/disturbance. Block 110/3b is a minimum of 3km from the site boundary that includes Shell Flat, and is 11.5km from the boundary with Lune Deep. 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 features and adverse effects from rig siting will not occur. Further mitigation measures are available (Section 5.2.1) and will be required, where appropriate, to ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity. The requirement for rig stabilisation measures would be determined by site survey of local conditions. In soft sediments (which includes the circalittoral muds and muddy sands covering the Block), rock placement may cause smothering of existing sediments and a physical change of seabed type. The potential requirement for rig stabilisation measures would be determined by site-specific survey of local conditions that would also inform stabilisation requirements. As the Block applied for is ~3km from the site boundary, there is no foreseeable impacts on the qualifying features of the site, and adverse impacts are not considered to be possible. 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; habitat structure changes - removal of substratum (extraction), smothering and siltation rate changes (light)*

[39] https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK0030376
[40] https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK0030376
[41] https://designatedsites.naturalengland.org.uk/Marine/FAPMatrix.aspx?SiteCode=UK0030376

The qualifying features are sensitive to smothering and siltation rate changes, however it is noted that this is generally low for Lune Deep due to the high degree of natural sediment influence there and relatively high level of recoverability, and also for Shell Flat due to frequent disturbance and recoverability[42]. It is assumed that effects relating to drilling discharges occur within 500m of the well location (Table 2.2) and therefore drilling discharges will not significantly impact the extent and distribution or the structure and function of the qualifying features given the distance of Block 110/3b from the site boundaries (~3km to Shell Flat and ~11.5km to Lune Deep) and its related features, such that site conservation objectives will not be undermined, and there will be no adverse effect on site integrity.

Other effects
N/A

In-combination effects
No intra-plan in-combination effects are likely given that 110/3b is the only Block applied for that is of relevance to the site, is not within the site boundaries, and is at a distance greater than that within which effects would be predicted. Section 5.4 provides a consideration of potential activities in-combination with other relevant plans and projects.

Liverpool Bay SPA[43]
Site Information
Area (ha/km^2): 252,800/2,528 **Relevant qualifying features:** breeding little tern, common tern; over winter red-throated diver, little gull, common scoter, and red-breaster merganser and great cormorant as named assemblage features. **Conservation objectives:** 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. Advice on seasonality for the site[44] indicates the key periods when significant numbers of qualifying interests are present (excluding assemblage features); presence of breeding (April-August) and non-breeding features (September-March) indicate year round presence of qualifying interests. Further relevant information on seasonality is provided below.
Relevant Blocks with potential for physical disturbance and drilling effects
110/3b, 113/27c
Activities associated with the proposed work programmes within the relevant licence areas
Drilling up to 2 wells involving - siting of rig, drilling discharges
Assessment of effects on site integrity
Rig siting ***Relevant pressures:*** *penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion; physical change (to another seabed type), introduction or spread of non-indigenous species*[45] Seabed sediments in Blocks 110/3b and 113/27 (noting that the latter Block has a substantial area outside of the site within which a rig could be sited) are likely to consist of circalittoral fine sand and sandy mud which are widespread in the eastern Irish Sea. Given the assumed distance from a jack-up rig within which effects may

[42] http://publications.naturalengland.org.uk/file/3268971
[43] https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9020294
[44] http://publications.naturalengland.org.uk/file/4591112403812352
[45] http://publications.naturalengland.org.uk/file/5733149452009472 - note that the "pressure" nomenclature has changed since the publication of the Regulation 35 advice for Liverpool Bay SPA. For the purposes of this assessment, they have been reviewed against the current JNCC pressure-activity database (JNCC 2022) and those considered to be relevant are listed and considered above.

occur (500m, see Table 2.2), and that if stabilisation material in the form of rock placement is required it would likely cover an area of 0.001-0.004km^2 and be immediately within the rig footprint, the potential loss of extent of sediment is small compared to the widespread nature of these sediment types across the large site (2,258km^2). Further mitigation measures are available which include use of removable mud mats or anti-scour mats as an alternative to rock placement (Section 5.2.1). Such measures will be required, where appropriate, to ensure that site conservation objectives are not undermined and there is 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.

Blocks 110/3b and 113/27c are partly or entirely within the site and coincide with foraging areas for little gull (Lawson *et al.* 2015) (non-breeding, significant numbers noted March-May and August-November). In the event that a rig is placed within Liverpool Bay SPA, the maximum spatial footprint of physical damage associated with jack-up rig siting is small (0.8km^2) relative to the size of the site, and effects would be temporary, such that the extent and distribution, structure and function of supporting habitat would not be adversely affected. The foraging ranges of common and little terns (mean maximum foraging ranges of 18±8.9km and 5km respectively, Woodward *et al.* 2019) are such that these species are unlikely (common tern) or highly unlikely (little tern) to interact with the relevant Blocks. The common and little tern colonies associated with Liverpool Bay SPA (e.g. at Seaforth Nature Reserve and Gronant, and those in contiguous sites including the Dee Estuary (Shotton Lagoons and Reedbeds) and Morecambe Bay and Duddon Estuary SPA (Hodbarrow, Foulney Island) are at least 17km from the nearest Block (110/3b), noting that the closest colony is for little tern, and that the closest colony for common tern is 22km from the Block. Any effect on the extent, distribution, structure, or function of tern supporting habitat would be temporary in nature and small relative to the overall foraging area encompassed by their range, and adverse effects on the features as a result of such disturbance are not considered to be likely.

The Blocks are located some distance from areas of high common scoter density over winter (Lawson *et al.* 2016), the distribution of which is strongly associated with the distribution of its benthic prey species (Kaiser *et al.* 2006). Wintering red-throated diver occur throughout much of the Liverpool Bay SPA, though with greatest densities off the Ribble Estuary, North Wales, and the North Wirral Foreshore (Webb *et al.* 2006), likely coinciding with sandbanks which support key prey species. Benthic communities of sandy sediments are in general relatively resilient to physical damage. However, repeated damage to the habitats (through changes in suspended sediment or physical disturbance such as anchoring) could adversely affect the ability of the habitats to recover, leading to permanent damage and ultimately lead to loss of prey species. This may result in a reduction in the value of habitats as foraging sites for the overwintering populations of common scoter and red-throated diver. Overall, the vulnerability of overwintering red-throated divers and common scoters in the Liverpool Bay and associated habitats to physical damage (through siltation and abrasion) and loss (through habitat removal and smothering) is considered to be low or moderate. The distribution of the great cormorant and red-breasted merganser assemblage features is also mapped in Lawson *et al.* (2016) as a single figure representing the wintering assemblage. The density surface appears to be dominated by the common scoter feature, however, the densities of all species are low or absent across the Blocks applied for. In view of the physical scale and temporary nature of the activities, and the location of the blocks relative to the habitat used by the common scoter, red-throated diver and named assemblage features (Lawson *et al.* 2016) and the related low densities of birds expected over the Blocks, site conservation objectives will not be undermined as a result of abrasion/disturbance resulting from rig siting or the use of stabilisation materials, and there will be no adverse effect on site integrity.

