Dales Voe – Capital Dredge
Shadow Habitats Regulations Appraisal (HRA)

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EXECUTIVE SUMMARY

EnviroCentre Limited were commissioned by Arch Henderson LLP to undertake a shadow Habitats Regulations Appraisal (HRA) to provide regulators with the information required to determine if proposed plans to undertake capital dredging will have any adverse impacts on European Sites.

An HRA is required to assess whether the project, alone or in combination with other projects, will have an adverse impact on the integrity of European designated sites. It is the responsibility of the competent authority to conduct the HRA (the Marine Directorate, in this case). This document aims to provide the information necessary for them to undertake the appraisal.

The proposed capital dredging works are driven by an urgent requirement to improve navigational safety through the harbour due to ever increasing vessel size and number being experienced in the port.

The following sites were scoped in to be screened for Likely Significant Effects (LSEs), based on their connectivity with the site, with those in bold screened in and taken forward to Appropriate Assessment as it wasn't possible to rule out LSE for all qualifying features:

- **East Mainland Coast, Shetland Special Protection Area (SPA)**
- Noss SPA
- **Mousa Special Area of Conservation (SAC)**
- Mousa SPA
- Pobie Bank Reef SAC
- The Vadills SAC
- **Yell Sound Coast SAC**
- Lochs of Spiggie and Brow SPA

The potential impacts arising from the proposed works which could affect the conservation objectives for the qualifying features screened in, are:

- Capital dredging and dredge disposal could give rise to suspended sediments within the water, which may affect water quality and indirectly affect the prey abundance for qualifying interests of the designated sites.
- Dredging and transportation of sediment could increase the risk of a pollution incident.
- Increased marine traffic as a result of dredging and transporting sediment could also cause increased risk of collision with marine mammals, as well as disturbance.
- Dredging, drilling, blasting and vessel movements may result in the generation of underwater noise, which can cause injuries and result in Temporary Threshold Shift (TTS) or Permanent Threshold Shift (PTS) in the hearing of marine mammals and birds.

It is anticipated that these impacts can be reduced and avoided through the implementation of adaptive management and standard mitigation protocols. These include:

- An adaptive management drilling and blasting protocol with low starting charge sizes;
- Lerwick Port Authority implementing speed restrictions on vessels; and
- Presence of a Marine Mammal Observer (MMO) and an Ornithologist.

It is considered that if the above mitigation is implemented it will be sufficient to avoid LSEs on any of the qualifying interests identified as being impacted by works. As such, there will be no adverse effects on site integrity for the designated sites that these features are qualifying interests of.

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1 INTRODUCTION

1.1 Terms of Reference

EnviroCentre Limited were commissioned by Arch Henderson LLP to undertake a shadow Habitats Regulations Appraisal (HRA) to provide regulators with the information required to determine if proposed plans to undertake capital dredging will have any adverse impacts on European Sites.

1.2 Background

A dredging & sea deposit licence is in place for capital dredging at Dales Voe (Ref MS-00011213) – the permitted volume is 168,000 wet tonnes.

Phase 1 of the dredging was carried out from July – September 2025 to remove all soft material using a trailer suction hopper dredger (TSHD) and backhoe dredging (BHD). Approximately 46,288m^3 of material has been removed.

Since the original dredging campaign was planned, the appointed dredging contractor has put forward a method to over-dredge to ensure that the depth required for safe navigation is achieved. The dredge area is unchanged.

The volume remaining to be dredged under Phase 2 is approximately 31,808m^3 of rock.

1.3 Scope of Report

A HRA is required to assess whether the project, alone or in combination with other projects, will have an adverse impact on the integrity of European designated sites. It is the responsibility of the competent authority to conduct the HRA (the Marine Directorate, in this case). This document aims to provide the information necessary for them to undertake the appraisal by:

- Providing information on the proposed works;
- Identifying European designated sites that are connected to and/or could potentially be affected by the proposed works;
- Identifying how the proposed works may affect the qualifying features of the European designated site(s), the test of Likely Significant Effects (LSE);
- Giving consideration to other projects that may have an ‘in combination’ effect on European designated sites;
- Recommending European designated sites that need to be taken forward for further assessment if LSEs to their qualifying features cannot be ruled out;
- Conducting an ‘Appropriate Assessment’ for those qualifying features for which LSE cannot be ruled out; and
- Proposing mitigation that would be required to avoid adverse impacts on the qualifying features of the European designated sites.

1.4 Legislative Context

The Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (hereafter called the Habitats Directive) requires ‘appropriate assessment’ of plans and projects that are likely to have a significant effect on European designated sites.

Article 6(3) establishes the requirement for Appropriate Assessment (AA):

"Any plan or project not directly connected with or necessary to the management of the [Natura 2000] site but likely to have a significant effect thereon, either individually or in combination with other plans and projects, shall be subjected to appropriate assessment of its implications for the site in view of the site's conservation objectives. In light of the conclusions of the assessment of the implication for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public".

Article 6(4) goes on to discuss alternative solutions, the test of 'imperative reasons of overriding public interest' (IROPI) and compensatory measures:

"If, in spite of a negative assessment of the implications for the site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of a social or economic nature, the Member State shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected. It shall inform the Commission of the compensatory measures adopted".

A number of guidance documents on the appropriate assessment process have been referred to during the preparation of this HRA. These are:

- Appropriate Assessment under Article 6 of the Habitats Directive: Guidance for Planning Authorities. Circular NPW 1/10 & PSSP 2/10.
- Managing Natura 2000 Sites: The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC (2000).
- Assessment of plans and projects significantly affecting Natura 2000 sites. Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC (Nov. 2001 – updated 2021).
- EU Guidance document on Article 6(4) of the 'Habitats Directive' 92/43/EEC (2007).
- Scottish Government Guidance Note; EU Exit: The Habitats Regulations Scotland (2020).
- NatureScot Guidance on Habitats Regulations Appraisal[1]
- East Mainland Coast, Shetland SPA Conservation and Management Advice. NatureScot (2022).
- Mousa SAC Conservation and Management Advice. NatureScot (2024)
- Yell Sound Coast SAC Conservation and Management Advice. NatureScot (2024)

Should a decision be reached to the effect that it cannot be said with sufficient certainty that the development will not have any significant effect on the European site, then, as stated above, it is necessary and appropriate to carry out an AA of the implications of the development for the sites in view of their conservation objectives.

The EEC (2001) guidance for AA states (Section 3.2, pg. 25):

"It is the competent authority's responsibility to carry out the Appropriate Assessment. However, the assessment process will include the gathering and consideration of information from many stakeholders, including the project or plan proponents, national, regional and local nature conservation authorities and relevant NGOs. As with the EIA process, the Appropriate Assessment will usually involve the submission of information by the project or plan proponent for consideration by the competent authority. The authority may use that information as the basis of consultation with internal

[1] Available online at: https://www.nature.scot/professional-advice/planning-and-development/environmental-assessment/habitats-regulations-appraisal-hra (Accessed 13/02/2024)

and external experts and other stakeholders. The competent authority may also need to commission its own reports to ensure that the final assessment is as comprehensive and objective as possible.

In this stage, the impact of the project or plan (either alone or in combination with other projects or plans) on the integrity of the Natura 2000 site is considered with respect to the conservation objectives of the site and to its structure and function."

It should be noted that following EU Exit, sites designated under the Habitats Directive are no longer part of the Natura network and are referred to only as European designated sites, which are part of a UK site network. The protection and guidance quoted above are, however, still applicable.

1.4.1 Special Areas of Conservation (SACs)

SACs are designated under Article 3 of the Habitats Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. It is transposed into Scottish law through the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended). This network comprises Annex I habitats - *"natural habitat types of community interest whose conservation requires the designation of Special Areas of Conservation"* and the habitats of Annex II species - *"animal and plant species of community interest whose conservation requires the designation of Special Areas of Conservation"*. Candidate SACs (cSACs) are sites that have been submitted to the Scottish Government, but not yet formally adopted. They are given the same level of protection as SACs.

1.4.2 Special Protection Areas (SPAs)

SPAs are designated under Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds (the Birds Directive), transposed into Scottish law through the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended). Under the Directive, Scotland is obliged to protect the habitats of birds which are vulnerable to habitat change or due to their low population numbers, i.e. rarity, especially species on Annex 1 of the Directive. Aspects of habitat protection are in the context of pollution, deterioration of habitat and disturbance.

1.4.3 Conservation Objectives

The overriding objective of the Habitats Directive is to ensure that the habitats and species covered achieve 'Favourable Conservation Status' and that their long-term survival is secured across their entire natural range within the European Union (EU). In its broadest sense, a favourable conservation status means that an ecological feature is being maintained in a satisfactory condition, and that this status is likely to continue into the future. Definitions as per the EU Habitats Directive are given below.

Favourable Conservation Status as defined by Articles 1 (e) and 1(i) of the Habitats Directive

The conservation status of a natural habitat is the sum of the influences acting on it and its typical species that may affect its long-term natural distribution, structure and functions as well as the long-term survival of its typical species. The conservation status of a natural habitat will be taken as favourable when:

- its natural range and areas it covers within that range are stable or increasing; and
- the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future; and
- the conservation status of its typical species is favourable'.

The conservation status of a species is the sum of the influences acting on the species that may affect the long-term distribution and abundance of its populations. The conservation status will be taken as 'favourable' when:

- the population dynamics data on the species concerned indicate that it is maintaining itself on a long term basis as a viable component of its natural habitats; and
- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future; and
- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

Site-specific conservation objectives define the desired condition or range of conditions that a habitat or species should be in, in order for these selected features within the site to be judged as favourable. At the site level, this state is termed 'favourable conservation condition.' Site conservation objectives also contribute to the achievement of the wider goal of biodiversity conservation at other geographic scales, and to the achievement of favourable conservation status at the national level and across the features natural range.

1.5 Report Usage

The information and recommendations contained within this report have been prepared in the specific context stated above and should not be utilised in any other context without prior written permission from EnviroCentre Limited.

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2 METHODOLOGY

2.1 The Habitat Regulations Appraisal Process

The Habitats Regulations Appraisal is a four-stage process with specific issues and tests outlined at each stage. An important aspect of the process is that the outcome at each successive stage determines whether a further stage in the process is required. The stages are summarised in Table 2-1.

Table 2-1: Key Stages in the HRA Process

Stage 1	
Screening for Likely Significant Effect (LSE)	- Identify European sites in and around the project area. - Examine conservation objectives of the interest feature(s) (where available). - Review plan policies and proposals and consider potential effects on UK sites (magnitude, duration, location, extent). - Examine other plans and programmes that could contribute to 'in combination' effects.
	- If no effects likely – report no likely significant effect. - If effects are judged likely or uncertainty exists – the precautionary principle applies, proceed to Stage 2. - If following screening the project is reviewed and includes integral mitigation which will ensure no likely significant effects, then no further Appropriate Assessment needed.
Stage 2	
Appropriate Assessment (AA)	- Complete additional scoping work including the collation of further information on sites as necessary to evaluate impact in light of conservation objectives. - Agree scope and method of AA with the competent authority. - Consider how the project 'in combination' with other projects will interact when implemented (the Appropriate Assessment). - Consider how effects on integrity of the site could be avoided by changes to the project and the consideration of alternatives. - Develop mitigation measures (including timescale and mechanisms). - Report outcomes of AA including mitigation measures.
	- If the project will not adversely affect European site integrity proceed with plan. - If effects or uncertainty remain following the consideration of alternatives and development of mitigation proceed to Stage 3.
Stage 3	
Alternative Solutions	- Consider alternative solutions, delete from project or modify. - Consider if priority species/habitats affected - identify 'imperative reasons of overriding public interest' (IROPI), economic, social, environmental, human health, public safety (only applicable in highly exceptional circumstances).
Stage 4	
Imperative Reasons of Overriding Public Interest (IROPI)	- Stage 4 is the main derogation process of Article 6(4) which examines whether there are imperative reasons of overriding public interest (IROPI) for allowing a plan or project that will have adverse effects on the integrity of a UK site to proceed in cases where it has been established that no less damaging alternative solution exists. - The extra protection measures for Annex I priority habitats come into effect when making the IROPI case. Compensatory measures must be proposed and assessed. The Scottish Government must be informed of the compensatory measures. Compensatory measures must be practical, implementable, likely to succeed, proportionate and enforceable, and they must be approved by the Ministers.

2.2 Overview of Screening Methodology

Screening determines whether or not the project is likely to (or potentially could) have significant effects on the national site network. All SACs, cSACs, SPAs and potential SPAs (pSPAs) that are within the predicted Zone of Influence (ZoI), designated for mobile species which have the potential to be affected by the proposed development, or are hydrologically connected to the site, were considered, and the qualifying interest features noted. Following this, the key environmental conditions (conservation objectives) needed to support site integrity were detailed for each site.

With reference to the NatureScot Guidance[2] the screening stage determines whether Appropriate Assessment is required by:

- Determining whether a project (or plan) is directly connected with or necessary to the conservation management of any European sites;
- Describing the details of the project (or plan) proposals and other projects that may cumulatively affect any European sites;
- Describing the characteristics of relevant European sites; and
- Appraising the likely significant effects of the proposed project on relevant European sites.

