Hornsea Project Four

Kittiwake Compensation Implementation and Monitoring Plan

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Acronyms

Acronym	Definition
AEoI	Adverse Effect on Integrity
ANS	Artificial Nesting Structure
AON	Apparently Occupied Nest
BTO	British Trust for Ornithology
DCO	Development Consent Order
DESNZ	Department for Energy Security and Net Zero
FFC	Flamborough and Filey Coast
HRA	Habitats Regulations Assessment
JNCC	Joint Nature Conservation Committee
KCIMP	Kittiwake Compensation Implementation and Monitoring Plan
KCP	Kittiwake Compensation Plan
MMO	Marine Management Organisation
NSN	National Site Network
OOEG	Offshore Ornithology Engagement Group
RAS	Retrapping Adults for Survival
RSPB	Royal Society for the Protection of Birds
SNCB	Statutory Nature Conservation Body
SPA	Special Protection Area

1 Introduction

1.1.1.1 A Development Consent Order (DCO) was awarded to Orsted Hornsea Project Four Limited (company number 08584182) (hereafter referred to as "Orsted H4") on 12 July 2023 authorising the construction and operation of the Hornsea Project Four Offshore Wind Farm (hereafter referred to as "Hornsea Four"). The Hornsea Four Offshore Wind Farm Order 2023 is hereinafter referred to as "the DCO". Orsted H4 has now been awarded a Contract for Difference in Auction Round 6 and will work towards reaching a final investment decision and taking Hornsea Four through the construction phase. As part of the DCO, Orsted H4 is required to compensate for predicted mortality from collision of adult kittiwake associated with the Flamborough and Filey Coast Special Protection Area (FFC SPA) from the operational turbines of Hornsea Four. The compensation that Orsted H4 is required to implement is in the form of an artificial nesting structure (ANS) designed to support sufficient breeding pairs of kittiwake to ensure that the potential impacts from Hornsea Four on this feature are offset.

1.1.1.2 This document serves as the Kittiwake Compensation Implementation and Monitoring Plan (KCIMP) for Hornsea Four. It has been produced to fulfil the requirements of paragraph 3 of Part 2 of Schedule 16 of the DCO that requires the undertaker to develop a KCIMP based on the strategy set out in the Kittiwake Compensation Plan (KCP) (a certified plan, pursuant to Article 49 of the DCO).

1.1.1.3 The document includes the following sections:

- **Section 2** presents the background to the kittiwake compensation and the DCO requirements;
- **Section 3** summarises the consultation that has been undertaken (Para. 3(g) of Part 2 of Schedule 16 of the DCO);
- **Section 4** sets out the chosen location of the ANS and the suitability of that location to deliver the measure (Para. 3(a) of Part 2 of Schedule 16 of the DCO);
- **Section 5** presents the designs of the ANS (Para. 3(c) of Part 2 of Schedule 16 of the DCO);
- **Section 6** outlines the maintenance that will be undertaken throughout the lifetime of the ANS (Para. 3(e) of Part 2 of Schedule 16 of the DCO);
- **Section 7** describes any permissions and licences required for the ANS;
- **Section 8** presents the plans for monitoring and adaptive management (Para. 3(f(i)-(ii) and (iv), h, and i) of Part 2 of Schedule 16 of the DCO);
- **Section 9** sets out the success criteria (Para. 3(f)(iii) of Part 2 of Schedule 16 of the DCO);
- **Section 10** outlines reporting requirements (Para. 4, 5, and 6 of Part 2 of Schedule 16 of the DCO);
- **Section 11** shows the programme for implementation and delivery (Para. 3(d) of Part 2 of Schedule 16 of the DCO);
- **Section 12** concludes how the paragraphs at Part 2 of Schedule 16 of the DCO have been discharged.

2 Background

2.1.1.1 In granting the DCO, the Secretary of State prepared a Habitats Regulations Assessment (HRA) Report which concluded that an adverse effect on integrity (AEoI) of the FFC SPA could not be excluded due to impacts on the kittiwake populations from the project, in combination with other projects. With regards to the kittiwake feature of the FFC SPA, the Secretary of State therefore determined that a derogation case was required, and based on the information provided by Orsted H4 was satisfied that appropriate compensation measures have been identified to offset the loss of 43.1 kittiwake per year, and that these measures can be secured in the DCO. This KCIMP addresses kittiwake compensation only. Compensation related to the guillemot feature of the FFC SPA will be presented with the Guillemot Compensation and Implementation Monitoring Plan. A number of documents were submitted by Orsted H4 in relation to kittiwake compensation. They can be viewed on the Planning Inspectorate website (Planning Inspectorate, n.d.).

2.1.1.2 In the DCO, the Secretary of State stipulated that a KCIMP be produced. Paragraph 3 of Schedule 16 of the DCO states that "*Following consultation with the H4 OOEG, the KCIMP must be submitted to the Secretary of State for approval in consultation with the MMO and relevant SNCB for the offshore compensation measure, and with the relevant local planning authority and relevant SNCB for any onshore measure (if such measure is required)*". Paragraph 4 of Schedule 16 of the DCO also states *"no operation of any turbine forming part of the authorised development may begin until the KCIMP has been approved by the Secretary of State and [two] full breeding seasons following the implementation of the measures set out in the KCIMP have taken place*" (BEIS, 2024). The number of breeding seasons was amended from four to two following a successful application for a non-material change by Orsted H4 (see paragraph 2.1.1.7 below).

2.1.1.3 The establishment of an Offshore Ornithology Engagement Group (OOEG) is a requirement of the DCO, with the first meeting of the Hornsea Four OOEG taking place on 24 March 2023. This KCIMP presents the kittiwake compensation measure that has been consulted on with the Hornsea Four OOEG and local planning authority particularly focusing on the location and design of the ANS and associated monitoring and adaptive management plans.

2.1.1.4 Three options for delivering an ANS were proposed in the application for the DCO as identified in the KCP, which is a certified document in Schedule 15 of the Hornsea Four DCO. The KCP identifies the options as a new offshore ANS, a repurposed offshore ANS or a new onshore ANS (see section 3 of the KCP). These options are permitted in the DCO, and as relevant, paragraph 1 of Part 1 of Schedule 16 of the DCO refers to the "offshore compensation measures" as including an offshore ANS, and the "onshore compensation measures" as including an onshore ANS. Paragraph 2 of Part 2 of Schedule 16 requires the KCIMP (this document) to be based on the strategy for kittiwake compensation identified in the KCP.

2.1.1.5 Orsted H4's original stated preference was to deliver a repurposed offshore ANS or a new offshore ANS, and post-consent discussions progressed with stakeholders regarding the design and implementation of such. However, due to increasing risks to Orsted H4 regarding supply chain constraints and escalating costs for offshore construction, Orsted H4 reviewed the options to ascertain if there was an option that was ecologically viable but more cost-efficient for delivery. An opportunity was identified within Orsted's existing portfolio; the Hartlepool Old Yacht Club. This is an onshore ANS site which has been selected and designed by Orsted Hornsea Project Three (UK) Limited ("Orsted H3") as a compensation measure for kittiwake for the Hornsea Three Offshore Wind Farm ("Hornsea Three") pursuant to the Hornsea Three Offshore Wind Farm Order 2020 ("the H3 DCO") in consultation with the Hornsea Three OOEG. During this strategy review, Orsted H4 consulted and updated the RSPB and Natural England by way of three meetings and then confirmed the decision at OOEG Meeting #5 (see **Table 1** for more details).

2.1.1.6 Upon review, Orsted H4 found that the Hartlepool ANS site has sufficient space to accommodate the compensation needs for both Hornsea Three and Hornsea Four. Further detail on the available capacity is set out at section 5.2 of this KCIMP and **Appendix A**. While **Appendix B** presents a legal review of Hornsea Three and Hornsea Four's DCOs and supporting documents and concludes that Hornsea Three and Hornsea Four can share the Hartlepool ANS site under their terms. This KCIMP will therefore focus on delivery of kittiwake compensation at this location.

Non-material Changes

2.1.1.7 Orsted H4 submitted an application for a non-material change to the DCO on 2 May 2024, which was accepted by DESNZ on 4 July 2024 (Pinsent Masons, 2024). A response was issued by the Secretary of State on 17 July 2024 authorising this change alongside an Amendment Order, which came into force the following day, on 18 July 2024 (DESNZ, 2024b; BEIS, 2024). This amendment requires the ANS to be in place for at least two full breeding seasons prior to the operation of any turbine, rather than the minimum four breeding seasons initially required by the DCO. No additional changes ensued from this document, and a breeding season for kittiwake remains defined as the period between 1 April and 30 September.

3 Consultation

3.1.1.1 Orsted H4 established the OOEG following consent award. Alongside Orsted H4 as the named undertaker, the following were invited to be members of the OOEG as the

named consultees for kittiwake compensation, as set out in paragraph 2(b)(i) of Part 1 of Schedule 16 of the DCO:

- The relevant statutory nature conservation body, i.e. Natural England as core members for both the offshore and onshore compensation measures;
- The Marine Management Organisation (MMO) as core members for offshore compensation measures;
- The relevant local planning authority as core members for the onshore compensation measures;
- The Royal Society for the Protection of Birds (RSPB) as advisory members for both the onshore and/or the offshore compensation measures subject to their areas of expertise; and
- The Wildlife Trust as advisory members for both the onshore and/or the offshore compensation measures subject to their areas of expertise.

3.1.1.2 The members provided representative(s) to attend meetings of the OOEG and otherwise participate in the business of the Hornsea Four OOEG in accordance with Orsted H4 (2024) Plan of Work (approved by DESNZ on 11th June 2024).

3.1.1.3 Orsted H4 also invited a number of specialist consultants or delivery partners (who are assisting in the delivery of the kittiwake compensation measures) to the OOEG meetings, including:

- Collaborative Environmental Advisers (independent chair); and
- NIRAS (ornithological specialists and compensation lead).

3.1.1.4 The Hornsea Four OOEG met throughout the consultation period in accordance with the needs of the project, and as of August 2024, there have been five OOEG meetings comprising: an initial inception meeting on 23 March 2023, followed by four further meetings relevant to the KCIMP, a summary of which is provided in **Table 1** below. As set out above, the selection of the Hartlepool ANS site for Hornsea Four (in addition to its use for similar purposes for Hornsea Three) means that the consultation undertaken by Orsted H3 in the site selection and ANS design in relation to this site is pertinent to Hornsea Four. A summary of consultation and project reviews Orsted H3 undertook in relation to the Hartlepool site is provided in **Appendix C**. The summary of meetings with the Hornsea Four OOEG below includes details on anything discussed since the Hornsea Three Consultation Report was filed.

Table 1: Summary of Hornsea Four OOEG meetings

Meeting	Date	Context
OOEG Meeting #0	23/03/2023	Meeting to provide a Hornsea Four and kittiwake compensation recap and updates; review lessons learned from Hornsea Three OOEG process; plans of work; survey and monitoring; strategic compensation; and next steps.
OOEG Meeting #1	23/08/2023	Meeting to provide an update and overview of the compensation measures proposed for kittiwake in relation to requirements of the DCO;

		ensure an efficient and productive process by discussing the OOEG engagement programme beginning the discussion around processes for the group such as the terms of reference; provide update on design progress and next steps to ensure transparency and opportunity for input at the appropriate stage.
OOEG Meeting #2	29/09/2023	Meeting to provide general updates on Hornsea Four in relation to compensation; provide updates on new offshore ANS design following discussions held and feedback provided at previous meetings; discuss monitoring expectation and requirements for the new offshore ANS.
OOEG Meeting #3	24/11/2023	Meeting to provide general updates on Hornsea Four in relation to compensation. Orsted H4 introduced and explain the proposal to apply for a non-material change Hornsea Four and to reduce the number of breeding seasons that the ANS is required to be installed ahead of windfarm operation. The group discussed the monitoring proposal for the Hornsea Four offshore ANS including the proposed success criteria. The non-material change has since then been approved and come into force (see paragraph 2.1.1.7).
OOEG Meeting #4	26/02/2024	The purpose of this session was to discuss guillemot compensation measures. It introduced the proposed strategy for predator eradication measures. This meeting did not address the KCIMP or kittiwakes other than to provide a brief update on the non-material change application referenced above.
ANS Strategy Call #1	27.03.2024	Call with Natural England and the RSPB regarding the strategy for delivering the ANS for Orsted H4. Orsted H4 set out challenges being faced on offshore ANS strategy and that the Project is being asked to review the strategy for cost saving opportunities. Natural England's position was that Orsted H4 should seek to find a solution to enable delivery of an offshore ANS, raising concerns around whether there is a need for more onshore nesting and advised the project spoke to DESNZ to inform them of the situation (which Orsted H4 did subsequently do).
ANS Strategy Call #2	08.04.2024	Follow up all with Natural England and the RSPB regarding the strategy for delivering the ANS for Orsted H4. Natural England proposed an alternate approach to solely delivering nesting at Hartlepool, suggesting as an interim approach Orsted H4 could use nest space at Hartlepool and deliver an offshore structure ahead of operation (but not the 4 years ahead specified at the time by the DCO). Orsted H4 reviewed this but it did not overcome the challenges faced delivering an offshore structure and made a decision to pursue the chosen strategy of delivering nest space at Hartlepool.
ANS Strategy Call #3	23.05.2024	Further follow up call with Natural England and the RSPB (under the confidentiality of the OOEG Plan of Works) regarding the strategy for delivering the ANS for Orsted H4. Orsted H4 explained that the project had carefully considered the Natural England interim proposal however it did not resolve the issues being faced and brings additional challenges around supply chain availability. Orsted H4 therefore confirmed the Project's decision to deliver its compensation requirements for kittiwake at the Hornsea Three Hartlepool Old Yacht Club site. Natural England's

		position remained that they do not support onshore delivery of kittiwake compensation for Hornsea Four and expressed concerns around discrepancies between the SoS HRA and the DCO in terms of the type of ANS permitted.
OOEG Meeting #5	10/06/2024	Meeting to provide general updates on Hornsea Four in relation to compensation (under the confidentiality clause of the OOEG Plan of Works) and confirm the proposal to deliver kittiwake compensation at the Hartlepool Old Yacht Club site with success allocated proportionally between the Hornsea Four and Hornsea Three projects. Discussed the key elements of the KCIMP for the Hornsea Four ANS. This included presentation of the success criteria and the strategies for monitoring and adaptive management based on the approved Hornsea Three KCIMP to ensure it remained appropriate. No concerns were raised regarding these (although Natural England's position regarding not being in support of onshore delivery of kittiwake compensation for the project remained the same).
Email to Hartlepool Borough Council (the relevant Local Planning Authority)	05/09/2024	Orsted H4 notified Hartlepool Borough Council of the updated strategy to deliver kittiwake compensation at an onshore site and explained that the DCO specifies them as a core OOEG member for an onshore kittiwake measure. Explained they will be a consultee for the KCIMP and invited to future OOEGs where kittiwake compensation is on the agenda.

3.1.1.5 As part of the selection of the Hartlepool Old Yacht Club ANS site for Hornsea Three, Orsted H3 consulted with the Hornsea Three OOEG alongside a range of landowners, the relevant Local Planning Authority (Hartlepool Borough Council). Given that the same site is proposed to be used for kittiwake compensation measures for Hornsea Four, and is capable of being shared for both projects, this consultation is considered valid and relevant for Hornsea Four (noting that the appropriate consultation with the Hornsea Four OOEG, as required by the DCO, has still been undertaken).

4 Scale, Projected Growth and Location of Compensation

4.1 Scale

4.1.1.1 Within the updated collision risk modelling that was submitted to the Secretary of State by Orsted H4 in April 2023, (which was based on the Secretary of State's accepted methodology) a predicted mortality rate of 43.1 adult kittiwake per year was determined.

4.1.1.2 The ANS would be installed to provide a significant amount of potentially optimal nesting space for kittiwake in a location where existing populations have favourable productivity but are constrained by nesting space availability, based on findings from Orsted H3's 2021, 2022, and 2023 monitoring campaigns (NIRAS 2022; NIRAS 2023).

4.1.1.3 Paragraph 3 of Schedule 16 of the DCO establishes that the KCIMP (and therefore, the compensation measure proposals) must be developed in line with the strategy for kittiwake compensation set out in the KCP, which is a certified plan pursuant to Article 49 of the DCO (as submitted by Orsted H4 in August 2022 during the Examination process). The KCP states that the provision of an ANS is proposed to accommodate additional breeding pairs to subsequently increase productivity to offset the predicted

impacts from the operation and maintenance of Hornsea Four (GoBe Consultants, 2022). Therefore, Orsted H4 is confident that this KCIMP is developed in line with the KCP's strategy.

4.1.1.4 The Secretary of State stated within the DCO the required scale of delivery is the provision of at least 750 nesting spaces on the proposed ANS (see **Section 5.2** for further information relating to capacity). However, while a minimum of 750 nesting spaces will be provided, additional aspects are required to be considered to determine the number of breeding adults needed at the ANS to produce offspring which will recruit into the UK national site network (NSN) and FFC SPA and therefore compensate for the predicted adverse effects on kittiwake.

4.1.1.5 Based on the predicted mortality of 43.1 adult kittiwake per year and the application of a 2:1 compensation ratio, a population of 230 breeding kittiwake pairs would be required at the ANS to compensate for the Hornsea Four predicted impact to the species. Further information pertinent to these calculations, and the overall delivery potential of the compensation measures are presented in the Growth Scenarios supporting document (NIRAS, 2023b). Information relating to how the measure will be deemed as successful (i.e., the success criteria) is presented within **Section 9**.

4.2 Projected Growth

4.2.1.1 Orsted H4's submission in May 2024 of a technical report supporting the non-material change application provides the ecological projected number of nests that will be accommodated on the ANS (Niras, 2024). The report presents a range of colony growth scenarios that include where the colony growth rate, productivity and number of nests at initial colonisation lie within the range of recent natural variability of these parameters at existing colonies along the east coast of England. It is where these combinations of parameter values lie inside the range of recent natural variability along the east coast of England, that a single ANS is predicted to succeed to accumulate adult production that exceeds the accumulated mortality from collision predicted at Hornsea Four over its proposed 35 years of operational life.

4.2.1.2 In addition, and as referenced at paragraph 2.1.1.7 above, a technical note has been prepared (**Appendix A**) which demonstrates that the Hartlepool ANS site is sufficient for both the Hornsea Three and Hornsea Four projects, in line with the overall strategy of compensation delivery set out in the KCP.

4.3 Site Selection

4.3.1.1 This section focuses on the steps taken since consent to identify suitable locations within the areas of search for a structure of sufficient size to support up to 750 breeding pairs of kittiwake as required by the DCO. A significant amount of the site selection work was completed as part of the Hornsea Three compensation process, which considered the ecological, land acquisition and technical constraints and requirements as explained in the Orsted H4 KCP (GoBe Consultants, 2022). Additional information on the specific site selection criteria stages is presented in the Hornsea Three Site Selection Report (NIRAS, 2022b).

4.3.1.2 During the planning process, Orsted H4 focused on the ecological objectives of the compensation measure and selected locations which are situated in proximity to existing kittiwake colonies, where populations are increasing, productivity is high and

natural nesting spaces are limited. The constraints and requirements established as part of the site selection process were led by an evidence based approach, which was described in the **B2.7.3 Compensation measures for FFC SPA: Onshore Artificial Nesting: Ecological Evidence (APP-189)**). A full account of the ecological criteria for the site selection process undertaken by Orsted H4 is provided in **B2.7.5 Compensation measures for FFC SPA: Artificial Nesting: Site Selection and Design (APP-191)** This consequently identified an onshore location which will be developed in partnership with Hornsea Three. The selected location therefore has a high likelihood of being colonised by kittiwake, meeting the requirements of the KCP and fulfilling the ecological objectives of this KCIMP (and satisfying paragraph 3(a) of Part 2 of Schedule 16 of the Hornsea Four DCO). The Hornsea Three OOEG agreed with the site selected and its ecological merit. The onshore site selected for Hornsea Four is therefore in line with the area of search which has already been consulted on as part of the approval of the Orsted H4 KCP.

4.3.1.3 Further details of the ecological merits of this location were discussed throughout consultation with the Hornsea Three OOEG leading up to development of the Hornsea Three Kittiwake Implementation and Monitoring Plan (KIMP), which was approved by the Secretary of State in April 2023 (DESNZ, 2023; DESNZ, 2024). Key ecological aspects supporting the sites selection are detailed in the Site Selection Narrative Report (NIRAS, 2022b). Specific design principles are also vital in ensuring the ecological objectives of the ANS are delivered. Important aspects considered include details relating to vertical elevations, narrow nesting ledges and overhangs to prevent avian and mammalian predation of kittiwake chicks. These design principles and further examples have been agreed with the Hornsea Three OOEG and are provided within **Appendix 1: Pattern Book** of **Appendix D: Design Report** of the Hornsea Three KIMP (GoBe Consultants and NIRAS, 2022). These design principles were subsequently confirmed as suitable for Hornsea Four during the project's own consultation period with the OOEG (**Table 1**).

4.3.2 Hartlepool - Old Yacht Club

4.3.2.1 The ANS for Hornsea Four will be located at the Old Hartlepool Yacht Club, Ferry Road, Hartlepool (grid reference: 452257 (Easting), 533546 (Northing)), which is illustrated in **Figure 1**, **Figure 2** and **Figure 3**. As detailed above, Hornsea Four will share the ANS with Hornsea Three.

Figure 1: Location of ANS at Hartlepool

Figure 2: Illustrative view of ANS design at Hartlepool showing the tower and the huts

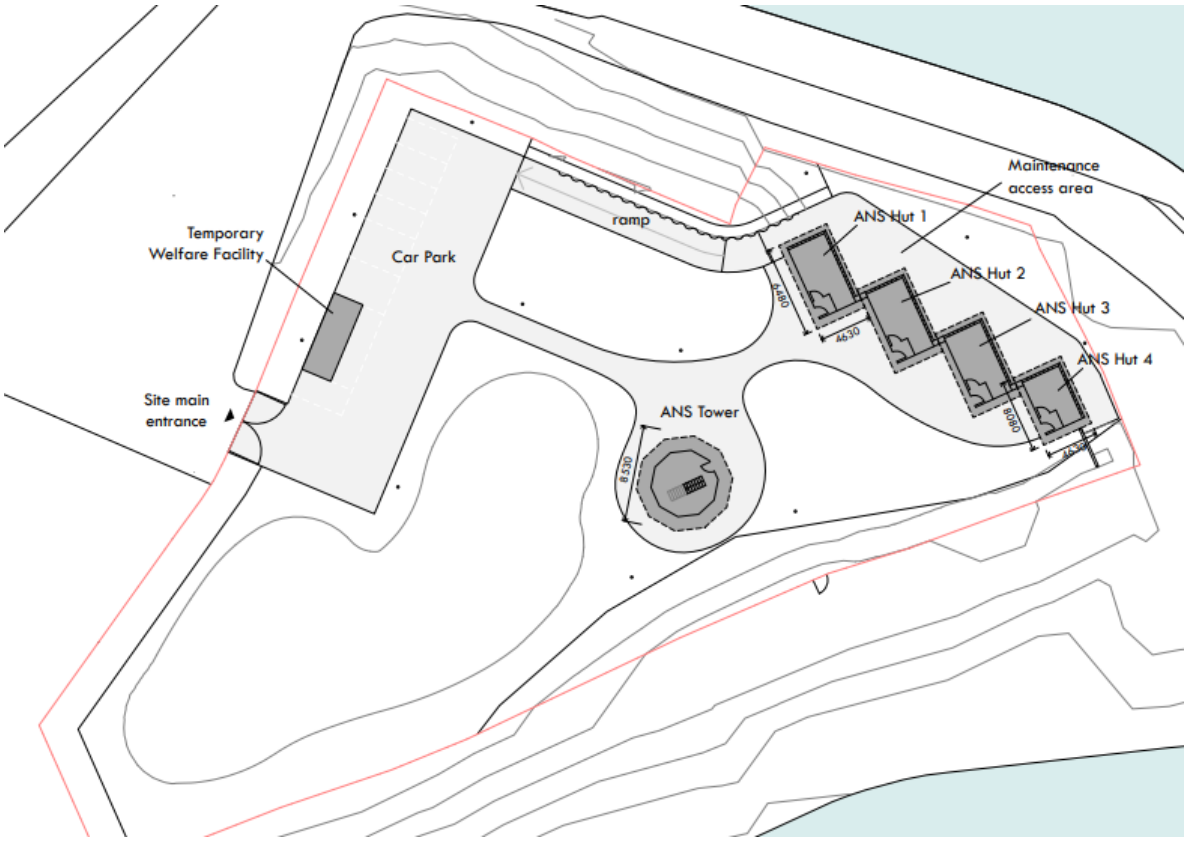

Figure 3 Hartlepool ANS indicative site layout

4.3.2.2 In December 2021, Orsted H3 completed the purchase of the Old Hartlepool Yacht Club, which is registered under the land registry title number "CE147445".

4.3.2.3 The Old Hartlepool Yacht Club lies in very close proximity (30 m) to an existing growing kittiwake colony, demonstrating its strong ecological suitability. As described in the KCP, an ecologically advantageous location would comprise:

- location near smaller kittiwake populations, indicating certainty around the species presence;
- evidence of stable/increasing productivity and expanding population (as proxy for favourable prey resources;
- lack of human-made or natural suitable nesting habitat (generally unfavourable nesting conditions); and
- location away from urban housing to minimise human interaction, and ideally overhanging the water to mimic natural nesting conditions (GoBe Consultants, 2022) ().

4.3.2.4 During the 2022 breeding season, 177 apparently occupied nests (AON) were found at this existing colony (which occupies the walkway to the lifeboat pontoon), representing 51% of recorded total occupied kittiwake nests in the Hartlepool Headland and port area (NIRAS, 2022). During the 2023 breeding season, 218 nests recorded as AONs in June and/or July were recorded at Hartlepool, with a productivity

rate of 54%, suggesting that an ANS near this pre-existing colony would be conducive to population growth.

4.3.2.5 The Old Hartlepool Yacht Club site comprises approximately 1 acre and is large enough to support more than one structure for the ANS. The Hornsea Three OOEG agreed to progress with this site for the northeast region during technical panel #4 on 07/07/2021 with it agreed as a location for an ANS in the northeast during technical panel #6 on 29/09/2021 (NIRAS, 2022), see **Appendix C** for more detail. Therefore, given it is a strong site ecologically and a preferred location by the Hornsea Three OOEG, it is being developed to support two typologies of structures for an ANS (see **Section 5** and **Figure 2** for design detail) a tower containing 850 nest spaces and huts containing 534 nest spaces, having a total site capacity of 1,384 nesting spaces. As this was selected as the preferred location for the Hornsea Four ANS, the available nesting spaces will be allocated as compensation to the two different projects as detailed in **Section 5** below.

4.3.2.6 Construction commenced at the Hartlepool ANS site on 15 July 2024, with an aimed completion date in time for the 2025 kittiwake breeding season (1 March 2025). This means that there is no risk to the Hornsea Four programme of delivery of the compensation measures (a risk that is more likely to be prevalent via any offshore delivery, if that option had been chosen) and therefore provides surety that Hornsea Four can begin delivering its kittiwake compensation in line with the timing requirements of the DCO and project programme. Following the non-material amendment to Hornsea Four described above, Orsted H4 will be delivering these compensation measures approximately two years ahead of schedule which allows further time for ecological benefits to realise prior to operation of Hornsea Four.

5 Design of Artificial Nest Structures

5.1.1.1 Para. 3(c) of Part 2 of Schedule 16 of the DCO requires the KCIMP to include "*details of the design of the artificial nest structure(s) to provide nesting for at least 750 pairs of kittiwake in total; including the projected number of nests that will be accommodated on the structure and how risk from predation and other perturbations have been designed out or mitigated*".

5.1.1.2 The Design Report from the Hornsea Three KIMP which is appended to this KCIMP at **Appendix D** provides a detailed overview of the design process, principles and proposals for the ANS, including how risks from avian or mammalian predation and unauthorised human access will be mitigated. For example, avian predator mitigation will be provided through the 0.2 m depth nesting ledge dimensions and the 0.2 m minimum overhang provided by ANS roofs above the highest nesting ledges, as advised and agreed by the Hornsea Three OOEG. Given the ANS locations and mitigation inherent to the design, it is not anticipated that the ANS will be susceptible to avian predation issues. With regard to mammalian predators, the design of the ANS integrates a minimum of 0.6 m deep overhangs below the lowest nesting ledges along all nesting faces to mitigate against ground predators, as advised and agreed by the Hornsea Three OOEG. In combination with this, there is a continuous concrete wall

beneath which forms a smooth vertical face in excess of 2.0 m height to mitigate against ground predators.

5.1.1.3 Other important considerations to reduce the chance of perturbations, such as the provision of adequate security interventions (i.e., perimeter fencing and CCTV where required), are further detailed within **Appendix D** to align with the DCO requirements relevant to design. The information presented in the Hartlepool section of that report remains fully relevant to Hornsea Four's compensation plan, given the proposed strategy to adopt this same site for Hornsea Four as described above.

5.1.1.4 The Design Report is accompanied by two further appendices:

- Appendix 1 – Kittiwake artificial nesting structure pattern book (onshore section only); and
- Appendix 2 – Supporting design information: Nearshore and Onshore ANS Typologies, visuals and dimensions (onshore section only).