In view of the physical scale and temporary nature of the activities, and in the context of the above discussion in relation to the habitat use of relevant qualifying interests and their potential for interaction with activities within the Blocks applied for, site conservation objectives will not be undermined as a result of abrasion/disturbance resulting from rig siting or the use of stabilisation materials, and there will be 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)*

It is assumed that effects relating to drilling discharges occur within 500m of the well location (Table 2.2). The maximum spatial footprint within which smothering by drilling discharges may occur (0.8km^2) is small (representing a maximum of 0.03% of the total site area). Physical loss by smothering of any of the habitats on which the qualifying interests depend may result in the loss of foraging sites and therefore the reduction of the food resource for the overwintering population. This would consequently be detrimental to the condition of the interest features. The overwintering populations are considered to be moderately vulnerable to physical loss of habitat through its removal or smothering. However, the small scale (as compared to the extent of supporting habitat) and temporary nature of potential smothering, the distance between the Blocks and the habitat used by all of the relevant features other than little gull, 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
Relevant pressures: *visual disturbance, above water noise*

Of the qualifying features, terns and little gull have a low sensitivity to disturbance by ship and helicopter traffic, while red-throated diver, common scoter and great cormorant are known to be highly sensitive to visual disturbance (Garthe & Hüppop 2004, also see Schwemmer *et al.* 2011, MMO 2018, and Mendel *et al.* 2019, and Section 4.2.6). There is considerable scope for drilling to take place outside of the site boundaries, and considering the seasonal nature of the sensitivity, where necessary, control of timing of offshore activities allows for mitigation, which would be identified once project plans are known. As noted above, the Blocks are some distance from the main areas of habitat use by sensitive species in the site (Lawson *et al.* 2016), and interaction with drilling operations is considered to be unlikely, though there is the potential for interactions with vessel and helicopter traffic. JNCC (2022) provide advice on potential displacement for sensitive species including seaduck and red-throated diver in relation to wind farm development. While the scale and duration of exploration drilling is significantly less than that for the installation of an offshore wind farm, a worst case displacement of up to 4km could be possible for the presence of the drilling rig and any associated vessels, but this should be considered in the context of existing levels of vessel activity in the area (see Section 5.4, Figure 5.5). The temporary and localised nature of drilling activities and limited number of associated supply vessel and helicopter trips (see Table 2.2), which would likely use established routes, are such that they will not likely lead to an impact on the qualifying features' distribution and use of the site such that the population within the site would be affected in the long-term. Additionally, there is the potential for mitigation by considering seasonal effects at the project level (Section 5.2.1). It is not considered that the licensing of Blocks 110/3b and 113/27c on their own, and the related level of vessel and helicopter traffic and potential displacement, would lead to adverse effects on site integrity through displacement of red-throated diver, common scoter, great cormorant, or red-breasted merganser.

In-combination effects
Intra-plan in-combination effects are possible although spatial footprints associated with rig installation and drilling discharges in the Blocks, which are both partly within the site, are localised and temporary, and unlikely to overlap between areas applied for either spatially or temporally. The combined spatial footprint within which physical disturbance and drilling effects could occur (within 500m of the rig/well location) across the two Blocks applied for (a worst-case scenario that 2 wells are drilled) is estimated at 1.6km^2 (<0.06% of the site area); note that there is considerable potential that a rig could be sited within either Block, but outside of the site boundaries. Additionally, visual disturbance effects are considered to be unlikely as the Blocks are not located within the habitat of sensitive qualifying interests, and support traffic is unlikely to represent a significant increment given the use of established ports and also likely routes to the Blocks, noting that existing oil and gas activity takes place in adjacent licenced areas. The temporary nature of the disturbance, the mobile nature of the qualifying features and mandatory control (Section 2.3.1), and other measures (Section 5.2.1) will ensure that site conservation objectives are not undermined. Section 5.4 provides a consideration of potential activities in-combination with other relevant plans and projects.

Morecambe Bay and Duddon Estuary SPA[46]

Site Information

Area (ha/km^2): 66,899/669
Relevant qualifying features: breeding common tern, Sandwich tern, little tern; over winter whooper swan, little egret, golden plover, ruff, bar-tailed godwit, Mediterranean gull, lesser black-backed gull, herring gull; On passage: pink-footed goose, shelduck, oystercatcher, ringed plover, grey plover, knot, sanderling, dunlin, black-tailed godwit, curlew, pintail, turnstone, redshank, lesser black-backed gull. Seabird (including herring gull,

[46] https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9020326

lesser black-backed gull, Sandwich tern, common tern, little tern) and waterbird (including great egret, spoonbill, brent goose, wigeon, teal, mallard, common eider, goldeneye, red-breasted merganser, great cormorant, lapwing, little stint, common greenshank, spotted redshank) assemblage all year round. **Conservation objectives:** Subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring: • the extent and distribution of the habitats of the qualifying features • the structure and function of the habitats of the qualifying features • the supporting processes on which the habitats of the qualifying features rely • the populations of qualifying features, and • the distribution of qualifying features within the site Attributes and related targets have been set for the site features which are presented in the site SACO[47]. These include a number of targets to restore the supporting habitat and breeding populations of gull and tern species, and non-breeding populations of grey plover, dunlin, sanderling and turnstone. Advice on seasonality for the site[48] indicates the key periods when significant numbers of qualifying interests are present (excluding assemblage features); presence of breeding (March-August) and non-breeding features (July-May) indicate year round presence of qualifying interests. Further relevant information on seasonality is provided below.
Relevant Blocks with potential for physical disturbance and drilling effects
110/3b, 113/27c
Activities associated with the proposed work programmes within the relevant licence areas
Drilling up to 2 wells involving - siting of rig, drilling discharges
Assessment of effects on site integrity
Rig siting ***Relevant pressures:*** *penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion; physical change (to another seabed/sediment type), introduction or spread of non-indigenous species*[49] Blocks 110/3b and 113/27c are 8km and 9.5km respectively 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 distribution of the habitats of the qualifying features within the site, and no adverse effects on site integrity are predicted. The distance between the Blocks and colonies for little tern is greater than the mean maximum foraging ranges of the species (5km, Woodward *et al.* 2019), and no effects are predicted. Block 110/3b is within the mean maximum foraging range of common tern (18km) and Sandwich tern (34.3km) colonies, which are known to be located at Foulney Island and Hodbarrow, however, the Block is only just within the range of common tern, and in view of the considerable area of the Block within which a rig could be sited, interaction with breeding common tern may be avoided; Block 113/27c is only within the mean maximum foraging range of Sandwich tern. Any effect on the extent, distribution, structure, or function of tern supporting habitat would be temporary in nature and small relative to the overall foraging area encompassed by their range, and adverse effects on the features as a result of such disturbance are not considered to be likely. There may be a requirement for rig stabilisation depending on local seabed conditions (The Blocks are within the eastern Irish Sea Mudbelt). It is assumed that rig stabilisation in the form of rock placement (if required) would be within the immediate vicinity of the rig and cover an estimated area of 0.001-0.004km^2 per rig siting (Table 2.2). Given that the closest Block is at least 8km from the site boundary (110/3b), the potential loss of extent of any supporting habitat outside of the site boundaries would be small compared to the extent of the circalittoral mud habitat across the Block and the wider region. It is concluded 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.