The guidance gives the following definition of LSE:

*"A likely effect is one that cannot be ruled out on the basis of objective information. The test is a 'likelihood' of effects rather than a 'certainty' of effects. Although some dictionary definitions define 'likely' as 'probable' or 'well might happen', in the Waddenzee case the European Court of Justice ruled that a project should be subject to Appropriate Assessment "**if it cannot be excluded, on the basis of objective information, that it will have a significant effect on the site, either individually or in combination with other plans and projects**". Therefore, 'likely', in this context, should not simply be interpreted as 'probable' or 'more likely than not', but rather whether a significant effect can objectively be ruled out."*

Throughout the screening process, the precautionary principle, established by the European Court of Justice in C 127/02, Waddenzee, was applied:

"*The authorisation of a plan or project may only be granted if the Competent National Authority is certain that it will not have any adverse effect on the integrity of the site concerned. That is where no reasonable scientific doubt remains as to the absence of such effect*."

As per the People vs Wind Judgement (CJEU C-323/17 People Over Wind and Peter Sweetman vs Coillte Teoranta), the LSE screening has not taken into consideration mitigation which is not an integral part of the project design.

2.3 Appropriate Assessment

The Appropriate Assessment establishes whether or not a project's LSE identified during the screening stage will have an adverse effect on the integrity of the affected site with regard to its conservation objectives. Based on the guidance provided by NatureScot, the effects of the proposal on the designated sites' qualifying features are determined by:

- Gathering information required to assess impacts (from site documents, scientific literature, EU and UK guidance on impact assessment and impact assessments from similar projects);

[2] NatureScot (2019. Available at: https://www.nature.scot/sites/default/files/2019-07/Habitats%20Regulations%20Appraisal%20of%20Plans%20-%20plan-making%20bodies%20in%20Scotland%20-%20Jan%202015.pdf (Accessed June 2024)

- Predicting the type and nature of impacts, e.g. direct or indirect, short or long term;
- Assessing whether there will be adverse effects on the integrity of the site as defined by the conservation objectives and the status of the site. The Precautionary Principle must be applied at this stage. If it cannot be demonstrated with supporting evidence that there will be no adverse effects, then adverse effects will be assumed; and
- Ascertaining if it is possible to mitigate adverse effects.

2.4 In Combination Effects

Under Regulation 43(1)(a) of the Habitats Regulations 1994 (as amended), it is necessary to consider whether a plan or project is likely to have a significant effect on the national site network "*either alone or in combination with other plans or projects."*

These should include:

- Approved but as yet uncompleted plans or projects;
- Plans and projects for which an application has been made and which are currently under consideration but not yet approved by the competent authorities; and
- Permitted ongoing activities such as discharge consents or abstraction licences.

3 DESCRIPTION OF THE PROPOSED WORKS

3.1 Site Location and Description

Dales Voe is a seawater inlet to the northwest of Lerwick, with the Dales Voe base, which is currently owned by Lerwick Port Authority (LPA), lying on the eastern shore of the inlet and extending southwest to northeast along the shorelines. There is open land to the east, and a road runs parallel to the southern edge of the site, connecting it with other areas of the island. The site is centred at OSGR HU 46002 45773, with the site location map provided in Appendix A.

The base was designed for inspection, repair and maintenance of drilling rigs, and in 2015, a multi-purpose deep water facility was developed to meet the needs of offshore industries, in particular decommissioning and renewables. It is now also recognised as a key site for supporting the assembly and deployment of large-scale floating structures for offshore windfarms.

The marine portion of the site falls under the East Mainland Coast, Shetland SPA.

3.2 Purpose and Programme of Works

Since the original dredging campaign was planned, the appointed dredging contractor has put forward a method to over-dredge to ensure that the depth required for safe navigation is achieved. The volume remaining to be dredged under Phase 2 is approximately 31,808m^3 plus an over dredge of rock. Revisions include the below and are shown in Appendix A:

1. Pre-treatment of hard rock strata using drilling and blasting over no more than 2.5 weeks, including contingency time for any delays due to weather or marine mammal presence s, including contingency time for any delays due to weather or marine mammal presence, and drilling may be undertaken 24 hours a day, seven days a week.
2. Larger vessels are proposed to reduce return trips to the designated dredge disposal site from 24 / day previously assessed down to 5 per day.
3. Contingency over dredge volume allowance based on contractor's methods that may not all be required (current contingency allowance of 29,000m^3 has been calculated).
4. While the dredging duration remains unchanged, dredging may be undertaken partly in winter.

Dredged materials will be disposed of at the nearest existing licensed sea disposal site (FI080) for LPA, which is approximately 350m offshore north of Bressay (centre point approximately OSGR HU 48277 45111), hereafter referred to as the 'disposal site'. The disposal site is located in naturally deep water with ease of access, has a large capacity with a footprint of 145,000m^2 in 30m of water and is anticipated to be active for the foreseeable future.

It should be noted that the dredging works at Dales Voe will be undertaken under the same contract as the dredging works at North Harbour (See Section 4.4 for further information). The current intention is to undertake the dredges consecutively with North Harbour completed first and then Dales Voe, over a period of 11 weeks.

3.3 Capital Dredging

The contractor completed Phase 2A Backhoe dredging works in Dales Voe on 8th October 2025 with the pre-survey paid volume above design = 78,097m3, interim survey volume above design = 31,809m3 and total Dales Voe dredge contract complete to date= **59.27%**

The current dredging campaign is now awaiting Marine Directorate / NatureScot assessment of the required final drill and blast (D&B) dredging campaign to complete dredging down to design levels using agreed methods and mitigation.

On completion of the drilling and blasting, dredging will be undertaken using BHD methods to remove blasted material from the seabed. The dredged material will be transferred to a split hopper barge. This material will then be deposited at the disposal site.

A Dredging Best Practicable Environmental Option Report (BPEO)[3] has been produced for the proposed development, informed by sediment sampling at both the Dales Voe dredge site and the disposal site. Samples from Dales Voe were noted to be largely either sand (23% to 92%) or gravel (2% to 37%) sized fractions with limited silt fractions recorded. Silt sized particles ranged from 2% to 12% in samples submitted for analysis. The BPEO included with the original application confirmed volumes in m^3 and the table below shows these together with additional volumes from the proposed revised dredging, together with a further contingency allowance for any over dredge due to specific dredging techniques:

Table 3-1: Summary of Dredge Volumes and Depths

Dredge Area	Dredge Volume (m^3)	Target Dredge Depth (m below Chart Datum)
Dales Voe -12.5 / -14.5m CD	42,044	-14.6
Dales Voe -16.5m CD	34,363	-16.5
Dales Voe Total Volume	**76,407**	
Additional Material		
Over Dredge (est. 500mm ave.)	29,000	
Dales Voe Total Volume (Revised)	**105,407**	

Due to the majority of the dredge material being of a coarse nature, plumes generated as a result of the dredging works will be very localised and short term in duration, and any sands and gravels lost to the water column during dredging will fall out of suspension quickly at both the dredge and disposal sites. The disposal site is a sacrificial disposal ground with a large footprint, and as such there is considered to be an allowance for some lateral dispersal of materials within the area of disposal over time due to sites typically being dispersive, rather than retentive.

The BPEO report concluded that one sample contained levels of contaminants above Marine Directorate Revised Action Level (RAL) 1 for Polycyclic Aromatic Hydrocarbons (PAH), but there were no exceedances of RAL2. Despite this, assessment of the key receptors identified from the Water Framework Directive assessment for estuarine and coastal waters concluded there is a low risk of the sediments impacting upon the overall ecological or chemical status classifications. The levels of contaminants encountered are typically within levels accepted for sea deposit of dredged material. Additionally, the contaminant levels recorded in the sediment are not considered likely to have a significant adverse impact once placed within the disposal site.

[3] EnviroCentre (2024). Dales Voe and Lerwick Harbour North Best Practicable Environmental Option. Document number 14356.

It is noted that the Lerwick disposal grounds have been utilised for historic dredge spoil disposal and water quality classification for chemical status of the waterbody which accommodates the disposal grounds was classified by SEPA as "good" in 2022[4]. On this basis, the associated risk with degradation of water quality directly associated with the proposed disposal is considered to be very low i.e. unlikely to cause a change in the status of the waterbodies in question at both the dredge and disposal sites.

Drilling and Blasting

Rock that could not be directly dredged during Phase 1 using a backhoe or trailer dredger, either because of rock strength or low fracture rate will require pre-treatment using drill and blast methodologies. The drilling and charging will continue on a 24 hours a day, 7 days a week basis.

Drilling and blasting will occur from a specialist drill platform, 'Rockmate' equipped with two marine drill tower units. The 'Rockmate' is 41m x 18m and utilises four spud legs (avoiding the requirement for anchor spread).

Drilling

To determine the starting position of the 'Rockmate' a drill/blast location will be determined in a less sensitive area to gather information on vibration and underwater noise impact. Drilling will start at the minimum rock layer depth meaning the explosive placed into the hole can be reduced, so the Maximum Instantaneous Charge (MIC) will also be small.

The drill pattern will vary between the areas based on design thickness, rock strength and locality to structures. The space between drill points will vary from 2.0m-5.0m, covering approximately 4m^2 to 20m^2 for each drill point. The drill pattern will be adjusted as required. Drilling will extend up to 2m below design to ensure the later dredging can fully remove the rock to the required design level and to reduce the number of pinnacles created during the blasting operation. Drill holes can vary in diameter from 85mm to 165mm. To ensure that the blasting extends over the full dredge area, it will be necessary to drill up to 1-2m beyond the planned extents of the dredge area.

Blasting

Offshore Kemiitti Explosives, a liquid explosive, with packaged boosters and detonators, will be used for the works. These explosives are specifically tailored to be used in underwater rock blasting. In addition, provision for EXEM 100 50mm diameter packaged emulsion provided by Explosives and Pyrotechnic Consultants (EPC) for required controlled works to manage MIC weights and thus controlling vibration as required.

Trial blasting is required to ascertain the site parameters for vibration predictions. Initial trial blasting will be carried out as part of the production, but with charged levels reduced to ensure vibration levels at nearby structures stay below the normal operational safe limits. Several trial blasts over the first days will be used to take these trial measurements.

A warning signal (both aural and visual) will be emitted several minutes before the blast, and the area checked visually for the presence of swimmers, divers, vessels, mammals, etc. in good time.

A typical example of a blast warning procedure is:

- The local VTS and other specified parties will be informed 60 minutes prior to planned blasting.
- Ten minutes before blasting: - Relevant parties will be informed by radio and/or phone.

[4] https://map.environment.gov.scot/sewebmap/

    - A blasting control vessel equipped with a red flag will depart the 'Rockmate' to patrol the designated safety area. An additional fast craft vessel will be available to encourage species out of the Marine Mammal Observer (MMO) area, if required. Acoustic Deterrent Devices (ADDs) will also be available on site but will only be used if persistent issues arise with species converging into or not leaving MMO area just prior to a blast.
    - VTS will be contacted to obtain all clear to blast (vessel traffic, divers etc.)
- The supervisor onboard will make a visual check of the area and obtain confirmation from the blasting control vessel that everything is correct.
- Upon receipt of clearance short sound signals will be given, and the blast will be initiated after the last signal.
- After successful blasting one long sound signal will be given, and the relevant parties will be informed on the radio that blasting is completed.

The use of bubble curtains has currently been discounted as it would be extremely challenging to deploy them effectively in open water and with the presence of the existing heavy vessel traffic, for individual blasts at different locations. A NatureScot report (2019)[5] completed a review of noise abatement systems for offshore wind farm construction noise, and the potential for their application in Scottish waters concluded that 'big bubble curtains' are effective for prolonged piling of large wind turbines, however, the evidence is mixed for blasting[6]. In addition, the report also acknowledges the significant logistical challenges and high costs of deploying them for individual blast locations. Furthermore, during the works at the Aberdeen South Harbour project, where double bubble curtains were implemented as mitigation, the programme was to undertake one blast a day, but only 12 blasts were carried out in 96 days, primarily due to the presence of seals in the mitigation zone for hours at a time, and/ or adverse weather conditions and operational issues preventing the bubble curtain from being operated effectively. As a result, blasting was abandoned, and instead, the rock was able to be removed by backhoe dredging[7].

The quantity of explosives in each hole will be dependent on the layer of rock and findings from trial blasting, which will start at MIC 20kg and work up in small increments (2kg or 5kg) whilst monitoring noise levels at 500m and 1000m (see Section 1.4.2 for further details). When noise levels reach near the PTS range at 1000m of the hearing frequencies of any marine mammals considered to be within waters associated with the site location (all relevant pinnipeds and cetaceans), then this will identify the maximum MIC for the project. It is also estimated that 9-90 holes will be drilled for each field.

Charges will go off at the beginning and end of each day (during daylight). Blasting is expected to occur over a duration of 2.5 weeks at Dales Voe, weather dependent, and may be undertaken partly in winter.

As part of an overall mitigation of blast noise impact intensity then the contractor is proposing to use 25 millisecond blast delays between each charged hole to help minimise the MIC / Qmax value for each overall blast. A sample blast design calculation is detailed in See Figure 3-1. It shows a drill pattern with a typical overall total charge weight of 980Kg over 30 holes, but with blast delays resulting in an MIC/ Qmax value of 70Kg. This individual blast hole charge delay method was previously used at Lerwick Harbour dredge campaign in 2008 and during the Holmsgarth Pier Development in 2018.