5.1.1.5 The designs and proposals for the ANS at Hartlepool were discussed during OOEG meetings conducted during the consultation period for the Hornsea Three KIMP. The specifics of the design were therefore agreed upon prior to any OOEG meetings pertaining specifically to Hornsea Four and are deemed to satisfy all relevant stakeholders listed in Section 3 of this document, as well as additional inputs provided by Associated British Ports, the Maritime and Coastguard Agency, Trinity House and the Suffolk Coast and Heaths Area of Outstanding Natural Beauty Partnership who provided input during the preliminary discussions regarding site selection during the Hornsea Three consultation period.

5.1.1.6 The two onshore structure typologies comprising the ANS have been designed specifically with the Old Hartlepool Yacht Club site in mind. They are both ecologically driven designs that are also responsive to the particular characteristics of the site and context to create successful structures for nesting kittiwakes as well as an appropriate fit within their landscape setting. The site-specific ecological strategy for kittiwake is to locate nesting spaces facing the existing kittiwake colonies on the walkway to the lifeboat pontoon and within Headland and Victoria Harbour, as well as providing nesting spaces that capitalise on sea views.

5.1.1.7 The ANS is designed to accommodate a minimum of 750 potential nesting compartments for Hornsea Four, in addition to the nesting spaces for Hornsea Three (see the following section for detail relating to overall capacity and sharing between Hornsea projects). As the location and details of the ANS at Hartlepool remain the same for Hornsea Four as was agreed with the Hornsea Three OOEG for Hornsea Three, no additional Hornsea Four specific report is required to provide details on the design and structure of the ANS proposed as compensation for Hornsea Four kittiwakes.

5.2 Hartlepool Capacity

5.2.1.1 As stated within paragraph 3(c) of Part 2 of Schedule 16 of the DCO "*details of the design of the artificial nest structure(s) to* ***provide nesting for at least 750 pairs of kittiwake in total***…". The Hartlepool site provides excess nesting above that required to accommodate the compensation requirements (set out within the relevant DCOs) for both Hornsea Three and Hornsea Four projects, with a total of 1,384 nesting

spaces across the site. Hornsea Three requires a minimum of 467 nest spaces, and Hornsea Four requires a minimum of 750 nest spaces, both fitting across the two Hartlepool structures forming the ANS, resulting in 167 surplus spaces between the two structures.

5.2.1.2 **Appendix A** presents a range of scenarios for colony growth, productivity and size of the starting colony at an ANS for the Old Hartlepool Yacht Club being jointly shared between Hornsea Four and Hornsea Three. In doing so, it identifies a range of predictions of the likely time scale within which the proposed compensation can be expected to achieve its aims for both Hornsea Three and Hornsea Four. Furthermore, **Appendix B** presents a legal review of Hornsea Three and Hornsea Four's DCOs and supporting documents and concludes that Hornsea Three and Hornsea Four can share the Hartlepool ANS site under their terms.

5.2.1.3 While the capacity of the ANS relevant to the overall Hornsea Four nesting space requirement is to deliver a minimum of 750 nesting spaces, the required number of breeding adults on the ANS to actually offset the collision impact of 43.1 adult kittiwake mortalities per annum has been described within **Section 4.1**. Both the scale and capacity are factors contributing to the success of the measure in terms of DCO requirements. Overall success criteria relevant to the Hornsea Four compensation measure is discussed within **Section 9**.

5.2.1.4 In terms of monitoring, Orsted H4 would seek to undertake a joint annual monitoring campaign of the Hartlepool ANS and relevant natural colonies with Orsted H3. The monitoring requirements in each project's respective DCO and KCIMP are in alignment and therefore allow for this.

5.2.1.5 With regards to adaptive management, Orsted H4's approach to adaptive management is the same as the approach set out in the Hornsea Three KIMP (as set out in **Section 8.3** of this document and section 3.4 of the KCP), accepted by the Secretary of State in his decision letter issued on 14 March 2024. Therefore, any requirement for adaptive management would be monitored and assessed on a site basis (rather than individually for each project) and then implemented jointly by Orsted H4 and Orsted H3.

5.2.1.6 It is currently envisaged that the OOEGs for H4 and H3 will continue to be held separately for each project for discussions on annual monitoring results and adaptive management (if required).

6 Maintenance

6.1.1.1 Maintenance will occur on an annual basis throughout the lifetime of the ANS and as required for urgent works. All planned maintenance activities including visual inspection and certification of all fall arrest systems and cleaning of the navigation lights will take place outside of the breeding season (between early October and late February). Kittiwake nests will be left in place between seasons, as this identifies the structure as a colony, indicates where nesting space is available and allows new colonists to take up occupancy between established nests.

6.1.1.2 Maintenance which requires urgent attention (for example, a loose nesting ledge damaged by storm activity which may fall on active nests below) may need to be actioned during the kittiwake breeding season. This would not be considered as

planned and therefore any ad-hoc works to the ANS required prior to the operation of Hornsea Three and Hornsea Four will be considered as structural maintenance. Structure maintenance will include actions to ensure the upkeep and function of the ANS including, but not limited to the following examples:

- Repairing storm damage to ANS; and
- Repairing damage to perimeter fence.

6.1.1.3 The process for determining structure maintenance action and notification with OOEG members is presented within **Figure 6**.

6.1.1.4 Any structural maintenance undertaken prior to Hornsea Three and Hornsea Four operation will not delay the intended date for operation of the wind turbines for the purposes of the DCO.

6.1.1.5 Adaptive management will be initiated, if required, after the operation of Hornsea Four. This process is set out in further detail in **Section 8.3**.

6.1.1.6 Maintenance requirements of the ANS will be reviewed by Orsted on an annual basis to ensure any additional needs are addressed throughout the lifetime of the ANS. Guano will not be removed from the nesting locations but will be removed from access infrastructure (i.e. access ladders) for health and safety reasons. The removal of debris (such as plastics) will also be undertaken if it is deemed to be a health and safety risk, or a risk to breeding kittiwake. However, it is acknowledged that some debris may be incorporated within kittiwake nests which may not pose a threat to birds or human health and safety. In such an instance, the debris will be left in situ.

6.1.1.7 An indicative rolling 10-year maintenance schedule for the onshore ANS is provided in **Figure 4**. This schedule will be revised according to experience gained during the operation of the ANS. It is noted that timeframes presented in these schedules are estimates, and if more frequent maintenance is needed for matters which require urgent attention, this will take place as and when required.

Activity	Ten year rolling cycle									
	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10
Inspection & cleaning of ANS										
Landscape maintenance e.g. irrigation, pruning and removal of weeds										
Inspect and maintain lighting/CCTV and replace when necessary										
Maintenance of external cladding materials*										

*Dependent on final materials selected
Note: Any other major or minor repairs would be conducted as and when required

Figure 4: Indicative maintenance schedule for ANS

7 Commercial Agreement at Hartlepool

7.1.1.1 As identified within **Section 4**, thorough consideration has been given to the consenting and planning requirements for the development of ANS at all stages of the site selection process.

7.1.1.2 In December 2021, Orsted H3 completed the freehold purchase of the Old Hartlepool Yacht Club land (registry title number "CE147445").

7.1.1.3 For the installation of ANS within the terrestrial/onshore environment, specifically the two structures at the Old Hartlepool Yacht Club, planning permission was required under the Town and Country Planning Act 1990 from the relevant Local Planning Authority (Hartlepool Borough Council).

7.1.1.4 Planning Permission for the demolition of the existing structure and construction of the two structures at the Old Hartlepool Yacht Club was awarded on appeal on 13 March 2023 (reference APP/H0724/W/22/3309272).

7.1.1.1 A Commercial Agreement will be put in place between Orsted H3 and Orsted H4 to set out the terms of the artificial nesting structures sharing arrangements. This will include the arrangements for the construction, operation and maintenance of the structures, ongoing monitoring, reporting and decommissioning obligations and will ensure that Orsted H4 has the necessary rights required to fulfil its obligations in this KCIMP. The draft agreement is currently well progressed, with expected completion towards the end of 2024.

8 Monitoring and Adaptive Management

8.1 Monitoring

8.1.1.1 Paragraph 3(f) and (i) of Part 2 of Schedule 16 of the DCO establishes that the KCIMP must provide details of the proposed ongoing monitoring and reporting of the measures including:

- Survey methods;
- survey programmes;
- success criteria;
- timelines for the monitoring repots to be delivered;
- evidence of how natal dispersal and colony interchange with the UK NSN[1] and FFC SPA kittiwake colony should be included; and
- information of any other seabirds attempting to and/or successfully nesting on the ANS should also be recorded.

8.1.1.2 The following sections provide a comprehensive overview of the intended monitoring approaches, DCO requirements and OOEG alignment around the current technological limitations associated with determining natal dispersal and colony interchange. Furthermore, it is considered that all baseline, colonisation, colony counts, productivity monitoring and additional monitoring information presented below which was determined by Hornsea Three and agreed with by the Hornsea Three OOEG, and which was consequently accepted by the Secretary of State within

[1] As defined in regulation 3 of the Conservation of Habitats and Species Regulations

the Hornsea Three KIMP, is relevant and transferable to Hornsea Four due the strategy of implementation at Hartlepool outlined in the preceding sections. There was no objection to this by the Hornsea Four OOEG when presented by Orsted H4 at OOEG Meeting #5 on 10/06/2024, noting that the members are mostly the same as for the Orsted H3 and therefore already familiar with monitoring agreed for Orsted H3. The approach to monitoring will be reviewed with the OOEG as new technologies emerge that might be relevant. Orsted H4 would seek to undertake a joint annual monitoring campaign of the Hartlepool ANS and relevant natural colonies with Orsted H3. The monitoring requirements in each project's respective DCO and KCIMP are in alignment and therefore allow for this.

8.1.2 Overview

8.1.2.1 Pre-construction baseline monitoring (colony counts and productivity) provides a benchmark for 'natural' kittiwake prior to the implementation of the compensation and permits future comparisons and perspective at a regional scale. Pre-construction baseline monitoring was commenced by Hornsea Three at existing kittiwake colonies within two search zones (Northeast and East Anglia) search in 2021. Ten potential colonies were considered (< 20 km from a proposed ANS) for baseline monitoring and were refined in discussions with the OOEG set up for Hornsea Three. In the East Anglia zone, Sizewell and Lowestoft colonies were selected, and in the Northeast zone, Boulby, Saltburn, Hartlepool, and Seaham were selected. Monitoring locations, methods and scope were also discussed and agreed upon by previous discussions of the OOEG set up for Hornsea Three and are considered transferable in context to Hornsea Four's monitoring requirements.

8.1.2.2 As set out within the Hornsea Three KIMP, colonisation monitoring at the ANS (**Section 8.1.4.3**) will be implemented from the first breeding season following construction, with baseline monitoring added when structures begin to be colonised (i.e., from when evidence of nesting attempts start to be detected at the site). Monitoring will commence from the breeding season following ANS implementation. Monitoring at existing colonies and those associated with the artificial structure will also continue post-construction and throughout the operational phase of Hornsea Four (currently expected to be 35 years) to measure ANS success, identify barriers to success and inform whether adaptive management measures should be considered.

8.1.2.3 The core data to be collected for baseline monitoring at existing colonies and at the ANS colony are colony counts and basic productivity, following methods detailed in Walsh *et al.* (1995) and in line with the Joint Nature Conservation Committee's (JNCC) Seabird Monitoring Programme (SMP). Data collection is (and will continue to be) carried out by at least two trained observers (paired to meet Orsted Health and Safety requirements).

8.1.3 Survey Platforms

8.1.3.1 At the ANS, baseline data will be collected from vantage points on land with observers using binoculars and/or telescopes or from within the structure itself.

8.1.4 Baseline monitoring at colony (Existing colonies and ANS)

8.1.4.1 An agreement was reached with the Hornsea Three OOEG on baseline monitoring, this includes colony counts and productivity surveys. Therefore, for Hornsea Four, at

OOEG Meeting #5 on 10/06/2024, Orsted H4 presented the approach taken on Hornsea Three (and agreed by the Hornsea Three OOEG) to the Hornsea Four OOEG to confirm that it remained appropriate, to which there were no objections.

Core data: Colony counts

8.1.4.2 A minimum of one full colony count will be made at each site during the latter half of the incubation period (mid-June), when numbers of nests are most stable. The count unit for kittiwake is AON, defined as a well-built nest capable of containing eggs with at least one adult present. Additional counts of site-holding birds with even a trace of a nest will also be made where practicable, to give an indication of site attractiveness to prospecting first time breeders. At the ANS the total number of AONs and nesting attempts (trace nests) will be recorded on each productivity visit (see **Section 8.1.4.4** below). If applicable (i.e. at the ANS and within productivity plots at existing colonies (or those relevant to Hornsea Three compensation at nearshore ANSs)), total numbers of AONs documented from mapped nests throughout seasonal productivity monitoring (i.e., multiple visits throughout the season) will be used alongside the June colony counts to provide a maximum AON count for each colony annually.

Colonisation monitoring

8.1.4.3 Once the ANS is in place, but before a colony is established, a period of colonisation monitoring will take place each breeding season. This will include two survey visits made annually (ideally around mid-June and late July) where any AON, trace nests, or prospecting birds will be counted. The Secretary of State requires (Para. 3(i) of Part 2 of Schedule 16 of the DCO) information on: *"the number of birds colonising the site including sufficient detail to identify barriers to breeding success (including nesting attempts and nest productivity) and target alternative or adaptive compensation measures. Evidence of natal dispersal and colony interchange with the UK NSN and FFC kittiwake colony should be included. Information of any other seabirds attempting to and/ or successfully nesting on the ANS should also be recorded"*. Following discussion with the Hornsea Three OOEG, colonisation monitoring may also involve additional systematic monitoring (potentially, and if feasible, by means of remote sensing with cameras) of the ANS to assess the prevalence of prospecting kittiwake (birds seen around/on the structure) and any early nesting attempts (birds seen bringing nesting material to structure and/or pair bonding behaviour). The presence of AON(s) or trace nests recorded during a census visit would initiate baseline monitoring with its inclusion of productivity monitoring (**Section 8.1.4.4**).

Core data: Productivity

8.1.4.4 Once a colony is established, productivity will be monitored using the mapped nests method (method 1 in Walsh *et al.* (1995)). A minimum of three visits to record nest contents for productivity calculations will be made each year. First and second visits will be made in late May and mid-June respectively, and nests marked (or updated in later years) on photographs/sketch maps of the colony. The status of each nest will be noted on each visit using the recording codes of Walsh *et al.* (1995). On a third visit (close to estimated time of first chicks fledging, generally early to mid-July), all nests recorded in the first visit will be re-checked. Additional visits will be made, if necessary,

depending on the synchrony of the breeding season, i.e. if there are a number of late broods with small young, a fourth visit may be made 5-7 days later to assess the fate of these nests. The contents of each nest will be noted, and if present, the number and age of chicks recorded. Whole colony productivity will be calculated as the number of chicks likely to fledge divided by the number of completed nests for each site or plot (following Walsh *et al.* (1995)). Where colonies are large within the ANS nests, a sub-sample of plots will be chosen to be representative of an even spread across the whole colony. Plots will be selected systematically ensuring the centre and edges of the colony are covered, containing nests at a range of altitudes. Plot locations will be mapped and included in annual reporting.

8.1.5 Additional Monitoring

8.1.5.1 The intensity and type of monitoring activities undertaken in addition to the baseline monitoring (**Section 8.1.4**) will be limited by site specific factors regarding accessibility of colonies, health and safety risks to surveyors and potential disturbance to breeding birds. An overview of monitoring activities planned for the ANS and existing colonies is outlined in **Table 2**.

Monitoring of natal breeding dispersal

8.1.5.2 The DCO requires that Orsted H4 considers natal dispersal from artificial colonies and colony interchange with the FFC SPA kittiwake colony and UK NSN as part of monitoring proposals (Para. 3(i) of Part 2 of Schedule 16 of the DCO). Orsted has fully explored this consideration as part of Hornsea Three OOEG discussions which are relevant to Hornsea Four also. The Hornsea Three OOEG were in agreement that it is not possible to quantitively measure natal dispersal as yet given the current technological limitations (e.g. size and weight of device), using satellite, radio or archival tags and loggers. The approach to monitoring will be reviewed with the OOEG as and when new technologies emerge that might be suitable for this purpose. Currently, however, chick-ringing at the ANS has been identified as a viable alternative. Ringing chicks with uniquely engraved colour-rings allows individuals to be re-sighted in subsequent years which will provide qualitative evidence of interchange between colonies. However, re-sighting of colour-ringed individuals recruiting to large colonies with restricted visibility of nests, such as ones at the FFC SPA, or more widely within the NSN, will be low. It is therefore not possible to measure empirically the recruitment of birds into the NSN and FFC SPA kittiwake population from the ANS and therefore their overall contribution to productivity, a point that has been confirmed in discussions with the Hornsea Three OOEG.

8.1.5.3 To qualitatively assess natal dispersal, Orsted H4 will undertake colour-ringing of chicks at ANS where it is practicable and safe to do so. Orsted can commit to carrying out ringing activities at the two structures at the Hartlepool ANS site. This data will allow for determination of natal dispersal rates from the ANS caveated by the use of generic survival rates (e.g. Horswill & Robinson, 2015) as a proxy for site-specific survival rates. Systematic re-sightings of individuals colour-ringed as chicks at the natal ANS will provide for an estimation of the kittiwake's tendency to return to their natal colony and will be undertaken alongside re-sightings as set out in **Section 8.1.5.4**. While kittiwakes may not return to their exact place of birth, they tend to breed in or near their natal area (Hatch *et al.*, 2020). As such, monitoring of the UK

NSN and FFC could inform survival rates of colour-ringed chicks at the ANS. Any re-sightings of colour-ringed birds away from the ANS at which they were originally ringed as chicks or adults, will be additional to the systematic monitoring for colour-ringed birds to be conducted by Orsted, the latter at the ANS. All such re-sightings by other persons, whether as part of other studies not commissioned by Orsted or from causal observations by birdwatchers, can be expected to be reported by the finder to the British Trust for Ornithology (BTO) (who maintain the National Ringing Database) and from there, accessible to Orsted (Woodward *et al.*, 2020).

Adult survival

8.1.5.4 Colour-ringing of breeding adult kittiwake accompanied by a systematic re-sighting programme at the colony, i.e. setting up a Re-trapping Adults for Survival (RAS) project, will be carried out at the ANS, where it is practicable and safe to do so (Woodward *et al.*, 2020). The RAS project will allow adult survival rates for the ANS to be calculated in due course, providing adequate re-sighting effort is achieved and sufficient numbers of breeding adult birds are ringed each year. To gain reliable colony-specific adult survival rates, a marked population of 100-150 adults would need to be maintained (O'Hanlon *et al.* 2021). A systematic re-sighting programme of colour-ringed adults at the ANS (identified in **Section 8.1.2**) will be established, guided by the findings of O'Hanlon *et al.* (2021)'s analysis of the effect of the number of visits on resighting probability. This would be additional to the prescribed baseline monitoring visits (**Section 8.1.2**).

Diet studies

8.1.5.5 During the ringing activities at the pre-construction phase and beyond, efforts will be made to collect diet samples from any regurgitates produced by birds during handling at the ANS and at neighbouring colonies where ringing is undertaken by volunteers. Samples from individuals will be stored separately, with the breeding location, date and nest status (e.g. eggs/chick) noted on each sample. Samples will be frozen for storage and analysed annually to investigate barriers to success which relate to prey availability. Dietary analyses will be caried out by suitably qualified professional biologists to estimate the frequency of occurrence and biomass proportions of prey species.

8.1.5.6 The proposed methodology for diet analyses is to follow those used by UKCEH as part of the Isle of May long-term study (IMLOTS) (such as methods stated for chick diet in Newell *et al.* (2016)). Regurgitates and food loads will be weighed, fish identified and, where possible, measured (total length, snout to tip of tail), and an initial estimate of diet composition made. Fish otoliths will be extracted from regurgitates, identified and measured. The weights of the fish from which they came will be calculated from otolith length/fish length and fish length/mass regression relationships from published relationships. Biomass proportions will be derived from initial estimates of diet composition, with species confirmed from identification of bones, or from fish mass estimates from otoliths where initial assessments are unavailable.

8.1.6 Monitoring considerations

8.1.6.1 At the ANS, internal access to nesting ledges enables safe access to conduct bird handling activities (i.e. ringing and diet studies) and also avoids undue disturbance to

the colony (see **Table 2**). Accessing birds on nests at many existing natural colonies is, however, not possible without causing undue risk to surveyors and/or disturbance to breeding colonies.

8.1.6.2 Birds are likely to be more prone to disturbance during the early stages of colony establishment. Therefore, studies which involve bird handling will not commence until it is deemed they will not compromise the colonisation process or success of the structures. Any monitoring method noted to cause undue disturbance to birds, or that could have an adverse impact on the success of the compensation measure, will be ceased and reviewed as soon as is practicable.

8.1.7 Annual review of monitoring

8.1.7.1 The annual monitoring approach and survey programme are presented in **Table 2** and **Table 3** below. The obligation which each monitoring activity fulfils is stated based on Paragraph 3 of Part 2 of Schedule 16 of the DCO.

Table 2: Overview of annual monitoring activities planned as part of the compensation measures.

Annual monitoring	DCO requirement fulfilled (Para. 3 within part 2 of Schedule 16)	ANS
Colony count (1 visit)	Para. 3 (i): number of birds colonising the site including sufficient detail to identify barriers to breeding success	✓
Productivity (minimum of 3 visits)	Para. 3 (i): number of nesting attempts and nest productivity (measured by egg laying, hatching and successful fledging)	✓
Colour-ringing of chicks	Para. 3 (i): evidence of how natal dispersal and colony interchange with the UK NSN and FFC kittiwake colony will be included	✓
Colour-ringing of breeding adults (Re-trapping Adults for Survival (RAS))	Not specifically stated in DCO: aim to gain site specific survival estimates for input to success criteria (Para. 3 (i))	✓
Diet Samples	Not specifically stated in DCO: will contribute to investigating barriers to success (Para. 3 (i))	✓
Survey platform:		Land based vantage point / internal access to ANS

Table 3: Expected survey programme at the Hartlepool ANS site (to be reviewed as new technologies merge).

Month	Colony Count (number of visits)		Productivity (number of visits)		Ringing (chicks & adults) & diet studies (number of visits)		Systematic re-sighting effort at ANS (number of visits) for RAS studies	
	ANS	*Neighbouring colonies*	*ANS*	*Neighbouring colonies*	*ANS*	*Neighbouring colonies*	*ANS*	*Neighbouring colonies*
March – July (pre-incubation – chick rearing)							✓ (multiple visits)	x
Late May – early June (incubation)			✓ (1)	✓ (1)				
Mid-June (peak incubation/ early chick stage)	✓ (1)	✓ (1)	✓ (1)	✓ (1)				
July – ~early August (chick-rearing / fledging)			✓ (1+)	✓ (1+)	✓ (multiple visits)	x		

8.2 Funding of additional research

8.2.1.1 Hornsea Four will also support additional kittiwake monitoring works. One option for this is through the JNCC kittiwake-fish prey research recommendations as commissioned by Orsted H3. This research has identified evidence needs and feasible research approaches that would lead to greater confidence when evaluating the resilience of kittiwake populations to spatio-temporal changes in their fish prey populations. The identified requirements were structured into four distinct Work Packages. Orsted H3 has committed to funding Work Package 1 and Orsted H4

would fund Work Package 2, the two packages being strongly linked and highly complementary:

- Work Package 1 – Kittiwake breeding season diet (Orsted H3 funded)
    - To quantitatively assess the relative contribution of different types of fish prey in the diet of adult kittiwakes and their chicks, and evaluate how this may vary across spatial and temporal scales.

- Work Package 2 – Kittiwake foraging behaviour (Orsted H4 funded should delivery of kittiwake compensation for the project at Hartlepool ANS proceed)
    - To assess the influence of prey availability in modulating foraging behaviour in breeding kittiwakes and evaluate the consequences of foraging decisions on energy budgets and breeding success.

8.3 Adaptive management

8.3.1.1 Orsted H4's approach to adaptive management is the same as the approach set out in the Hornsea Three KIMP (NIRAS, 2022), accepted by the Secretary of State in his decision letter issued on 14 March 2024 (DESNZ, 2024) and specified in the Orsted H4 KCP.

8.3.1.2 The compensatory measure will be implemented once the construction of the ANS has been completed. If needed, adaptive management will be applied after Hornsea Four becomes operational. The compensation method will adopt a pragmatic approach to determine whether adaptive management actions are necessary before the project is operational, and will consult with the OOEG regarding possible options.

8.3.1.3 During the lifetime of the ANS, a surplus or debt of kittiwake with respect to the required compensation number of 43.1 may be determined by monitoring. If any kittiwake debt or surplus is accrued during this time, it will be given due consideration within each monitoring years' success criteria calculations (as discussed in **Section 9**). As outlined in the certified plan (the KCP) pursuant to Article 49 of the DCO, adaptive management will be an iterative process which combines management measures and subsequent monitoring with the aim of improving effectiveness of the measure, whilst also updating knowledge and improving decision making over time. Adaptive management will be an important component of the compensation measures and will be used as a method to address unforeseen issues or deviations from expected outcomes of the compensation (e.g. low colonisation rate of structure).

8.3.1.4 Through considerate design and careful site selection, it is Orsted H4's intention that the ANS will not require any substantive management actions (i.e., outside of general structure maintenance) during the lifetime of Hornsea Four, though it is important to remain mindful of unexpected and unforeseen events which might require adaptive management (e.g. lack of colonisation despite in-depth site selection; or predation risk e.g. from corvids). It is Orsted H4's intention that all foreseen risks are mitigated as far as practicable through good design of the ANS and planned maintenance.

8.3.1.5 Further adaptive management options may become apparent and will subsequently be explored as the monitoring of the ANS and associated kittiwake nesting is

undertaken (see **Figure 5**). If relevant (i.e. requiring discussion with OOEG members), OOEG members will be notified, and discussion points will be set for annual OOEG meetings (See **Section 9.4** and **Figure 6**). Kittiwake populations show a varying degree of interannual variability so population variability will be an integral consideration, alongside review of monitoring results, before any subsequent adaptive management measures are considered. Adaptive management will only be undertaken in relation to the ANS and not 'natural' breeding kittiwake colonies.

8.3.1.6 Measures that have been discussed with the Hornsea Three and Hornsea Four OOEGs in relation to the potential adaptive measures include:

- Extension of ANS to facilitate further nesting spaces which will include the provision of additional nesting structures if capacity in one location is exceeded;
- Relocation of nesting structure;
- Additional protection from the elements;
- Enhanced predator deterrents;
- Provision of nesting material, such as soil and dry vegetation;
- Enhanced recruitment support – kittiwake calls, decoys etc; and
- Provision of supplementary food.

8.3.1.7 In addition, to the above measures, another option for adaptive management could be the delivery of seagrass habitat enhancement to increase biodiversity and act as a nursery for juvenile fish species that are a common prey resource for seabirds including kittiwake. This measure would therefore serve as a more indirect means to offer resilience to kittiwake populations.

8.3.1.8 Orsted H4 is also in discussion regarding the potential to facilitate the development of an offshore structure by another developer, potentially allowing Orsted H4 the opportunity to utilise nest space on that structure as an option for adaptive management (if required) in the future.

8.3.1.9 The likely trigger points (**Figure 5**) for the application of adaptive management will relate to:

- Population trends (at ANS and of the wider population);
- Colony establishment rates; and
- Productivity trends (at ANS and of the wider population).

8.3.1.10 There is no firm commitment to any of the above individual adaptive management measures, with the adaptive management thresholds to be informed by monitoring of the ANS. However, the measures listed above retain the necessary flexibility for Orsted H4 to be able to carry out the adaptive management measures that may be required for Hornsea Four, notwithstanding that the Hartlepool ANS is being shared between both Hornsea Three and Hornsea Four. The link between specific adaptive management actions and how they will be informed by monitoring has been discussed with OOEG members during the technical panel meetings for Hornsea Three. It has been agreed that ongoing consultation on the need for adaptive management will be undertaken with the Hornsea Four OOEG post ANS construction (as indicated by

Figure 5 and Figure 6). The core monitoring of the above three drivers (breeding population, colony establishment and productivity) will be able to inform decisions relating to adaptive management. Some factors may be beyond the control of Orsted H4 and may therefore not trigger adaptive management measures. This process has been highlighted within Figure 5 and Figure 6 and will be informed by the monitoring process detailed in Section 8.1.

8.3.1.11 It is not necessarily appropriate to set quantitative timescales for trigger points in relation to adaptive management due to the complexity of potential issues (i.e., the drivers of population trends at the ANS). At this stage, quantitative trigger points would only permit hypothetical and therefore potentially incorrect timescale estimates. A more appropriate approach, which has been discussed and agreed within the H3 OOEG, is presented in Figure 5. This sets out the process of determining trigger points based on a review of monitoring each year following the breeding season. This will permit the monitoring results to be viewed in context of the ANS baseline monitoring results and that of neighbouring kittiwake colonies, as well as data and trends at a wider regional and national level. If necessary, this process will inform the most appropriate response in terms of adaptive management.

8.3.1.12 The approach to identifying appropriate adaptive management will follow a hierarchy-based system. At this stage, a hypothetical example has been presented in Figure 5 and, in reality, the process would be discussed with the Hornsea Four OOEG during the monitoring phase of the ANS.