47 https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK9020326
48 https://designatedsites.naturalengland.org.uk/Marine/Seasonality.aspx?SiteCode=UK9020326
49 https://designatedsites.naturalengland.org.uk/Marine/FAPMatrix.aspx?SiteCode=UK9020326

Drilling discharges
Relevant pressures: *abrasion/disturbance of the substrate on the surface of the seabed, changes in suspended solids (water clarity); smothering and siltation rate changes (light); physical change (to another sediment type), habitat structure changes – removal of substratum (extraction) and contaminants)*

It is assumed that effects relating to drilling discharges occur within 500m of the well location (Table 2.2). Therefore, drilling discharges will not significantly impact the extent and distribution or the structure and function of the habitats of the qualifying features for any Blocks identified as relevant as these are at least 8km from the site boundaries. For those species which may be present beyond the site boundaries, the small scale and temporary nature of potential smothering, 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
Relevant pressures: *visual disturbance, above water noise*

Blocks 110/3b and 113/27c are not located within the site and are at least 8km from its boundaries, and the potential for disturbance to impact the distribution of qualifying features is therefore primarily associated with the movement of supply vessels and helicopters to drilling rigs. Of the qualifying features likely to be present within the site, breeding common tern (May-August), Sandwich tern (April-August), lesser black-backed gull (all year) and herring gull (March-August) are not considered to be sensitive to disturbance by ship and helicopter traffic (Garthe & Hüppop 2004, Fliessbach *et al.* 2019). For all the other wintering species, should supply vessels transit the site, this would likely be due to their association with a relevant port, to which the additional traffic (2-3 trips per week) would be minor. Both Blocks 110/3b and 113/27c are currently exposed to high shipping densities, and the temporary nature of drilling activities and limited number of associated supply vessel and helicopter trips (Table 2.2), is unlikely to represent a significant increase in the level of disturbance to the qualifying features. Further control measures are also available (Section 5.2.1) and will be required, where appropriate, to ensure that site conservation objectives are not undermined and there is no adverse effect on site integrity.

In-combination effects
No intra-plan in-combination effects are likely given the distance between the Blocks applied for and the site, that no effects on the supporting habitat of the majority of species will occur, and that where activities could interact with Sandwich or common tern species and their foraging habitat, that the assumed scale and duration of physical impacts related to drilling are small relative to the overall available foraging habitat of the species. Section 5.4 provides a consideration of potential activities in-combination with other relevant plans and projects.

5.2.1 Further physical disturbance and drilling mitigation measures

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

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

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

5.2.2 Conclusions

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

5.3 Assessment of underwater noise

The site conservation objectives and other relevant information relating to site selection and advice on operations has been considered against indicative work programmes (see Section 2.2.1) to determine whether they could adversely affect site integrity. No new seismic surveys have been proposed in the Block work programmes (Table 2.1) which are relevant to the assessment for this site. Sites relevant to this part of the assessment are shown in Figure 5.2 and the results are given in Table 5.2 below. All mandatory control requirements (as given in Section 2.3.2) are assumed to be in place as a standard for all activities assessed at this stage.

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

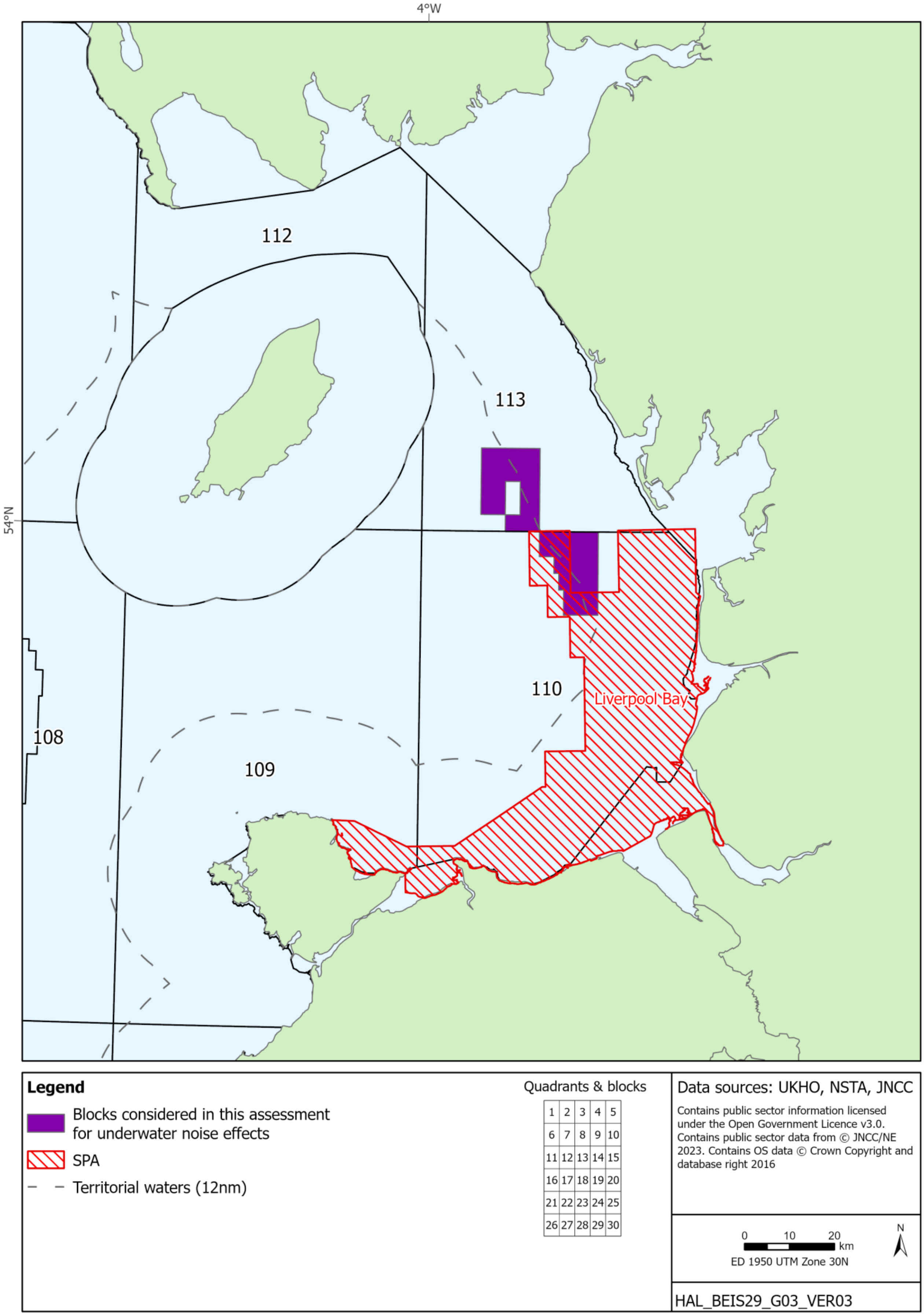


Table 5.2: Consideration of potential underwater noise effects and relevant site conservation objectives