[5] Verfuss, U.K., Sinclair, R.R. & Sparling, C.E. 2019. A review of noise abatement systems for offshore wind farm construction noise, and the potential for their application in Scottish waters. Scottish Natural Heritage Research Report No. 1070.
[6] This report refers to blasting from detonating UXOs, rather than blasting in the same respect as this project, so although some differences, the theory is considered relevant.
[7] It has been demonstrated that the remaining material to be removed at Dales Voe cannot be excavated using a backhoe dredger.

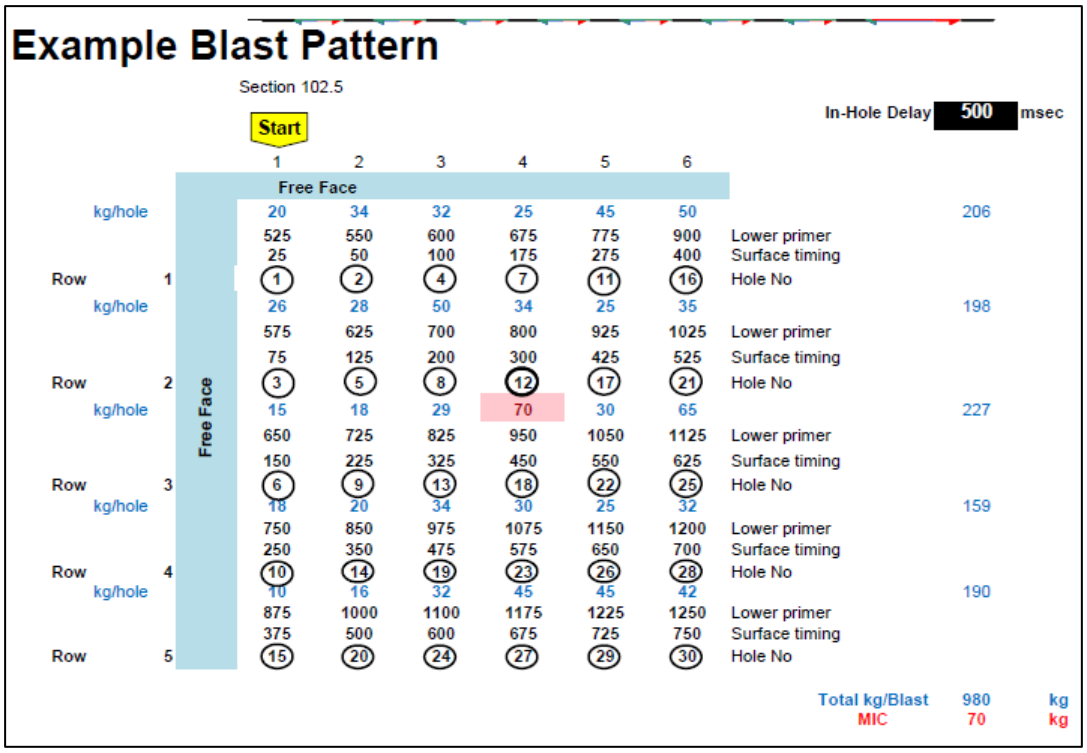

Figure 3-1: Example blast pattern previously used at Lerwick Harbour dredge campaign in 2008 and during Holmsgarth Pier Development in 2018 obtained from the drilling and blasting method statement provided by the contractors

3.3.1 Trial Blasting

Underwater noise monitoring

In order to record impulsive noise in the field and assess relative to the above MMO mitigation zones then the following method is proposed to be undertaken by a specialist underwater acoustic noise contractor during a programme of trial blasts leading onto the main drilling and blasting campaign in order to have confidence that suitable and practical MMO distance is used.

In order to monitor underwater noise levels during blasting, measurements of blast noise will be recorded simultaneously at locations of 500m and 1000m from the trial blast centre in a direction north of blast. The trial test blast locations will be determined in a less sensitive area to gather information on vibration and underwater noise impact. The proposed trial blast method is to restrict initial MIC to 20Kg with incremental trial increases (2kg or 5kg) up to an agreed maximum MIC that maintains underwater noise impact thresholds below disturbance levels for marine mammals at the agreed MMO distance. The objective is to ensure that all recording stations lay along a direct line-of sight transect commencing at the blast field.

Two boats will be used during the drilling and blasting trials with hydrophones capable of detecting marine mammals. The provided vessels must go dead ship (engines and depth sounders switched off) and drift for a short duration for each trial blast to enable high quality data capture from the blast events.

If at any time during the D&B dredging works, there are issues with marine mammals converging inside the agreed MMO distance, then an ADD will be available on site and deployed on the above boats to encourage marine mammals to leave the area ahead of the blast. The ADD is essentially a transducer on the end of a 50m cable connected to a topside unit with only a single switch to turn the device on or off. A back-up spare device will be deployed on each boat.

Blasting will not take place when the weather and sea state affects the efficiency of the MMO and mitigation measures.

Prior to each blasting schedule, a specialist noise survey team will liaise with the Boskalis Westminster Ltd blasting engineers to ensure that two survey vessels are on the 500m and 1000m lines in good time. Noise data, that is collected at each recording station over durations ranging from a few minutes to one hour or more will be recorded to provide general background noise, which can be calibrated and used in the data acquisition system to provide a standardised noise level against which all subsequent measurements would be compared, and the blast noise itself.

In addition to the noise data, the specialist noise survey team will also collate log sheets indicating which blast field was being drilled; the numbers of boreholes prepared, the numbers of charges that were successfully detonated, the state of weather and tide; and any other sources of noise that were present in the area from time to time. All data will then be made available for subsequent data processing and analysis.

Analysis and reporting

The noise data will be supplied as voltage-time series in one or more .WAV files. Subsequently, a calibration adjustment factor related to the ratio of the output signal amplitude to the input signal amplitude will be applied to the blast wave data.

Two boats will be used during the drilling and blasting trials with hydrophones (Passive Acoustic Monitor (PAM)) capable of detecting marine mammals at 500m and 1000m.

The blast data will then be converted into a pressure-time series after taking into account the hydrophone frequency sensitivity; the terminal unit gain settings; and calibration factor. The maximum amplitude of each blast event is then transcribed to give the peak blast level at each station distance. The rms value is then ascertained over each time duration. From the positional data contained within both Boskalis Westminster Field Contractor's Log and the special monitoring contractors log, the distance between the blast site and each recording station is determined.

Summaries of the peak and rms noise levels at each station are then established.

Results will then be shared with MD-LOT and NatureScot with recommendations on final practical MMO distances and impulsive noise limits for marine mammals to avoid temporary and permanent noise-induced threshold shifts; TTS and PTS. Additional mitigation actions will be outlined if PTS are outside the mitigation zones.

Marine mammal detection

The project will provide visual MMOs and the requirement for marine mammal vocalisation detection would also be required via the inclusion of a PAM during trial works and project works.

To comply with Joint Nature Conservation Committee (JNCC) guidelines, the PAM system will be operated by an experienced PAM operator. The PAM operator will be responsible for deploying the vertical PAM system and documenting all PAM actions, including deployment times and detection records.

3.4 Vessel Movements Associated with Works

Dredging

The dredging works will include associated vessel movements with the dredging itself and then barges moving between the dredge site and the disposal site.

Movements associated with the drill and blast campaign are approximately a maximum of four to five barges per 24 hours throughout the overall final D&B / dredging period. Therefore, total vessel movements in Dales Voe to complete the dredging area is approximately 30 to 45 barge transits over 2.5, weeks depending on final over dredge quantities.

The vessel route is expected to run from the dredge location adjacent to the Dales Voe base, north east out of Dales Voe, before then heading southeast towards the disposal site off the north coast of Bressay. The vessel route is approximately 4.5km long.

Drilling and Blasting

The explosives will be delivered in 75 tonne loads by coaster to Lerwick, taking station at one of the three Dangerous Goods anchorages specified by Lerwick Port Authority. Two vessel movements are proposed to facilitate this.

Once the area requiring pre-treatment has been established, the ‘Rockmate’ will be towed to the location and positioned using the onboard RTK/ DGPS positioning equipment.

4 SCREENING FOR LIKELY SIGNIFICANT EFFECTS

4.1 Zone of Influence for the Proposed Works

For significant effects to arise, there must be a risk enabled by having a 'source' (e.g. construction works at a proposed development site), a 'receptor' (e.g. a European site or its qualifying interests), and a pathway between the source and the receptor (e.g. mobile marine species travelling between the proposed development site and the designated site). The identification of a pathway does not automatically mean that significant effects will arise. The likelihood for significant effects will depend upon the characteristics of the source (e.g. duration of construction works), the characteristics of the pathway (e.g. what species and the number of individuals travelling between the two sites) and the characteristics of the receptor (e.g. the sensitivities of the European site and its qualifying interests).

NatureScot (2015)[8] guidance states that sites with mobile species should be considered within the screening process where there is a significant ecological link between the designated site and the proposed development site. It also states that for developments which could increase recreational pressures on designated sites, all sites within a reasonable travel distance of the development should be considered for screening. It is also necessary to consider sites which are part of the same coastal ecosystem, where the proposed development may affect coastal processes.

Sites within 30km of the proposed works were identified for screening. The following sites have been scoped in for assessment due to their being within proximity to the site and/or considered connected to the site via dispersal of designated mobile species:

- East Mainland Coast, Shetland SPA
- Noss SPA
- Mousa SAC
- Mousa SPA
- Pobie Bank Reef SAC
- The Vadills SAC
- Yell Sound Coast SAC
- Lochs of Spiggie and Brow SPA

4.2 Potential Impacts to Qualifying Interests

It is anticipated that the proposed works described in Section 3 could give rise to the following impacts if no mitigation is employed during dredging or vessel movements to transport sediment:

- Capital dredging and dredge disposal could give rise to suspended sediments within the water, which may affect water quality and indirectly affect the prey abundance for qualifying interests of the designated sites.
- Dredging and transportation of sediment could increase the risk of a pollution incident.
- Dredging, drilling, blasting and transportation of sediment, and the resulting increase in marine traffic, could cause increased risk of collision with qualifying interests (particularly marine mammals), as well as disturbance.

[8] NatureScot (2015) '*Habitats Regulations Appraisal of Plans, Guidance for Plan-Making Bodies in Scotland V3*'. Available at: https://www.nature.scot/sites/default/files/2019-07/Habitats%20Regulations%20Appraisal%20of%20Plans%20-%20plan-making%20bodies%20in%20Scotland%20-%20Jan%202015.pdf [Accessed June 2024).

- Dredging and vessel movements may result in the generation of underwater noise, which can cause injuries and result in Temporary Threshold Shift (TTS) or Permanent Threshold Shift (PTS) in the hearing of qualifying interests (particularly marine mammals).

4.3 Screening Assessment

The screening assessment for LSE of the proposed development on the qualifying features of the European designated sites are shown in Table 4-1 below.

Table 4-1: Screening Assessment for LSE of the Proposed Development

Site Name (Distance to Proposed Works[9])	Conservation Objectives	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
East Mainland Coast, Shetland SPA (under footprint of proposed works)	1. To ensure that the qualifying features of the East Mainland Coast, Shetland SPA are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status 2. To ensure that the integrity of the East Mainland Coast, Shetland SPA is maintained in the context of environmental changes by meeting objectives 2a, 2b and 2c for each qualifying feature: 2a. The populations of the qualifying features are	Great northern diver (*Gavia immer*), non-breeding	Pathway for LSE identified Great Northern Diver could be directly impacted during the dredging activities through disturbance from blasting activities and/or vessel movements. They may also be impacted if pollutants are released into the water, which could have an indirect effect on this species if their prey availability is affected. If prey item availability is affected, this could result in death or injury to individuals and loss of condition or reduction in breeding success. LSE cannot be ruled out for Great Northern Diver.	**Screened in**
		Red-throated diver (*Gavia stellata*), breeding	Pathway for LSE identified. Red-throated Diver from the SPA may utilise coastal water in the vicinity of the proposed works for foraging. Red-throated Diver could be directly impacted during the dredging activities through disturbance from blasting activities and/or vessel movements. They may also be impacted if pollutants are released into the water, which could have an indirect effect on this species if their prey availability is affected. If prey item availability is affected,	**Screened in**

[9] Distance is measured from the closest points around the coastlines rather than 'as the crow flies', unless otherwise specified.