8.3.1.13 As a result of the 2022 outbreak of highly pathogenic avian influenza (HPAI) in the UK it may also be necessary to react to potential cases or prevent the spread of cases. Any work undertaken during a HPAI outbreak will be conducted in line with statutory advice and guidance and will be captured in monitoring reports.

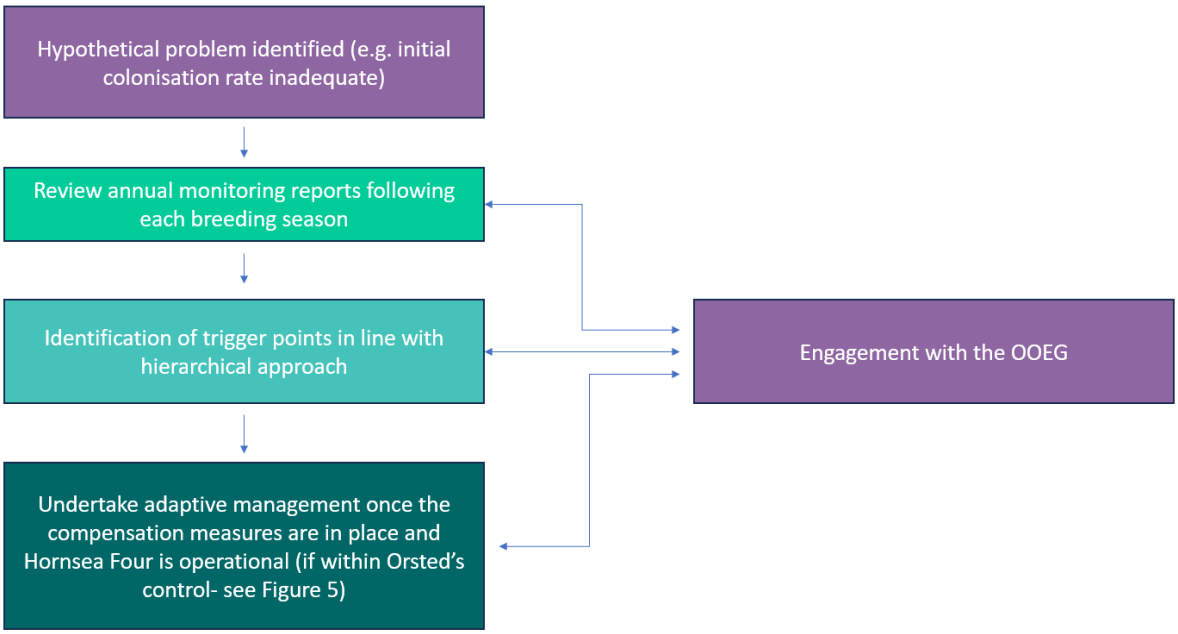

Figure 5: Flow diagram illustrating the process of identifying trigger points for adaptive management

8.4 OOEG Engagement in Adaptive Management

8.4.1.1 As outlined in **Section 8.2.1.9**, monitoring of the ANS will be used to inform a hierarchy-based approach to determine trigger points for adaptive management (presented in **Figure 5**). **Figure 6** presents a schematic overview of how monitoring will determine the level of input required by OOEG members.

8.4.1.2 Those issues which are classed as 'non-ecological' are deemed not to require discussion with OOEG members based on their simplicity. In this instance, OOEG members would be notified by email and any actions summarised as part of the OOEG reporting process. Ecological issues related to breeding kittiwake are likely to be more complex and therefore require discussion with OOEG members regarding appropriate next steps. Such issues would be highlighted to OOEG members ahead of the OOEG

meetings in which the issue would be discussed and, if necessary, appropriate action identified.

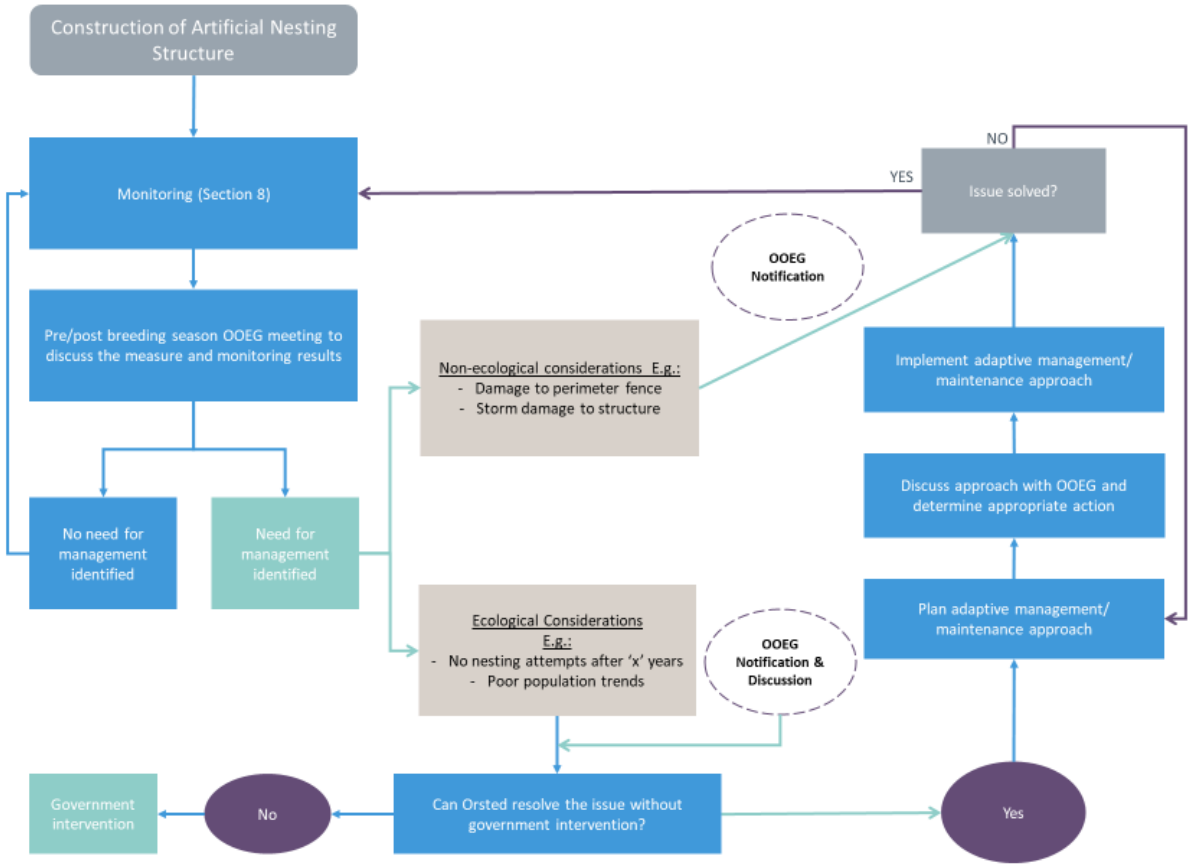

Figure 6: Flow diagram outlining the process informing the OOEG of adaptive management solutions.

9 Success Criteria

9.1.1.1 The document submitted at Deadline 1 "Calculation Methods of Hornsea Four Proposed Compensation Measures for Features of the FFC SPA" (APEM, 2022) established a precautionary, yet realistic, set of assumptions on which to calculate the number of breeding pairs required to deliver a minimum of 43.1 breeding adults (see paragraph 4.1.1.1 regarding updated collision risk modelling) to the existing wider breeding population (biogeographic population). To calculate the breeding population required to be achieved, this number requires several factors to be considered, these being productivity, age at first breeding, survival rates and breeding dispersal. In predicting the target population to achieve 43.1 adult breeding kittiwake each year, an average productivity rate of 0.819 was taken as calculated for colonies located in the east of the UK in the Horswill & Robinson (2015) recommended

estimates of demographic rates. Further detail relating to the scale of compensation is presented within **Section 4.1**.

9.1.1.2 Productivity rates and occupancy at the ANS will, however, vary between years in response to site-specific, regional, and national factors. Therefore, measurement of productivity annually will be a key parameter to be used in calculating whether the ANS delivers what equates to 43.1 additional birds per annum over the lifetime of the Hornsea Four (currently expected to be 35 years), to the existing wider UK NSN breeding population. As stipulated in Paragraph 7 of Part 2 of Schedule 16 of the DCO, the ANS shall be maintained for as long as they are colonised, and planned maintenance and adaptive management measures and monitoring must continue whilst the ANS is in place. A model will, with each successive year, be populated from the ongoing monitoring of the ANS, with year-specific data on colony size and productivity used to monitor progress and future requirements of the ANS, in delivery of this compensation measure to provide 43.1 additional birds annually over Hornsea Four's lifetime to the wider breeding population. This future projection of the number of nests required will be modelled to discharge the accrued debt or surplus in productivity achieved cumulatively across the ANS which was targeted for the current and past years. The model's future projection would ordinarily be described using the latest year's productivity rate for the ANS. Circumstances may arise that lead to seeking a consensus of expert opinion from the OOEG as to the projected productivity rate following e.g., a breeding failure due to a now extinguished disturbance event.

9.1.1.3 Orsted's success criteria are therefore based on an ongoing review process, which will identify aspects required to deliver compensation for 43.1 kittiwake per year whilst also discharging accrued debt or surplus in productivity as monitored. Whilst the ANS will have the capacity to support a minimum of 750 nesting pairs of kittiwake, providing the required compensation when using a precautionary, yet realistic, set of assumptions (**Section 9.1.1.1**), the metric of success is linked directly to the overall productivity of the ANS to deliver 43.1 kittiwake per year to the existing wider breeding population.

10 Reporting

10.1.1.1 Paragraphs 4, 5 and 6 of Part 2 of Schedule 16 of the DCO (as amended) establish the reporting requirements that will be adhered to by Orsted in relation to the ANS. These are as follows:

4. The undertaker must implement the measures set out in the KCIMP approved by the Secretary of State, unless otherwise agreed by the Secretary of State in consultation with the relevant SNCB, MMO and the relevant local planning authority. No operation of any turbine forming part of the authorised development may begin until the KCIMP has been approved by the Secretary of State and two full breeding seasons following the implementation of the measures set out in the KCIMP have taken place. For the

purposes of this paragraph each breeding season is assumed to have commenced on 1 April in each year and ended on 30 September.

5. The undertaker must notify the Secretary of State of completion of construction of the artificial nesting structure as set out in the KCIMP.

6. Results from the monitoring scheme must be submitted at least annually to the Secretary of State and the relevant SNCB. This must include any finding that the measures have been ineffective in securing an increase in the number of adult kittiwakes available to recruit into the FCC and in such case proposals to address this. Any proposals to address effectiveness must thereafter be implanted by the undertake as approved in writing by the Secretary of State in consultation with the relevant statutory nature conservation body.

10.1.1.2 The first report to the Secretary of State will therefore be provided following the end of the first breeding season, with annual reports following thereafter. Project reviews will take place after each breeding season, in consultation with the OOEG, once monitoring reports are available. It is anticipated that these annual reports will capture the level of breeding success at the ANS, along with other pertinent information gathered from the monitoring of the birds associated with the ANS.

11 Programme for Implementation and delivery

11.1.1.1 The ANS must be in place for two full kittiwake breeding seasons prior to the operation of any turbine forming part of the authorised development. As set out in paragraph 4.3.2.5 above, Orsted has been developing the proposals with a view to construction on the Hartlepool ANS site (i.e. the ANS being in place) being finished in time for the 2025 kittiwake breeding season (1 March 2025).

12 Discharge of Consent Condition

12.1.1.1 **Table 4** sets out a summary of the Hornsea Four DCO conditions as required to be drafted into the KCIMP and which section of the KCIMP this detail is provided.

Table 4: Summary of DCO requirements as addressed within the KCIMP.

DCO Schedule 16 Part 2 (Para. 3)	Section and/or Appendix where requirement is addressed
(a) *Details of the location where the compensation measure will be delivered and the suitability of the site to deliver the measures (including why the location is appropriate ecologically and likely to support successful compensation);*	**Section 4** presents how Orsted has met this requirement by setting out the location of the ANS (**Figure 1**) and its ecological merits. Further evidence surrounding kittiwake breeding ecology and how it has been drawn upon during the site selection process is provided within the Site Selection Narrative Report (NIRAS, 2022b) and the Kittiwake Artificial Nest Provisioning: Ecological Evidence report (NIRAS, 2020).
(b) in relation to an offshore structure, details of any relevant seabed agreement(s);	(Not applicable).
(c) details of the design of the artificial nesting structure(s) to provide nesting for at least 750 pairs of	**Section 5** and **Appendix D** presents how Orsted has met this requirement.

kittiwake in total; including the projected number of nests that will be accommodated on the structure, and how risks from predation and other perturbations have been designed out or mitigated;;	
(d) an implementation timetable for delivery of the artificial nesting structure, such timetable to ensure that the structure is in place to allow for at least two full kittiwake breeding seasons prior to operation of any turbine forming part of the authorised development. For the purposes of this paragraph each breeding season is assumed to have commenced on 1 April in each year and ended on 30 September.	**Section 11** presents how Orsted has met this requirement for the KCIMP and shows the programme for implementation and delivery.
(e) details of the maintenance schedule for the artificial nesting structure;	**Section 6** sets out how Orsted has met this requirement and outlines the planned maintenance that will be undertaken throughout the lifetime of the ANS.
(f) details for the proposed ongoing monitoring and reporting of the effectiveness of the measures including— (i) survey methods; (ii) survey programmes; (iii) success criteria; and (iv) timescales for the monitoring reports to be delivered.	The following sections set out how Orsted has met this requirement: **Section 8** presents the plans for monitoring and adaptive management, including survey methods and annual survey programme (i.e. months in which it will be undertaken each year); **Section 9** sets out the success criteria; and **Section 10** outlines reporting requirements and project reviews
(g) recording of H4 OOEG consultations and project reviews	**Section 3** and **Appendix C** summarises the consultation that has been undertaken
(h) details of any adaptive management measures, with details of the factors used to trigger any alternative and/or adaptive management measures; and	**Section 8** sets out how Orsted has met this requirement and presents the plans for monitoring and adaptive management.
(i) monitoring should include annual monitoring of the number of birds colonising the site including sufficient detail to identify barriers to breeding success (including nesting attempts and nest productivity) and target alternative or adaptive compensation measures. Evidence of natal dispersal and colony interchange with the UK NSN and FFC kittiwake colony should be included. Information of any other seabirds attempting to and/ or successfully nesting on the ANS should also be recorded	**Section 4** and **Section 8** summarise the proposed monitoring and adaptive management measures

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Appendix A

Hornsea Project Four Artificial Nesting Structure:

Achievement of success when using Hartlepool Artificial Nesting Structure for Hornsea Projects Three and Four

Document Properties	
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Title	Achievement of success when using Hartlepool ANS for Hornsea Projects Three and Four

Version History			
Date	*Version*	*Status*	*Description / Changes*
05/09/2024	1	Draft	Draft as submitted to the OOEG and Local Planning Authority for review
27/09/2024	2	Final	Final report as submitted to the Secretary of State for the Department for Energy Security and Net Zero
31/10/2024	3	Final (minor update)	Final report resubmitted to the Secretary of State for the Department for Energy Security and Net Zero to correct error in Table 6.1

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Acronyms

Term	Definition
ANS	Artificial Nesting Structures
DCO	Development Consent Order
Hornsea Three	Hornsea Project Three Offshore Windfarm
Hornsea Four	Hornsea Project Four Offshore Windfarm
RSPB	The Royal Society for the Protection of Birds
SPA	Special Protection Area

1 Introduction

1.1.1.1 Orsted Hornsea Project Four Limited (hereafter 'Orsted H4') is required by The Hornsea Four Offshore Wind Farm Order 2023 (DCO) to construct an artificial nesting structure (ANS) for kittiwake as a compensation measure for the potential impacts of the Hornsea Project Four Offshore Windfarm (hereafter 'Hornsea Four'). Similarly, Orsted Hornsea Project Three (UK) Limited (hereafter 'Orsted H3') have constructed three ANS for kittiwake off the coastline of East Suffolk and are constructing further ANS at the site of the Old Hartlepool Yacht Club, Hartlepool Headland, North East England, as a compensation measure for the potential impacts of the Hornsea Project Three Offshore Windfarm (hereafter 'Hornsea Three').

1.1.1.2 This note considers a range of scenarios for colony growth, productivity and size of the starting colony at an ANS should the Old Hartlepool Yacht Club be jointly shared between Hornsea Four and Hornsea Three. In doing so, it identifies a range of predictions of the likely time scale for each scenario within which the proposed compensation can be expected to achieve its aims for both Hornsea Three and Four.

2 Potential for colonisation

2.1.1.1 There will be two structures comprising a single ANS at the Old Hartlepool Yacht Club site; a tower containing 850 nest spaces and huts containing 534 nest spaces, having a total site capacity of 1,384 spaces.

2.1.1.2 The ANS being constructed at the Old Hartlepool Yacht Club is intentionally positioned in proximity to existing colonies where productivity is high. Kittiwake are colonial nesting species so are strongly attracted to areas where other kittiwake are already nesting. In addition to this, areas where populations are increasing and breeding success is high are more attractive to birds wanting to recruit into the breeding population and are indicative of favourable environmental conditions (e.g. prey resource availability in the region). Existing colonies which are known to have growing populations (which indicate good productivity) show that prey availability is not likely to be a constraint locally.

2.1.1.3 Orsted H4 is confident that the ANS at Hartlepool will be populated given that there has been a thorough site selection and careful design process. There is a high likelihood of achieving the required targets of:

- 230 breeding pairs per year, as would be required to replenish annually the predicted 43.1 collisions of breeding adult Kittiwake apportioned to Flamborough and Filey Coast Special Protection Area (SPA) at a maximum compensation ratio of 2:1[1] for Hornsea Four, in addition to;
- a quarter of the 404 breeding pairs per year[2] required cumulatively across the four Hornsea Three ANSs as they provide a 4:1 compensation ratio in nest site provisioning.

[1] Since the end of the Examination for Hornsea Four, Natural England has issued new interim guidance on avoidance rates for use in collision risk modelling. When applied, Orsted have calculated decreases to the Project's and Natural England's predicted impacts on kittiwake to respectively 15.7 birds and 43.1 birds per year for the central estimate impact. Using Orsted's calculation methodology (Orsted 2022a), 230 breeding pairs would be required to deliver Natural England's central estimate impact (43.1) at a 2:1 ratio.
[2] 101 nests i.e. 404 nests per year cumulatively across the Hornsea Three ANSs (Orsted 2020, 2022b) divided by 4.

3 Colony Growth

3.1 Growth rate

3.1.1.1 Projecting the growth rate of a new artificial site is challenging as data on the colonisation of artificial structures is limited (Orsted 2020). At natural sites, new colonies are usually created by young birds and will typically grow rapidly, but thereafter increase at a progressively lower rate (Coulson 2011, Kidlaw *et al.* 2005). Their initial growth for the first ten years or so has been found to be typically of an annual (compound) rate of increase of 50-80% amongst UK colonies (Coulson 2011). Thereafter, growth rate of the larger and older colonies having declined to around 10%–20% per annum or less (Coulson 2011, Kidlaw *et al.* 2005).

3.2 Realistic scenario of colony growth

3.2.1 Coquet Island's kittiwake breeding population trajectory

3.2.1.1 Coquet Island (Northumberland) has been monitored from colonisation and initial breeding in 1991, so is likely to present a scenario for establishment of a new colony at a new site where birds had not bred prior. Furthermore, kittiwake had not previously bred nearby to Coquet[3], thus providing what is likely to be a precautionary scenario, this is perhaps exemplified by the colony being initiated by only one breeding pair in 1991[4] . In addition, the colony has been limited by available nesting space, running out of natural cliff ledges in recent years which has led to RSPB providing artificial nesting ledges from 2019 (Morrison 2021[5]). The result is a colony that has continued to expand to 512 apparently occupied nests (AON) in 2022[6].

3.2.1.2 The growth rate of the kittiwake colony at Coquet Island conforms with that described for starting colonies in general. The annual (compound) rate of increase is:

- 63% in the first ten years,
- 12% for the second ten year period (2001-2010), and
- 9% for the last ten real data years (2013-2022), and
- a modelled 0.7% for the period years 26 to 35 using the average growth rate for the five years 2018-2022, for those three years after the last real count data in 2022.

3.2.1.3 The growth rate of the kittiwake colony at Coquet Island is used in this note as the first real example as the basis to predict how quickly the proposed compensation for Hornsea Four would achieve its aims following a delay in the initial colonisation of the ANS.

3.2.2 Marsden Cliff's kittiwake breeding population trajectory

3.2.2.1 Marsden Cliff (South Shields, Tyneside) has been monitored from the first few years after colonisation that occurred between 1929 and 1931 (Coulson 2011). Following that initial colonisation, the colony increased by a similar number of nests (about 100) each year throughout the period 1932 to 1955 with the exception of a deviation between 1937 and 1953; World War II

[3] Nearest colony is over 30 km away on the Farne Islands, Northumberland.
[4] In contrast to Coquet Island with no nearby colonies, the ANS at Hartlepool Old Yacht Club will have existing breeding kittiwakes within 400 m.
[5] https://community.rspb.org.uk/ourwork/b/natureshomemagazine/posts/handy-hammocks---getting-creative-for-kittiwakes , https://www.theambler.co.uk/2021/10/14/bumper-seabird-season-on-coquet-island/
[6] BTO/JNCC Seabird Monitoring Programme (SMP) https://www.bto.org/our-science/projects/seabird-monitoring-programme

is considered a possible explanation for the latter deviation (Coulson 2011). Colony growth following the initial few years of colonisation, can be mathematically described by the equation:

$$y = 98.7(1931 + x) - 190767$$

Where x = year (where 1 = year of colonisation) and y = the number of nests.

3.2.2.2 The growth rate of the kittiwake colony at Marsden Cliff is used in this note as the basis of a second real example from the east coast of England, of how quickly the proposed compensation for Hornsea Four could achieve its aims following a delay in the initial colonisation of the ANS.

3.2.3 Logistic growth rate model

3.2.3.1 Natural England has previously stated that whilst recognising the limited data available to predict the likely growth of a generic colony, a 10% per annum growth rate would be more appropriate for the lifetime of the wind farm. This is based on Natural England's advice when commenting on a comparable kittiwake compensation project for Norfolk Boreas offshore wind farm, where they also acknowledged that a 20% growth rate may well be achieved or exceeded in the early years of the colony (Natural England 2021). To accommodate this view-point in the absence of any in-situ examples from which to inform, a logistic growth rate model (Vandermeer 2010) is presented as an alternative scenario to using the population trajectories observed at Coquet Island, Marsden Cliff and elsewhere. In logistic growth, a breeding population's per capita growth rate gets smaller and smaller as population size approaches a maximum imposed by limited resources in the environment, in the current scenario that is nesting space. For the model used in this note, the logistic growth curve for the breeding population commences with a 20% growth in accordance with Natural England's view on what may be achieved in the early years of the colony (Natural England 2021), together with a 50% and 80% initial growth rate in accordance with the findings of Coulson (2011).

3.3 Size of the starting colony

3.3.1.1 Kidlaw *et al.* (2005) described the growth of colonies in Alaska and record that they are typically founded by variable numbers of pioneers (23 pairs on average). Within the UK, Coulson (2011) noted that new colonies are usually formed by between three and 20 breeding pairs.

3.3.1.2 This note presents for each of the three colony growth rate models, (i.e. the logistic growth rate model and models following Coquet Island's and Marsden Cliffs kittiwake breeding population trajectories) two scenarios of differing initial colony sizes:

- Scenario One: uses a starting position of one nest in year 1, the same scenario as founded the Coquet Island colony; and
- Scenario Two: shows an alternative scenario, based on a starting colony size of 20 breeding pairs in year one, as representative of a realistic upper value as suggested from UK colonies (Coulson 2011).

4 Productivity

4.1.1.1 To achieve a sustainable kittiwake population, annual breeding success should be maintained at, at least 0.8 chicks per nest (Coulson 2017) when adult survival rates are that of recent years (1985-2015), with no evidence of any change since. The latter threshold approximates to the regional-specific productivity that had earlier been estimated by Horswill and Robinson (2015) for the east coast of Britain (i.e. 0.819). At a site level, between 1991-2022, 1.16 fledglings per pair

were produced at the kittiwake colony at Coquet Island, and 1.27 fledglings per pair for the last five of those years (2017-2022). Whereas for the last five year period for which data is available, the number of fledglings per pair has been 0.64 at Flamborough and Filey Coast SPA (2018-2022), and 1.025 at Lowestoft (2013-2017). At the latter site, Lowestoft, productivity has been estimated as high as 1.27 fledged chicks per nest as in 2021. However, at the nearby two water intake/outflow rigs inshore at Sizewell (19 miles south of Lowestoft) productivity has been estimated as high as 1.38 fledged chicks per nest as in 2021 (NIRAS 2023).

4.1.1.2 Four productivity values (as listed 1 to 4 below) are used as a basis to predict how quickly the proposed compensation for Hornsea Four would achieve its aims:

1) the actual productivity observed for each year of growth of the kittiwake colony at Coquet Island is used as the primary source, given its unique insight into the full trajectory of kittiwake colony growth from colonisation.

To provide context, the growth rate of colony observed at the Coquet Island is also modelled using three additional productivity values defined as:

2) "Low" - 0.8 fledglings per nest, the threshold for a sustainable colony detailed by Coulson (2017);

3) "Medium" - 1.025 fledglings per nest, the average productivity of the last five year period (2013-2017) for which data is available at Lowestoft, being representative of the region where ANS is proposed; and

4) "High" - 1.38 fledglings per nest, the peak productivity of the last three years (2021, 2022, 2023) at Sizewell rigs.

4.1.1.3 For the logistic growth curve model and the colony growth recorded at Marsden Cliff, productivity was set at the above defined low, medium and high productivity values. Use of this alternative approach for a real example of colony growth was taken for Marsden Cliff in the absence of availability of annual productivity data.

5 Survival rates and age of first breeding

5.1.1.1 Parameterisation of both models that which replicated kittiwake colonisation of Coquet Island (3.2.1), Marsden Cliff (3.2.2) and the logistic growth rate model (3.2.3) required several additional factors to be considered:

- The survival rate of kittiwake varies by age with juvenile birds typically experiencing slightly higher levels of mortality than older birds. In alignment with the review of seabird demographic rates by Horswill and Robinson (2015), the following survival rates used were:
  - Juvenile survival (0-1 years) = 0.790
  - Adult survival (≥2 years) = 0.854
- Age at which birds start to breed (age of recruitment) = four years of age (Horswill and Robinson 2015).

6 Computational steps of the models

6.1.1.1 Table 6.1 presents the stepwise progression of the computational process in each of the three models used to determine the likelihood of when the cumulative adult production from chicks

fledged at the ANS, begins to exceed the accrued mortality debt from predicted collisions at Hornsea Four.

Table 6.1 Stepwise calculation of the cumulative total of the production of adults from ANS when using a model that either (a) replicates kittiwake colonisation of Coquet Island or alternatively (b) Marsden Cliff, and (c) that uses the logistic growth rate model

Successive steps of the analysis	Formulas used (using the parameters identified in first and third columns)	Value
(a) Breeding season of ANS		*t*
(b) Initial colony size: 1 nest 20 nests		1 20
(c) a. Initial colony logistic growth rate: Low Medium High **Or alternatively:** b. Colony growth rate as annually recorded at: (1) Coquet Island (1991 - 2022) (2) Marsden (1932 - 1995)		20%[7] 50%[8] 80%[8] Colony growth rate as annually recorded at (1) Coquet Island and (2) Marsden Cliffs
(d) Carrying capacity of ANS (i.e. no. of nesting spaces)		1384
(e) Colony size (breeding pairs) in t^{th} breeding season of ANS: Logistic growth rate model **Or alternatively:** Growth in colony size as annually recorded at: (1) Coquet Island (1991 - 2022) (2) Marsden (1932 - 1995)	$e_{t-1} \times c \times ((d - e_{t-1})/d) + e_{t-1}$ (1) Coquet Island colony size (1991-2021) where 1991 is t = 1[9] (2) Marsden where 1932 is t = 1[8]	
(f) Productivity (fledglings/nest): Low Medium High **Or** Productivity as annually recorded at Coquet Island (1991 - 2022)		0.8[10] 1.025[11] 1.38[12] 0.4-1.69[13]
(g) No. of chicks fledged in year t from ANS	e x f	
(h) Survival rate of juvenile birds		0.79[14]

[7] Natural England (2021)
[8] Coulson (2011)
[9] Seabird Monitoring Programme https://app.bto.org/seabirds/public/index.jsp
[10] Coulson (2017)
[11] 5 year mean (2013-2017), Lowestoft
[12] Peak productivity in 2021 - 2023, Sizewell (NIRAS 2021, 2022, 2023)
[13] Coquet Island from 1993 to 2022 (Seabird Monitoring Programme https://app.bto.org/seabirds/public/index.jsp)
[14] Horswill and Robinson (2015)

(i) No. of year t cohort of fledged birds from ANS surviving first year	h x g	
(j) Survival rate of sub-adults/adults		0.854[14]
(k) No. of year t cohort of fledged birds from ANS surviving second year	j x i	
(l) No. of year t cohort of fledged birds from ANS surviving third year	j x k	
(m) No. of year t cohort of fledged birds from ANS surviving fourth year	j x l	
(n) Cumulative total of the production of adults	$\sum_{1}^{t} m$	

7 Division of nests and productivity between projects

7.1.1.1 This note presents for each of the three colony growth rate models, (i.e. the logistic growth rate model and models following Coquet Island's and Marsden Cliffs kittiwake breeding population trajectories) three different approaches ("setups") to dividing the contribution of nests and productivity at the ANS between the two projects, Hornsea Three and Four:

- Setup One ("nesting space"): uses the proportional split across the site weighted at 62% for Hornsea Four and 38% for Hornsea Three that reflects the relative weighting of each project's minimum nesting requirement for a single ANS in accordance with their DCO requirements i.e. 750 and 404 nesting spaces respectively (UK Statutory Instruments 2023; Orsted 2022b). However, as soon as the productivity assigned to Hornsea Three has recruited 639 adults of breeding age into the metapopulation (i.e. 73 collisions x 35 years / 4)[15], all productivity going forward is assigned to Hornsea Four; and
- Setup Two ("Hornsea Three first"): shows an alternative setup that assumes all productivity from the ANS is initially assigned to Hornsea Three then, on having achieved the recruitment of 639 adults of breeding age into the metapopulation, all productivity going forward is assigned to Hornsea Four; and
- Setup Three ("ratio based on productivity required"): shows a second alternative setup, based on productivity being divided in each year between the Projects in the ratio of their respective requirement for the recruitment of adults of breeding age into the metapopulation i.e. 86.2:18.25 = (43.1 collisions x 2):(73 collision/4)[16].