Liverpool Bay SPA
Site Information
Area (ha/km^2): 252,800/2,528 **Relevant qualifying features**; over winter red-throated diver, common scoter, and red-breaster merganser and great cormorant as named assemblage features. **Conservation objectives:** See Table 5.1above.
Relevant Blocks with potential for underwater noise effects
110/3b, 113/27c
Assessment of effects on site integrity
A large proportion of Block 110/3b, and a very small part of Block 113/27c, overlap the site. The areas within Liverpool Bay SPA identified as supporting the highest densities of red-throated diver and common scoter are to the south and east of Blocks 110/3b and 113/27c (Lawson *et al.* 2016). While the distribution of these mobile species within the site will vary, there appears to be no or limited spatial overlap between the Blocks and those areas of greatest importance for these features and therefore there is a low potential for underwater noise effects. The distribution of great cormorant within the site during winter shows the majority of birds to occur in inshore areas which do not overlap with the relevant Blocks, including the adjacent bays and estuaries from Morecambe south to the Dee Estuary (Kober *et* al. 2010), while red-breasted merganser also favours inshore waters. **Impulsive noise (rig site survey, VSP, conductor piling)** *(**Relevant pressures:** underwater noise change, vibration)* As detailed in Section 4.3.2, there is very little evidence of impacts of underwater noise on diving birds. Mortality of seabirds has not been observed during extensive seismic operations in the North Sea and elsewhere, and flushing disturbance associated with the physical presence of survey vessels and rigs would be expected to displace most diving seabirds from close proximity to noise sources, particularly in the case of divers and scoters which are known to display a large avoidance radius of vessels and surface infrastructure (up to several kilometres – see Sections 4.2.6 and 5.2). Such avoidance behaviour is also expected to reduce the potential for diving birds to be exposed to noise levels which may result in potential behavioural disturbance, although it is noted that very little evidence for such effects exist and, should they occur, they would be expected to be short-term, temporary and of limited spatial extent. Considering the seasonal nature of the sensitivity, where necessary, control of timing of offshore activities allows for mitigation, which would be identified once project plans are known. Negative indirect effects of impulsive noise on qualifying features may arise through effects on prey species, primarily small fish, if those prey are subject to injury or disturbance which reduce their availability to qualifying seabirds. Such effects relate to the primarily piscivorous red-throated diver, as the winter diet of common scoter is largely restricted to sessile bivalves on the seabed (Fox 2003). While there is some evidence that a reduction in fish catches or abundance can be associated with seismic survey activity, these are temporary in nature, and the sensitivity of the relevant prey species to underwater noise is considered to be generally low. The disturbance of sensitive spawning periods will be considered through the activity consenting process. As such, any underwater noise effects on fish associated with licensing Blocks 110/3b and 113/27c are not anticipated to result in significant effects on the food resources of the qualifying diving bird features. Considering the limited potential for effects of 2D/3D seismic survey on diving birds identified above and in Section 4.3.2, and the lower amplitude, shorter duration and smaller geographic footprint associated with other impulsive noise such as VSP, rig site survey and conductor piling (noting that no new seismic survey has been proposed in the Block work programmes), any disturbance to qualifying features or their prey will be highly localised, short-term, and will not result in an adverse effect on the integrity of the site. **Continuous noise (drilling, vessel & rig movements)** *(**Relevant pressures:** underwater noise change, vibration)* No significant effects on the relevant qualifying species are anticipated from continuous underwater noise from drilling and vessel movements due to the lower amplitude and non-impulsive nature of the sound resulting in no potential for acute trauma and no evidence of significant disturbance to diving birds from such sources.

In-combination effects
Intra-plan in-combination underwater noise effects are considered highly unlikely given the low potential for effects identified above, that there is limited overlap between the Blocks and the habitats used by the species considered to be most sensitive to underwater noise, and the potential to time activities to avoid intra-plan in-combination effects. Section 5.4 provides a consideration of potential Block activities in-combination with other relevant plans and projects.

5.3.1 Further underwater noise mitigation measures

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

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

5.3.2 Conclusions

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

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

5.4 In-combination effects

Potential incremental, cumulative, synergistic, and secondary effects from a range of operations, discharges and emissions (including noise) were considered in the latest Offshore Energy SEA (BEIS 2022). There are a number of potential interactions between activities that may follow licensing and those existing or planned activities, for instance in relation to renewable energy, offshore oil and gas and gas storage, fishing, shipping, and aggregate extraction. These activities are subject to individual permitting or consenting mechanisms or are otherwise managed at a national level. The Blocks applied for are located within the North West Marine Plan Areas. These plans set out objectives and policies to guide development in these areas, and are referred to where relevant, in the following sections.

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

Sources of potential effect

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

The principal sources of in-combination effects are regarded to be related to noise, physical disturbance, and physical presence, primarily arising from offshore wind development. OWF development will introduce noise and disturbance sources (particularly during construction) and present an additional physical presence in the marine environment. Offshore wind zones (e.g. those associated with Rounds 3 and 4) have already been subject to SEA and plan-level HRA, and any related projects have been, or will be, subject to their own individual assessment and HRA processes[50].

The UK Government believes that the oil & gas and the renewables industry can successfully co-exist, as stated in Other Regulatory Issues[51], "…*we advise that potential applicants on such blocks [(areas where oil and gas licenses and proposed or actual wind farm sites exist and indeed overlap)] should make early contact with the holders of any relevant wind farm lease or Agreement for lease (AfL), or the relevant zone developer(s), and establish in good time a mutual understanding of the respective proposals and time frames envisaged (acknowledging that not all aspects of the future plans of either side will necessarily be definitively decided at that time)*". Early discussions between the developers will ensure that any potential conflict can be mitigated so that both developments can proceed with minimal delay and without the

[50] 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. A review of consents for SPAs relevant to the Irish Sea is ongoing. See: https://www.gov.uk/government/consultations/southern-north-sea-review-of-consents-draft-habitats-regulations-assessment-hra and https://www.gov.uk/government/consultations/review-of-consents-for-major-energy-infrastructure-projects-and-special-protection-areas-2022

[51] See: https://www.gov.uk/guidance/oil-and-gas-offshore-environmental-legislation#offshore-oil-and-gas-exploration-production-unloading-and-storage-environmental-impact-assessment-regulations-2020, Quadrant/Block Specific Issues (version at September 2022).