Site Name (Distance to Proposed Works[9])	Conservation Objectives	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
	viable components of the site. 2b. The distributions of the qualifying features throughout the site are maintained by avoiding significant disturbance of the species. 2c. The supporting habitats and processes relevant to qualifying features and their prey/food resources are maintained		this could result in death or injury to individuals and loss of condition or reduction in breeding success. LSE cannot be ruled out for Red-throated Diver.	
		Slavonian Grebe (*Podiceps auratus*), non-breeding	Slavonian Grebe could be directly impacted during the dredging activities through disturbance from blasting activities and/or vessel movements. They may also be impacted if pollutants are released into the water, which could have an indirect effect on this species if their prey availability is affected. If prey item availability is affected, this could result in death or injury to individuals and loss of condition or reduction in breeding success. LSE cannot be ruled out for Slavonian Grebe.	**Screened in**
Noss SPA (c. 6.3km by sea, c. 4.6km as the crow flies)	To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term:	Gannet (*Morus bassanus*), breeding	Pathway for LSE identified. Gannet from the SPA may utilise coastal water in the vicinity of the proposed works for foraging. It is possible that foraging gannet within the vicinity of the proposed works could experience disturbance from increased noise and vibration during the dredging and associated vessel movements. Gannet could also be impacted during the dredging activities if pollutants are released into the water, which could have a direct or indirect effect on this species if their prey availability is affected. If prey item availability is affected, this could result in death or injury	Screened out

Site Name (Distance to Proposed Works[9])	Conservation Objectives	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
	• Population of the species as a viable component of the site • Distribution of the species within the site • Distribution and extent of habitats supporting the species • Structure, function and supporting processes of habitats supporting the species • No significant disturbance of the species		to individuals and loss of condition or reduction in breeding success. However, it is considered that there is sufficient resource for gannet within the SPA and other surrounding areas in terms of foraging, such that disturbance or pollution relation impacts experienced outside the SPA would have a negligible impact on the population. In addition, given that there are already considerable noise and vessel movements associated with the Dales Voe base, vessel movements are unlikely to result in disturbance to gannet already utilising the site. No LSEs are predicted for gannet in the Noss SPA.	
		Great skua (*Stercorarius skua*), breeding	Pathway for LSE identified. Great skua from the SPA may utilise coastal water in the vicinity of the proposed works for foraging. It is possible that foraging great skua within the vicinity of the proposed works could experience disturbance from increased noise and vibration during the dredging and associated vessel movements. Great skua could also be impacted during the dredging activities if pollutants are released into the water, which could have a direct or indirect effect on this species if their prey availability is affected. If prey item availability is affected, this could result in death or injury to individuals and loss of condition or reduction in breeding success.	Screened out

Site Name (Distance to Proposed Works[9])	Conservation Objectives	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
			However, it is considered that there is sufficient resource for great skua within the SPA and other surrounding areas in terms of foraging, such that disturbance or pollution relation impacts experienced outside the SPA would have a negligible impact on the population. In addition, given that there are already considerable noise and vessel movements associated with the Dales Voe base, vessel movements are unlikely to result in disturbance to great skua already utilising the site. No LSEs are predicted for great skua in the Noss SPA.	
		Guillemot (*Uria aalge*), breeding	Pathway for LSE identified. Guillemot from the SPA may utilise coastal water in the vicinity of the proposed works for foraging. It is possible that foraging guillemot within the vicinity of the proposed works could experience disturbance from increased noise and vibration during the dredging and associated vessel movements. Guillemot could also be impacted during the dredging activities if pollutants are released into the water, which could have a direct or indirect effect on this species if their prey availability is affected. If prey item availability is affected, this could result in death or injury to individuals and loss of condition or reduction in breeding success. However, it is considered that there is sufficient resource for guillemot within the SPA and other surrounding areas in terms of foraging, such that disturbance or pollution relation impacts	Screened out

Site Name (Distance to Proposed Works[9])	Conservation Objectives	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
			experienced outside the SPA would have a negligible impact on the population. In addition, given that there are already considerable noise and vessel movements associated with the Dales Voe base, vessel movements are unlikely to result in disturbance to guillemot already utilising the site. No LSEs are predicted for guillemot in the Noss SPA.	
		Seabird assemblage, breeding – in addition to the above: • Atlantic puffin (*Fraterna arctica)* • Fulmar (*Fulmaris glacialis*) • Kittiwake (*Rissa tridactyla*)	Pathway for LSE identified. The breeding seabird assemblage from the SPA may utilise coastal water in the vicinity of the proposed works for foraging, loafing and / or roosting. It is possible that foraging birds within the vicinity of the proposed works could experience disturbance from increased noise and vibration during the dredging and associated vessel movements. The seabird assemblage could also be impacted during the dredging activities if pollutants are released into the water, which could have a direct or indirect effect on this species if their prey availability is affected. If prey item availability is affected, this could result in death or injury to individuals and loss of condition or reduction in breeding success. However, it is considered that there is sufficient resource for birds within the SPA and other surrounding areas in terms of foraging, such that disturbance or pollution relation impacts experienced outside the SPA would have a negligible impact on the population.	Screened out

Site Name (Distance to Proposed Works[9])	Conservation Objectives	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
			In addition, given that there are already considerable noise and vessel movements associated with the Dales Voe base, vessel movements are unlikely to result in disturbance to birds already utilising the site. No LSEs are predicted for the breeding seabird assemblage in the Noss SPA.	
Mousa SAC (c. 20km)	1. To ensure that the qualifying features of Mousa SAC are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status. 2. To ensure that the integrity of Mousa SAC is restored in the context of environmental changes by meeting objectives 2a, 2b and 2c for each qualifying feature: *Reefs and submerged or partially submerged sea caves:*	Harbour seal (*Phoca vitulina*)	Pathway for LSE identified. Harbour seals are mobile species known to range up to 50km from haul out sites in search of food. It is therefore possible that individuals from the SAC could forage in the waters in the vicinity of the proposed works, given it is c. 20km away as the seal swims. The nearest seal haul out site to the works being Holm of Beosetter, approximately 500m by sea from the closest aspect of the proposed works (the disposal site) which could be used by seals from the SAC. During the dredging and disposal, any pollutants released into the water could have temporary impacts on harbour seal either directly, or indirectly if prey items are affected. Toxic pollutants could result in habitat avoidance, injury or death of individuals and / or reduced prey availability, leading to loss of condition. There is already considerable noise and vessel movements associated with the Dales Voe base, however, it is noted the works will result in an increased in vessel movements. Vessel movements	**Screened in**

Site Name (Distance to Proposed Works[9])	Conservation Objectives	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
	2a. Extent and distribution of the habitat within the site. 2b. Structure and function of the habitat and the supporting environment on which it relies. 2c. Distribution and viability of typical species of the habitat. *Harbour seal:* 2a. Harbour seal is a viable component of Mousa SAC. 2b. The distribution of harbour seal throughout the site is maintained by avoiding significant disturbance. 2c. The supporting habitats relevant to harbour seal are maintained.		can result in disturbance and / or collision related injury / mortality to harbour seal utilising the site. In addition, dredging, drilling, blasting and vessel movements may result in the generation of underwater noise, which can cause injuries and result in TTS or PTS in hearing of marine mammals and general disturbance. LSE cannot be ruled out for harbour seal.	
		Reefs	No pathway for LSE identified. At its nearest point the site is c. 20km south of the proposed works. No alterations to coastal processes are predicted at these distances, and there will be no sediment transportation of this significance. Therefore, there is no connectivity.	Screened out
		Sea caves (submerged or partially submerged)	No pathway for LSE identified. At its nearest point the site is c. 20km south of the proposed works. No alterations to coastal processes are predicted at these distances, and there will be no sediment transportation of this significance. Therefore, there is no connectivity.	Screened out
Mousa SPA (c. 21km)	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the	Arctic tern (*Sterna paradisaea*), breeding	No pathway for LSE identified.	Screened out

Site Name (Distance to Proposed Works[9])	Conservation Objectives	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
	qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: • Population of the species as a viable component of the site • Distribution of the species within site • Distribution and extent of habitats supporting the species • Structure, function and supporting processes of habitats supporting the species • No significant disturbance of the species		The mean foraging distance for Arctic tern is 4.4km. Mousa SPA is 21km at its nearest point to the proposed development. Therefore, there is no connectivity.	
		Storm petrel (*Hydrobates pelagicus*), breeding	No pathway for LSE identified. Research of storm petrel foraging[10] from the Mousa SPA indicates that they typically forage south of Shetland, as far as south-east Orkney (~300km). Additionally, the foraging areas within Lerwick harbour and at the disposal site are likely sub-optimal for this species. Therefore, there is no connectivity.	Screened out

[10] Bolton, M. (2021). GPS tracking reveals highly consistent use of restricted foraging areas by European Storm-petrels Hydrobates pelagicus breeding at the largest UK colony: implications for conservation management. Bird Conservation International. Available at: https://www.cambridge.org/core/journals/bird-conservation-international/article/gps-tracking-reveals-highly-consistent-use-of-restricted-foraging-areas-by-european-stormpetrels-hydrobates-pelagicus-breeding-at-the-largest-uk-colony-implications-for-conservation-management/DE6A57A1B5C3141DAB63A854610334D7 [Accessed June 2024].

Site Name (Distance to Proposed Works[9])	Conservation Objectives	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
Pobie Bank Reef SAC (c. 26 km)	Subject to natural change, maintain or restore the reef in / to favourable condition, such that: • the natural environmental quality and processes supporting the habitat • the extent of the habitat on site • the physical structure, community structure , function, diversity and distribution of the habitat and typical species representative of the reef in the *Northern North Sea* regional sea are maintained or restored, thereby ensuring the integrity of the site and also making an appropriate contribution to favourable conservation status of the Annex 1 habitats.	Offshore reefs	No pathway for LSE identified. At its nearest point the site is c. 26km north-east of the proposed works. No alterations to coastal processes are predicted at these distances, and there will be no sediment transportation of this significance. Therefore, there is no connectivity.	Screened out
The Vadills SAC (c. 120km	1. To ensure that the lagoons at The Vadills SAC are in	Lagoons	No pathway for LSE identified.	Screened out

Site Name (Distance to Proposed Works[9])	Conservation Objectives	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
by sea, c. 19km as the crow flies)	favourable condition and make an appropriate contribution to achieving Favourable Conservation Status. 2. To ensure that the integrity of The Vadills SAC is maintained in the context of environmental changes by meeting objectives 2a, 2b and 2c for lagoons: 2a. Extent and distribution of the habitat within the site. 2b. Structure and function of the habitat and the supporting environment on which it relies. 2c. Distribution and viability of typical species of the habitat.		At its nearest point via hydrological connectivity the site is c. 120km west of the proposed works. No alterations to coastal processes are predicted at these distances, and there will be no sediment transportation of this significance, particularly given the site is on the opposite side of Shetland. Therefore, there is no connectivity.	
Yell Sound Coast SAC (c. 28km)	1. To ensure that the qualifying features of Yell Sound Coast SAC are in favourable condition and make an appropriate	Harbour seal	Pathway for LSE identified. Harbour seals are mobile species known to range up to 50km from haul out sites in search of food. It is therefore possible that individuals from the SAC could forage in the waters in the vicinity of	**Screened in**

Site Name (Distance to Proposed Works[9])	Conservation Objectives	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
	contribution to achieving Favourable Conservation Status. 2. To ensure that the integrity of Yell Sound Coast SAC is restored in the context of environmental changes by meeting objectives 2a, 2b and 2c for each qualifying feature: 2a. Harbour seal and otter are viable components of the Yell Sound Coast SAC. 2b. The distribution of harbour seal and otter throughout the site is maintained by avoiding significant disturbance. 2c. The supporting habitats and processes relevant to harbour seal and otter are maintained, including prey resources for otter.		the proposed works, given it is c. 28km away as the seal swims. The nearest seal haul out site to the works being Holm of Beosetter, approximately 500m by sea from the closest aspect of the proposed works (the disposal site) which could be used by seals from the SAC. During the dredging and disposal, any pollutants released into the water could have temporary impacts on harbour seal either directly, or indirectly if prey items are affected.. Toxic pollutants could result in habitat avoidance, injury or death of individuals and / or reduced prey availability, leading to loss of condition. There is already considerable noise and vessel movements associated with the Lerwick Harbour, however, it is noted the works will result in an increase in vessel movements. Vessel movements can result in disturbance and / or collision related injury / mortality to harbour seal utilising the site. In addition, dredging, drilling, blasting and vessel movements may result in the generation of underwater noise, which can cause injuries and result in TTS or PTS in hearing of marine mammals and general disturbance. LSE cannot be ruled out for harbour seal.	
		Otter (*Lutra lutra*)	Pathway for LSE identified. The proposed development site is within feasible commuting distance for otter residing within the Yell Sound Coast SAC.	Screened out

Site Name (Distance to Proposed Works[9])	Conservation Objectives	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
			It is possible that commuting, foraging and resting otter within the vicinity of the proposed works could experience disturbance from increased noise and vibration during the dredging and associated vessel movements. They could also be affected directly or indirectly by a pollution event. It is considered that there is sufficient resource for otters within the SAC and other surrounding areas in terms of foraging, commuting and resting habitat that disturbance or impacts from pollution experienced outside the SAC would have a negligible impact on the population. No LSEs are therefore predicted for otter within the Yell Sound Coast SAC.	
Lochs of Spiggie and Brow SPA (c. 29.7km as the crow flies, no hydrological connectivity.	To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term:	Whooper swan (*Cygnus cygnus*), non-breeding	No pathway for LSE identified. Whooper swan may utilise some coastal habitats such as saltmarsh and mudflats however, they predominantly utilise agricultural fields and freshwater bodies for foraging and roosting. These habitats are unlikely to be affected by the proposed works. In addition, the core foraging range of whooper swan is less than 5km[11], and the nearest point as the crow flies from the proposed works to the Lochs of Spiggie and Brow SPA is 29.7km. Hence, there is no connectivity.	Screened out

[11] NatureScot (2016). Assessing Connectivity with Special Protection Areas (SPAs). Available at: https://www.nature.scot/sites/default/files/2022-12/Assessing%20connectivity%20with%20special%20protection%20areas.pdf [Accessed June 2024].