8 Delivery

8.1.1.1 **Table 8.1** shows the year that the cumulative production of adults at the ANS attains (1) the total predicted mortality from collision at Hornsea Four (HOW04) at a 2:1 compensation ratio and (2) 25% of the predicted mortality from collisions at Hornsea Three (HOW03). Each model is based on an initial colony size of either one or twenty breeding pairs on the ANS in 2025, two and

[15] For Hornsea Three, the assumption is that a quarter of adults of breeding age that are required to compensate for the 73 collision per annum, 639 birds, are to be recruited into the metapopulation from each of the four ANS from the 404 breeding pairs per year required cumulatively across the four Hornsea Three ANSs (Orsted 2020, 2022b) on the assumption that they provide a 4:1 compensation ratio in nest site provisioning.

[16] For Hornsea Four, the objective of compensation as set out by the Secretary of States Habitat Regulations Assessment is for the potential of the structure to deliver 43.1 adult kittiwakes (number of collisions per annum) into the metapopulation at a 2:1 compensation ratio i.e. 43.1 x 2 = 86.2 birds. For Hornsea, Three see the previous footnote.

four years prior to when Hornsea Three and Four are anticipated to become operational respectively. Parameters include:

- The growth rate replicating that of Coquet Island with productivity replicating that at either:
    - Coquet Island (between 0.4 - 1.7 fledglings per pair, mean of 1.1; 1991-2022); or
    - Sizewell Rigs in 2021 (1.38 fledglings per pair) defined as "High"; or
    - Lowestoft (1.025 fledglings per pair; 2015-2017) defined as "Medium"; or
    - Colonies attaining the threshold of being sustainable (0.8 fledglings per pair; Coulson 2017) defined as "Low"; or
- The growth rate replicating that of Marsden Cliffs with productivity replicating that at either:
    - Sizewell Rigs in 2021 (1.38 fledglings per pair) defined as "High"; or
    - Lowestoft (1.025 fledglings per pair; 2015-2017) defined as "Medium"; or
    - Colonies attaining the threshold of being sustainable (0.8 fledglings per pair; Coulson 2017) defined as "Low"; or
- A logistic growth rate set initially at 20%, 50% or 80%, with productivity set “Low” at 0.8 fledglings per pair.

Table 8.1 A comparison of models and parameter values for the year that cumulative adult production from chicks fledged at old Hartlepool Yacht Club ANS, attains (1) the total predicted mortality from collision at Hornsea Four at a 2:1 compensation ratio and (2) 25% of the predicted mortality from collisions at Hornsea Three, under the assumption of initial colonisation in 2025.

Growth rate	Productivity (no. of fledged birds per nest)	Initial colonisation in Year 1 = 1 nest						Initial colonisation in Year 1 = 20 nest					
		Setup One: Nesting space[17]		Setup Two: *HOW03 first*[18]		Setup Three: *Ratio based on productivity required*[19]		Setup One: *Nesting space*		Setup Two: *HOW03 first*		Setup Three: *Ratio based on productivity required*	
		HOW04 62%	*HOW03 38%*	*HOW04 after HOW03 quota*	*HOW03 Initial output*	*HOW04 100% needs*	*HOW03 25% needs*	*HOW04 62%*	*HOW03 38%*	*HOW04 after HOW03 quota*	*HOW03 Initial output*	*HOW04 100% needs*	*HOW03 25% needs*
Coquet Island	*Coquet Island*	2061	2054	2061	2045	2061	2061	2057	2050	2057	2042	2057	2057
Coquet Island	*Lowestoft (1.025)*	2063	2055	2063	2046	2063	2063	2058	2051	2058	2043	2058	2058
Coquet Island	*Sizewell (1.38)*	2059	2052	2060	2044	2060	2060	2055	2048	2055	2041	2055	2055
Coquet Island	*Coulson (0.8)*	2066[20]	2057	2066	2048	2066	2066	2061	2053	2061	2044	2061	2061
Marsden Cliff	*Lowestoft (1.025)*	2041	2037	2041	2034	2041	2041	2041	2037	2041	2034	2041	2041
Marsden Cliff	*Sizewell (1.38)*	2039	2036	2039	2033	2039	2039	2039	2036	2039	2033	2039	2039
Marsden Cliff	*Coulson (0.8)*	2043	2038	2043	2037	2043	2043	2043	2038	2043	2035	2043	2043

[17] Setup One: Nesting space – the available nests are in a given year divided between Hornsea Four and Hornsea Three respectively 62% and 38%. As soon as the productivity assigned to Hornsea Three has recruited 639 adults of breeding age into the metapopulation (i.e. 73 collisions x 35 years / 4), all productivity going forward is assigned to Hornsea Four.
[18] All productivity is initially assigned to HOW03 then on achieving the recruitment of 639 adults of breeding age into the metapopulation, all productivity going forward is assigned to Hornsea Four.
[19] Productivity is divided in each year between the Projects in the ratio of their respective requirements for the recruitment of adults of breeding age into the metapopulation i.e. HOW04:HOW03 = 86.2:18.25 = (43.1 collisions x 2):(73 collision/4).
[20] Red text in white cells indicates where the cumulative adult production from chicks fledged at the ANS, begins to exceed respectively 25% and 200% of the total predicted mortality from collisions at the windfarm after the latter's 35 years of operation for Hornsea Three and Hornsea Four.

Growth rate	Productivity (no. of fledged birds per nest)	Initial colonisation in Year 1 = 1 nest						Initial colonisation in Year 1 = 20 nest					
		Setup One: Nesting space[17]		Setup Two: *HOW03 first*[18]		Setup Three: *Ratio based on productivity required*[19]		Setup One: *Nesting space*		Setup Two: *HOW03 first*		Setup Three: *Ratio based on productivity required*	
		HOW04 62%	*HOW03 38%*	*HOW04 after HOW03 quota*	*HOW03 Initial output*	*HOW04 100% needs*	*HOW03 25% needs*	*HOW04 62%*	*HOW03 38%*	*HOW04 after HOW03 quota*	*HOW03 Initial output*	*HOW04 100% needs*	*HOW03 25% needs*
Logistic Growth Curve (0.2)	*Coulson (0.8)*	>2067	2061	>2067	2061	>2067	>2067	2057	2051	2057	2045	2057	2057
Logistic Growth Curve (0.5)	*Coulson (0.8)*	2053	2049	2053	2045	2053	2053	2045	2041	2045	2038	2045	2045
Logistic Growth Curve (0.8)	*Coulson (0.8)*	2047	2043	2047	2041	2047	2047	2042	2038	2042	2036	2042	2042

8.1.1.2 Each model presented is for one ANS as proposed for the Hornsea Four kittiwake compensation measure to replenish annually the predicted 43.1 collisions of breeding adult Kittiwake apportioned to Flamborough and Filey Coast SPA at a **2:1 compensation ratio**. Therefore, progress should be viewed in delivering from the structure that which equates to 86.2 additional birds per annum over the lifetime of Hornsea Four (35 years). The ANS produces 3,017 additional breeding birds contributing to the existing wider breeding population[21] within the lifetime of the Project when productivity is comparable to the average recorded in recent years at kittiwake colonies in eastern England (2021 – 2023; NIRAS 2023), which is 200% of the total predicted mortality for kittiwake from Hornsea Four during its operational lifetime.

8.1.1.3 In addition, when considering that each model presented is for one ANS, as this latter ANS will be the last constructed of four ANS for the Hornsea Three Kittiwake compensation measure, progress should therefore be viewed in delivering cumulatively across the structures which equates to 73 additional birds per annum over the lifetime of the Hornsea Three (35 years). If colonisation, growth rate and productivity were equal across all four ANS, then the compensation measure would be delivered cumulatively across the structures when the cumulative production of adults at each ANS attains 25% cumulative mortality from predicted collisions at Hornsea Three i.e. 639 additional breeding birds contributing to the existing wider breeding population[22].

8.1.1.4 The ANS in construction at Old Hartlepool Yacht Club will provide nesting opportunities for 1,384 breeding pairs of kittiwake. However, it is unlikely that the maximum capacity will ever be achieved. ANS generally do not reach full capacity, for example the Gateshead kittiwake Tower, South Shields, has plateaued at an occupancy rate of approximately 40%[23] . The latter site's low occupancy is in itself however, a consequence of a sub-optimal design, having been installed prior to current understanding of the importance of carefully orientating artificial nest site ledges. The optimally designed ANS at Hartlepool aims to provide a nesting ledge microclimate where the net balance between heat stress from solar irradiation, and cold stress from wind exposure is least thermoregulatory stressful for both adults and chicks. For all scenarios using the Marsden Cliff growth rate, full colony occupancy is achieved in the years 2044 and 2043 for an initial colonisation of 1 and 20 nests respectively. Whereas using the Logistic Growth Curve, full colony occupancy is achieved between the years 2042 – 2051 for initial growth rates of 50% and 80%, whilst for 20%, only 27% and 91% occupancy by 2063 for initial colonisation in Year 1 of 1 and 20 nests respectively. Finally, use of the Coquet Island breeding population trajectory, results in 63% occupancy being achieved by the year 2063.

8.1.1.1 **Table 8.1** includes showing modelled outputs of the time taken to achieve the cumulative adult production aims for both Hornsea Three and Four at differing rates of initial growth and initial colony size, when using the logistic growth rate model with productivity set at 0.8 fledglings per pair. There is no evidence to suggest that colony size will follow any of

[21] 200% cumulative mortality from a predicted 43.1 collision per annum over the lifetime of the Hornsea Four (35 years) equates to 3,017 birds i.e. 43.1 collisions x 35 years = 1,508.5 collisions, 200% of which is 3,017 birds.
[22] 25% cumulative mortality from a predicted 73 collision per annum over the lifetime of the Hornsea Three (35 years) equates to 639 birds i.e. 73 collisions x 35 years = 2,555 collisions, 25% of which is 639 birds.
[23] A higher level of occupancy than 40% would be expected at each of the ANS on account of having optimised the location and design of the structure for nesting kittiwake.

the trajectories presented here in reality; this is in part due to several external factors which the colony could be impacted by (both negatively and positively), such as severe weather events or changes in food availability. However, the model accommodates for a decreasing growth rate with time, the direction and scale if not the timeline of percentage change, comparable to colonies monitored.

8.1.1.2 A range of scenarios have been modelled for completeness and as shown in **Table 8.1**. There are just a few modelled scenarios where cumulative adult production from chicks fledged at old Hartlepool Yacht Club ANS does not the meet the required success for both projects within 35 years. What is of ecological pertinence to Hornsea Four and Three is that cumulatively across the one or four ANS respectively, the agreed annual excess productivity is attained and maintained, with the accrued debt fully compensated, at a point within the windfarm's operational lifespan. Of the ten scenarios presented, it is only where a combination of the parameter values lie outside the range of recent natural variability (e.g. initial colony growth rate of 20%; see section 3.1), that the ANS is not modelled to accumulate adult production that exceeds much more than 27% of the accumulated mortality for Hornsea Four for example, from collision predicted over 35 years. However a realistic timeframe for this, when reviewing a range of predicted scenarios as in the preceding table (**Table 8.1**), is captured by the scenarios whose parameter values lie within recent and known natural variation.

8.1.1.3 In the context of the scenarios mentioned above, it is pertinent to recognise the precautionary nature in colonisation when being initiated by only one breeding pair, whereas three to 20 breeding pairs is typically encountered in the UK (Coulson 2011). Moreover, those scenarios parameterised with a low productivity of 0.8 fledglings per nest, lie below the average recorded in recent years at kittiwake colonies in eastern England (2021 – 2023; NIRAS 2023). Therefore, on the basis of this Orsted H4 is confident excess productivity can be attained and maintained.

8.1.1.4 The three setups were modelled (as described in **Section 7**) in terms of the division of nests and productivity between projects for completeness to assess how best to share the site. Following the results of the modelling, the preference of both projects from both a productivity and commercial perspective, is to split the site according to setup 1 and that is therefore what the commercial agreement will be based on.

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Appendix B

Hornsea Project Four Artificial Nesting Structure:

Pinsent Masons legal review for the sharing of Hartlepool ANS site between Hornsea Three and Hornsea Four

Document Properties	
Author	Pinsent Masons
Checked by	Felicity Le Page (Orsted)
Approved by	Natalie Bown (Orsted)
Title	Pinsent Masons legal review for the sharing of Hartlepool ANS site between Hornsea Three and Hornsea Four

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Pinsent Masons

APPENDIX B

Memorandum: Sharing of ANS between Hornsea Three and Hornsea Four

1. OVERVIEW

1.1 On 31 December 2020, Orsted Hornsea Project Three (UK) Limited ("**the H3 undertaker**") was granted development consent for the Hornsea Three Offshore Wind Farm via the Hornsea Three Offshore Wind Farm Order 2020. The Hornsea Three Offshore Wind Farm Order 2020 was subsequently corrected and amended by the Hornsea Three Offshore Wind Farm (Correction) Order 2021, the Hornsea Three Offshore Wind Farm (Amendment) Order 2023 and the Hornsea Three Offshore Wind Farm (Amendment) Order 2024. The term "H3 DCO" in this document refers to the Hornsea Three Offshore Wind Farm Order 2023 as corrected and amended.

1.2 On 12 July 2023, Orsted Hornsea Project Four Limited ("**the H4 undertaker**") was granted development consent for Hornsea Four Offshore Wind Farm via the Hornsea Four Offshore Wind Farm Order 2023 (the "**H4 DCO**"), as subsequently corrected and amended.

1.3 The H3 DCO requires the H3 undertaker to deliver compensatory measures for the Hornsea Three impacts on kittiwake at the Flamborough and Filey Coast SPA. The H4 DCO also requires the H4 undertaker to deliver compensatory measures for the Hornsea Four impacts on kittiwake at the Flamborough and Filey Coast SPA. Each undertaker identified the provision of one or more artificial nest structures ("**ANS**") as a proposed compensation measure.

1.4 The H3 undertaker is well progressed in delivering its compensation requirements to secure compliance with the H3 DCO, having delivered three out of the four ANS required. The H3 undertaker is proposing to share the ANS at its onshore site ("**the Hartlepool ANS**") with the H4 undertaker, who will then use the Hartlepool ANS to discharge its compensation requirements under the H4 DCO.

1.5 We have undertaken a review of the H3 DCO and H4 DCO requirements and supporting documents to determine whether the H3 undertaker and the H4 undertaker can share the Hartlepool ANS under the terms of the H3 DCO and H4 DCO and supporting documents.

1.6 The conclusion is that the legal requirements of the H3 DCO and specifically the requirement to comply with the approved H3 Kittiwake Implementation Monitoring Plan ("**KIMP**") would not be hindered by the H3 undertaker and H4 undertaker sharing the Hartlepool ANS. We also conclude that proposed sharing is also in accordance with the terms of the H4 DCO and the certified kittiwake compensation plan which must inform the H4 Kittiwake Compensation Implementation and Monitoring Plan ("**KCIMP**").

1.7 This conclusion is based on our assumption that there will be sufficient available ecological capacity at the Hartlepool ANS to demonstrate to the Secretary of State that it can be used for the purposes of compliance with both the H3 and H4 DCOs. We

understand this to be the case and separate ecological advice (Appendix A to the KCIMP) has been provided to the H3 undertaker and the H4 undertaker to confirm this, a summary of which is provided at Appendix A to the H4 KCIMP.

1.8 This advice is provided to Orsted Hornsea Project Three (UK) Limited and Orsted Hornsea Project Four Limited. It may not be disclosed to or relied upon by any other person except with Pinsent Masons LLP's prior written consent.so long as the

2. **THE H3 DCO**

2.1 Paragraph 3 of Part 1 of Schedule 14 to the H3 DCO requires the H3 undertaker to submit a KIMP to the Secretary of State for approval. The KIMP must be based on the strategy for kittiwake compensation set out in the kittiwake compensation plan (as defined in the H3 DCO and certified for that purpose).

2.2 Sub-paragraphs 3(a) – (i) of Part 1 of Schedule 14 to the H3 DCO also sets out the specific details of what must be included in the KIMP. For example, the KIMP must (amongst other things):

2.2.1 include provision for the construction and maintenance of four ANS on the English east coast onshore or coastal locations to benefit the eastern Atlantic kittiwake population; and

2.2.2 provide details of the proposed ongoing monitoring of the compensation measures.

2.3 Thereafter, there is a requirement for the H3 undertaker to implement the KIMP as approved. There is a prohibition on turbine operations linked to the delivery of the ANS. Following the most recent non-material amendment order, paragraph 4 of Part 1 of Schedule 14 to the H3 DCO states:

"*The undertaker must implement the measures as set out in the KIMP approved by the Secretary of State and no operation of any turbine forming part of the authorised development may be commenced until three full breeding seasons have elapsed from the implementation of three of the artificial nest structures and no final commissioning of the authorised development must take place until the fourth artificial nest structure has been implemented.*"

2.4 As noted above, three of the four required ANS are in operation and the H3 undertaker is currently delivering the fourth ANS at Hartlepool. It is the Hartlepool ANS which the H3 undertaker proposes to share with the H4 undertaker.

2.5 We do not consider there to be any provision on the face of the H3 DCO to prohibit the sharing of the Hartlepool ANS with Hornsea Four.

2.6 **THE H3 KITTIWAKE IMPLEMENTATION MONITORING PLAN**

2.7 In December 2022, the H3 undertaker submitted the KIMP to the Secretary of State for approval. The KIMP was subsequently updated in July 2023 and was approved by the Secretary of State on 14 March 2024 to discharge paragraph 3 of Part 1 of Schedule 14 of the H3 DCO.

2.8 The KIMP requires the delivery of ANS for Hornsea Three, in order to compensate for predicated collision mortality on kittiwake from the operation of Hornsea Three. The KIMP provides that the compensation measure will be implemented for the purposes of the H3 DCO once all four ANS are completed. Thereafter, adaptive management will

be implemented if necessary following monitoring, based on thresholds and "trigger points" to be agreed with the Offshore Ornithology Engagement Group (OOEG).

2.9 Section 8 of the KIMP sets out the monitoring and adaptive management measures pursuant to paragraph 3 of Part 1 of Schedule 14 to the H3 DCO. The adaptive management measures will be used as a method to address unforeseen issues with or deviations from expected outcomes of the compensation measures implemented under the H3 DCO.

2.10 Measures which are referenced in the KIMP as having been discussed with the OOEG are:

(a) Extension of ANS to facilitate further nesting spaces which will include the provision of additional nesting structures if capacity in one location is exceeded;

(b) Relocation of ANS;

(c) Additional protection from the elements;

(d) Enhanced predator deterrents;

(e) Provision of nesting material, such as soil and dry vegetation;

(f) Enhanced recruitment support – kittiwake calls, decoys etc; and

(g) Provision of supplementary food.

2.11 It is noted that there is no firm commitment to any of these adaptive management measures in the KIMP. As section 8.2 of the KIMP explains, the need for the above measures (if at all) will be informed by monitoring of the required ANS and analysis of population trends, colony establishment rates and productivity trends. The H3 undertaker must therefore retain its ability to implement the adaptive management measures, in order to comply with the KIMP if such measures are required.

2.12 Our interpretation of these adaptive management provisions in the context of sharing the Hartlepool ANS is:

2.12.1 If required, and relevant to the management required following the outcome of the monitoring, sub-paragraph (a) could be complied with by the H3 undertaker, notwithstanding the sharing of the Hartlepool ANS with Hornsea Four. If the capacity at the original Hartlepool ANS were to be exceeded, whether that capacity has been ascribed to Hornsea Three and/or Hornsea Four, the wording of the KIMP simply suggests that an appropriate measure would be to seek an extension of the ANS to facilitate further nesting spaces. In any event, this measure is not restricted to a specific ANS location. Therefore, whilst an extension may be sought at the Hartlepool ANS, Hornsea Three may also seek an extension at its other ANS locations (as well as considering the other adaptive measures as an alternative altogether). In any event, we understand from Orsted that ANS generally do not reach full capacity in any case; and

2.12.2 The implementation of the measures at sub-paragraphs (b) to (g) could be complied with by the H3 undertaker, notwithstanding the sharing of the Hartlepool ANS with Hornsea Four. For example, the allocation of nests to Hornsea Three and Hornsea Four should not impact the ability to relocate the ANS or provide supplementary food to make the Hornsea Three ANS more productive.

2.13 Overall, we have not identified any provisions within the KIMP that would prevent sharing, assuming that doing so would not prejudice the ecological delivery of the compensation measures pursuant to the H3 DCO.

2.14 On the above basis, our view is that the provisions of the approved KIMP for Hornsea Three does not preclude sharing of the Hartlepool ANS with the H4 undertaker and that compliance with the H3 DCO would not be prejudiced by doing so.

3. THE H4 DCO

3.1 Paragraph 3 of Part 2 of Schedule 16 to the H4 DCO requires the H4 undertaker to submit a KCIMP to the Secretary of State for approval. The KCIMP must be based on the strategy for kittiwake compensation set out in the kittiwake compensation plan (as defined in the H4 DCO and certified for that purpose). For kittiwake, the proposed compensation measure is an offshore nesting structure or an onshore nesting structure. The DCO provisions do not favour one over the other and the provisions apply equally to whichever option the H4 undertaker chooses to take forward.

3.2 Sub-paragraphs 3(a) – (i) of Part 2 of Schedule 16 to the H4 DCO also sets out the specific details of what must be included in the KCIMP. For example, the KCIMP must (amongst other things) include:

3.2.1 details of the location where the compensation measure will be delivered and the suitability of the site to deliver the measures (including why the location is appropriate ecologically and likely to support successful compensation);

3.2.2 details of the design of the ANS to provide nesting for at least 750 pairs of kittiwake in total;

3.2.3 an implementation timetable for delivery of the ANS;

3.2.4 details of the maintenance schedule for the ANS;

3.2.5 details for the proposed ongoing monitoring and reporting of the effectiveness of the measures; and

3.2.6 details of any adaptive management measures.

3.3 Thereafter, similarly to the H3 DCO, there is a requirement for the H4 undertaker to implement the KCIMP as approved and there is a prohibition on turbine operations linked to the delivery of the ANS as set out in the KCIMP. Paragraph 4 of Part 2 of Schedule 16 to the H4 DCO states:

"*No operation of any turbine forming part of the authorised development may begin until the KCIMP has been approved by the Secretary of State and two full breeding seasons following the implementation of the measures set out in the KCIMP have taken place.*"

3.4 As noted at paragraph 2.4, the H3 undertaker is currently delivering the Hartlepool ANS. Provided that the H4 undertaker drafts the KCIMP to secure the delivery of kittiwake compensation by allocating a proportion of the ecological capacity at the Hartlepool ANS, we do not consider any provision on the face of the H4 DCO to prohibit the sharing of the Hartlepool ANS between the H3 undertaker and the H4 undertaker.

3.5 We note that the H4 Undertaker submitted an Outline KCIMP into the Examination for Hornsea Four. Amongst other things, the Outline KCIMP includes a section that is dedicated to onshore ANS. The Outline KCIMP therefore envisages the delivery of compensation measures using facilities such as the Hartlepool ANS. We do not consider

anything in the Outline KCIMP to present an issue in respect of the sharing of ANS between Hornsea Three and Hornsea Four provided the appropriate levels of compensation are achieved for the purposes of the KCIMP.

4. THE H4 KITTIWAKE COMPENSATION PLAN

4.1 The Hornsea Four kittiwake compensation plan sets out how the compensation measure of artificial nesting for kittiwake can be secured. Further details on the precise delivery methodology for the measure are to be provided in a KCIMP.

4.2 Section 3.1.1.1 of the kittiwake compensation plan sets out:

"*The compensation measure that the Applicant proposes to implement for kittiwake is the provision of an artificial nesting structure. This structure would be either the preferred option of repurposing an existing offshore structure or a new structure, either offshore or onshore.*"

4.3 The inclusion of an appropriate part of the Hartlepool ANS within the KCIMP as an onshore compensation measure therefore aligns with the kittiwake compensation plan. Whilst an offshore ANS option is identified in the kittiwake compensation plan as the preferred measure, the compensation measure for Hornsea Four is stated to comprise the delivery of one ANS in 'either the offshore or onshore environment'[1]. As such, the Hartlepool ANS is a legitimate measure pursuant to the kittiwake compensation plan.

4.4 Section 3.1.1.2 of the kittiwake compensation plan continues to explain that the aim of the compensation is to provide one structure that can sustain the required breeding population of kittiwake (breeding adults). As explained at 1.7, our understanding is that there will be sufficient available ecological capacity at the Hartlepool ANS to allow it be used for the purposes of both Hornsea Three and Hornsea Four. Further detail on the onshore site selection is provided at section 3.4.4 of the kittiwake compensation plan.

4.5 Section 3.4.4.3 of the kittiwake compensation plan sets out that:

"*The purpose of site selection has been to identify an area to host onshore an artificial nesting structure that will be occupied by new recruits in the English southern North Sea, whilst contributing to an increase of breeding adults to the biogeographic population*".

4.6 This approach aligns with the site selection process used for the purposes of Hornsea Three, as set out at Section 4.2 and 4.3 of the H3 KIMP. As such, it appears to us that the Hartlepool ANS has been identified using a site selection process which is in accordance with the process within the kittiwake compensation plan, such that utilising the Hartlepool ANS as the compensation measure is aligned with the kittiwake compensation plan.

4.7 Section 3.2.1.8 of the kittiwake compensation plan explains that an artificial nest design for kittiwake has been developed which draws upon the extensive ecological evidence and associated design criteria. Further detail regarding onshore design is then set out at section 3.5.2. Orsted has confirmed that the design pursuant to the planning permission for the Hartlepool ANS (APP/H0724/W/22/3309272) is in accordance with the design principles for an onshore ANS that were specified in section 3.5.2 of the kittiwake compensation plan.

4.8 The kittiwake compensation plan confirms that any ANS selected as the compensation measure will need to be monitored to inform the adaptive management programme and influence any potential maintenance work required on the structure. Whilst the kittiwake

[1] Section 3.2.1.1 of the Kittiwake Compensation Plan

compensation plan does not identify specific adaptive management measures, it confirms that multiple adaptive management measures will be explored prior to the construction of the ANS. Paragraph 2.10 above sets out the measures which have already been explored by Orsted in relation to the Hartlepool ANS (albeit for the purposes of Hornsea Three). We understand that these measures could be complied with notwithstanding the sharing of the Hartlepool ANS between Hornsea Three and Hornsea Four.

4.9 The H4 kittiwake compensation plan also expressly identifies that the data collected as part of the adaptive management process may be shared with relevant advisors and authorities. At Section 3.4.2.4, the kittiwake compensation plan sets out that the H4 Undertaker would "*look to consider collaboration on monitoring with Hornsea Three and potentially other developers who are also providing onshore nesting structures*". This identifies that the adaptive management work done for Hornsea Three can help inform the adaptive management measures for the purposes of Hornsea Four.

4.10 Overall, as for the position in relation to H3 DCO, we have not identified any provisions within the H4 DCO or the certified H4 kittiwake compensation plan that would prevent sharing of the Hartlepool ANS between Hornsea Three and Hornsea Four, assuming that doing so would not prejudice the ecological delivery of the compensation measures required by the H4 DCO.