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)[52], 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 policies of the North West Marine Plans, including NW-CO-1 and NW-OG-1/OG-2 which indicate a preference for projects that optimise their use of space and consider co-existence opportunities, and safeguard existing seaward oil and gas licences and future discoveries from new proposals respectively.

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

Relevant project	Project summary	Project status/indicative timing	Relevant sites[1]
Offshore renewables and interconnectors			
Walney Offshore Wind Farm (OWF)	Located approximately 14km from the Cumbrian coast, the project area contains 101 turbines with an overall installed capacity of 367MW. The export cable landfalls are near Heysham and Fleetwood.	In-operation	Liverpool Bay SPA
Walney extension OWF	Located approximately 19km from the Cumbrian coast, and to the north west of the Walney I and II windfarms, the extension is due to have an installed capacity of 659MW generated from 87 turbines. The export cables are routed to the south of the Walney and West of Duddon Sands wind farms and have a landfall near Heysham.	In-operation	Liverpool Bay SPA
West of Duddon Sands OWF	West of Duddon Sands is located approximately 14km offshore, and contains 108 turbines, with an overall installed capacity of 389MW. The export cable landfall is at Heysham.	In-operation	Liverpool Bay SPA
Barrow OWF	Located approximately 7km from the Cumbrian coast, the project area contains 30 turbines and together have an overall installed capacity of 90MW. The wind farm export cable runs in parallel with those of the Ormonde, West of Duddon sands and Walney I offshore wind farms in the nearshore, having its landfall near Heysham.	In-operation	Liverpool Bay SPA
Burbo Bank OWF	Located approximately 7km from the coast, with a cable landfall at Wallasey. Has an installed capacity of 90MW generated by 20 turbines.	In-operation	Liverpool Bay SPA
Burbo Bank extension OWF	Located approximately 7km from the coast, with a cable landfall between Rhyl and Prestatyn. Has an installed capacity of 258MW generated by 32 turbines.	In-operation	Liverpool Bay SPA

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

Relevant project	Project summary	Project status/indicative timing	Relevant sites[1]
Gwynt y Môr OWF	Located approximately 13km from the coast, with a cable landfall at Pensarn. Has an installed capacity of 574MW generated by 160 turbines. The Crown Estate has indicated an extension with an installed capacity of up to 576MW has been applied for.	In-operation	Liverpool Bay SPA
Awel y Môr OWF	The proposed wind farm is located immediately to the west of Gwynt y Môr, and may include 34-50 turbine. The overall capacity of the wind farm has not been set.	In-planning	Liverpool Bay SPA
North Hoyle OWF	Located approximately 7km from the coast, with a cable landfall at Rhyl. Has an installed capacity of 60MW generated by 30 turbines.	In-operation	Liverpool Bay SPA
Rhyl Flats OWF	Located approximately 8km from the coast, with a cable landfall at Towyn. Has an installed capacity of 90MW generated by 25 turbines.	In-operation	Liverpool Bay SPA
Round 4 preferred project area 5 (Morecambe)	The proposed project area covers 126km^2 and has a potential installed capacity of 480MW. No firm project plans, including the scale and number of turbines or any export cable route, have been made.	Pre-planning	Liverpool Bay SPA
Gas storage			
Carbon Storage Licence CS004	The carbon storage licence was awarded in 2020 for an appraisal period of six years, with site characterisation due to be completed by 2023.	Pre-planning	Liverpool Bay SPA
Bains gas storage licence	A gas storage licence was awarded for in April 2023 covering the depleted Bains gas storage field. At this stage, the proposed work programme includes only desk-based studies.	Pre-planning	Liverpool Bay SPA
1st Carbon Storage round licence provisional awards	One licence was issued in the eastern Irish Sea as part of the 1st Carbon Storage licensing round. The licence covers an appraisal term which includes seismic survey and the drilling of wells. No details of any potential development are presently known, or are likely to be known for some time, should the licence proceed past the appraisal term.	Pre-planning	Liverpool Bay SPA
Oil and gas, including decommissioning			
Morecambe gas fields	The Morecambe Hub incorporates a number of manned and unmanned platforms and export infrastructure which is processed at the Barrow gas terminal.	In operation	Liverpool Bay SPA
South Morecambe decommissioning project	The decommissioning programme for South Morecambe DP3 and DP4 involved the removal of topsides and jackets to shore, with buried pipelines remaining *in situ*, and exposed sections being removed.	Completed	Liverpool Bay SPA

Relevant project	Project summary	Project status/indicative timing	Relevant sites[1]
Aggregate areas			
Aggregate areas 393 and 1808	As part of the wider north west region, 3.44km^2 were actively dredged in 2021, representing 3.97% of the total licensed area, with 90% of effort in 1.82km^2. Dredging intensity in the 393 area is considered to be high, covering 0.12km^2, with the wider remaining area being low to moderate. Area 1808 is an exploration and option area immediately to the north of area 393 and no data is presently available on the scale of potential aggregate extraction that could take place.	Active production areas	Liverpool Bay SPA