Site Name (Distance to Proposed Works[9])	Conservation Objectives	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
	• Population of the species as a viable component of the site • Distribution of the species within site • Distribution and extent of habitats supporting the species • Structure, function and supporting processes of habitats supporting the species • No significant disturbance of the species			

4.4 In Combination Effects

A review of the Shetland Islands Council Planning Portal, the MD-LOT portal and information provided by LPA identified the following projects in the vicinity of the site which may have the potential for in combination effects. Full details are provided in Table 4-2.

Table 4-2: Projects identified with potential for in combination effects.

Proposal Details	Local Authority and Ref No.	Applicant	Status / Decision	Conclusion
Dales Voe - Extension to open storage area	Shetland Islands Council - 2023/289/PPF	Captain Calum Grains	Pending Consideration	No in combination effects. A consultation response from NatureScot concluded that "*on the basis of the information provided, if the proposal is carried out strictly in accordance with the following mitigation, our conclusion is that the proposal will not adversely affect the integrity of the site: Surface water drainage management must be detailed so that Shetland Islands Council is satisfied that significant release of sediment and other pollutants into Dales Voe will be avoided, including during extreme rainfall events.*"
The Proposed Development replaces two previously consented wind turbines at Luggies Knowe, Gremista and will comprise the construction and operation of one wind turbine with a ground to blade tip height of up to 149.9 m, battery energy storage system units, site access tracks and associated infrastructure	Shetland Islands Council - 2024/006/PPF	Mr Brendan Hall	Pending Consideration	No in combination effects. A consultation response from NatureScot concluded that although *"There are natural heritage interests of international importance on the site… our advice is that these will not be adversely affected by the proposal"*
Peatland Restoration	Shetland Islands Council - 2023/189/PN	Mr Eric Graham	Prior Approval Not Required	No in combination effects. A consultation response from NatureScot concluded that they *"do not intend to offer formal comment on this proposal as it does not meet our criteria for consultation, as outlined in our document, How and when to consult NatureScot"*
New Shellfish Farm - Muckle Ayre, Dales Voe, Shetland	MD-LOT - 06865	Blueshell Mussels Ltd	Marine Licence Granted – start 2019-	No in combination effects.

Proposal Details	Local Authority and Ref No.	Applicant	Status / Decision	Conclusion
			04-25 and end 2025-04-24	There is no information available on the MD-LOT planning portal to advise whether this development was likely to have LSEs on qualifying interests of any designated sites.
Arlanda Quay Development and Reclamation - The requirement for reclamation arises from the need for more shoreline land for development use. The scheme will use material for land reclamation from an LPA owned source.	MD-LOT – N/A	Lerwick Port Authority	Pre-application	No in combination effects. The Arlanda Quay will not be undertaken simultaneously with the capital dredge at North Harbour and / or Dales Voe.
Capital Dredge North Harbour - The proposed dredging works are driven by an urgent requirement to improve navigational safety through the harbour due to ever increasing vessel size and number being experienced in the port. It is anticipated the dredge volume will be 301,150m^3, to a maximum depth of -10.5 m below Chart Datum. The proposed works are anticipated to be undertaken in summer 2025 for 11 weeks, subject to time taken to obtaining the relevant permits and suitable weather conditions for dredging and associated vessel movements. It should be noted that the dredging works at North Harbour will be undertaken under the same contract as dredging works at Dales Voe, but it has not been identified how long the dredges at each site will take. Please see Section 3 for more information on the proposed works (which will follow the same method as the dredge at Dales Voe).	MD-LOT – N/A	Lerwick Port Authority	Pre-application	No in combination effects. The current intention to undertake the dredges consecutively with North Harbour completed first and then Dales Voe. The two dredges will not be undertaken simultaneously.

Proposal Details	Local Authority and Ref No.	Applicant	Status / Decision	Conclusion
Dales Voe Ultra-Deep Water Quay (UDWQ) – The proposed works include the construction of temporary bunds, excavation, capital dredging, controlled blasting, land reclamation, construction of quay and laydown area and construction of potential industrial site.	MD-LOT – N/A	Lerwick Port Authority	Pre-application	No in combination effects. It is expected that works at Dales Voe UDWQ will commence a number of years after the capital dredge at Dales Voe will be undertaken.

4.5 Screening Conclusion

The outcome of screening for Appropriate Assessment is to reach one of the following determinations:

a) A Stage 2 AA of the proposed development is required if it is concluded, on the basis of objective information, that the proposed development, individually or in combination with other plans or projects, will have a significant effect on a European site.
b) A Stage 2 AA of the proposed development is not required if it can be concluded, on the basis of objective information, that the proposed development, individually or in combination with other plans or projects, will not have a significant effect on a European site.

Following an examination, analysis and evaluation of the relevant information, including, in particular, the nature of the proposed development, it is the professional opinion of the authors that at present it is not possible to rule out likely (or possible) LSEs to the specified qualifying interests of the following sites:

- East Mainland Coast, Shetland SPA (Red-throated Diver)
- Mousa SAC (harbour seal)
- Yell Sound SAC (harbour seal)

As such, an AA for the proposed development will therefore be required to ascertain whether or not the proposed works will adversely impact the integrity of the designated sites' qualifying features.

The projects detailed fully in Section 4.4 are not anticipated to result in any in combination effects.

5 APPROPRIATE ASSESSMENT: EAST MAINLAND COAST, SHETLAND SPA

5.1 Designated Site Description

The East Mainland Coast, Shetland SPA comprises a total area of 23,333ha, starting in the north at Fish Holm and Lunna Ness before extending south and encompassing most of Whalsay before ending on the north coast of Bressay. Much of the site's water depths are generally less than 40m, but in the north, the depth increases rapidly. A lot of the shore on the east coast of Shetland consists of cliffs, though interspersed with sandy beaches and bays, such that the sediments are largely gravel and sand. The east coast is also relatively sheltered compared to the west. The diversity of fish, polychaete worms, gastropod, and bivalve molluscs, dependent upon the sediments and seaweeds present, provides potential prey for seabirds foraging in the area.

The SPA supports the following species:

- Non-breeding population of Great Northern Diver (c. 7.3% of the GB population or 182 individuals);
- Breeding population of Red-throated Diver (c. 15.8% of the GB population or 205 pairs); and
- Non-breeding population of Slavonian Grebe (c. 4.9% of the GB population of 54 individuals).

None of the qualifying interests has been assessed for their condition, and have no negative pressures identified. Only Red-throated Diver is discussed further within this AA, given that the other two qualifying interests were screened out at Stage 1: Screening (see Section 4.3 for further details).

5.2 Summary of Red-throated Diver Occurrence at Proposed Works

The SPA site selection document[12] details the identification of protected foraging areas for breeding Red-throated Diver, which is based on modelled outputs underpinned by survey data from the Red-throated Diver national survey undertaken in 2006[13], and further boat-based surveys to inform the habitat model[14]. The resulting predicted usage of the site is shown in Figure 5-1, with the SPA within the foraging range of 205 pairs of Red-throated Diver breeding on the nearby islands.

The predicted usage shows that Red-throated Diver is likely to be present in moderate numbers within Dales Voe (where the proposed dredging is to be undertaken) but likely absent from the disposal site (where dredged material is to be disposed of), and the majority of the vessel route between the two as it comes out of Dales Voe and into the North Sea.

Wintering and breeding bird surveys have been undertaken at Dales Voe since October 2023. Table 5-1 details the average and peak numbers of Red-throated Diver at Dales Voe. The data shows that small numbers are present within 500m of the harbour during the critical chick-rearing period (June to August), with a peak of two birds in July. Larger numbers are present between 1km and 2km of the

[12] NatureScot (2019). Marine Special Protection Areas – Final Advice to Scottish Government. Available at: https://www.nature.scot/doc/marine-special-protection-areas-final-advice-scottish-government [Accessed June 2024).
[13] Dillon, I.A., Smith, T.D., Williams, S.J., Haysom, S. and Eaton, M.A. (2009). Status of Red-throated Divers Gavia stellata in Britain in 2006. Bird Study 56(2), 147-157.
[14] Black, J., Dean B.J., Webb A., Lewis, M., Okill D. and Reid J.B. (2015). Identification of important marine areas in the UK for red-throated divers (*Gavia stellata*) during the breeding season. JNCC Report No 541. Available at: https://data.jncc.gov.uk/data/aa2b2c8d-950f-4328-bb80-89b4453c78c6/JNCC-Report-541-FINAL-WEB.pdf [Accessed June 2024].

harbour, with a peak of 5 birds. There was a spike in numbers in October, presumably with the addition of juvenile birds.

Table 5-1: Average and Peak Numbers of Red-throated Diver at Dales Voe

Species	Distance	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Red-throated Diver	Up to 500m	0.3 (1)	0.3 (1)	0 (0)	0.3 (1)	0.8 (2)	0.5 (1)	1.5 (2)	1 (1)	2 (4)	2 (3)	0.8 (2)	0.3 (1)
	Up to 1km	0.3 (1)	0.5 (1)	0 (0)	0.5 (2)	1 (2)	0.5 (1)	2 (2)	1 (1)	2.5 (4)	5.3 (7)	1.5 (3)	0.5 (2)
	Up to 2km	0.3 (1)	0.8 (2)	1 (2)	2.8 (5)	2 (4)	0.5 (1)	4 (5)	1 (1)	3 (4)	6 (8)	1.8 (3)	1.3 (4)

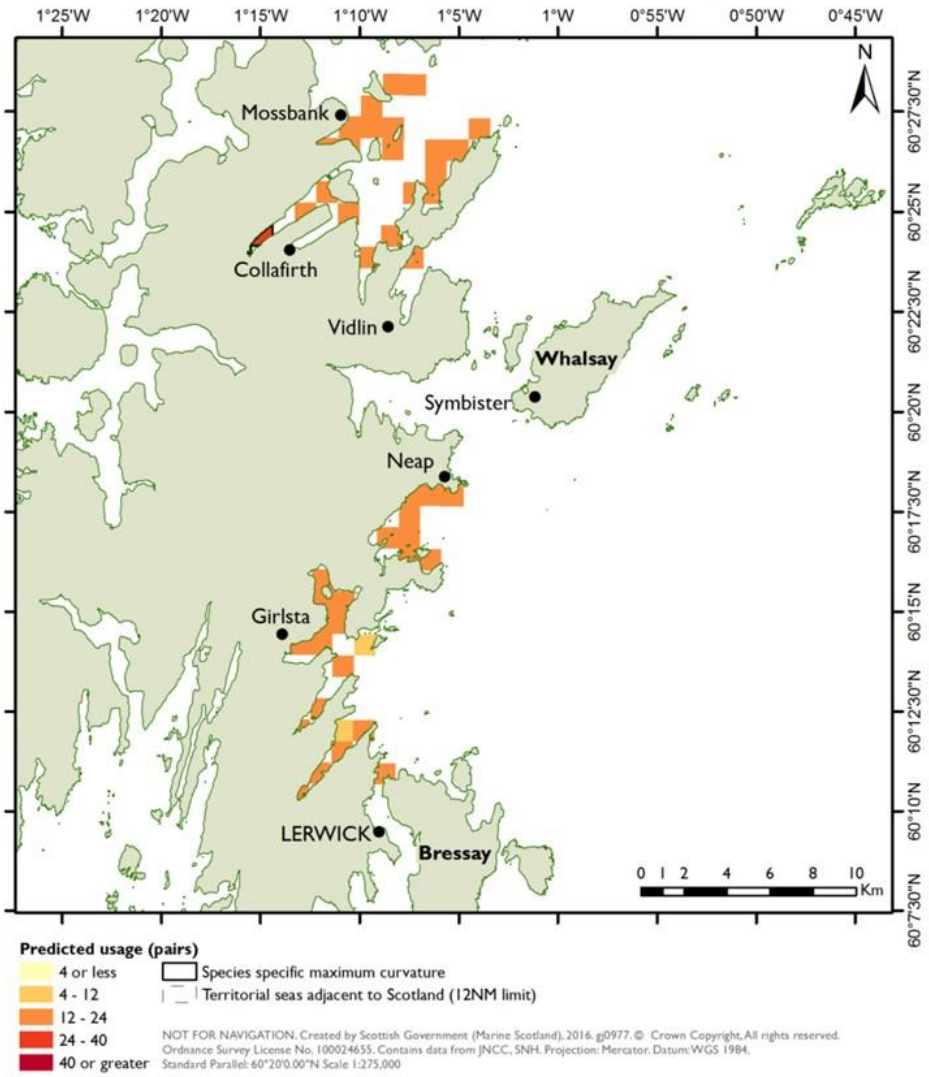

Figure 5-1: The predicted usage of Red-throated Diver in Shetland, including within the East Mainland Coast, Shetland SPA

Tables 5.2 and 5.3 overleaf show the Red-throated Diver counts during the breeding season in 2024 and 2025 (April to September).