Pinsent Masons LLP
03 September 2024

Appendix C

Hornsea Project Four Artificial Nesting Structure:

Summary of consultation undertaken by Hornsea Three for the Hartlepool

Document Properties	
Author	Felicity Le Page (Orsted)
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Approved by	Natalie Bown (Orsted)
Title	Summary of consultation undertaken by Hornsea Three for the Hartlepool

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12/09/2024	1	Draft	Final Draft as submitted to OOEG for review
27/09/2024	2	Final	Final report as submitted to the Secretary of State for the Department for Energy Security and Net Zero

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Acronyms

Term	Definition
ANS	Artificial Nesting Structures
BEIS	Department for Business, Energy and Industrial Strategy
DCO	Development Consent Order
DEFRA	Department for Environment, Fisheries and Rural Affairs
DESNZ	Department for Energy Security and Net Zero
EIA	Environment Impact Assessment
HBC	Hartlepool Borough Council
KCP	Kittiwake Compensation Plan
KCIMP	Kittiwake Compensation Implementation and Monitoring Plan
KIMP	Kittiwake Implementation and Monitoring Plan
MMO	Marine Management Organisation
OOEG	Offshore Ornithology Engagement Group
RSPB	The Royal Society for the Protection of Birds
SPA	Special Protection Area
UKCEH	UK Centre for Ecology and Hydrology

1 Introduction

1.1.1.1 Orsted Hornsea Project Four Limited (hereafter 'Orsted H4') is required by the Development Consent Order (DCO) to construct an artificial nesting structure (ANS) for kittiwake as a compensation measure for the potential impacts of the Hornsea Project Four Offshore Windfarm (hereafter 'Hornsea Four'). To meet this requirement, the project will utilise nest space at the ANS at Old Hartlepool Yacht Club, Hartlepool Headland, Northeast England, sharing the site with Orsted Hornsea Project Three (UK) Limited (hereafter referred to as "Orsted H3"). Stakeholder engagement and consultation for the ANS site selection and design for the Hartlepool site was therefore carried out in advance by Orsted H3 prior to Orsted H4 identifying the site as an option for delivery.

1.1.1.2 This Appendix to the Hornsea Four Kittiwake Compensation Implementation and Monitoring Plan (KCIMP) therefore provides a summary of consultation undertaken by Orsted H3 in relation to the site selection and design for the ANS at Hartlepool Old Yacht Club. This includes a summary of relevant consultation responses received and regard given by Orsted to these responses.

1.2 Consultation Methodology

1.2.1.1 Under the conditions of the Orsted H3 DCO, an Offshore Ornithology Engagement Group (OOEG) needed to be formed to consult on the compensation proposals. Orsted H3 established the OOEG following consent award. The OOEG comprises the following core members:

- Orsted Hornsea Project Three (UK) Limited;
- Natural England; and
- Marine Management Organisation (MMO).

1.2.1.2 In addition, the following consultee was specified in the Kittiwake Compensation Plan (KCP) and attends the Hornsea Three OOEG as a core member:

- The Royal Society for the Protection of Birds (RSPB).

1.2.1.3 The core members provide representative(s) to attend meetings of the OOEG and otherwise participate in the business of the OOEG in accordance with the Plan of Work, which was approved by BEIS (now DESNEZ) on 7th September 2021.

1.2.1.4 Orsted H3 invited a number of specialist consultants and delivery partners (who are assisting in the delivery of the kittiwake compensation measures) to the OOEG meetings, as follows:

- GoBe Consultants Ltd (planning, strategic and technical advice (including ornithology));
- NIRAS (ornithological specialists); and
- LDA Design (landscape and architectural design and planning specialists).

1.2.1.5 To assist in the OOEG discussions, Orsted H3 also invited the following organisations to join the technical panel meetings as advisory members:

- The Department for Environment, Food and Rural Affairs (DEFRA);
- The Joint Nature Conservation Committee (JNCC); and

- UK Centre for Ecology and Hydrology (UKCEH).

1.2.1.6 Hornsea Three OOEG meetings were initially held on a minimum six weekly basis from March 2021, with additional OOEG meetings scheduled as required. At the time of the Orsted H3 Kittiwake Implementation and Monitoring Plan (KIMP) submission, there had been sixteen OOEG meetings comprising an initial inception meeting on 17th March 2021, followed by seven further Technical Panel meetings (including both core and advisory members), and eight Steering Group meetings (core members only).

1.2.1.7 In these OOEG meetings, during the period 17th March 2021 to 14 February 2023, members discussed site selection, design principles, monitoring requirements, the KIMP, as well as any relevant site and project updates following the site selection process. The Steering Group also held a Success Criteria Workshop on 16th September 2021.

1.2.1.8 The OOEG were involved in the development of the Orsted H3 KIMP through discussions, document reviews, and written comments. Feedback from OOEG members has been summarised within Section 2 of this Consultation Summary, along with details of how this was addressed by Orsted H3 in the preparation of the Orsted H3 KIMP where relevant and details of agreements reached.

1.2.1.9 In addition, Orsted H3 held consultation meetings with relevant local planning authorities for the proposed locations of the ANS, which took place separately to the OOEG meetings, to allow for location-specific discussions. In relation to the Hartlepool site, these discussions were held with Hartlepool Borough Council (HBC)) between May 2021 and December 2022. The below **Table 1** summarises the topics discussed in these meetings and further detail on consultation with HBC is included at **Section 2**.

Table 1: Summary of Consultation with Hartlepool Borough Council (the relevant Local Planning Authority)

Topic	Date of meeting / correspondence
Artificial nesting structures for kittiwake (introduction and project updates)	02 June 2021
	25 May 2022
Community benefits	09 June 2022
Draft KIMP consultation	02 December 2021
	14 December 2021
	22 November 2022
Environmental Impact Assessment (EIA) Screening opinion	06 July 2021
	24 September 2021
Site Visit	20 July 2021
Formal pre-application advice	17 September 2021
Orsted's response to planning objections	08 April 2022
	26 April 2022

1.2.1.10 In addition to the consultation with Hartlepool Borough Council detailed in **Table 1**, topic-specific consultation took place with the following stakeholders via letter and/or email correspondence and/or telephone correspondence:

- Flood Risk officer – Hartlepool Borough Council, Ecologist

- Hartlepool Borough Council, Environmental Health
- Hartlepool Borough Council, Landscape Officer
- Hartlepool Borough Council, Tees Archaeology, local ward councillors, Headland Parish Council, PD Ports, and the RNLI.

2 Summary of Consultation

2.1.1.1 Feedback from Orsted H3 OOEG members in response to development of the Orsted H3 KIMP (written feedback, and discussions from OOEG meetings/workshops) up to the submission of the Orsted H3 are summarised in **Table 2** along with details of how this was addressed by Orsted H3 in the preparation of the KIMP, where relevant, and details of agreements reached.

2.1.1.2 Consultation with Hartlepool Borough is also summarised below.

Table 2 - Summary of Consultation and agree positions with Orsted H3 OOEG members

Summary of consultation and agreed positions with Orsted H3 OOEG members
Site Selection
Natural England provided advice on site selection and scoring criteria which Orsted H3 had regard to when finalising its site selection criteria. Natural England advised that sites which on biological grounds appear to be most suitable should not lightly be excluded due to planning/time/technical constraints. Orsted H3 confirmed that sites with planning/time/technical constraints were explored by Orsted H3 to determine potential inclusion as a location. For example, areas with high planning risk due to their inclusion in an AONB/SSSI were considered in detail, as were areas with higher engineering risk, due to their ecological suitability. However, weight was given to planning factors as well as ecological factors during the site selection process, as these are also a crucial part in delivering the compensation for Hornsea Three. Following the inclusion of OOEG feedback and Natural England's written feedback on site selection a short list of site locations were agreed with Orsted H3 OOEG members of which Hartlepool Onshore site was one: • Natural England considered the Hartlepool onshore site very promising, discussed within OOEG Technical Panel #4 on 07/07/2021 and within Natural England advice note, 21/07/2021 (doc. ref. SLA/359406). This advice was subject to general location-specific considerations, for example that ecological, heritage and other planning factors would have to be taken into account when implementing the ANS in each area. At Technical Panel Meeting #3 held on 26/05/2021 the OOEG agreed with the Lowestoft, Sizewell (Minsmere), Hartlepool and Seaham sites identified through Orsted's BRAG (Black, Red, Amber, Green) process.

Summary of consultation and agreed positions with Orsted H3 OOEG members

Design

The Orsted H3 OOEG agreed with the factors listed within the Design Principles (April 2021 OOEG briefing note) which Orsted used to develop the design of the ANS. Section 5 of the Hornsea Four KCIMP (and associated appendices) provides a summary of aspects which have been incorporated into the design to increase the likelihood of colonisation.

All OOEG members agreed that the design process would incorporate adaptive solutions and 'future proofing' (e.g. for climate change) (discussed within OOEG Technical Panel #2 on 21/04/2021).

Overall, Natural England acknowledged that the best available evidence has been used to inform the design and have no further comment (discussed within OOEG Technical Panel #4 on 07/07/2021).

Adaptive Management, Monitoring and Success Criteria

Natural England agreed that the potential adaptive management solutions presented in the April 2021 OOEG briefing note are suitable and cover realistic scenarios.

Adaptive management flow diagrams were drafted and several iterations were presented to and discussed with the Orsted H3 OOEG. The final versions, with inputs from the OOEG, were incorporated into the Orsted H3 KIMP (**Figure 7** and **Figure 8**). Natural England, the RSPB and the MMO agreed with the hierarchy approach to adaptive management at Technical Panel Meeting #7 held on 10 November 2021.

Approaches to understanding and quantifying mortality debt and surplus were presented to OOEG members during the Success Criteria Workshop (OOEG Steering Group Meeting #2 on 16/09/2021). Subsequently, text was provided within **Section 8** and **Section 9** of the KIMP on how debt/surplus will be considered over time. Productivity and its influence within success criteria will be considered, as outlined within **Section 9** (Success Criteria) of the Orsted H3 KIMP.

The flow diagrams were simplified following detailed discussion with OOEG members. During the Orsted H3 OOEG Technical Panel #8 on 21/12/2021, all parties agreed that the flow diagrams were logical and clear with no further edits required. The resulting flow diagrams are illustrated within **Figure 7** and **Figure 8** of the Orsted H3 KIMP.

Pre-implementation baseline monitoring is outlined in **Section 8** of the Orsted H3 KIMP. The locations and scope for this monitoring were discussed and agreed with the Orsted H3 OOEG.

During the Orsted H3 OOEG Technical Panel #3 (26/05/2021), it was agreed that quantifying recruitment of kittiwake into the FFC SPA is currently unfeasible due to the lack of enabling technology. This was discussed in further detail during the OOEG meeting on 20/01/22 with both Natural England and RPSB scientists with all parties confirming there is no current technology which permits this interchange to be quantitatively assessed. Orsted agreed to colour ring chicks where it is safe and practicable to do so– see **Section 8** of the Orsted H3 KIMP and **Section 9** of the Orsted H4 KCIMP.

Natural England agreed that compensation will be delivered to the national site network (biogeographical scale) at the Orsted H3 Steering Group Meeting #2 held on 16 September 2021 and Technical Panel Meeting #7 held on 10 November 2021.

Summary of consultation and agreed positions with Orsted H3 OOEG members

Following Natural England's written comments and discussions during Orsted H3 Steering Group meeting #2 on 16/09/2021, it was agreed to base success on productivity measurements with consideration given to mortality debt and surplus. A detailed success criteria section (**Section 9**) was added to the Orsted H3 KIMP. Natural England and RSPB agreed that the statistical approach to mortality debt and growth rates presented were suitable at Steering Group Meeting #4 on 13/04/2022.

KIMP

Overall, Natural England considered the sections included in the draft Orsted H3 KIMP to be appropriate, although considered it necessary to include a section detailing the success criteria and the adaptive management triggers. Sections on success criteria and adaptive management were included in the Orsted H3 KIMP. Also at the request of Natural England, additional monitoring information, over and above those required by the DCO, was added into the Orsted H3 KIMP. This process also informed the planning of adaptive management measures and was discussed and agreed with Natural England.

RSPB provided various suggestions to improve clarity of sentences within the KIMP and other minor amendments which were incorporated into the KIMP.

2.2 Hartlepool Borough Council (HBC)

2.2.1.1 At an introductory meeting on 02/06/2021, HBC welcomed Orsted H3's early engagement and approach of submitting an EIA screening request to formalise that no EIA was required (noting Orsted H3's view of requiring an EIA is unlikely). HBC subsequently issued a screening opinion on 24/09/2021 confirming that the proposed ANS was not EIA development and therefore no environmental statement was required with the application.

2.2.1.2 At a previous meeting on site on 20/07/2021, HBC provided advice on assessments required as part of the proposed planning application and provided advice on design and local considerations. This was expanded in pre-application advice provided on 17/09/2021, in which HBC also noted that it was supportive of the proposed structures and were accepted in principle.

2.2.1.3 In response to consultation specifically on the KIMP, HBC's Ecology department confirmed it considered the site at the Old Hartlepool Yacht Club to be a suitable location for artificial nest sites, that it had no objection to the proposed design, routine structure maintenance and that it supported the adaptive management. Overall, HBC Ecology department confirmed it had no objection to the location, design or proposed management of the ANS located within Hartlepool Borough.

2.2.1.4 A planning application was submitted by Orsted H3 to Hartlepool Borough Council on 15/12/2021. This was validated on 27/01/2022 (reference H/2022/0009). Following the statutory and public consultation period, Orsted H3 responded to comments and worked closely with Hartlepool Borough Council to resolve outstanding areas of concern. This resulted in a positive decision in Hartlepool Borough Council's planning officer's report which concluded "the proposal in the context of relevant planning policies and material planning considerations is acceptable" and recommended approval. However, during the planning committee meeting on 22/06/2022, four local councillors voted in favour of the application

and seven voted against the application, which meant that planning permission was refused. Orsted submitted an appeal to the Planning Inspectorate on 18/10/2022 (reference APP/H0724/W/22/3309272) and a Planning Obligation by Unilateral Undertaking relating to the Old Yacht Club site was entered into on 20th December 2022. Planning Permission APP/H0724/W/22/3309272) for the demolition of the existing structure and construction of the ANS at the Old Yacht Club was awarded on appeal on 13th March 2023. The Town and Country Planning Act (TCPA) Conditions were discharged on 11th March 2024.

2.3 PD Ports

PD Ports were consulted on the proposals for the site by Orsted H3, specifically the proposed access use of Ferry Road with the first meeting being held in April 2022. Following engagement with PD Ports, in July 2024, Hornsea Three entered into a long-term lease agreement with the landowner, PD Ports, for rights of access to the Old Hartlepool Yacht Club site.

Appendix D

Hornsea Project Four Artificial Nesting Structure:

Hornsea Three Design Report

Document Properties	
Author	LDA Design
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Approved by	Natalie Bown (Orsted)
Title	Hornsea Three Design Report

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Hornsea Three Kittiwake Implementation & Monitoring Plan (KIMP)

Appendix A: Design Report

Ørsted

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Author	LDA Design
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22/12/2022	3	Final	Final report as submitted to the Secretary of State of the Department for Business Energy and Industrial Strategy.

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Appendix 1 - Pattern Book

Appendix 2 - Supporting design information: Nearshore and Onshore ANS Typologies, visuals and dimensions.

Acronyms

Acronym	Definition
ANS	Artificial Nesting Structure(s)
AONB	Area of Outstanding Natural Beauty
CCTV	Closed-circuit television
DEFRA	Department for Environment, Food and Rural Affairs
ESC	East Suffolk Council
HBC	Hartlepool Borough Council
HAT	Highest Astronomical Tide
JNCC	Joint Nature Conservation Committee
MCA	Maritime and Coastguard Agency
MMO	The Marine Management Organisation
OOEG	Offshore Ornithology Engagement Group
RSPB	Royal Society for the Protection of Birds
SSSI	Site of Special Scientific Interest
SPA	Special Protection Area
RAMSAR	Wetlands of international importance designated under the criteria of the Ramsar Convention on Wetland
RNLI	Royal National Lifeboat Institution
UKCEH	UK Centre for Ecology & Hydrology

1 Design Process and Principles

1.1.1.1 This report describes the design process, design principles and design proposals for the Artificial Nesting Structures (ANS) that are required to deliver the ecological compensation requirements for the Hornsea Project Three Offshore Windfarm (hereafter 'Hornsea Three') in the East Anglia and North East search zones.

1.1.1.2 The design objective is to create a series of world class exemplar ecological installations through a process that involves a close, interactive, and iterative working relationship between stakeholders and the team of specialists required to deliver the project, including ecologists, architects, engineers, planning consultants and ornithologists. The relationship between NIRAS (kittiwake ecologists) and LDA Design (architect, landscape architect and planning consultant) has been especially critical to ensure the ANS proposals are rooted in providing the best ecological conditions for ANS success.

1.1.1.3 The design process has involved the presentation and discussion of design thinking and proposals at the regular Offshore Ornithology Engagement Group (OOEG) meetings. Presentation information has included written and graphic content describing proposals as well as live 3D models to help communicate proposals and their 3-dimensional appearance as clearly as possible. OOEG members include:

Core members:

- Orsted;
- Natural England;
- The Royal Society for the Protection of Birds (RSPB); and
- Marine Management Organisation (MMO).

Advisory body members:

- The Department for Environment, Food and Rural Affairs (DEFRA);
- The Joint Nature Conservation Committee (JNCC); and
- UK Centre for Ecology and Hydrology (UKCEH).

Hornsea Three consultants:

- Collaborative Environmental Advisers (independent chair);
- NIRAS;
- GoBe Consultants; and
- LDA Design.

1.1.1.4 At the outset of the project a set of universal ecological design principles were developed by NIRAS that would inform an ecologically driven design process for the ANS. These principles were shared and agreed with the OOEG. Once the ecological design principles were established, a pattern book (**Appendix 1**) was created to act as the primary tool to inform the design of the ANS. The pattern book was also shared with the OOEG to help provide an agreed set of holistic design principles that would inform the site specific ANS design proposals. These design principles were agreed with the OOEG at Technical Panel #3 on 26/05/2021.

1.1.1.5 The pattern book (**Appendix 1**) comprises a set of 28 interrelated design patterns that form the basis for ANS design approach in any appropriate location. Patterns 01 - 18 provide ecological performance requirements (the agreed design principles) with patterns 19 - 28 providing landscape performance requirements for the ANS. The ecological patterns are concerned firstly with the creation of successful nesting conditions and the ability to monitor and potentially adapt the ANS over time in response to research findings or changes in environmental conditions. The landscape patterns are concerned with the appropriate contextual integration of ANS within the landscapes they are located and key considerations in terms of their functional performance including durability, maintenance, and sustainability.

1.1.1.6 The intention of the pattern book is to provide a live document that can be:

- Used by designers of ANS;
- Used to communicate ANS design approach to stakeholders as part of engagement and planning activities;
- Updated in response to design development, research findings from Orsted ANS once installed or third party ANS research findings; and
- Shared with the wider public to communicate ANS design approach and Orsted's commitment to high quality environmental design.

1.1.1.7 Further information, including the ecological principles that have informed the design of all ANS in the East Anglia and North East zones, is contained within the pattern book (**Appendix 1**).

1.1.1.8 All ANS are being designed to provide capacity for an assumed minimum of 467 nesting pairs of kittiwake per ANS. The different ANS designs may provide a greater number of nesting spaces (more than 467 nesting spaces) according to the dimensions and practical fit of the number of ledges on each structure design.

1.1.1.9 As well as ongoing engagement with NIRAS and the OOEG to principally address the ecological design of the ANS, extensive engagement has also taken place with a range of local stakeholders. For example, in relation to the Old Yacht Club site, consultation took place with Hartlepool Borough Council (planning department, flood risk team, ecology department, environmental health department and landscape department) and Tees Archaeology. Consultation letters were sent to local ward councillors, parish councils and neighbouring businesses. Leaflets were posted to local residents and information was made available via the Hornsea Three website.

1.1.1.10 For the nearshore locations, consultation has been undertaken with local planning authorities ([redacted], East Suffolk Council), local port authorities (Associated British Ports and [redacted]) and [redacted] in addition to site-specific stakeholders (e.g. local infrastructure owners, local RSPB, Suffolk Coast and Heaths Area of Outstanding Natural Beauty (AONB) Partnership and National Trust). The Maritime and Coastguard Agency (MCA), Trinity House, Historic England, National Federation of Fishermen's Organisations (NFFO) and Eastern Association of Inshore Fisheries and Conservation Authorities (IFCA) have also been consulted.

1.1.1.11 Engagement with the Local Planning Authorities and other stakeholders was critical to understand the site-specific planning related considerations, requirements, deliverables, and to take on board considerations of the local community, in order to achieve a comprehensive and well considered Planning Application or Marine Licence Application for all ANS sites.

2 Nearshore ANS Design Proposals

2.1 Design Approach

2.1.1.1 The ANS takes an octagonal form to provide multiple aspects to enhance ecological performance. In addition, it has sides that align to the 4 cardinal and 4 ordinal points of the compass to assist scientific observations and is a design that is not overly complex (for reasons of buildability).

2.1.1.2 Seven elevations of the ANS contain nesting spaces with the blank eighth elevation incorporated for construction and maintenance reasons. Where possible, the blank elevation is orientated to face the direction of the least preferred nesting direction by birds, whether that is the one of the sunniest directions and/or the prevailing wind direction during the kittiwake nesting season, so providing the maximum amount of sheltered nesting space preferred by nesting birds.

2.1.1.3 All nesting elevations of the ANS will be formed as individual nesting compartments, grouped nests in 2s and/or 3s and some open ledges to maximise shelter provided from sun and wind for nesting birds as well as providing diversity so nesting preferences can be observed during annual

monitoring. Whilst a more sheltered aspect may be preferred for nesting, birds still do nest in more exposed conditions, as concluded through NIRAS's UK field observations that recorded kittiwake nesting on all aspects of the Sizewell A rigs. The octagonal form of the ANS provides a variety of nesting conditions and with carefully considered massing, detailing, materiality, and an appropriate contextual fit is achieved in consideration of views from land.

2.1.1.4 The ANS has an ecologically driven design as well as a design that is responsive to the particular characteristics of the site and context to create a successful structure for nesting kittiwake as well as an appropriate fit within the landscape / seascape setting. Due regard for all operational practicalities has also been made to ensure the ANS is both efficient and safe to access and maintain.

2.2 Contextual Design

2.2.1.1 Consideration has been given to the appropriateness of the design with regard to its coastal context. In the case of the locations along the Suffolk Coast the design is contextualised in character as part of the enigmatic military structures[1], energy and coastal defence infrastructure and busy coastal towns (including piers, recreational and leisure facilities, and art works), as well as areas of more remote rural character of its coastline. The ANS has been conceived as an extension of this unique collection of functional and enigmatic structures that are characteristic of the place and so creating an appropriate fit into the distinct 'unusualness' of the area.

2.3 Key features

- The ANS is an independent marine structure comprising of an octagonal ANS topside supported above the water on a single monopile;
- Capacity for a total of approximately 504 nesting spaces[2] with 72 on each of the 7 nesting elevations, all comprising 8 rows of ledges and 9 nesting compartments on each row. One elevation of the octagon includes no nesting space or ledges. Specific numbers of nesting spaces are subject to change depending on the final detailed designs for each location;
- Nesting spaces are incorporated on 7 of the 8 elevations of the ANS. Typical dimensions of the nesting compartments are 0.4m width x 0.4m height x 0.2m depth, noting specific dimensions are subject to change depending on the final detailed designs for each location;
- The lowest nesting spaces are located at a safe height of approximately 3.0m above Highest Astronomical Tides (HAT), 6.0m above projected HAT when accounting for sea level rise over 40 years, which is the minimum life requirement for the ANS, and 1.88m above the highest predicted wave with a probability of 1 in 200 years or 0.5% per year;
- Avian predator mitigation is provided primarily through the 0.2m depth nesting ledge dimensions and the 0.2m minimum overhang provided by the ANS roof above the highest nesting ledges. The overhangs mean the shelves will not be visible from the roof and are likely to prevent predators from swooping towards the nests. Further, the ANS roof pitch is in excess of 25 degrees to discourage nesting by any birds. Given the ANS location and mitigation inherent to the design, it is not anticipated that the ANS will be susceptible to avian predation issues. However, should any issues arise in operation, the situation will be reviewed by ornithologists and appropriate action identified;
- Nesting ledges are arranged with slight overhangs to help avoid droppings landing on nesting ledges below;
- Due to the marine location, ground predators are not anticipated to be an issue. The ANS is however located a significant distance above water level at approximately 3.0m above HAT with a significant overhang between the central access point under the ANS and outer extent of the lowest nesting ledges;

[1] https://www.suffolkcoastandheaths.org/wp-content/uploads/2022/05/A-Map-of-Mystery-April-2022.pdf
[2] The required minimum provision for each ANS was set at 467 nests. This number was rounded up to 500 to include contingency for the purposes of the design process and to avoid falling below the required minimum. The final design due to its geometry and size resulted in 504 nests as the closest matching quantity of nests.

- The ANS is equipped with operable nest panels accessible from the inside of the structure. For health and safety reasons access has been limited to the lower shelves with the highest ones permanently fixed;
- The ANS is predominantly a steel structure mounted on a central monopile support. Most parts are finished with highly durable paint systems typically used for harsh offshore maritime conditions to ensure corrosion protection, durability, aesthetic performance, contextual fit and low maintenance requirements over time;
- The ANS is accessed by water as described in the access section; and
- The ANS will require navigational aids and internal safety lighting that can be solar powered. These requirements are being finalised in consultation with the MCA and Trinity House.

2.4 Colours

2.4.1.1 The nearshore ANS's colour scheme has been developed to response to its marine context in terms of navigational safety, seascape integration and longevity in a harsh environment. In consultation with the local port authority, MCA and Trinity House, a yellow colour for the pile was established to increase visibility for marine traffic in all weather conditions. The paint used will be protective as a coat but to aid further in increased protection of the structure a light grey, close to white, was chosen for the topside (the part of the ANS above the pile) to reflect as much UV radiation as possible while visually integrating the structure in its marine environment by blending in with the sea and the sky. The colour was chosen following stakeholder consultation for which a range of extensive studies were undertaken to define the overall direction and then distil the selection to the precise tone.

2.5 Access

2.5.1.1 The ANS will be located beyond the low water mark and accessible by water only. Access to the ANS will be for occasional monitoring and access of nests from the interior as well as maintenance by appropriately qualified and trained personnel. The central monopile that supports the ANS will incorporate a vessel docking and ladder arrangement to accommodate the safe transfer of authorised and trained personnel and equipment for the undertaking of any scheduled and reactive maintenance required.

2.5.1.2 Access to and from the structure shall be designed in compliance with industry standards; the safe transfer of equipment and materials shall also be taken into consideration. Most ecological monitoring would be carried out from a vessel, primarily for reasons of health and safety and associated practicalities for ornithologists carrying out the monitoring operations. The ANS has been designed to ensure viewing angles from a vessel would allow suitable visual access to all nesting space on all ANS elevations (using binoculars) to carry out the required monitoring operations. Monitoring of nesting space can also be carried out by drone.

2.5.1.3 Unauthorised human access is mitigated firstly due to the visually open location of the ANS beyond the low water mark and secondly with access to the ANS interior restricted to a locked cage facilitating safe use of the ladder whilst restricting access to the interior of the structure. Access to the ANS exterior and nesting elevations is mitigated due to the height of the ANS above water and the significant horizontal overhang between the centrally located access ladder underneath the ANS and the outer faces of the ANS.

2.5.1.4 Emergency evacuation of personnel and potential casualties has been considered in the design and layout of the ANS. The non-nesting side of the ANS is fitted with an operable aperture through which equipment and casualties can be transferred to and from vessels. The use of a portable Davit Arm Jib Crane could be employed in such scenarios being brought onto the structure when needed and removed after use.

2.6 Stakeholder Design Advice

2.6.1.1 The following advice has been received from OOEG members during technical panel meetings and designs have been updated accordingly:

- Consideration of shelter and aspect in the design; in particular, solar and wind;
- For Lowestoft location: Consideration of the ANS response to the pier / town / seafront / seascape context;
- For the Minsmere location: Consideration of views to the horizon and their potential interruption by the ANS in an AONB setting;
- Consideration of potential prevention of unauthorised access to the ANS;
- Consideration of whether ANS colour will influence kittiwake use of the ANS; and
- Consideration of potential internal access to the ANS for additional monitoring activities (e.g. colour ringing) and a clear health and safety rationale for the remote monitoring proposed.

2.6.1.2 During a consultation meeting held on 21/01/22, the National Trust noted hues of grey may be preferable to white. During a consultation meeting held on 03/02/22 with the Suffolk Coast and Heaths AONB, RSPB and the National Trust, it was noted that the Proposed Development is more linked to the maritime environment than the land. A colour preference for lighter greys or sand was stated. A study on lighter greys and sand tones were investigated with the lighter greys found to be better suited to the marine environment.

2.7 Drawings

2.7.1.1 Design drawings are presented in **Appendix 2**. Note, exact dimensions are specific to each location and subject to change.

3 Onshore ANS Design Proposals

3.1 Design Approach

3.1.1.1 The two onshore ANS typologies have been designed with the Old Hartlepool Yacht Club site in mind. They are both ecologically driven designs that are also responsive to the particular characteristics of the site and context to create successful structures for nesting kittiwakes as well as an appropriate fit within their landscape setting. The site-specific ecological strategy for kittiwake is to locate nesting spaces facing the existing kittiwake colonies on the walkway to the lifeboat pontoon and within Headland and Victoria Harbour, as well as providing nesting spaces that capitalise on sea views.