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

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

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

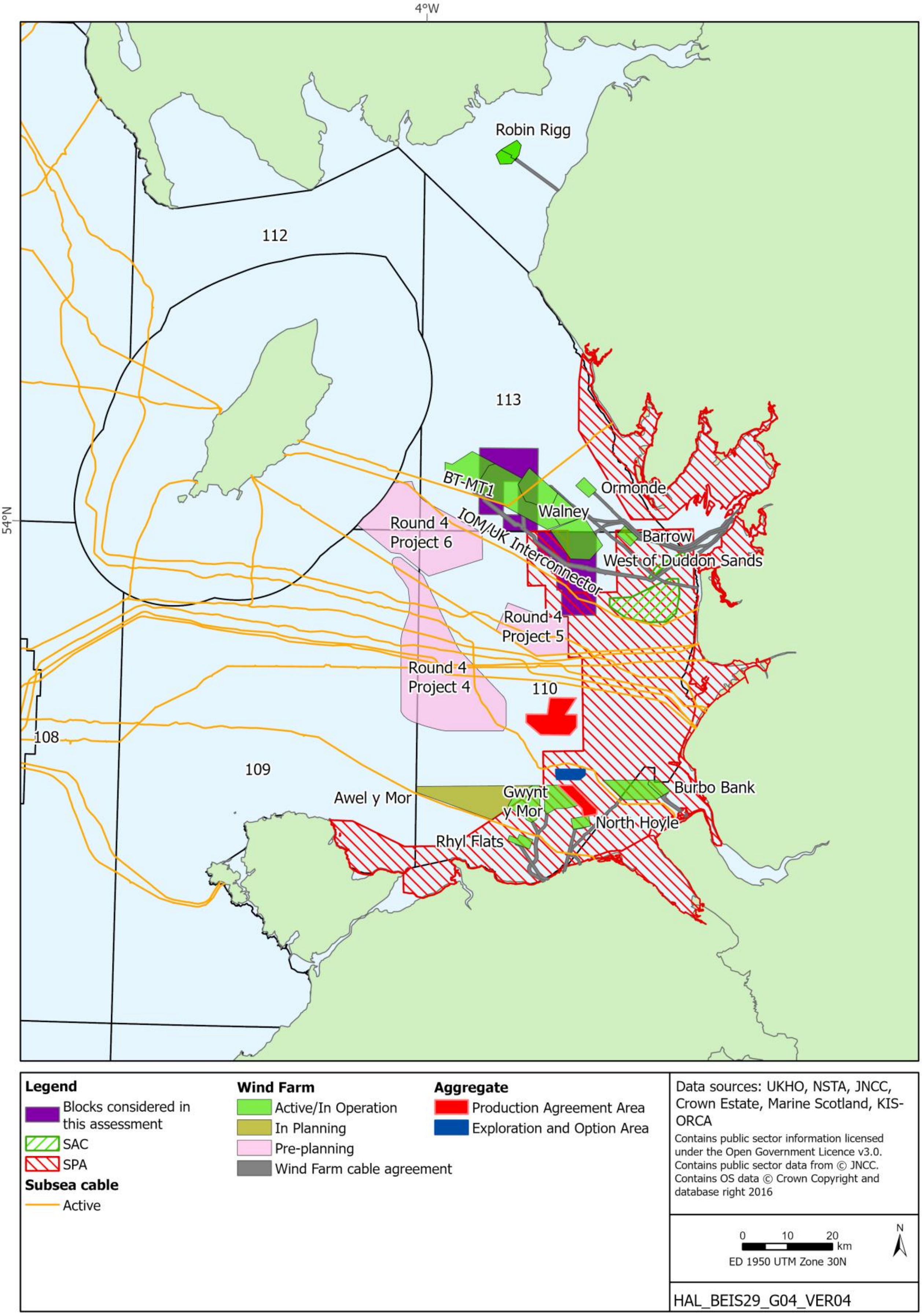


Figure 5.4: Location of areas applied for in relation to other projects (continued)

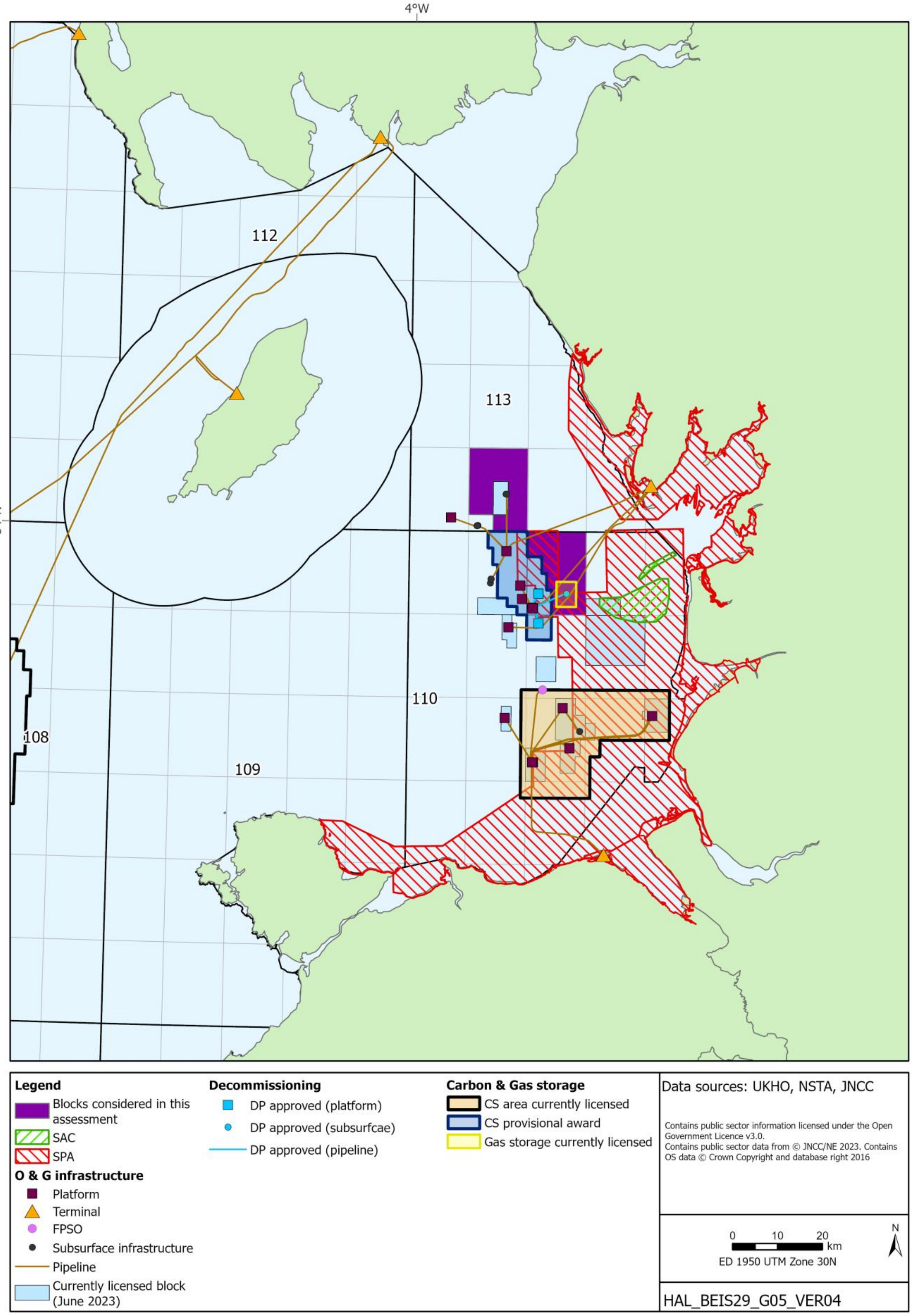
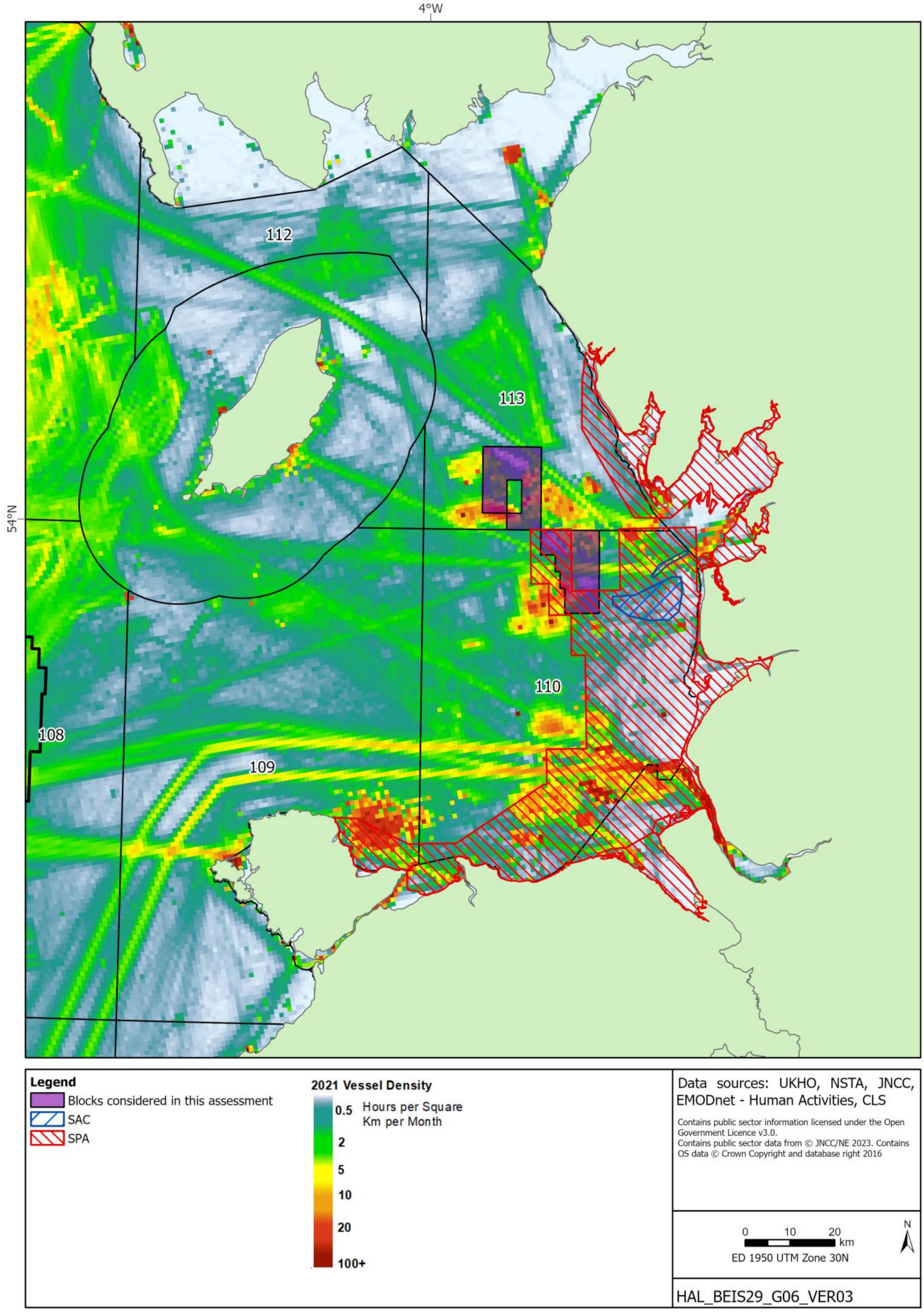