Table 5-2: Red-throated Diver Counts During 2024 Breeding Season

Date	Count	Number present within 1km	Numbers present outwith 1km
10/04/2024	2	0	2
25/04/2024	2	0	2
11/05/2024	1	0	1
28/05/2024	0	0	0
12/06/2024	0	0	0
24/06/2024	1	0	1
08/07/2024	4	1	3
01/08/2024	0	0	0
07/08/2024	2	0	2
29/08/2024	1	1	0
09/09/2024	2	0	2
28/09/2024	4	4	0

Table 5-3: Red-throated Diver Counts During 2025 Breeding Season

Date	Count	Number present within 1km	Numbers present outwith 1km
08/04/2025	7	0	7
21/04/2025	4	1	3
08/05/2025	4	1	3
19/05/2025	4	2	2
06/06/2025	0	0	0
26/06/2025	2	1	1
05/07/2025	3	0	3
29/07/2025	1	0	1
18/08/2025	1	0	1
31/08/2025	0	0	0
13/09/2025	4	2	2
30/09/2025	2	2	0

As can be seen from the data above, the majority of Red-throated Diver are present outwith 1km from the proposed development during the breeding season. In addition, a peak of seven birds represents 3% of the SPA population (assuming all birds present are from a pair). However, given that birds won't have been on nest sites on 8th April, the peak of seven birds would in fact represent 1.5% of the SPA population.

5.3 Summary of Great Northern Diver Occurrence at Proposed Works

Wintering and breeding bird surveys have been undertaken at Dales Voe since October 2023. the average and peak numbers of Great Northern Diver during the 2023/24 season, which were recorded on all winter surveys, with small numbers lingering into the summer.

Great Northern Diver was recorded on all 'winter' surveys, with small numbers lingering into the summer. Ten to 15 or more were frequently present within 2km of the UDWQ site, particularly in late Autumn (October-November) and Spring (March to May), but also during Winter 2024/25. Maximum counts in Year 1 and Year 2, respectively, were 16 on 15th March 2024 and 28 on 25th March 2025; this is during the flightless moult period extending from February to mid-April. Great Northern Divers were recorded throughout the Voe.

details the average and peak numbers of Great Northern Diver during the 2023/24 season, which were recorded on all winter surveys, with small numbers lingering into the summer.

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Table 5-4: Average and Peak Numbers of Great Northern Diver at Dales Voe

Species	Distance	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Great Northern Diver	Up to 500m	2.5 (5)	4.3 (7)	3.8 (5)	6.3 (10)	5 (7)	1 (2)	0.5 (1)	0.5 (1)	0 (0)	2.7 (5)	3.3 (4)	2.8 (4)
	Up to 1km	7.3 (15)	7 (9)	9.8 (15)	10.3 (13)	7.3 (11)	1 (2)	1 (2)	0.5 (1)	0 (0)	4.7 (10)	6.5 (8)	5.3 (8)
	Up to 2km	13.8 (22)	10 (13)	17.5 (28)	14.3 (19)	10.5 (19)	1 (2)	1.5 (3)	0.5 (1)	0 (0)	7 (13)	9.8 (13)	8 (11)

5.4 Summary of Slavonian Grebe Occurrence at Proposed Works

Slavonian Grebes were only seen on five dates, between October and January, with two to three birds seen within 2km of the UDWQ site on each occasion. All birds were recorded greater than 1km further up the Voe from the site, generally in the vicinity of Muckle Ayre. On 4th December 2024, when three were recorded within 2km, a fourth individual was also seen at the head of the Voe, beyond 2km; it is possible that birds may also have been present at the head of the Voe in Autumn/ early Winter 2023, before this area was added into the surveys.

Table 5.5 details the average and peak numbers of Slavonian Grebe during the 2023/24 season, which were only infrequently recorded within Dales Voe during surveys, being present only in October, December and January, and all sightings were far away from the proposed works (1-2km distance).

Table 5-5: Average and Peak Numbers of Slavonian Grebe at Dales Voe.

Species	Distance	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Slavonian Grebe	Up to 500m	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Up to 1km	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Up to 2km	1.3 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.7 (2)	0 (0)	1.3 (3)

5.5 Assessment Against the Conservation Objectives

As discussed in Section 0 - 5.3, the surveys show that Red-throated Diver and Great Northern Diver are present in the blasting and dredging works area, and are likely present at the disposal site and vessel route between the two. Slavonian Grebe is not present in the vicinity of the works (only between 1 and 2km distance) and the dredge disposal site, and only in very small numbers along the proposed vessel route. As such, Slavonian Grebe are not considered further.

The predicted numbers and survey results are relatively low in comparison to the wider SPA population for Red-throated Diver and there is ample alternative foraging habitat within the SPA. For Great Northern Diver, peak numbers (28) are high, representing 15% of the SPA population, with the peak average count (17.5) representing 9.6% of the SPA population. Closer to the proposed works (within 500m), the number of Great Northern Diver are significantly lower, with a peak of 10 birds and a peak average of 6.3 birds representing 5.5% and 3.5% of the SPA population, respectively. The 2023 Shetland Bird Report[15] contains counts of wintering Great Northern Diver. One of these counts relates to Shetland Oil Terminal Environmental Advisory Group (SOTEAG) boat survey counts of Great Northern Diver on 20 January 2023, during which 119 were observed between Rova Head, Lerwick, and Kirkabister, Nesting. This demonstrates that any displaced birds from Dales Voe during the 2.5 week blasting period would have suitable habitat to move into.

It is therefore considered that the populations of Red-throated Diver and Great Northern Diver will remain as viable components of the site and hence there will be no adverse effect on site integrity.

Other direct effects (i.e. disturbance) are dealt with in Objective 2b, and indirect effects (i.e. impacts on water quality) are dealt with in Conservation Objective 2c.

5.5.1 Objective 2b. The distributions of the qualifying features throughout the site are maintained by avoiding significant disturbance of the species.

Disturbance may occur through drilling, blasting, dredging and vessel movements. Blasting is likely to give rise to the most significant potential disturbance. Quantifying any additional sea surface disturbances due to blasting is difficult at this time and is likely to relate to the depth and weight of the explosive charge used, the geometry of the seabed holes into which the charges are placed and the sea conditions at the time of detonation, amongst other possible factors. Divers are expected to be temporarily displaced from the immediate vicinity of blast sites due to associated vessel movements and charge laying activities, and so are unlikely to be caught in blasts or within domes of disturbed water.

To mitigate any potential disturbance, an ornithologist will be present during daylight hours to monitor the works within 500m (for dredging) and 1000m (for drilling and blasting) of the Proposed Development and record behavioural responses within this zone (the species to be monitored will depend on the timing of works). Should Great Northern Diver and Red-throated Diver still be present in this zone around the time that blasting is planned, it is recommended that a small vessel be used to encourage them out of the area. An ornithologist (or marine ornithology advisor) will be present on the boat to monitor effectiveness. Post works, a report will be prepared to evaluate the success and effectiveness of this method. Given that there is no robust evidence to support the effectiveness of ADDs for birds, the method described above will serve as the mitigation measure for divers.

[15] https://www.nature-shetland.co.uk/shetland-bird-report

As discussed above, it is highly likely that birds will be displaced from the working area (but acknowledging that the wider SPA has the capacity to accommodate displaced birds), at a sufficient distance such that noise disturbance does not cause an impact.

This localised and temporary impact would not result in significant impacts to both diver species within the SPA.

Vessel movements to and from the disposal site will be much reduced (from 24/day to 5/day) from the previous approved movements. Therefore, disturbance through vessel movements is not considered significant. This localised and temporary impact would not result in adverse effects on site integrity with regard to this species.

5.5.2 Objective 2c. The supporting habitats and processes relevant to qualifying features and their prey/food resources are maintained.

Although some aspects of the proposed works are within the boundary of the SPA (a small section of the dredge area, the disposal site and vessel route between the dredge site and disposal site), there will be no direct habitat loss from the SPA considering the nature of the works.

As described in NatureScot's Conservation and Management Advice Document for the East Mainland Coast, Shetland SPA[16], the key supporting processes for Red-throated Divers, Great Northern Divers and Slavonian Grebe are water quality (nutrients and turbidity), tidal cycles and water flow, which underpin the supply of food resources for the species. The proposed works are not anticipated to have a permanent impact on tidal cycles and water flow, but have been assessed as having the potential for LSEs as a result of pollutants being released into the water, which could have an indirect effect on both diver species and Slavonian Grebe if their prey availability is affected.

The dredge budget is expected to consist largely of either sand or silt sized fractions, with some gravel (see Section 3.3 for full details). This, combined with the weak tidal currents in the vicinity of the proposed dredge pockets, will result in very localised and short-term plumes from dredging. The magnitude of the sediment discharge and dispersion from dredging works will be low within the dredge area and its immediate vicinity, and similarly, it is expected that the majority of deposited material will fall out of suspension quickly at the disposal site with limited lateral spread. Further, the BPEO report concluded that although several samples taken from North Harbour contained levels of contaminants above RAL1, there is a low risk of the sediments impacting upon the overall ecological or chemical status classifications.

Therefore, any changes to water quality, which may have an indirect effect on Red-throated Divers prey availability, are anticipated to be localised, minor and temporary. Thus, the supporting habitats for Red-throated Diver, Great Northern Diver and Slavonian Grebe beyond the proposed works will be maintained in the long term, and there will be no adverse effects on site integrity in regard to this species.

5.5.3 Objective 1. To ensure that the qualifying features of the East Mainland Coast, Shetland SPA are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status

It is predicted that, with standard mitigation, there will be no significant impacts on Conservation Objectives 2a, 2b and 2c. Therefore, the favourable condition of Red-throated Diver, Great Northern

[16] NatureScot (2022). Conservation and Management Advice: East Mainland Coast, Shetland SPA. Available at: https://sitelink.nature.scot/site/10482 [Accessed June 2024].

Diver and Slavonian Grebe in the East Mainland Coast, Shetland SPA will be maintained, and there will be no adverse effects on site integrity.

6 APPROPRIATE ASSESSMENT: HARBOUR SEAL

This section forms the AA for the Mousa SAC and Yell Sound Coast SACs, as the Stage 1: Screening identified that there may be LSEs on harbour seal as a qualifying interest of both of these SACs. As the wording of the conservation objectives pertaining to each site have slight differences though the same intent, they have been generalised for the purposes of this AA. Please see Section 4.3 for specific wording of the conservation objectives pertaining to each site.

The following sources were used to conduct a desk-based assessment to inform this AA, occurrence of harbour seals at the proposed works and the general ecology of the species.

- NatureScot[17 &18 &19];
- National Biodiversity Network (NBN) Atlas[20] (search within 10km of the site within the last 10 years, excluding non-confirmed and CC-BY-NC records);
- Marine Scotland website for designated haul-out sites for seals[21];
- Relevant research[22]; and
- Scottish Marine Animal Stranding Scheme (SMASS)[23].

6.1 Designated Site Descriptions

6.1.1 Mousa SAC

Mousa SAC comprises a total area of 259.74ha, encompassing the uninhabited island of Mousa and some of the waters around it. The SAC supports the following qualifying interests:

- Reefs;
- Submerged or partially submerged sea caves; and
- Harbour seal (c. 1% of the UK population).

The first two qualifying interests are not discussed further in this AA, given they were screened out at Stage 1: Screening (see Section 4.4 for full details).

The Mousa SAC supports one of the largest groups of harbour seal in Shetland; of particular importance to them are the large rocky tidal pools regularly used by seals for pupping, breeding and moulting. Areas of the island provide shelter from the exposed conditions on the open coast.

The feature condition for harbour seal have been assessed as “unfavourable declining”, which corresponds to about a 98% decline in the SAC population since the 1990s. This does not reflect the

[17] NatureScot Seals available at: https://www.nature.scot/plants-animals-and-fungi/mammals/marine-mammals/seals [Accessed June 2024]
[18] NatureScot (2024). Mousa SAC Conservation and Management Advice. Available at: https://sitelink.nature.scot/site/8333 [Accessed June 2024]
[19] NatureScot (2024). Yell Sound Coast SAC Conservation and Management Advice. Available at: https://sitelink.nature.scot/site/8409 [Accessed June 2024]
[20] NBN Atlas, Available at: https://nbnatlas.org/ [Accessed, June 2024]
[21] Marine Scotland, Designated haul-out sites for seals (Protection of Seals Orders). Available at: https://marine.gov.scot/maps/446 [Accessed June 2024]
[22] Carter et al. (2022). Sympatric Seals, Satellite Tracking and Protected Areas: Habitat-Based Distribution Estimates for Conservation and Management. Available at: https://www.frontiersin.org/journals/marine-science/articles/10.3389/fmars.2022.875869/full [Accessed June 2024].
[23] Species reported within a 10km (sea route) from 2001-2020 to Scottish Marine Animal Stranding Scheme (SMASS) available at: https://strandings.org/map/ [Accessed June 2024)

trend of the Shetland Seal Management Area, with a 40% decline between 2001 and 2005, with the wider Shetland population remaining stable since 2006, though showing no sign of recovery. No specific reason has been attributed to the unfavourable condition, with research ongoing in an effort to determine whether wider influences such as predation, competition for prey, prey quality and availability, and toxin exposure from harmful algae may be contributing factors. Some research indicates that killer whale (*Orcinus orca*) predation rate on harbour seal in Shetland, in particular, may be high[24].

Female harbour seal give birth in June or July, often returning to the haul-out sites where they were born themselves. Harbour seal moult between July and September. These are considered particularly sensitive times for this species.

6.1.2 Yell Sound Coast SAC

The Yell Sound Coast SAC comprises a total area of 1544.44ha, encompassing rocky shores, uninhabited islands and skerries within Yell Sound. The SAC supports the following qualifying interests:

- Otter; and
- Harbour seal (over 1% of the UK population).

Otter are not discussed further in this AA, given they were screened out at Stage 1: Screening (see Section 4.3 for full details).