3.1.2 ANS Hut Typology

3.1.2.1 The first onshore ANS typology takes inspiration from the fishermen's huts that can be seen locally as well as historically within the Old Hartlepool Yacht Club site itself. Fishermen's huts can often be found in coastal communities, and as such provide a good local archetype upon which to build a site-specific concept for one of the ANS. The ANS huts are arranged along the northeast edge of the site facing towards the existing kittiwake colony. Key features of the hut ANS typology include:

- Capacity for a total of 534 preferred nesting spaces (i.e. facing the sea);
- Nesting spaces incorporated along the seaward facing elevations of the huts. Typical dimensions of each nesting compartment are 0.4m width x 0.4m height x 0.2m depth;
- Avian predator mitigation is provided primarily through the 0.2m depth nesting ledge dimensions and the 0.2m minimum overhang provided by ANS roofs above the highest nesting ledges, as advised and agreed by the OOEG. Given the ANS locations and mitigation inherent to the design, it is not anticipated that the ANS will be susceptible to avian predation issues. However, should any issues arise in operation, appropriate action can be taken to mitigate the

particular predation issue. For instance, if corvids or large gulls are seen to be using structures on / in the vicinity of the ANS as perches from which to launch predatory attacks on nesting birds, additional deterrents such as wires or spikes would be added to these structures. If monitoring revealed predation was still an issue, and specialist individuals could be identified, where appropriate, control measures would be sought under licence from the relevant authorities, though non-lethal control methods will be explored in the first instance;

- Hut roof pitch is in excess of 25 degrees to discourage nesting of all birds;
- Nesting ledges are arranged with slight overhangs to help avoid droppings landing on nesting ledges below;
- The huts are located with 0.6m deep overhangs below the lowest nesting ledges along all nesting faces to mitigate against ground predators, as advised and agreed by the OOEG;
- In combination with the huts' lowest nesting ledge 0.6m overhangs, there is a continuous concrete wall beneath that forms a smooth vertical face in excess of 2.0m height to mitigate against ground predators. The concrete walls are sand colour to match the adjacent sandy beach;
- Nesting ledges have been designed for adaptability to allow all ledges to be changed to be fully partitioned into 0.4m width compartments, contain no compartments or any combination in between;
- The huts provide a sheltered environment for ornithological monitoring operations where kittiwake will not be able to see those conducting the monitoring operations;
- Within the huts, most nesting spaces can be accessed physically and individually for monitoring purposes, such as ringing, using a sliding access panel system. A transparent panel system that includes opaque and one-way film elements provides visibility of most nesting spaces from within the huts without disturbing the birds;
- CCTV is mounted within columns set back from the hut nesting faces to allow remote monitoring for research and security purposes;
- CCTV is included elsewhere in the site within columns at key locations for security, mitigating unauthorised human access;
- The Old Yacht Club site will have a 1.8m height weldmesh perimeter fence around its periphery, on-site CCTV security system and locked access gates as part of the site security measures which will mitigate unauthorised human access;
- The huts are timber clad structures on galvanised steel frames. Timber will weather to a natural grey colour providing a low maintenance material with good thermal properties that fits contextually. Nesting ledges and compartments are formed using folded steel sheet to help provide acceptable durability, longevity, and maintenance performance. Steel components and some cementitious panels, which are used in difficult to maintain areas instead of timber, will have a matt grey or galvanised / powder coated finish to match weathered timber cladding on the ANS;
- Huts have access doors on the landward sides;
- Huts are supplied with power and internal lighting; and
- Access to huts for maintenance activities is by cherry picker from level space created within the site, adjacent to landward and seaward hut elevations for any exterior maintenance operations required.

3.1.3 ANS Tower Typology

3.1.3.1 The second onshore ANS takes inspiration from the various tower typologies that can be found in the locality. The ANS has been designed as a ten-sided decagon, whereby multiple external faces provide a variety of nesting aspects, and the structure forms an internal space that allows sheltered working conditions for those involved in ecological monitoring operations. The tower

ANS is located west of the ANS huts to provide good sea views. Key features of the tower ANS typology include:

- Capacity for a total of 510 preferred nesting spaces (i.e. seaward facing) and 340 non-preferred (i.e. landward facing) nesting spaces (assuming 6 faces of the tower are counted as preferred faces);
- Nesting space is incorporated on all 10 faces of the tower. Typical dimensions of each nesting compartment are 0.4m width x 0.4m height x 0.2m depth;
- Avian predator mitigation is provided primarily through the 0.2m depth nesting ledge dimensions and the 0.2m minimum overhang provided by ANS tower roof above the highest nesting ledges. Given the ANS location and mitigation inherent to the design, it is not anticipated that the ANS will be susceptible to avian predation issues. However, should any issues arise in operation, appropriate action can be taken to mitigate the particular predation issue in consultation with the OOEG;
- Tower roof pitch is in excess of 25 degrees to discourage nesting by any birds;
- Nesting ledges are arranged with slight overhangs to help avoid droppings landing on nesting ledges below;
- The lowest nesting ledges have a 0.6m deep overhang (as advised and agreed by the OOEG) over the vertical faces that forms the base of the tower;
- In combination with the 0.6m nesting ledge overhang, the vertical faces that form the base of the tower provide clear, smooth surfaces in excess of 2.0m height to mitigate against ground predators;
- Nesting ledges have been designed for adaptability to allow all ledges to be changed to be fully partitioned into 0.4m width compartments, contain no compartments or any combination in between;
- The tower provides a sheltered environment for ornithological monitoring operations where kittiwakes will not be able to see those conducting the monitoring operations;
- Within the tower, most nesting spaces can be accessed physically and individually for monitoring purposes, such as ringing, using a sliding access panel system. A transparent panel system that includes opaque and one-way film elements provides visibility of most nesting spaces from within the huts without disturbing the birds;
- CCTV is mounted within columns set back from the tower faces to allow remote monitoring for research and security purposes, mitigating unauthorised human access;
- CCTV is included elsewhere in the site within columns at key locations for security;
- The tower is a timber clad structure on a galvanised steel frame. Timber will weather to a natural grey colour providing a low maintenance material with good thermal properties that fits contextually. Nesting ledges and compartments are formed using folded steel sheet to help provide acceptable durability, longevity, and maintenance performance. Steel components and some cementitious panels, which are used in difficult to maintain areas instead of timber, will have a matt grey or galvanised / powder coated finish to match weathered timber cladding on the ANS;
- The tower has an access door on the landward side at the base of the structure. The tower is naturally ventilated;
- The tower is supplied with power and internal lighting; and
- Access to the tower for maintenance activities is by cherry picker from level space created within the site around its base for any exterior maintenance operations required.

3.1.3.2 Both tower and huts are served by paths that provide accessible level access to them for people or occasional maintenance equipment.

3.2 Site Specific OOEG Design Advice

3.2.1.1 The following advice has been received from OOEG members during technical panel meetings and designs have been updated accordingly:

- 2.0m height minimum from lowest nesting ledge for ground predator mitigation;
- Requirement for smooth faces to any walls that provide ground predator mitigation to help stop climbing;
- Confirmation of a 0.6m recessed overhang required beneath lowest nesting ledges;
- Confirmation that grass or plants that do not provide potential footholds for ground predators can be used at the foot of the vertical faces that provide ground predator mitigation; and
- For the tower ANS it would be good for experimental design to have nesting ledges on all sides (landward and seaward facing) – interesting for futureproofing and to observe what kittiwake want and like and where they chose to nest.

3.3 Drawings

3.3.1.1 Design drawings are presented in **Appendix 2**. Note, exact dimensions are specific to each location and subject to change.

Ørsted

Appendix 1: Pattern Book

Kittiwake Implementation & Monitoring Plan

Design Report

Hornsea Three

Kittiwake artificial nesting structure pattern book

May 2021

LDĀDESIGN

When the tarrock takes to air
from his western cliff,
he'll never look at land again –
his cloud-high soul adrift –
until he shrugs his shoulders clean
and shakes his heart awake:
the tarrock dips his wings in ink,
becomes a kittiwake,

and on the swell he finds a mate
to please his infant soul;
they scud beneath the firmament,
they fish above a shoal,
the sky itself their waking day,
the sea-swell is their rest,
until the blush of thrift on stone
calls them in to nest,

and by the samphire on a ledge,
the kelp-blotched eggs are laid.
Where there's scarce a place to perch
the chicks hatch unafraid,
in briny air amid the gales
where seething waters break,
and little Keltie, who is dead,
becomes a kittiwake.

Kittiwake, by Giles Watson

Contents

Version:	1.3
Version date:	October 13 2021
Comment	Final

This document has been prepared and checked in accordance with ISO 9001:2015

1.0 Introduction

The purpose this document is to act as a tool that can be used to inform the design of kittiwake artificial nesting structures (ANS) in any appropriate location, building on the ecological design principles developed by Orsted, NIRAS and WSP developed as part of the Hornsea Project Three Offshore Wind Farm (Hornsea Three). The criteria involved in the initial selection of the ANS sites is not covered in this document.

The intention is to create a live document that can be:

- used by designers of ANS;
- used to communicate ANS design approach to stakeholders as part of engagement and planning activities;
- updated in response to design development, research findings from Orsted ANS once installed or ANS research findings external to Hornsea Three.
- potentially shared with the wider public to communicate ANS design approach and Orsted's commitment to high quality environmental design.

1.1 Kittiwake - *Rissa tridactyla*

Kittiwakes are coastal gulls who spend the majority of their time out at sea, landing only on coastal cliffs to nest. The population of these gulls is continually declining, likely due to a lack of key food sources and kittiwakes therefore hold a red conservation status. There are currently 380,000 breeding pairs in the UK situated around various coastal regions of the country.

The birds are characterised by their 'dipped in ink' markings and are thought by many to be the most beautiful of all gulls. They have short black legs and when in flight no white can be seen on their black wing tips, setting them apart from other gull species. They have a short yellow beak and dark eyes with thin red edge markings.

Kittiwakes natural nesting habitats are steep coastal cliff ledges that are too narrow to be landed on by larger gull species. They build nest structures from a variety of materials, typically including mud to seaweed. Often, they can also be found nesting in built structures such as piers, offshore oil rigs and abandoned buildings. These structures often provide similar characteristics to the sea-cliff.

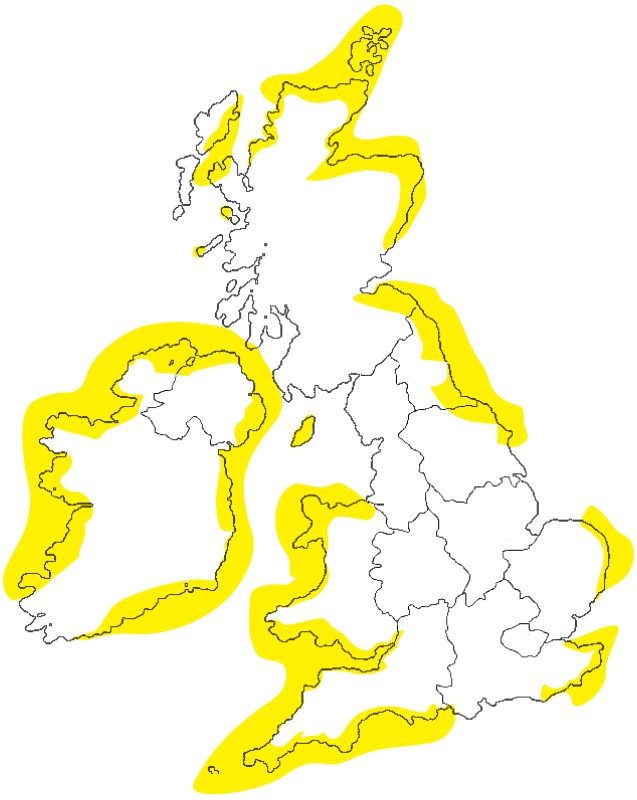
The birds generally lay two eggs during their breeding season from March to July and after fledging, the young birds stay at sea for 2-3 years before searching for a life long breeding colony.

Once a successful colony has been found, the birds will likely continue to return there annually. The average lifespan of a kittiwake is around 12 years.

Kittiwakes natural nesting habitat is on the medium to upper rocky sea cliff ledges and the built structures that kittiwakes nest on generally provide similar characteristics to the successful cliff ledge environments.

Typical features of the nesting habitats include:

- medium to high ledges, out of the splash zone of the sea;
- ledges with a slight overhang or ceiling to increase protection from predators;
- narrow ledges which are too small for larger gull species to land on;
- completely horizontal ledge surfaces are not necessarily essential as kittiwakes build nest structures up on top of the ledge surfaces;
- offshore oil rigs, abandoned buildings, railway and pier substructures can also provide small sheltered ledges which kittiwakes are attracted to;
- conditions that provide a degree of shelter and protection from wind, rain and direct sunlight are advantageous.



UK kittiwake colonies

2.0 The design patterns

The design of the ANS involves a range of complexities related to providing optimum ecological nesting conditions for kittiwakes and making ANS so they become a positive part of the varied landscapes within which they can be located.

Given all the ecological and landscape complexities when considering ANS design, a pattern language provides the ideal basis for establishing a design approach and applying design thinking that is:

- consistent;
- principled;
- flexible and adaptable in response to any ANS locations.

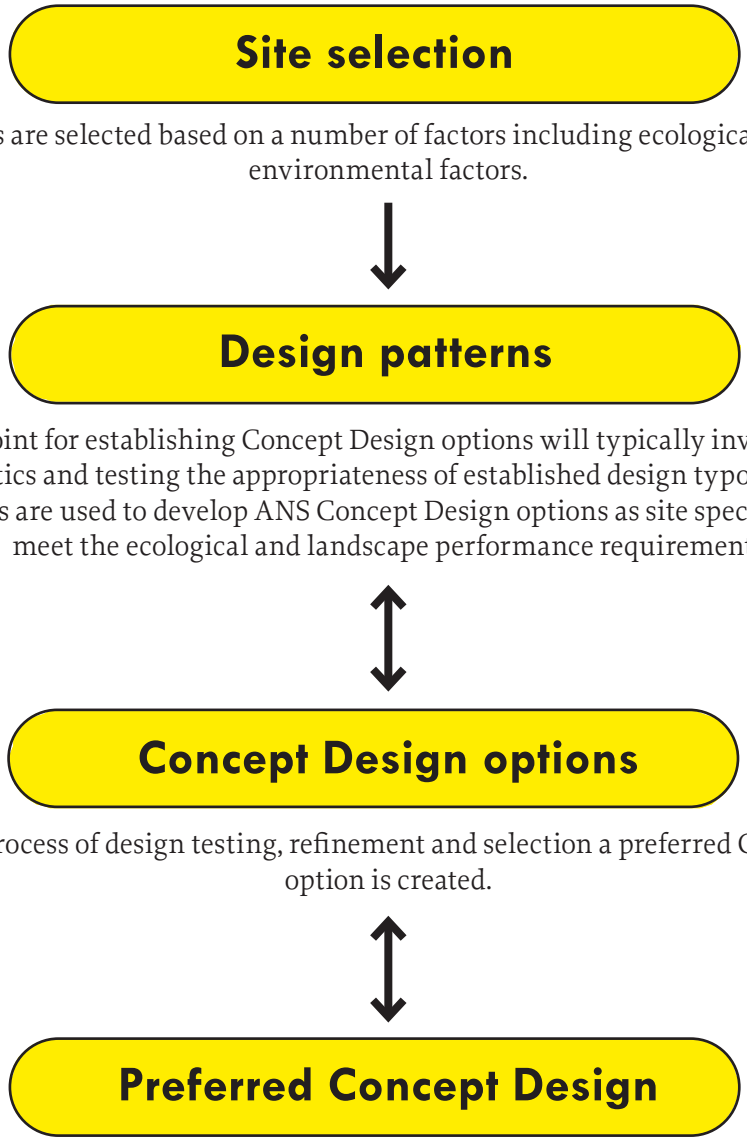
The pattern language provides a set of timeless solutions that can be applied in a diversity of ways that address the opportunities and challenges of the ANS design. This provides an approach that is flexible, enduring and capable of adapting to future changes.

Patterns provide the units of this language and these are kittiwake and landscape-centred, derived from the universal ecological requirements for successful nesting conditions and the unique qualities of place particular to each ANS location. The pattern book provides a tool that will allow the creation of ANS with optimised nesting conditions as well as ANS that have an optimised fit within any landscape they are located.

The pattern language comprises a set of twenty eight interrelated design patterns shaped around ecological and landscape design requirements.

The patterns are used for design but they are equally useful to communicate the ANS approach to stakeholders as part of a transparent and easy to understand process. Over time, findings from ANS once installed and in use can inform the refinement of existing design patterns or the creation of new patterns.

2.1 Design process



2.2 The design patterns

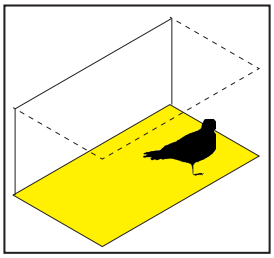
A set of 28 interrelated design patterns have been created that will form the basis for ANS design approach in any appropriate location.

Patterns 01 - 18 provide ecological performance requirements with patterns 19 - 28 providing landscape performance requirements for the ANS.

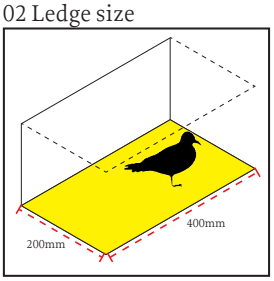
The ecological patterns are concerned with the creation of successful nesting conditions and the ability to monitor and potentially adapt the ANS over time in response to research findings or changes in environmental conditions such a sea level rise.

The landscape patterns are concerned with the appropriate contextual integration of ANS within the landscapes they are located and key considerations in terms of their functional performance including durability, maintenance and sustainability.

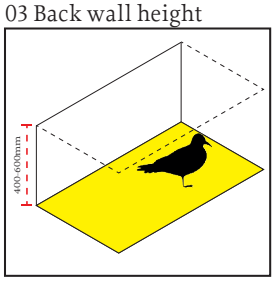
01 Structure



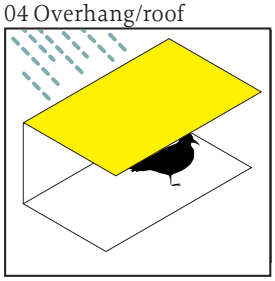
02 Ledge size



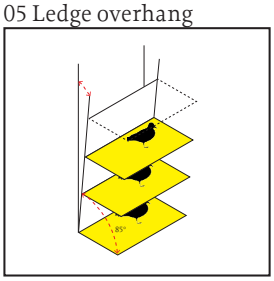
03 Back wall height



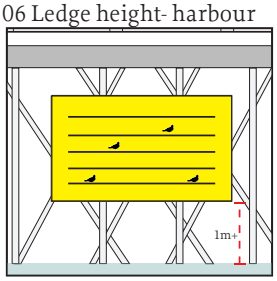
04 Overhang/roof



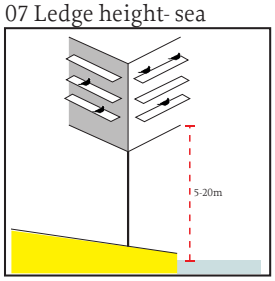
05 Ledge overhang



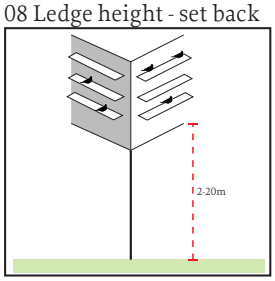
06 Ledge height- harbour



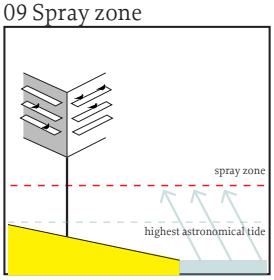
07 Ledge height- sea



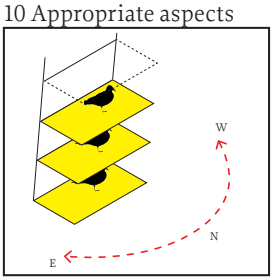
08 Ledge height - set back



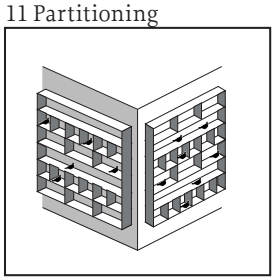
09 Spray zone



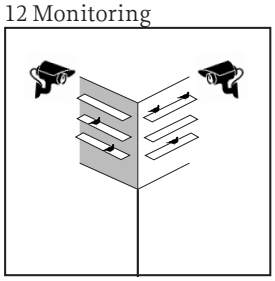
10 Appropriate aspects



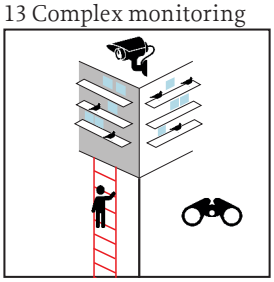
11 Partitioning



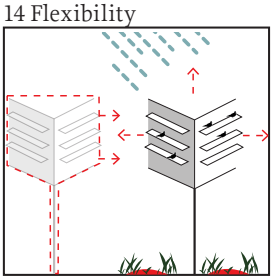
12 Monitoring



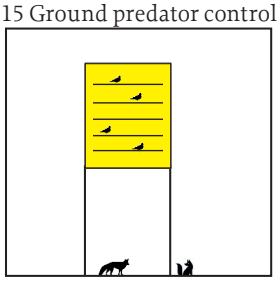
13 Complex monitoring



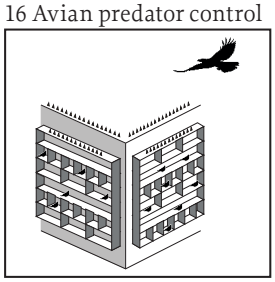
14 Flexibility



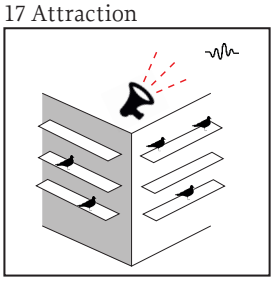
15 Ground predator control



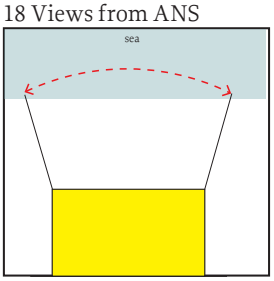
16 Avian predator control



17 Attraction



18 Views from ANS



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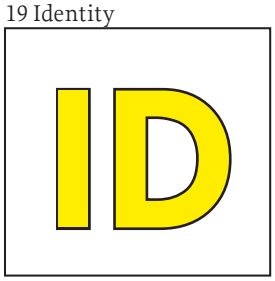
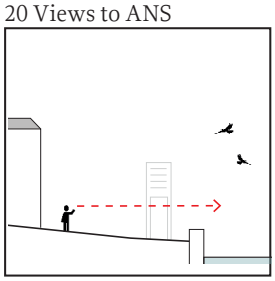
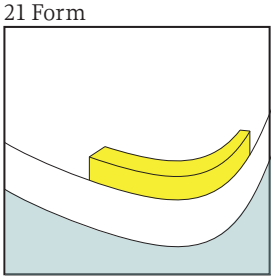


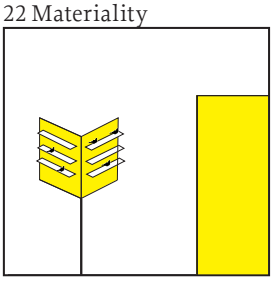
20 Views to ANS



21 Form

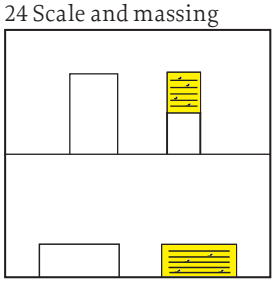


22 Materiality

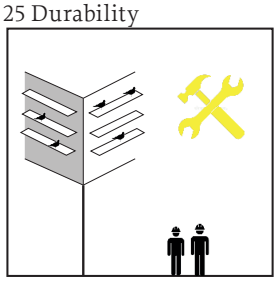


23 Neighbouring uses

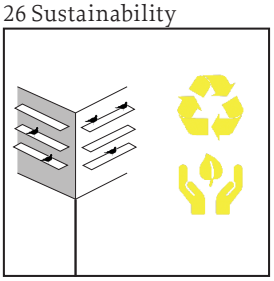
24 Scale and massing



25 Durability

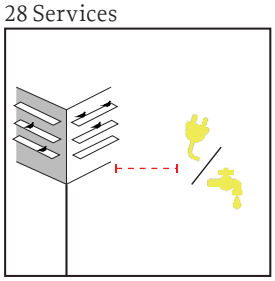


26 Sustainability

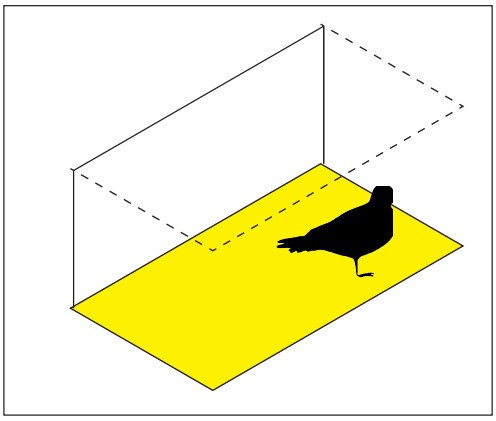


27 Access

28 Services

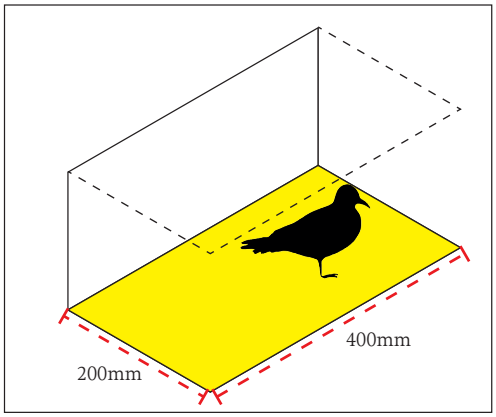


01 Structure



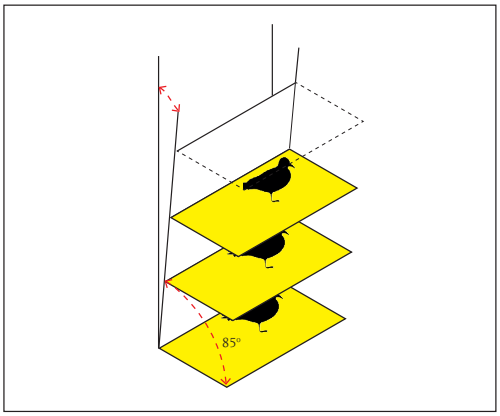
Essential: a high and steep sided structure with a near vertical back wall and narrow horizontal ledges.

02 Ledge size



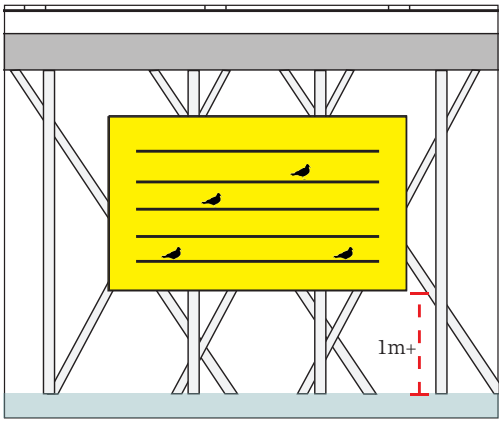
Essential: adequate ledge dimensions: horizontal ledges 200mm width; length per pair from 300mm (working length 400 mm).

05 Creating ledge overhang



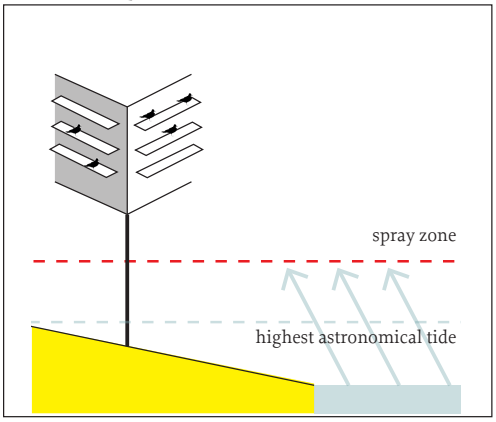
Optimising success: vertical wall designed to create nesting ledge overhangs sufficient to minimise lower ledge fouling by droppings and potential for reducing avian predation risk.

06 Ledge height - harbourside



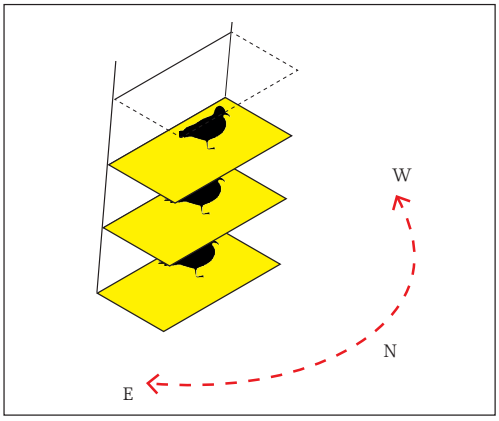
Essential: minimum height if at harbourside waterfront location. 1 m + above wave height/ splash zone of HAT , predicted for 2050 accommodating for sea level rise (in > 50 years).

09 Spray zone



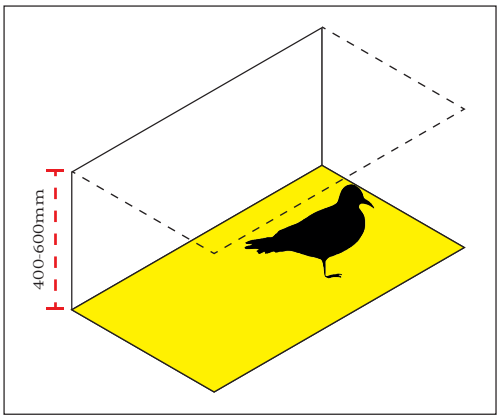
Essential: nesting ledges located above the level of highest astronomical tide and beyond the reach of wave action.