Figure 5.5: Vessel traffic in the Eastern Irish Sea



5.4.1 Physical disturbance and drilling effects

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

Oil and gas infrastructure associated with the Morecambe Hub is located immediately adjacent to Block 110/3b and 113/27c; two unmanned platforms associated with the South Morecambe field, DP3 and DP4, were removed in 2021 (Figure 5.4) but no further decommissioning plans have been submitted for other installations associated with the hub. The Morecambe field installations are well-established, and in the absence of any further project plans for the fields, in-combination effects on the Liverpool Bay SPA from the drilling on a single well in either Block are not anticipated. Carbon storage licence CS004 is 17km to the south of Block 110/3b and partly overlaps Liverpool Bay SPA. As noted in Table 5.3, the appraisal work programme covered by this licence should be complete in 2023, and therefore any potential temporal overlap with activities associated with the Blocks applied for is not expected, such that in-combination effects will not occur. A provisional licence, EIS Area 1 (see DESNZ 2023b), was applied for in the 1st Carbon Storage Round and was subject to HRA in relation to an overlap with the Liverpool Bay SPA, and in particular, the area used by wintering little gull[53]. EIS Area 1 is located immediately adjacent to Blocks 110/3b and 113/27c and has a proposed work programme that includes the drilling of up to one appraisal well. In view of the likely temporal and spatial separation between the work programmes proposed for EIS Area 1 and the Blocks relevant to this assessment, and the temporary and limited spatial scale of any effect (see Table 2.2 and also Table 5.1 in relation to the assessment of Liverpool Bay SPA), adverse in-combination effects are not predicted in relation to the distribution and extent, structure and function of the site's supporting habitat. As part of the Net Zero Strategy, the Government set out its ambition to deliver four carbon capture usage and storage (CCUS) clusters, capturing 20-30 $MtCO_2$ across the economy, including 6 $MtCO_2$ of industrial emissions, per year by 2030, and 9 $MtCO_2$ per year by 2035. HyNet is one of the Track-1 clusters, as part of the CCUS cluster sequencing process. Developed alongside hydrogen, CCUS will be part of creating transformative "SuperPlaces" in areas such including the North West. The storage of carbon dioxide associated with these Track-1 clusters, and any future projects, may take place in any of the currently leased/licensed carbon dioxide storage areas, and in view of the targets set out in the Net Zero strategy, development of these stores should be anticipated over the next decade and beyond.

A gas storage licence was awarded in April 2023 covering the depleted Bains gas field (Figure 5.4), which ceased producing in 2017, and for which a decommissioning programme has been approved. The gas storage licence area overlaps with Block 110/3b; the proposed work programme in the gas storage application only includes desk-based activities, and at this stage, no field activities are proposed to take place. While development of the field for gas storage could take place at some point in the future, the nature and timing of any such activities are not known at this time. The decommissioning programme for Bains includes well decommissioning involving a jack-up rig, the removal of the subsea installation, and the leaving *in situ* of pipelines and umbilicals other than for exposed sections. The well was plugged and abandoned in 2019, however, the other subsea activities are yet to take place. Where there is the potential for decommissioning activities and 33rd Round activities to temporally overlap,

[53] https://www.gov.uk/government/consultations/1st-offshore-carbon-dioxide-storage-licensing-round-appropriate-assessment

spatial overlap is considered unlikely, and there is considerable scope to avoid any interaction through activity timing.

A number of offshore wind farms are located partly or wholly within Liverpool Bay SPA (Figure 5.3), as is one Round 4 preferred project. To date, wind farms in the eastern Irish Sea have been installed using fixed monopile foundations, with inter array and export cables trenched and buried, and subject to cable protection where necessary; future cables should be installed in keeping with North West Marine Plan policy NW-CAB-1, such that burial is preferred. Blocks 110/3b and 113/27c overlap an area of Liverpool Bay SPA which was extended to cover the distribution of wintering little gull. While no project level details are available for Round 4 preferred project 5, the plan level HRA for Round 4 concluded that, with the exception of collision risk, all other pressures would lead to a negligible impact on the little gull population, and adverse effects were discounted both alone and in-combination with other plans and projects. The drilling of one well in either of the Blocks applied for, which could have a maximum area of disturbance of 1.6km^2 and noting that there is substantial scope to site a rig outside of the site boundaries, is unlikely to significantly contribute to physical disturbance of the supporting habitat for the little gull feature of Liverpool Bay SPA in-combination with currently operating wind farms, or the preferred Round 4 project 5.