The Yell Sound SAC is one of the most northerly UK designated sites selected for harbour seal and supports one of the largest groups of harbour seal in Shetland; of particular importance to them are the beaches and gently sloping rocky shores along the coast of mainland Shetland, Yell and the islands in Yell Sound for hauling out.

The feature condition for harbour seal has been assessed as “unfavourable no change”, which corresponds to the population trends described in Section 6.1.1above.

6.2 Summary of Harbour Seal Occurrence at Proposed Works

Research has generated estimates of mean seal density at-sea on a 5 x 5km grid, as shown in Figure 6-1**Error! Reference source not found.**. The values given present the percentage of the UK and Ireland at-sea population estimated to be present at any one time during the main foraging season per 25km^2.

The results indicate that the waters around Dales Voe and the disposal site (where impacts will be experienced), are expected to be less well used than other areas. A mean percentage at-sea population per 25km^2 ranges between 25-50 seals is estimated within the proposed works, but >50 estimated for other locations in Shetland, particularly in the immediate vicinity of one of the four haul out sites nearby (E South Shetland, approximately 7.7km south of the proposed works).

There are no records of stranded seals within the proposed works area.

[24] SCOS (2021). Scientific Advice on Matters Related to the Management of Seal Populations 2021, Sea Mammal Research Unit, University of St Andrews. Available at: https://www.smru.st-andrews.ac.uk/files/2022/08/SCOS-2021.pdf [Accessed June 2024].

A search of NBN Atlas returned eight records of harbour seal, but none within the proposed works area, and the closest record was approximately 1.5km north (location OSGR HU 47207 48861) of the anticipated vessel route between the dredge site and disposal site.

In addition, during Vantage Point surveys at Dales Voe for birds conducted monthly from October 2023 to September 2025 within 2km of the site, a total of 43 seal sightings were confirmed, 17 of which were harbour seal. One sighting of a single harbour seal was recorded within the site boundary during the 2024/25 survey season. Three of the harbour seal sightings were of two animals together, including hauled out at Califf on the opposite side of the Voe from the site on 21st April 2025. All other sightings were of lone animals in the water. A plan of the location of seals identified during these surveys is provided in Appendix B[25].

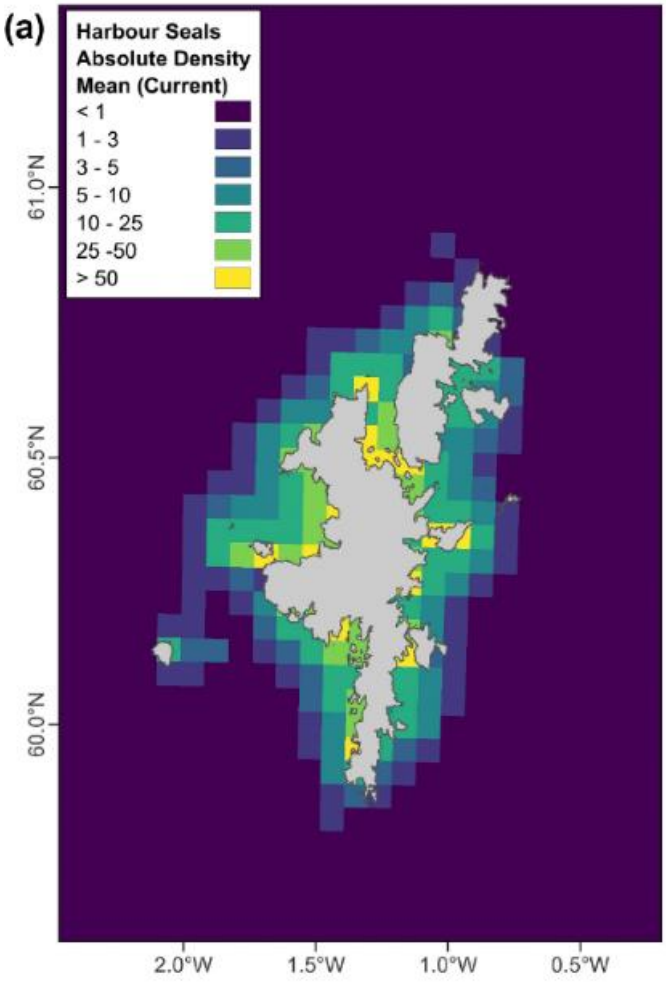

Figure 6-1: Map showing harbour seal distribution estimates. The mean number of harbour seals estimated to be present in each 5 km by 5 km grid cell at any one time[26]. Image taken from Carter et al (2025).

[25] To note, nine sightings were not digitised, due to not having locations for these on the field maps provided and two were beyond 2km so not included on the plan

[26] The conversion process from relative to absolute density involves use of population scalars derived from telemetry data (see Carter et al. (2022)), and uncertainty in these scalars is not propagated through to the confidence intervals around the mean. Confidence intervals therefore only reflect uncertainty in the modelled habitat preference relationships. Another consideration is that density estimates are scaled using the most recent available count data. While relative density estimates are somewhat robust to changes in abundance (provided the distribution of the population remains the same proportionally among haul outs), the absolute density estimates are not. As such, absolute density estimates provided here reflect an approximation of seal distribution in 2023. Maps of absolute density are shown for ease of interpretation but GIS layers for both absolute and relative density are available.

6.3 Assessment Against the Conservation Objectives

6.3.1 Objective 2a. Harbour seal is a viable component of the SAC

Vessel Movement

Given that Dales Voe is already an established quay, the baseline level of vessel movements is moderate in and around the proposed works. Figure 6-2 below shows the annual average vessel density for all vessel types, within the vicinity of the site, with the image taken from the National Marine Plan Interactive (NMPi) map[27]. However, it is anticipated that there will be an increase in vessel movements as a result of the proposed works, albeit temporary and short term. In addition, although there will be an increase in dredging vessel activity, no port activity will take place, and therefore, there will be an offset with a reduction in normal harbour vessel activity.

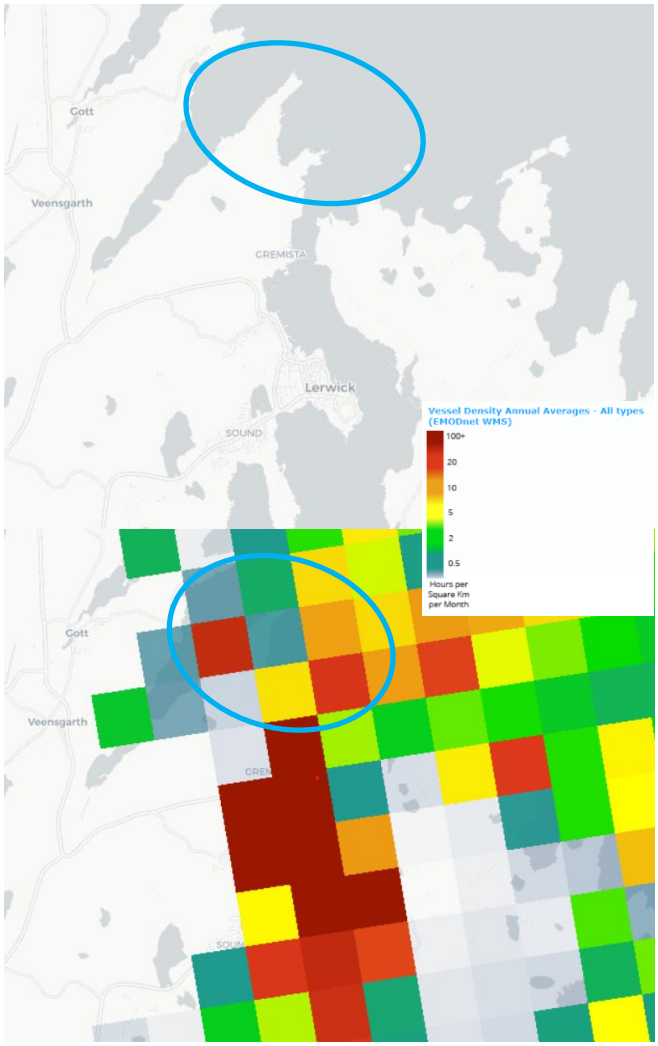

Figure 6-2: Annual average vessel density based on vessel Automatic Identification System (AIS) data. The basemap showing the location of Dales Voe is shown above, with the vessel density below, and the approximate location of works indicated by a blue circle.

[27] Marine Scotland (2024). Vessel Density Annual Averages - All types (EMODnet WMS) NMPi Map. Available at: https://marinescotland.atkinsgeospatial.com/nmpi/default.aspx?layers=1972 [Accessed June 2024]

In the absence of mitigation, increased vessel movements could result in an increased risk of collisions, resulting in injury or death of individuals. Individual collisions are unlikely to have an impact on longer-term viability, but cumulatively and considered in-combination with existing vessel movements, there is potential for effects at the population level.

However, vessel strikes are generally more associated with larger and less agile marine mammals, and so the number of harbour seals affected will likely be minimal. In addition, dredging vessels are relatively slow moving and follow established routes. The effects of these impacts will be highly localised and unlikely to affect the conservation status of this species. If there is some displacement from areas of high activity, it is considered that there is sufficient alternative habitat for foraging and commuting. In addition, the Dales Voe harbour is already part of an established port and the site is within a highly trafficked area for vessels, and the area within the proposed works is not estimated to be an area with a particularly high usage by harbour seal for foraging. As such, it is considered that seals utilising the waters within this area would likely avoid or be accustomed to the regular movements of vessels, and thus the likelihood of a vessel strike may be lower. Further, is anticipated that a Vessel Management Plan will detail measures to reduce collision related impacts (see Section 7 for further information).

Dredging, Drilling and Blasting

Dredging, drilling and blasting will result in underwater noise, which can cause injuries and result in a PTS or TTS in hearing. Prolonged exposure to underwater noise within the PTS and TTS thresholds can reduce individual fitness as it interferes with individuals' ability to communicate with others, feed and navigate in an effect known as masking. In extreme cases, exposure to high levels of underwater noise can result in death. A Seal Risk Assessment (SRA)[28] was undertaken to identify known populations and records of seals and assess the potential risks of causing injury and disturbance as a result of the proposed activities and found the following.

Dredging

Research[29] conducted in Shetland recorded backhoe dredgers source level noise within 1m as 163dB re 1µPa rms. The National Marine Fisheries Services (NMFS) (2024)[30] reported that for continuous (non-impulsive) noise, the TTS and PTS thresholds for seals are 175 and 223dB re1 μPa^2s, respectively. As such, the noise emitted by backhoe dredgers (BHD) is under both the PTS and TTS threshold for seals. It should also be noted that the continuous thresholds detailed above are based on animals staying in close proximity to the sound source for 24 hours, and the source level noise for the dredger is experienced within 1m. In addition, from a review of other relevant projects, Aberdeen Harbour Expansion Project Environmental Statement[31] (AHEPES) the underwater noise from dredging activities (BHD and TSHD) was modelled and identified the following for both grey and harbour seals in relation to Cumulative TTS (TTS onset not considered worst-case scenario) and Cumulative PTS (PTS as auditory injury onset and Level A-Auditory Injury were not considered the worst-case scenario) as seen in Table 6-1.

Table 6-1: Predicted significance of effects from underwater noise from dredging. Information obtained from AHEPES

Species	Effect	Range of Effect	Criterion
Grey Seal	Cumulative PTS	270m	203 dB re 1 µPa2 s
	Cumulative TTS	1840m	183 dB re 1 µPa2 s

[28] ECREP 15619 Dales Voe Seal RA_FinalV3
[29] Todd, V. L. G., Todd, I. B., Gardiner, J. C., Morrin, E. C. N., MacPherson, N. A., DiMarzio, N. A., and Thomsen, F. A review of impacts of marine dredging activities on marine mammals. – ICES Journal of Marine Science, doi: 10.1093/icesjms/fsu187
[30] 2024 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 3.0)
[31] Microsoft Word - 01 Introduction to the Proposed Development FINAL.docx

Species	Effect	Range of Effect	Criterion
Harbour Seal	Cumulative PTS	270m	203 dB re 1 μPa2 s
	Cumulative TTS	1840m	183 dB re 1 μPa2 s

It is likely that once dredging commences, any individuals within the area will move away from the sound source fairly quickly. Therefore, the likelihood of dredging resulting in physical trauma or death to individuals is considered to be low. It is considered that individuals are expected to be able to avoid adverse noise arising from the dredging by simply moving out of these areas before the onset of significant injury or mortality and in relation to TTS, it would likely result in avoidance and temporary displacement of seals from these areas for the duration of dredging activities. These effects are temporary and not a permanent loss of hearing. Individuals would be expected to forage in adjacent waters for these periods. The disturbance related effects of harbour seal moving away from works are addressed in Section 6.3.3 below.

Drilling

Drilling through hard sediment can be significantly noisy, and given that the drilling will be part of the wider blasting activity and will occur up to 24 hours a day and a 7 day a week basis, the noise from drilling will not be dominated by the acoustic impact of the blasting. Drilling will be undertaken for up to approximately 90 holes per field, during which there would likely be a noise increase in the water environment over 2.5 weeks, weather depending, and it may be undertaken partly in winter. The noise that drilling generates is considered to vary mainly depending on the bed substrate type being drilled, with some drilling noise levels for underwater being found to range up to approx. 190dB re 1μPa rms[32], whilst a detailed analysis of underwater noise during offshore exploratory drilling found noise levels to be 155.9dB re 1μPa rms[33]. In addition, underwater noise modelling undertaken for a Hatston, in Orkney (a recent harbour extension site) by Irwin Carr[34], which is expected to have 10 holes drilled per day included a summary of 13 different recorded drilling episodes, showing noise levels to vary considerably between sites and equipment, and there is no clear connection between drill size, power or sediment type to the emitted noise level (as seen in Figure 6-3).