10 Appropriate aspects



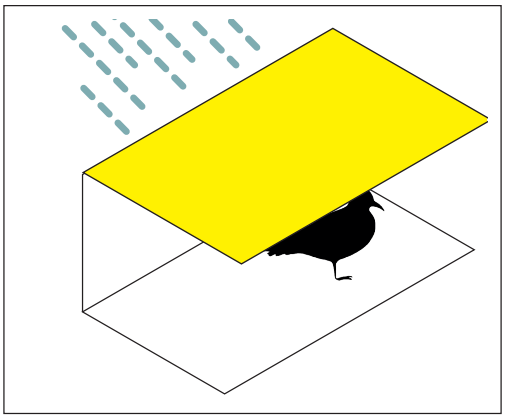
Essential: majority of nesting ledges should not be south-facing. If this is not possible, ledges should be facing multiple aspects. Shelter from prevailing wind may also need consideration.

03 Back wall height



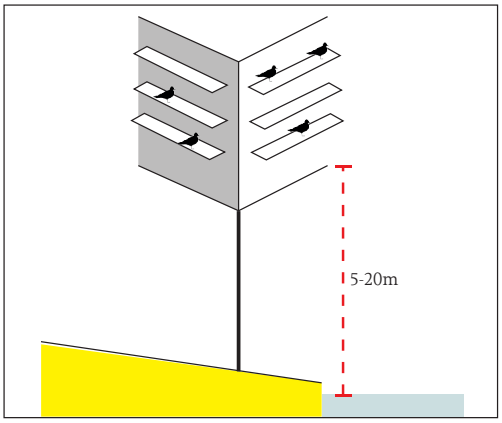
Essential: height between ledges at a minimum of 400 mm and maximum of 600 mm.

04 Overhang / Roof



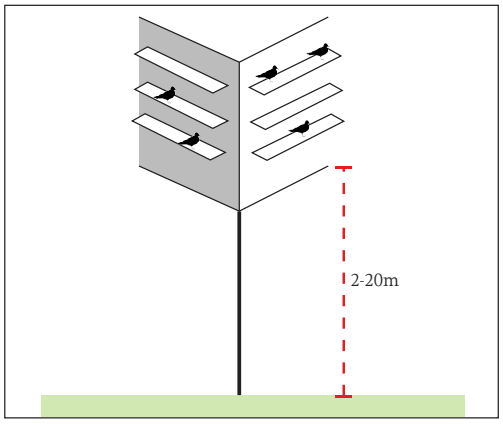
Optimising success: overhang / roof to help protect against weather conditions and additional predator deterrent. Roof pitch in excess of 25 degrees can be used to deter nesting.

07 Ledge height - exposed sea frontage



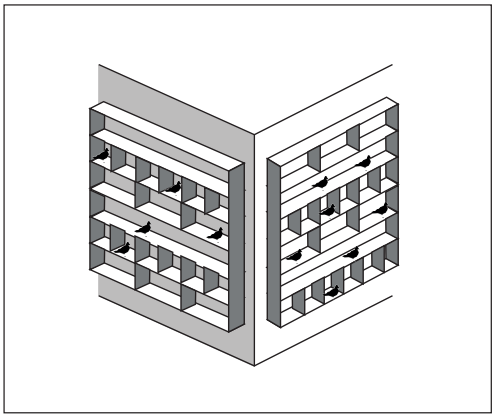
Essential: minimum height if at exposed waterfront location. 5-20 m (above HAT site dependent;) above wave height/ splash zone of HAT predicted for 2050, accommodating for sea level rise (in > 50 years).

08 Ledge height - set back



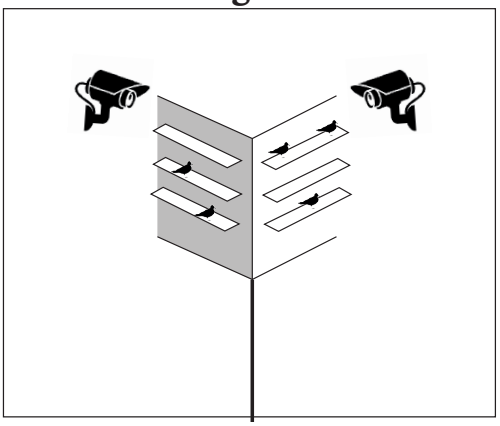
Essential: minimum height if set back from water depends on anticipated disturbance likelihood. Restricted human access - 2m+, low disturbance - 3-4m+. high disturbance - 10-20m. Shelving high enough for direct line of sight/flight to water.

11 Partitioning



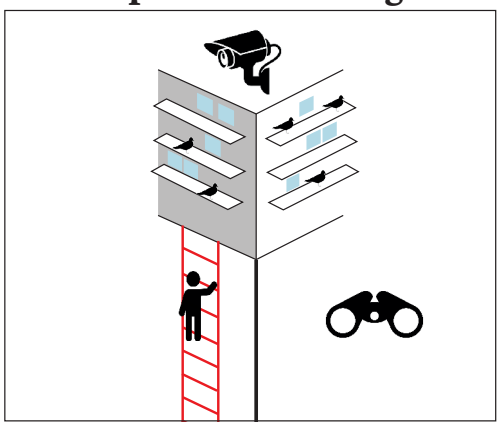
Optimising success: walls/partitions between groups of nests. To facilitate an experimental design, each structure should have alternating rows with and without compartments. The order of alternation should be different on adjacent faces. Design should allow for easy addition/removal of partitions.

12 Monitoring



Optimising success: include capacity for remote monitoring devices e.g. cameras to provide coverage of all available ledges at a sufficiently high resolution to monitor individual nests including chicks and eggs to be inspected.

13 Complex monitoring



Optimising success: complex monitoring features to be included as required:

a) Internal access.

b) Enclosed structures where the personnel monitoring within would be hidden from view, including to birds flying above and therefore minimising any disturbance.

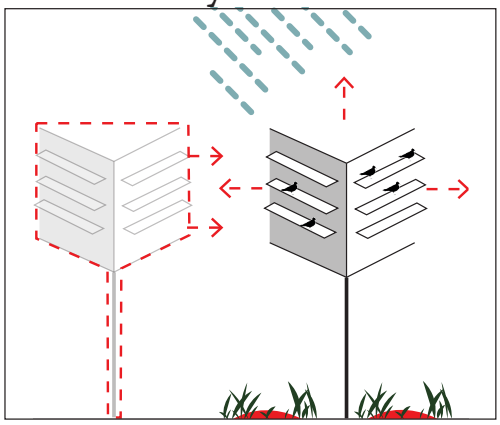
c) Either with hatches to allow access from behind/within the structure to individual nests by ornithologists undertaking monitoring works.

d) And / or one-way glass to allow observations to be made from interior/ back of structure.

e) Capacity for additional monitoring equipment to be accommodated within/on the structure

f) Welfare facilities.

14 Flexibility



Essential (a,d), optimising success (b, c, e): capacity for the structure to be modified to facilitate adaptive management design features after they have been operational for 4+ years. These may include:

a) Extension of structure to facilitate further nesting spaces.

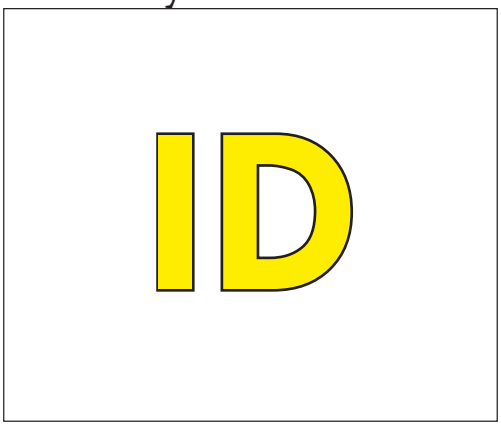
b) Relocation of nesting structure.

c) Additional protection from elements e.g. wind/weather shield location points.

d) Enhanced predator deterrent e.g. straightforward roof and fencing, including opportunities to add avian predator deterrents.

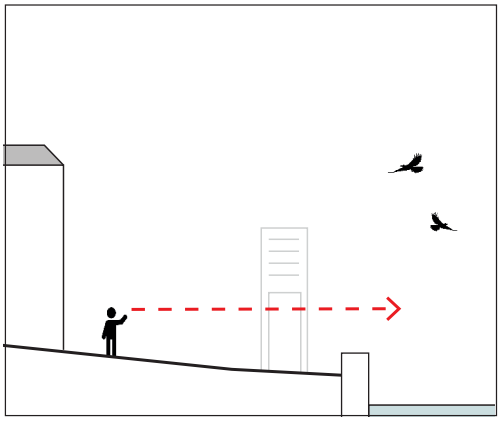
e) Provision of nesting material, such as seaweed. This would require additional protected space around or under the structure.

19 Identity



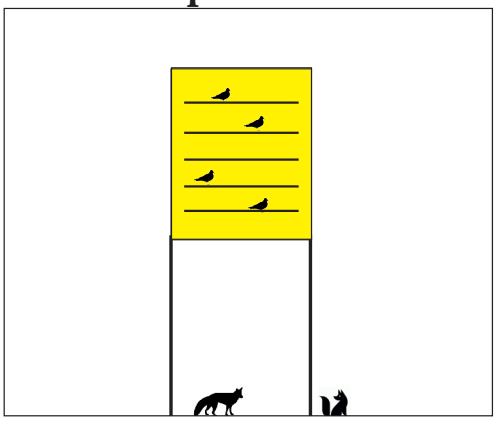
Essential: the ANS design must be contextually driven, responsive to landscape setting qualities and make a positive contribution to local identity, ensuring the ANS becomes a part of the landscape within which it is situated.

20 Views to ANS



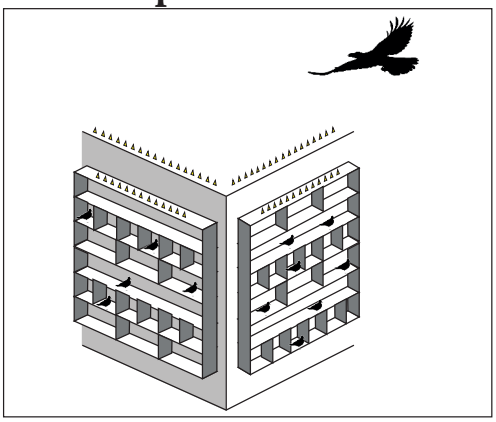
Essential: locate the ANS to avoid detriment to key views and support legibility.

15 Ground predator control



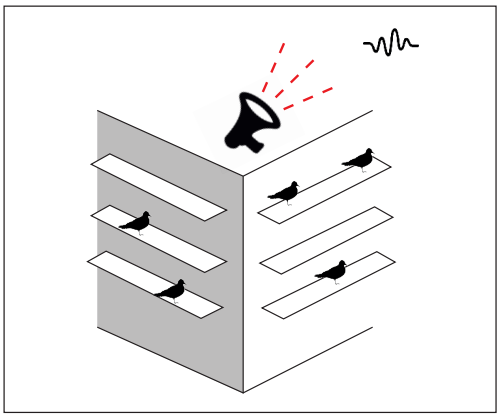
Essential: inaccessible / non climbable to ground predators such as foxes and rats; additional anti-predation features may be required such as fences / barriers but any features must be integrated with ANS design and context.

16 Avian predator control



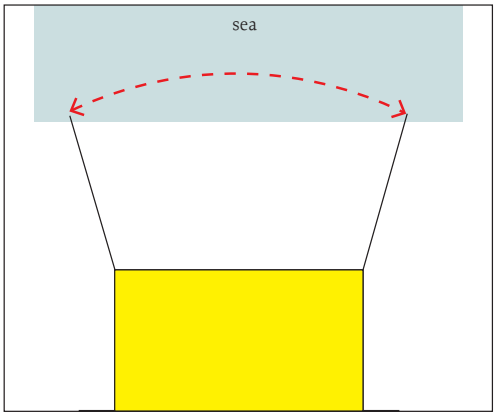
Essential: inaccessible to avian predators with special attention paid to top of ANS and nesting ledge depths; additional anti-predation features may be required but any features must be integrated with ANS design and context.

17 Attraction



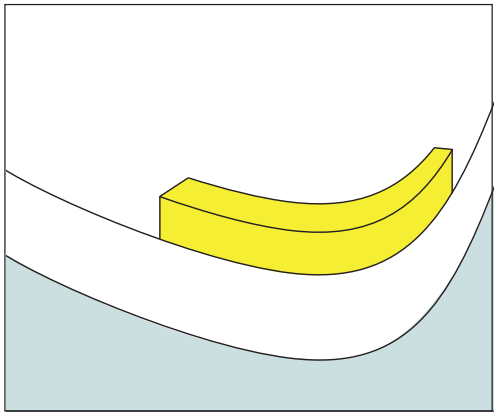
Essential: capacity for addition of decoy nests/birds and audio systems to play kittiwake calls to attract birds. These items will no longer be required once the colony is inhabited, so they should be removable or concealed within the design.

18 View from ANS



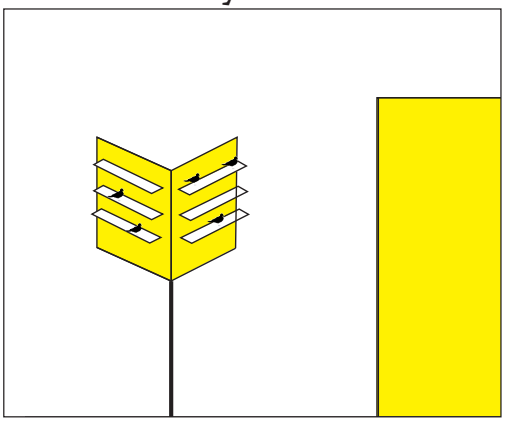
Essential: a location close to water, facing out to sea (i.e. nest adjacent to / above harbour waters / sea).

21 Form



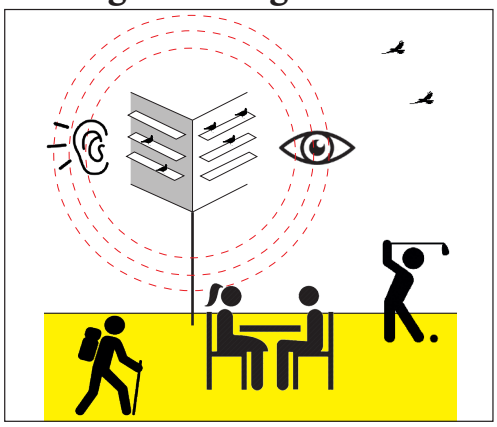
Essential: the ANS must adopt a form driven by the contextual characteristics. of the site.

22 Materiality



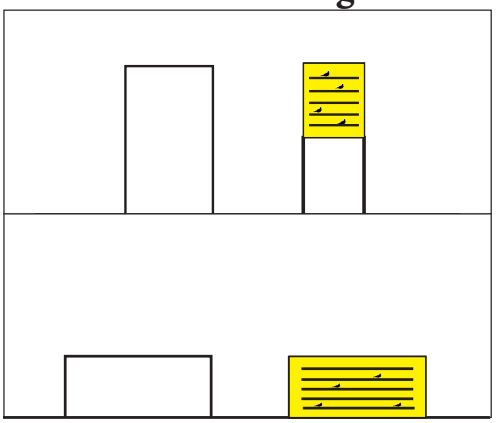
Essential: the ANS must use materials that are responsive to local contextual identity and informed by successful kittiwake nesting conditions.

23 Neighbouring uses



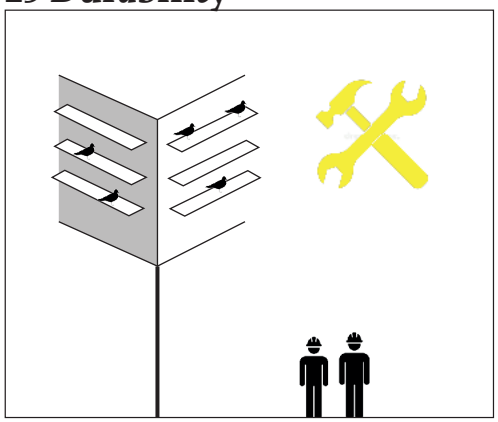
Essential: locate the ANS to avoid potential visual and noise conflict issues between the ANS, neighbouring uses and vice versa.

24 Scale and massing



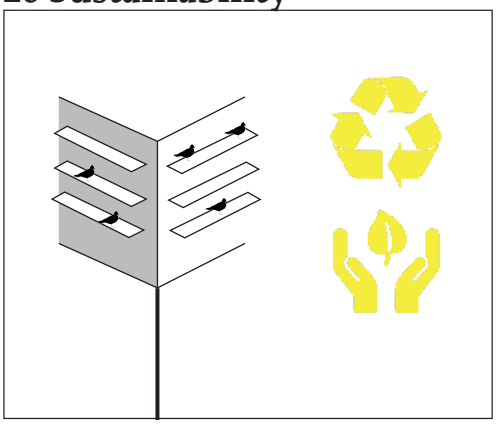
Essential: the size and shape of the ANS must be responsive and appropriate to the landscape setting within which they are located.

25 Durability



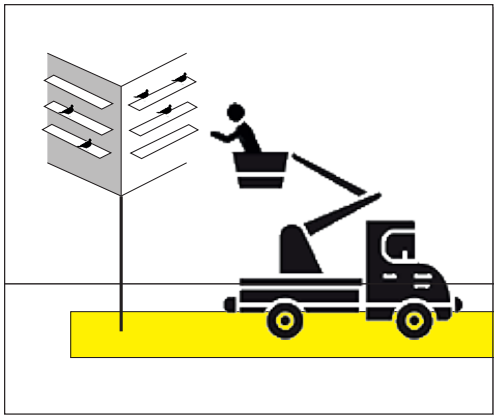
Essential: the ANS must be made to stand the test of time in the coastal conditions with associated low maintenance requirements.

26 Sustainability



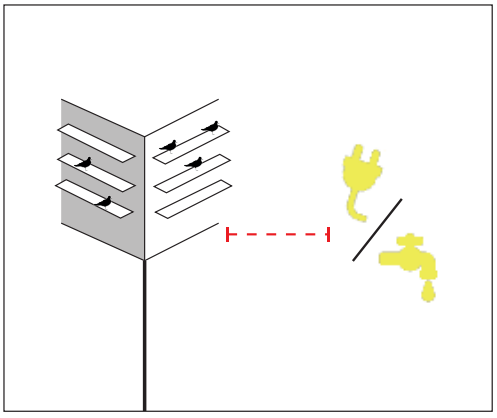
Essential: design and construction of the ANS must embed a sustainable approach throughout the process.

27 Access



Essential: access arrangements to the ANS must be considered for people and potential vehicles related to construction, ongoing visits and maintenance. Special attention must be given to safety of any access requirements, especially those at height.

28 Services



Essential: connectivity requirements for ANS features such as monitoring, audio or welfare facilities need special consideration in light of potential locations. Battery / solar power for instance may be required.

3.0 Precedents and lessons learned

A series of precedent studies were carried out by NIRAS looking at purpose made artificial nesting sites for kittiwakes that have been successful. A brief summary of the study sites is included here with lessons learned as a point of reference when considering the design of ANS.

Once constructed and in use, the Hornsea Three ANS can be added to existing precedents in the pattern book along with any new precedents external to the Hornsea Three project. Given that there are generally a lack of ANS precedents that have been evaluated with regard to successful and unsuccessful characteristics; there is an opportunity for the Hornsea Three project to make a valuable contribution in this respect.

NIRAS work concluded that kittiwakes show no preference for purpose-built artificial versus non-purpose-built artificial structures and that new kittiwake recruits take to artificial sites faster than established breeders. If designed correctly and in the right location, an artificial structure should have every chance of success in supporting a kittiwake colony.

Tyne Kittiwake Tower

Inland tower structure constructed of timber nesting and metal support legs.

Outcomes to date:

- Successful breeding on all sides, particularly north east / north west facing.
- Clay decoys successfully used to attract birds at outset.
- There have been some issues with avian predation from crows.
- The structure is not close to full capacity.

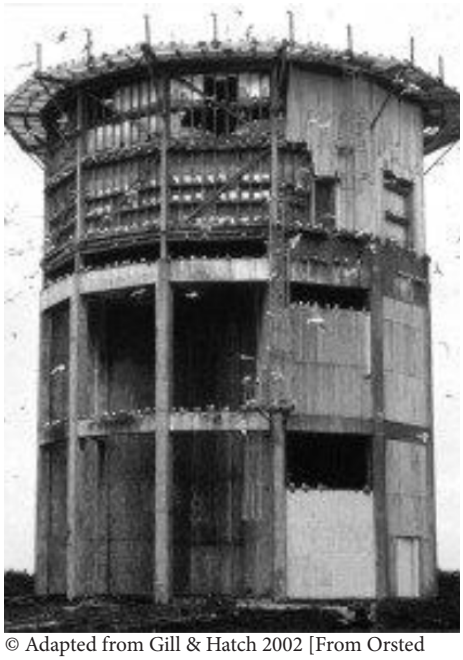
© Les Hulls Geograph.co.uk [From Orsted Ecological evidence document]

Middleton Island Seabird Tower, Alaska

Modified, decommissioned radar tower. Additional food is supplied during nesting season and monitoring opportunities are provided from inside the structure.

Outcomes to date:

- All sides occupied.
- Max recorded 400 pairs.
- Considered to probably be the best kittiwake ANS precedent.



© Adapted from Gill & Hatch 2002 [From Orsted Ecological evidence document]

Lowestoft Wall, Suffolk

Concrete wall with ledges at entrance to fishing harbour. Accessible by foot to the rear.

Outcomes to date:

- North / north west facing sides are well occupied.
- Predation issues with larger gull species on top shelves and foxes on the lower shelves.
- Despite many nests being present in various years, no chicks were raised.

© M Swindells [From Orsted Ecological evidence document]

Mumble Shelves, Swansea

Wooden shelves attached onto an existing pier structure. Placed as temporary compensation whilst renovation work was taking place on the pier.

Outcomes to date:

- 76 nests reported in 2013.
- Birds initially tried to use original nests but gradually moved across to the purpose built shelves.

© Nilfanion Wikimedia UK [From Orsted Ecological evidence document]

Boulogne Wall, France

Concrete wall with discreet compartments on top of a sea wall in an industrial port. Built as compensation for the demolition of a nearby building where kittiwakes were nesting.

Outcomes to date:

- In 2017, there were 155 nests with chicks.

© J M Sauvage [From Orsted Ecological evidence document]

4.0 Artificial nesting structure typologies

Orsted, NIRAS and WSP initially identified a number of potential design typologies for the ANS including:

- simple shelves attached to an existing structure (discounted as inappropriate for Orsted's ANS);
- purpose built tower;
- purpose built wall;
- modified wall to allow access to nests for monitoring e.g. hatches / one way glass;
- purpose built tower or structure with internal access for nest monitoring.

The typologies have associated differences in terms of:

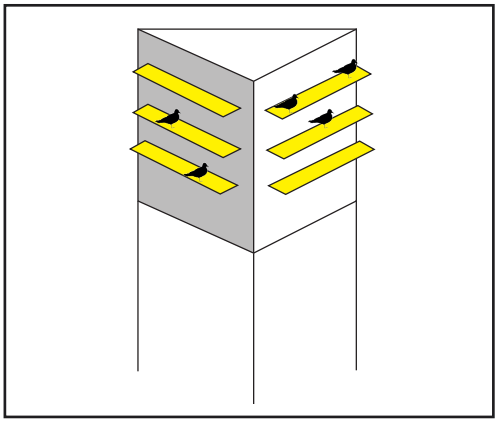
- monitoring and research potential;
- complexity of design;
- size of structure footprint;
- potential fit within the landscape setting;
- financial cost.

The typologies provide the starting point for considering the most appropriate options for a specific site in consideration of the ecological and landscape patterns. Once initial ANS typologies have been identified, Concept Design options can then be generated and through a process of testing, refinement and selection, a preferred Concept Design option can be created.

The typologies therefore provide the starting point for ANS design that will be subsequently shaped in response to the site specific application of the ecological and landscape design patterns. It is possible through the design process that new ANS typologies could be identified and these can be added to the existing typology collection in the pattern book.

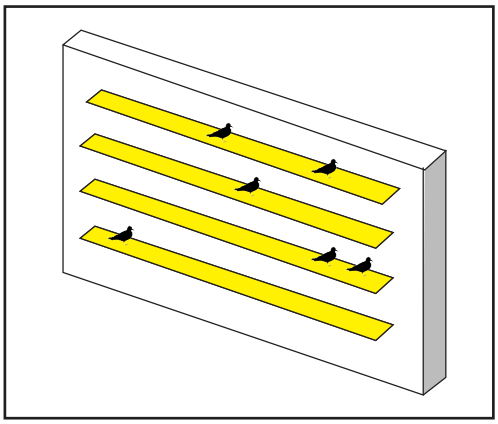
Purpose built tower

- Can be placed almost anywhere and is flexible in size and form.
- Limited options for incorporating access to the tower.
- Shape could vary.
- Versatile for relocation.



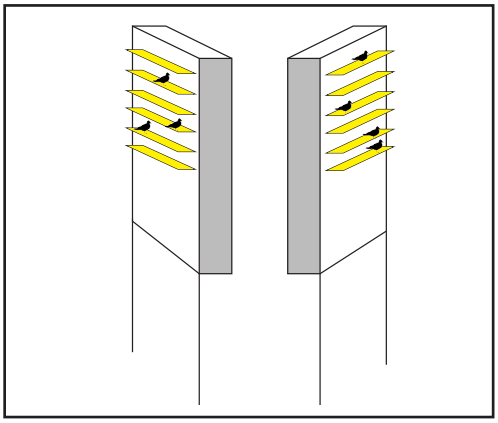
Purpose built wall

- A practical approach at waterfront locations.
- The lack of height on this option could lead to predation issues.
- Permanent, immovable design.
- Monitoring opportunity could be limited.



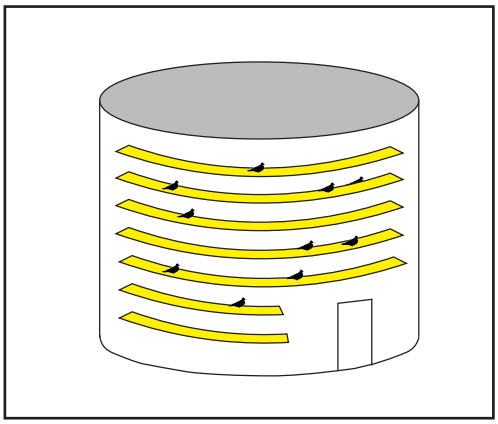
Modified wall structure

- Can fit in small constrained areas.
- Flexible in size and form.
- Potential opportunity for monitoring from the back of the walls.
- Less foundation work required compared to a purpose built building typology.



Purpose built building

- Most complex option and could have location limitations.
- Offers greatest opportunity for monitoring and access.
- May require avian predator deterrents.
- Design approach flexible in complexity and form.
- Would require a larger footprint and foundations than other typology options.



5.0 References

Information and research

- NIRAS, 2021, Hornsea 3 Kittiwake Compensation : OOEG meeting 2
- Orsted, 2020. Hornsea Project Three, Offshore Wind farm, Response to the Secretary of State's Minded to Approve Letter Annex 2 to Appendix 2: Kittiwake Artificial Nest Provisioning: Ecological Evidence
- Orsted, 2021. Hornsea Three Kittiwake Compensation. Design Principles
- Orsted, 2020, Hornsea 3 OOEG briefing note, ORSTED
- April OOEG Briefing Note - Appendix A (WSP Overview of Typical ANS developed)
- Orsted, 2020. Response to the Secretary of State's Minded to Approve Letter Annex 2 to Appendix 2: Kittiwake Artificial Nest Provisioning: Ecological Evidence. [online] Orsted. Available at: ‹https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010080/EN010080-003241-HOW03_30Sep_Appendix_2_Annex_2%20Ecological%20Evidence%20(06543000_A)%20combined%20(06543760_A).pdf›
- Scottish Wildlife Trust. 2021. Kittiwake. [online] Available at: ‹https://scottishwildlifetrust.org.uk/species/kittiwake/›
- The RSPB. 2021. Kittiwake Bird Facts | Rissa Tridactyla - The RSPB. [online] Available at: ‹https://www.rspb.org.uk/birds-and-wildlife/wildlife-guides/bird-a-z/kittiwake/›

Images

- All images of precedent Kittiwake nesting structures are adapted from Orsted, 2020. Hornsea Project Three, Offshore Wind farm, Response to the Secretary of State's Minded to Approve Letter Annex 2 to Appendix 2: Kittiwake Artificial Nest Provisioning: Ecological Evidence. Copyright/credit under each image.