With respect to drilling discharges, previous discharges of WBM cuttings in the UKCS have been shown to disperse rapidly and to have minimal ecological effects (See Section 4.2, also see individual site assessments in Section 5.2). Dispersion of further discharges of mud and cuttings could lead to localised accumulation in areas where reduced current allows the particles to accumulate on the seabed. The potential for in-combination effects relating to chemical usage and discharge from exploratory drilling is limited by the existing legislative and permitting controls that are in place (see Section 2.3.1 and 5.2.1), which the UK Marine Strategy[54] has identified as relevant measures contributing to managing discharges. Discharges are considered to have negligible in-combination effect (BEIS 2022).

Fishing, and particularly bottom trawling, have historically contributed to seabed disturbance over extensive areas and was identified as an ongoing issue in the UK assessment of good environmental status[55]. 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, though no bylaws within Liverpool Bay SPA have been proposed to date, with the exception of any overlap with Shell Flat and Lune Deep SAC (also see the MMO call for evidence on stage 2 draft fisheries assessments[56]). Whilst fishing may be linked to historical damage to site features, and presents a continuing risk to these, recent, ongoing, and future management measures should limit the potential for in-combination effects with other activities. When any surface structure (fixed and floating installations) used for exploration/appraisal drilling becomes operational, a safety zone with a radius of 500m is created under an amendment to the *Petroleum Act 1987* made by the *Energy Act 2008* and other activities are excluded from taking place within the zone, including fisheries. Safety zones apply to mobile drilling rigs and are notified to other users of the sea (e.g. through notices to mariners and Kingfisher charts). In view of the

[54] https://www.gov.uk/government/consultations/marine-strategy-part-three-programme-of-measures Note that the updated programme of measures was due to be published by the end of 2022, but is not available at the date of this assessment.
[55] https://consult.defra.gov.uk/marine/updated-uk-marine-strategy-part-one/supporting_documents/UKmarinestrategypart1consultdocumentfinal.pdf
[56] https://consult.defra.gov.uk/mmo/call-for-evidence-stage-2/supporting_documents/MMO%20Call%20for%20Evidence%20on%20Stage%202%20Draft%20MPA%20Fisheries%20Assessement%20Background%20%20May%202022.pdf

differences in relative scale of physical impacts resulting from trawling and from oil and gas exploration/appraisal (both spatially and temporally), significant incremental effects following the licensing the two Irish Sea Blocks are not predicted.

5.4.2 Physical presence

Physical presence of offshore infrastructure and support activities may potentially cause behavioural responses in fish, birds, and marine mammals (see Section 5.6 of BEIS 2022 and Section 4.2). 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, including those which are planned for the area of the eastern Irish Sea (Figure 5.4). Additional in-combination physical presence effects are possible with proposed wind farm project extensions (Awel y Môr) and/or any projects arising from Round 4 of wind leasing. As noted above, plan level HRA has been completed for both the extension projects and Round 4 preferred projects, and any subsequent projects will be subject to their own HRA processes.

As noted above, the area of Liverpool Bay SPA which is most relevant to the Blocks applied for relates to the wintering little gull feature of the site, which are not considered to be particularly vulnerable to disturbance by shipping (Fliessbach *et al.* 2019). Support vessels could potentially traverse Liverpool Bay SPA, which has the potential to result in incremental disturbance to species which are sensitive to vessels, including red-throated diver, common scoter, red-breasted merganser and great cormorant, however, the increment of two to three vessels per week to existing vessel traffic associated with gas field support, and wind farm operations and maintenance, and assuming that vessels would follow established routes, is not considered to be significant (see Figure 5.5), or would be completely avoided if activity took place outside of the wintering period. It is not regarded that the temporary addition of a drilling rig and associated shipping of a scale outlined in Table 2.2 will lead to adverse in-combination effects on site integrity for any of the relevant sites considered in this AA for which physical presence was identified as a potential source of likely significant effect (see Table 1.1).

5.4.3 Underwater noise effects

A number of projects are relevant to the consideration of in-combination underwater noise effects with activities which may follow the licensing of the Blocks applied for (Table 5.3). The associated activities can generate noise levels with the potential to result in disturbance or injury to animals associated with relevant sites (see BEIS 2022). Here, we focus attention on diving birds, these being the most sensitive feature to underwater noise considered in this AA for the eastern Irish Sea.

The majority of wind farm projects listed in Table 5.3 are in operation, and the major noise sources for such projects is during construction (e.g. pile driving, UXO disposal). Of the remaining wind farm projects (Awel y Môr, Round 4 preferred project 5), the timescales for their consenting and construction are such that temporal overlap with wind farm construction activities and the work programmes of the Blocks applied for (noting no new seismic survey is proposed in the work programmes) are highly unlikely. There is the potential for seismic surveys to take place in areas covering parts of the Blocks applied for, or in areas close to or adjacent to these, under non-exclusive exploration licences. 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. Such surveys would be a consideration of any project level in-combination effects assessment.

In addition to those activities which may follow licensing of Blocks 110/3b and 113/27c 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) noise-producing activities in overlapping or adjacent areas. Despite this, the Department is not aware of any projects or activities which are likely to cause cumulative and in-combination effects that, when taken in-combination with the potential number and scale of activities likely to result from the licensing of the areas applied for (Section 2.2), would adversely affect the integrity of the relevant sites. This is due to the presence of effective regulatory mechanisms (Section 5.2 and also Appendix 3 of BEIS 2022) which ensure that operators, the Department, and other relevant consenting authorities take such considerations into account during activity permitting. These mechanisms generally allow for public participation in the process[57].

5.4.4 Conclusion

While exploration activity is identified as a pressure to which the relevant sites are sensitive (e.g. from physical effects or underwater noise), the sources of effect associated with the licensing of Blocks 110/3b and 113/27c are short-term and temporary. Available evidence (see e.g. UKBenthos database, OSPAR 2010 and the 2017 intermediate assessment[58]) indicates that past oil and gas activity and discharges have not led to adverse impacts on the integrity of 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 eastern Irish Sea (i.e. any potential incremental effects). The current controls on terrestrial and marine industrial activities, including activities that could follow licensing, can be expected to prevent significant in-combination effects affecting relevant sites.

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

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

6 Overall conclusion

Taking account of the evidence and assessment presented above, it has been determined that the licensing of the two Blocks through the 33rd Licensing Round considered in this AA, will not have an adverse effect on the integrity of the relevant sites (identified in Section 1.2), and the Department have no objection to the NSTA awarding seaward licences (subject to meeting application requirements) covering those Blocks listed in Section 1.2. This is because there is certainty that licensing of the areas applied for will not adversely affect the integrity of relevant sites (as described in Sections 5.1 to 5.3), taking account of the mitigation measures that can be imposed through existing permitting mechanisms on the planning and conduct of activities.

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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