Poem

- Watson, G., 2013. Kittiwake. [online] Available at: [redacted]

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LDA Design is a ISO 9001 / ISO 14001 accredited company

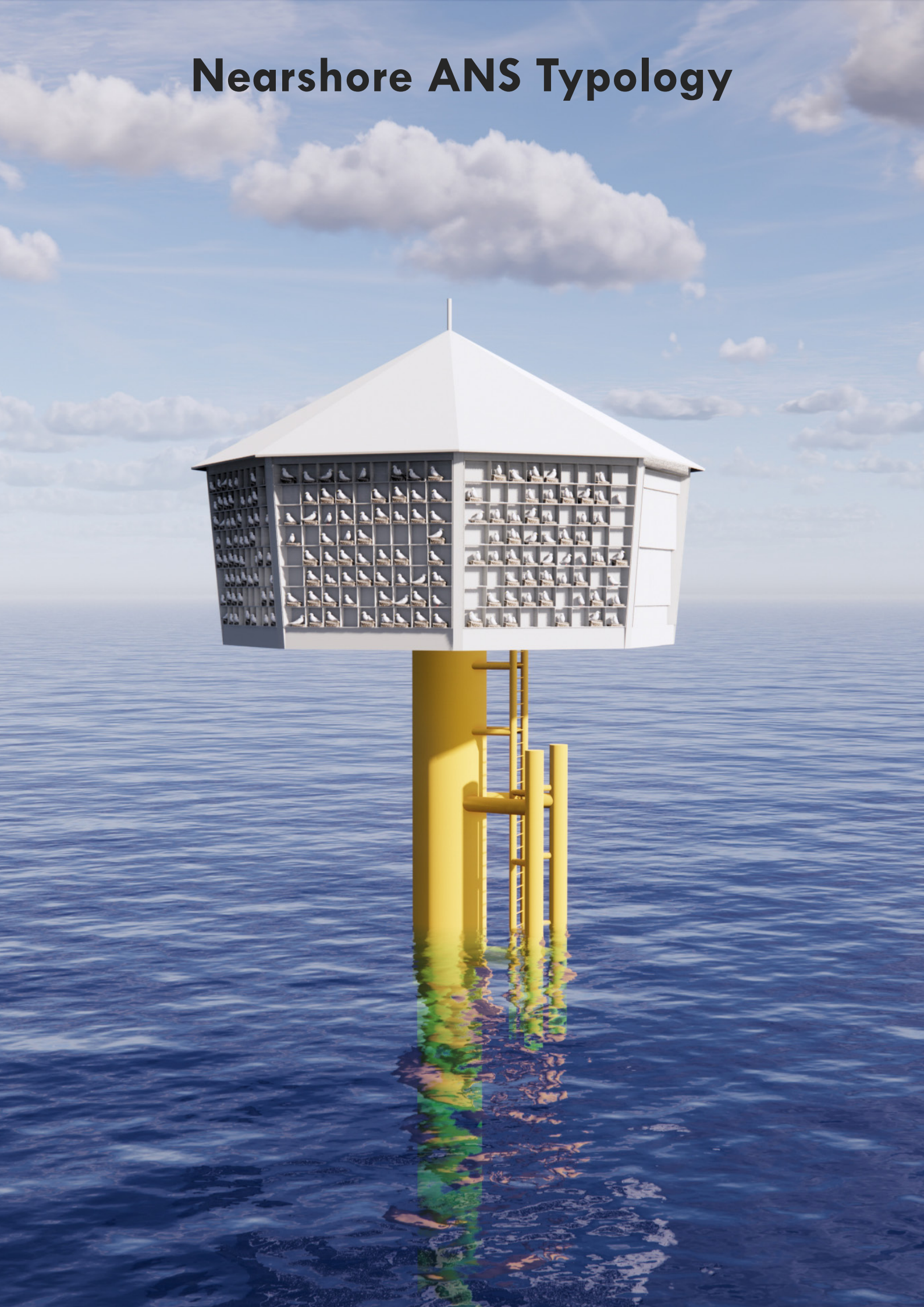
Ørsted

Appendix 2: Supporting Design Information

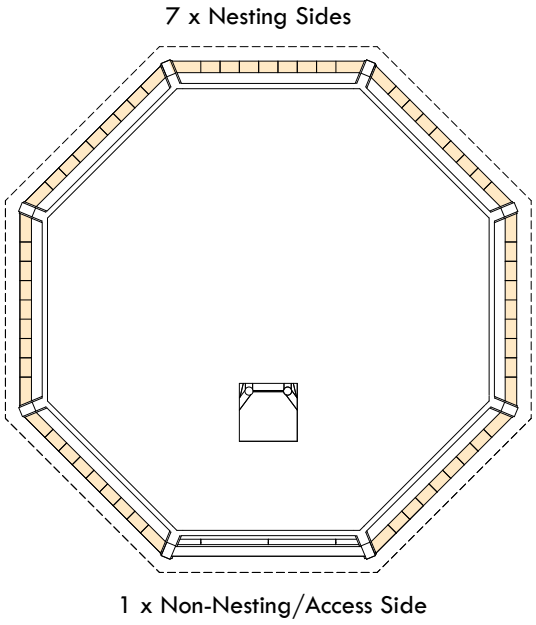
Kittiwake Implementation & Monitoring Plan

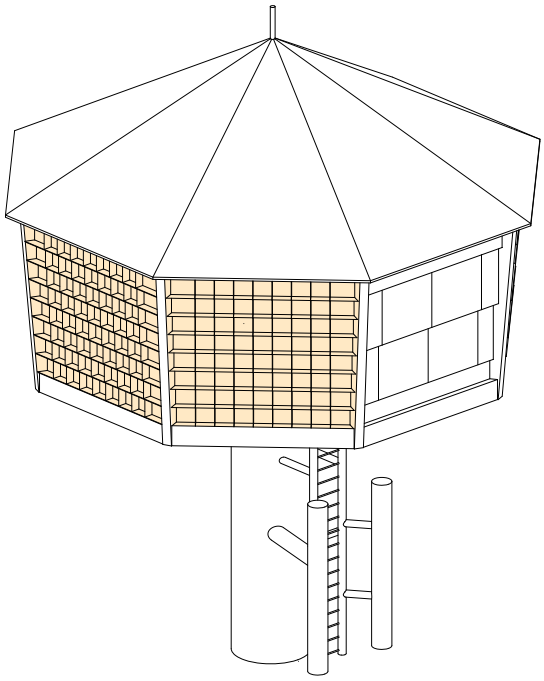
Design Report

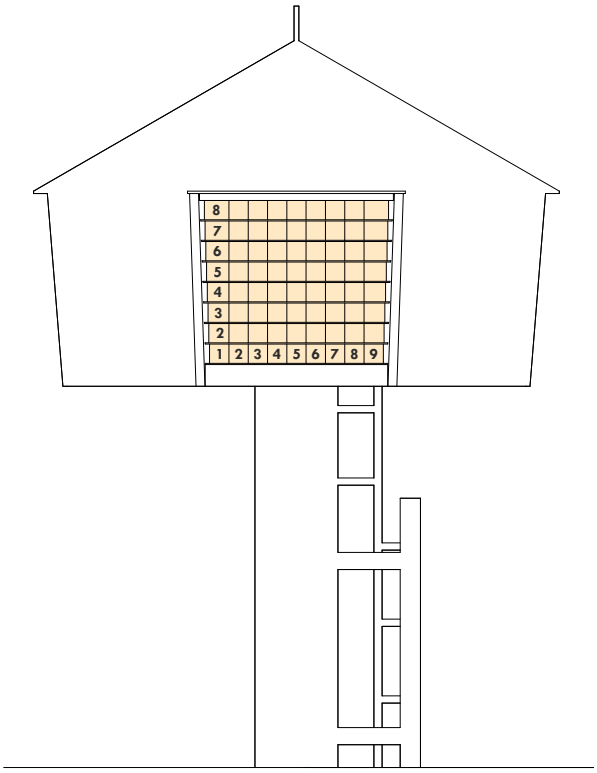
Nearshore ANS Typology



Nearshore ANS Type Total number of nests: **504**

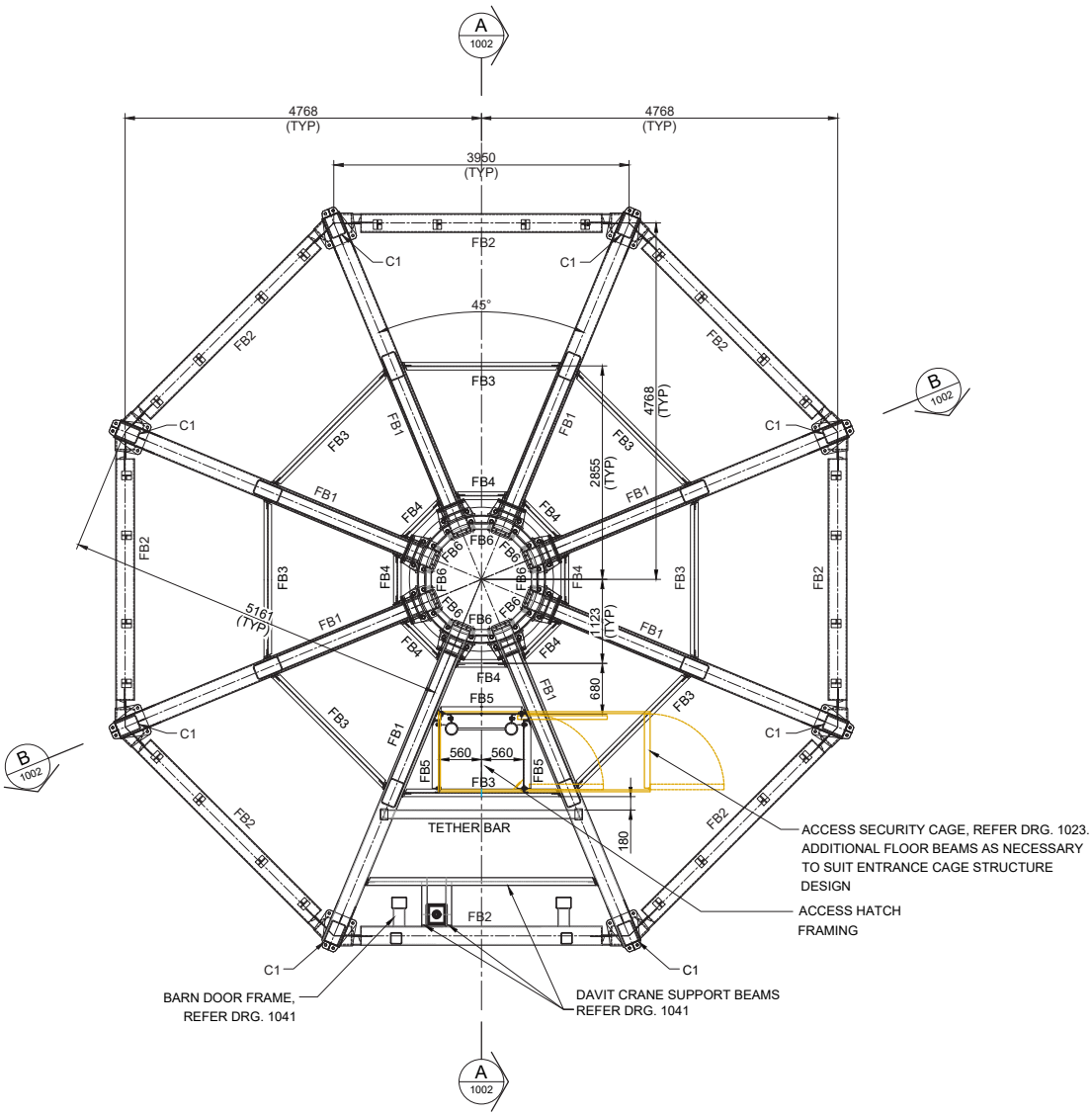






8 rows x 9 columns = 72 nests per nesting side

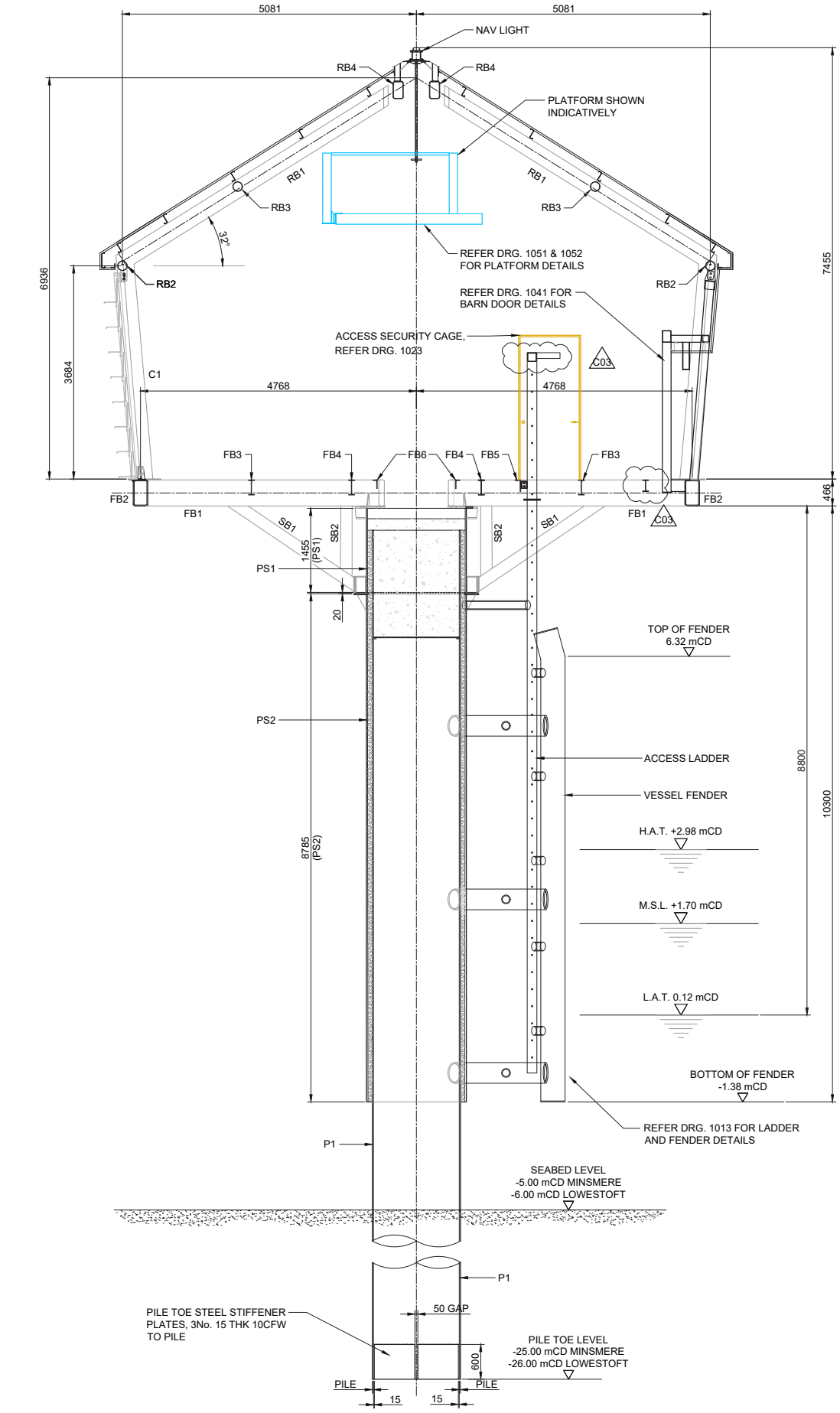
72 nests x 7 sides = 504 nests total



FLOOR FRAMING PLAN

SCALE 1:50

1:50 0 0.5 2.5 5m



SECTION A-A (DRG. 1001)

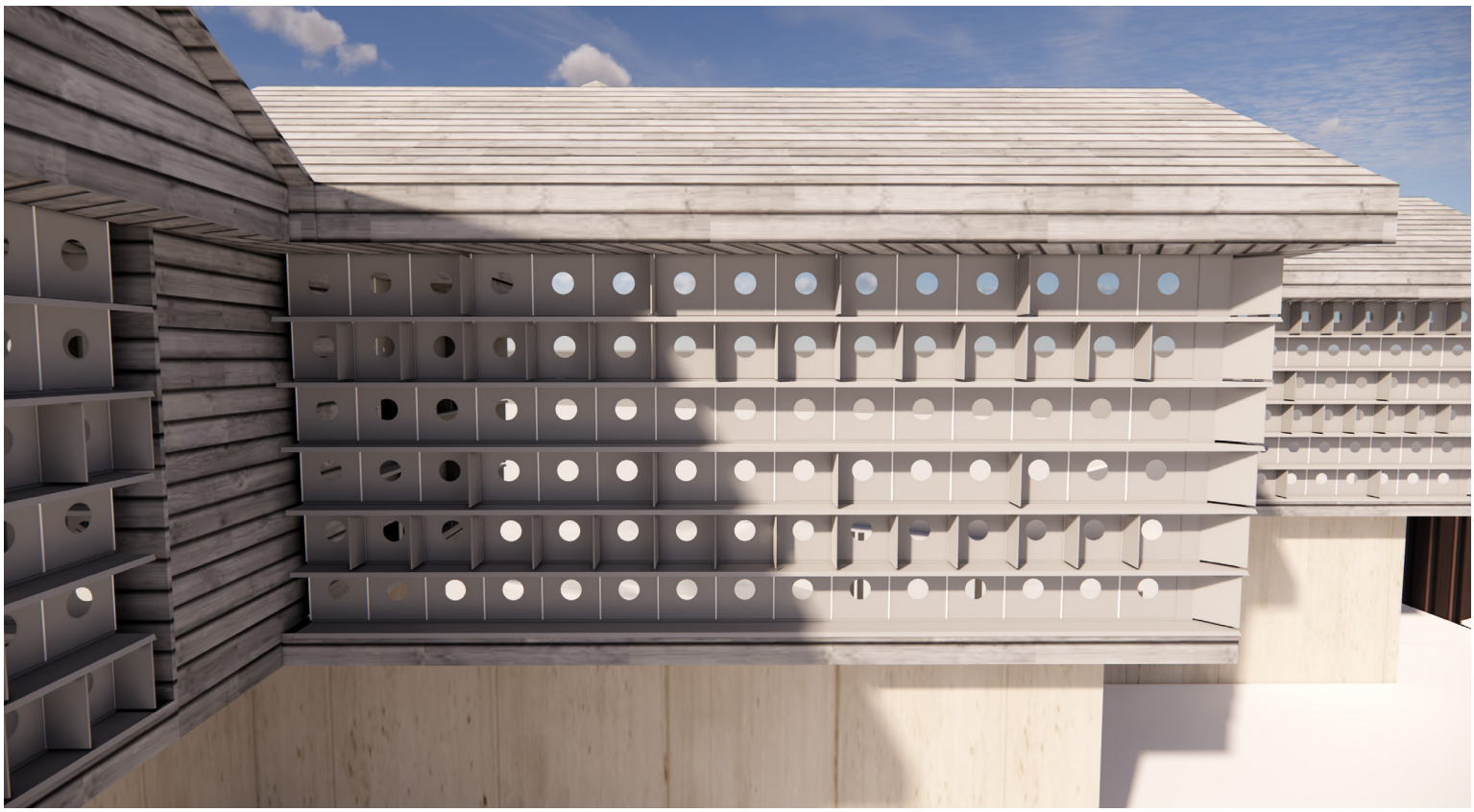
SCALE 1:50

0 0.5 2.5 5m

1:50

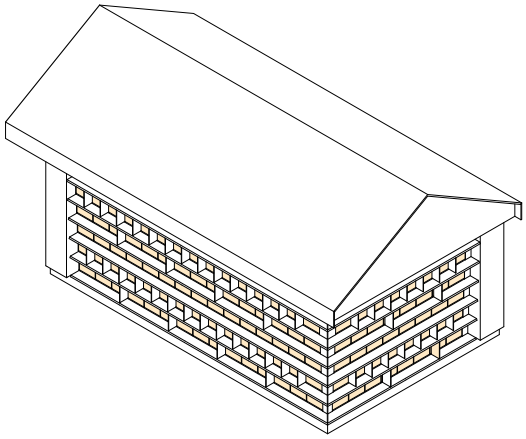
Onshore ANS Typologies

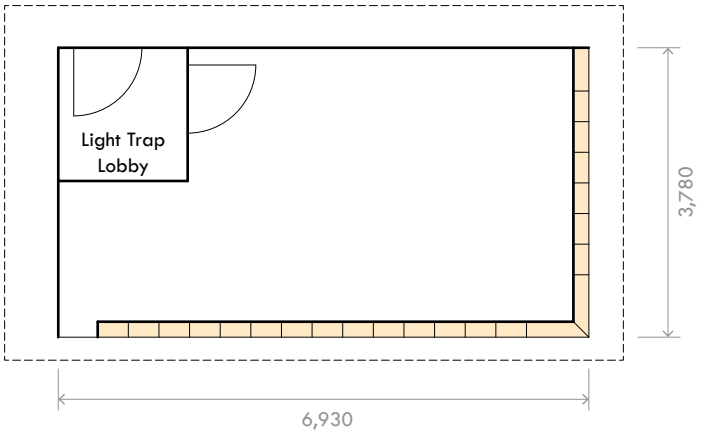
(Hartlepool)

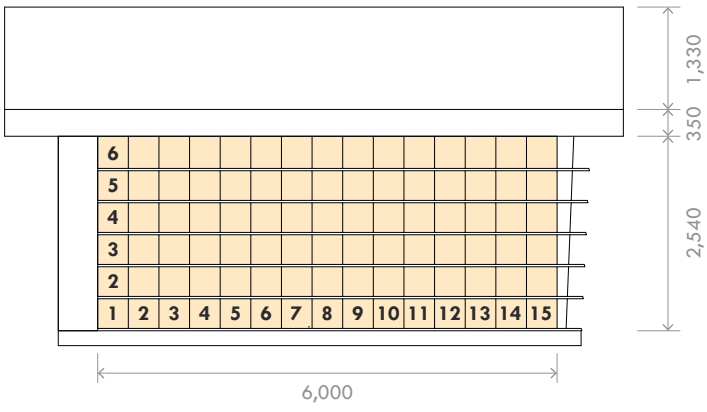


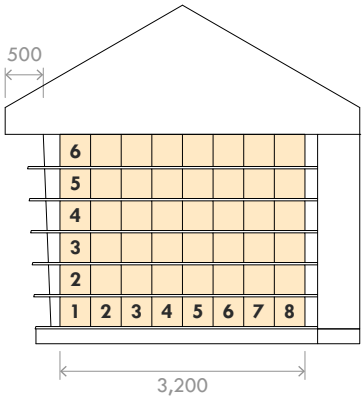
Hut ANS Type A

Total number of nests: **138**
Number of shelves: **6**
Number on site: **3**







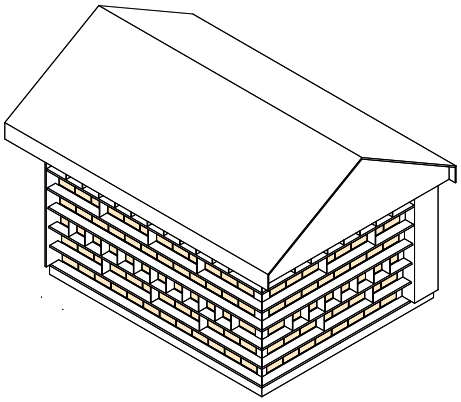


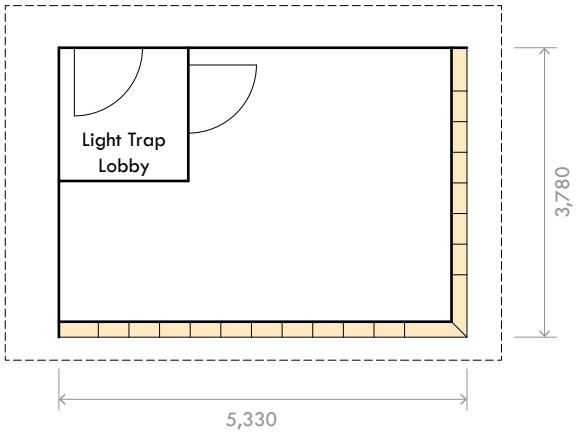
Not To Scale

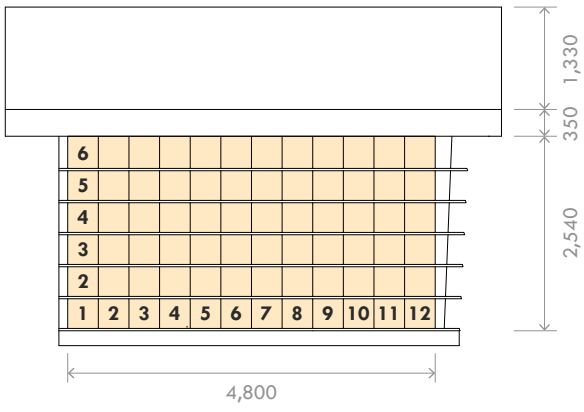
All dims in mm

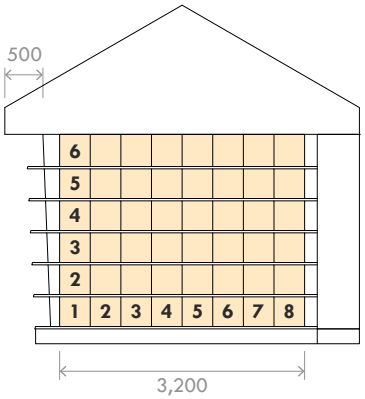
Hut ANS Type B

Total number of nests: **120**
Number of shelves: **6**
Number on site: **1**







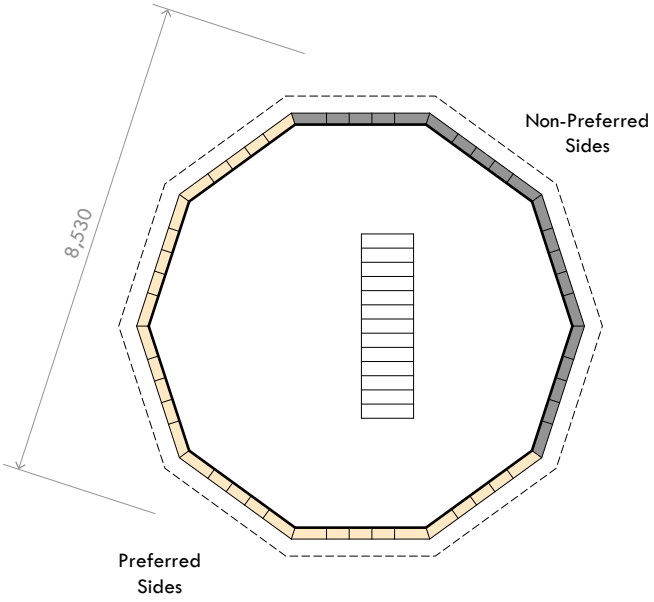


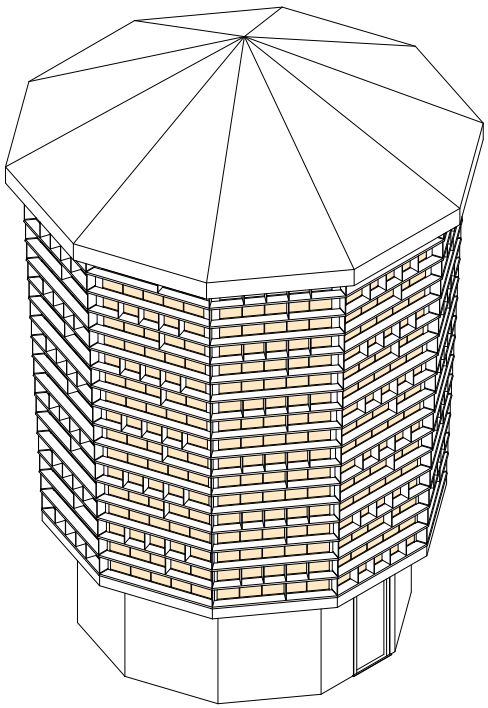
Not To Scale

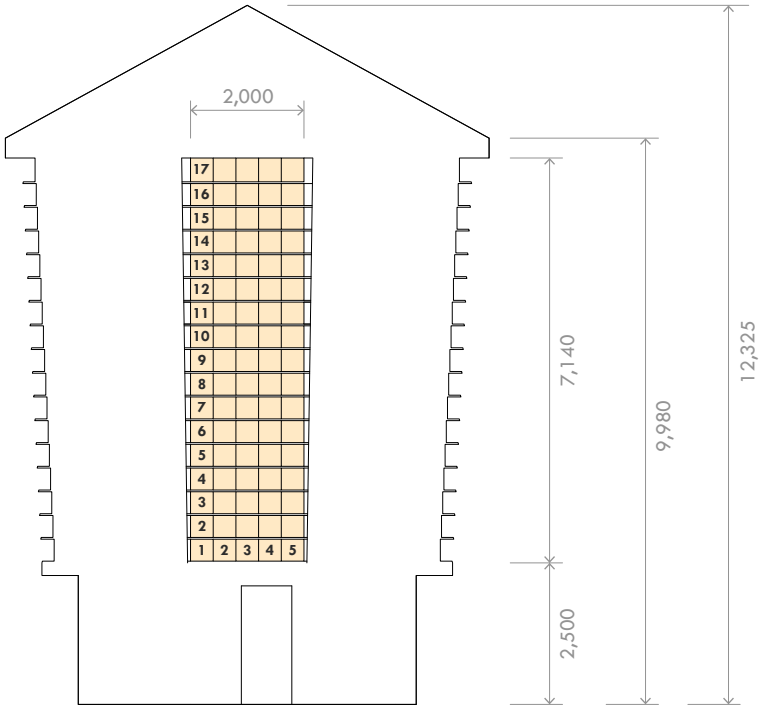
All dims in mm

Tower ANS

Total number of nests: **850** (510 on preferred sides, 340 on non-preferred sides)
Number of shelves: **17**
Number on site: **1**







Not To Scale

All dims in mm