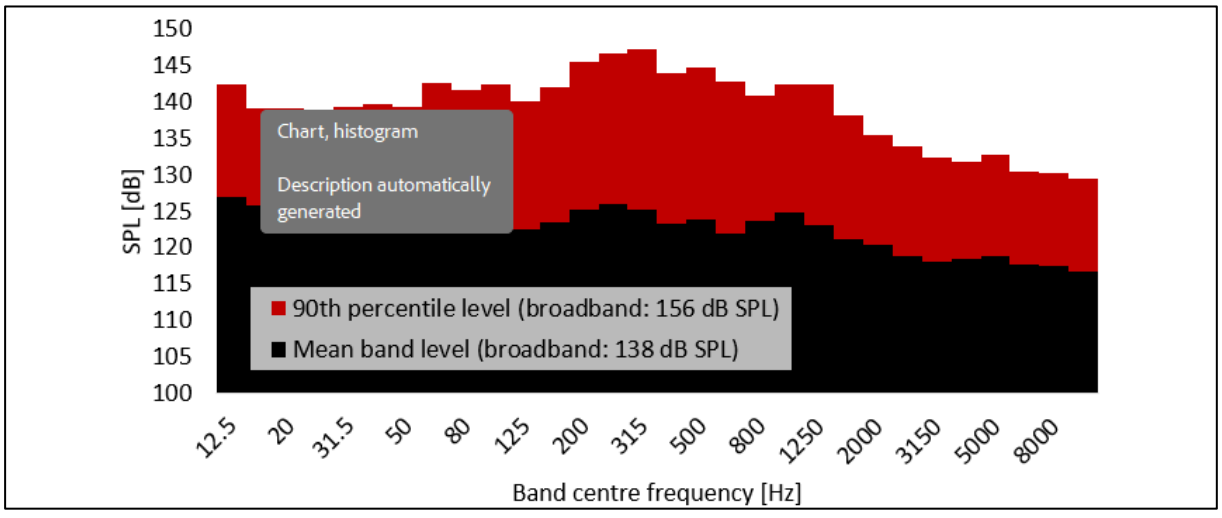

Figure 6-3: Example of drilling noise band levels. Data from various drills, diameter 0.1-1.2 m and various rock types. Figure obtained from Irwin Carr UWNM report

[32] OSPRA Commission, Assessment of environmental impact of underwater noise (2009)
[33] Huang L-F, Xu X-M, Yang L-L, Huang S-Q, Zhang X-H and Zhou Y-L (2023) Underwater noise characteristics of offshore exploratory drilling and its impact on marine mammals. *Front. Mar. Sci.* 10:1097701. doi: 10.3389/fmars.2023.1097701
[34] RP001 Rv3 2022248 (Hatston Pier UW Modelling)

Drilling has a broadband level of 156 dB SPL at the 90th percentile, which will mean that its impact on the marine environment is minimal, and therefore it is considered that drilling would be unlikely to have major auditory impacts, however, drilling may still have impacts on seals in relation to general disturbance (behavioural changes). Although the implementation of mitigation, including MMOs, PAM and soft-start will reduce general noise disturbance to seals.

Blasting

For blasting, the charge per holes at Dales Voe will commence at 20kg MIC[35] and be undertaken within the parameters identified in the trial blasting, described in section 3.3.1. It is estimated that 9-90 holes will be drilled in for each field. Charges will go off at the beginning and end of each day (daylight). This would occur over a 2.5 week period. As part of an overall mitigation of blast noise impact intensity then the contractor is proposing to use 25 millisecond blast delays[36] between each charged hole to help minimise the MIC / Qmax value for each overall blast. This means that the number of charges detonated alone does not necessarily relate to the overall blast noise level. It is also worth noting that the noise (peak sound pressure) of each blast will only be as high as that of the largest (loudest) detonation in each blast sequence. Subsequent detonations in the sequence which are of equal or lesser noise level, will not add to the overall noise of the blast, although the time component of the blast event will increase.

A report was undertaken by Subacoustech[37] (see Appendix C) which assessed MIC values up to 130kg and total charge weights up to 700kg based on predictions using Soloway and Dahl (2014)[38] calculations and was then compared to a real-world project at Singapore Harbour 2024[39].

Following the prediction in Soloway and Dahl (2014), (which includes a correction for explosives in rock noted in MTD 96/101[40]), a noise level of 191.6 dB SPL_{peak} at 1000m from a blast with a MIC up to 130kg is predicted, which is substantially below the threshold of instantaneous PTS onset for seals of 223 dB SPL_{peak}. The estimated distance at which 223 dB SPL_{peak} is predicted for seals to occur is approximately 45m from the blast location using this methodology. A total charge weight of 700kg (including the 30% correction for embedded charges) leads to a noise level of 183 dB SEL (PCW weighted, as per Southall *et al*., 2019[41]) at 1000m, marginally below the 185 dB SEL limit for PTS onset in seals[42]

[35] The total charge mass of explosives firing at one instant during a blast, a key measure in managing blasting vibration.
[36] Colin Fergusson who is advisor to contractors who completed the drilling and blasting method statement advised that 25 millisecond delays between charges are regarded as individual blasts and therefore minimise the MIC/ Qmax overall.
[37] *Subascoustech report P438LR0102*
[38] Soloway and Dahl (2014) sets out calculations for the prediction of noise from detonations of explosives underwater, with a specific focus on UXO (i.e. unconstrained detonation in the water column)
[39] Mason T and Morgan I (2024) *Underwater noise monitoring, drilling and blasting in Temasek Fairway, Singapore*. Subacoustech report ref. P398R0102
[40] MTD 96/101 also states that the explosive peak pressure of explosions in rock reduces to approximately 5% of the value for freely suspended charges, or 30% for total exposure
[41] Southall B L, Finneran J J, Reichmuth C, Nachtigall P E, Ketten D R, Bowles A E, Ellison W T, Nowacek D P, Tyack P L (2019). *Marine mammal noise exposure criteria: Updated scientific recommendations for residual hearing effects.* Aquatic Mammals 2019, 45 (20, 125-232) DOI 10.1578/AM.45.2.2019.125.
[42] Note that criteria for PTS onset based on the instantaneous SPLpeak threshold use the NMFS (2024) guidance, whereas the SEL criteria use the older Southall *et al.* (2019) guidance. This is because the SPLpeak thresholds are straightforward to update, whereas the species-weighted SEL thresholds would require considerable reanalysis of the Singapore data to update and enable a direct comparison. Subacoustech's analysis previously of the difference between seal criteria in Southall *et al.* (2019) and NMFS (2024) indicate that the overall difference between the two criteria is relatively small.

However, when the theoretical calculation is compared to real-world measurements in Singapore, it suggests that charge weights with a MIC of >50 kg will result in Auditory Injury (AUD INJ) threshold distances outside the mitigatable 1000m range for seals (see Figure 6-4[43]).

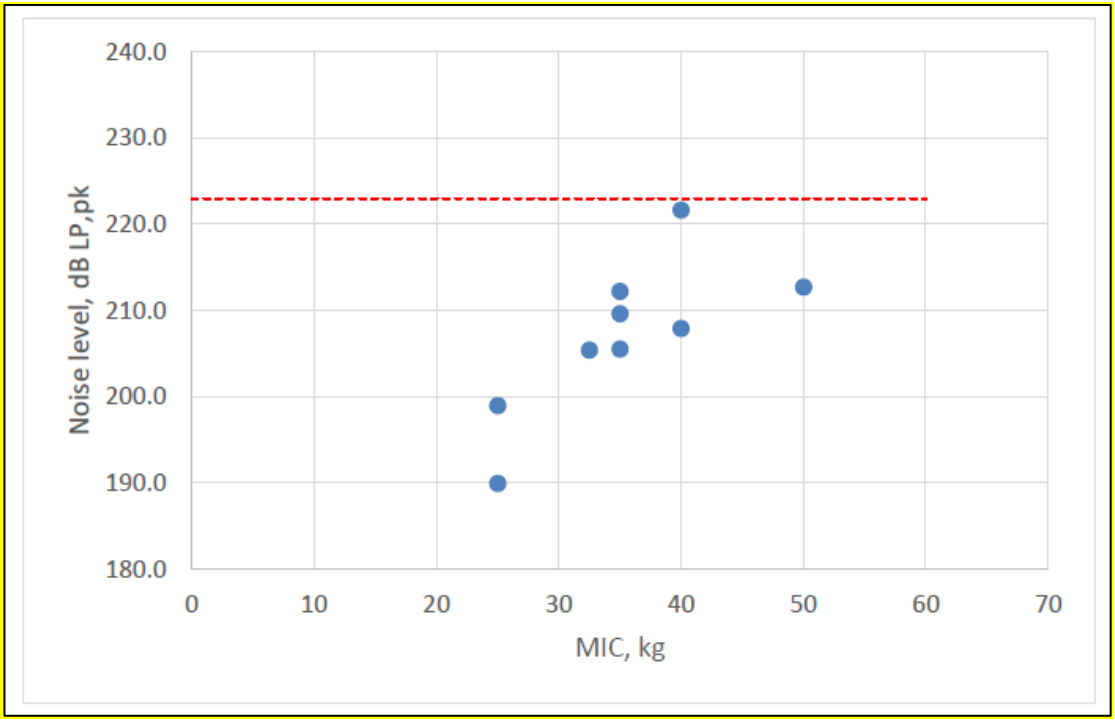

Figure 6-4: Shows the SPL_{peak} measurements against MIC size, normalised to 1000m with seal instantaneous PTS threshold marked (223 dB SPL_{peak}, as per NMFS, 2024 threshold). Figure obtained from the Subacoustech report

The theoretical models suggest noise levels at 1000m are safely below the point where seals would suffer permanent hearing damage, though close to the limit when considering total exposure. However, real-world measurements from Singapore Harbour indicate that there could be a risk of exceeding this limit above 50kg MIC. Overall, predictions based on total exposure still indicate levels just under the threshold.

Due to similarities in parameters, findings from Singapore Harbour may closely mirror the required works at Dales Voe. Therefore, it is considered possible that PTS could be <1000m at ≤50kg. However, the noise produced from blasting is based on a worst-case scenario, and other factors, such as local geological conditions, hole drill depth, hole geometry, water depth and water stratification can also influence noise levels propagating from each blast[44]. Such variables further limit the consideration of the effect of charge numbers on blast noise levels alone.

As the blasting has no slow build-up of noise or soft-start and leaves no time for seals to vacate the area, mitigation will be put in place to ensure seals are clear of the area prior to blasting. Working within the charge and mitigation buffers identified in the trial blasting and implementing MMOs, use of PAMs and, if required, ADD to ensure seals are clear of the area prior to blasting would reduce the likelihood of auditory impacts occurring to seals. As drilling will occur continuously between blasts, there will be a constant noise source occurring within the vicinity of the blasting area, and this will likely

[43] The results shown in the figures were obtained from the measurements at Singapore Harbour. A range of distances were sampled, between 580m and 2000m (most at 800m to 1000m), and the measurements were normalised using a simple acoustic principle (15.log[r]), as if all measurements were sampled at 1000m and the only variable was the charge weight.

discourage seals from using the area of works ahead of blasting occurring. Additionally, the findings from trial blasting will better confirm these parameters for the Dales Voe site.

ADDs

As ADDs emit noise levels that deter the target species from a certain area, there are concerns that some of the louder ADD devices may have the potential to result in PTS onset, particularly from accumulated exposure to the sound. JNCC developed a simple empirical model in 2022 (still considered relevant in the updated report[45]) that estimated PTS onset threshold (i.e. hearing frequency weighted SELcum) for all mammals was not exceeded beyond a range of 100 m for any of the modelled devices (except one). A comprehensive review of peer-reviewed literature was undertaken to support this, which found ADDs do have the potential to induce auditory injury in marine mammals[46], and that injury in marine mammals may be avoided by the judicious and proportionate use of ADDs. As such, it is considered that although there are some risks of ADDs affecting seals negatively, the risk of PTS occurring can be avoided/ and the risk of physical injury or death (due to blasting) can be greatly reduced by utilising ADDs proportionately to ensure seals are not present within 1000m of the noise source to avoid PTS. Ahead of using ADDs, MMOs should ensure seals are not present within a 1000m range before switching on, to avoid PTS (this can be done with the assistance of PAM and MMO pre-works searches).

Other direct effects (i.e. disturbance) are dealt with in Objective 2b, and indirect effects (i.e. impacts on water quality) are dealt with in Conservation Objective 2c. With no predicted impacts on either of these conservation objectives, it is considered that the population of harbour seal will remain a viable component of the Mousa SAC or the Yell Sound Coast SAC, and hence there will be no adverse effect on site integrity.

6.3.2 Objective 2b. The distribution of harbour seal throughout the site is maintained by avoiding significant disturbance.

Vessel Movement

Given that Dales Voe base is already part of an established port, the baseline level of vessel movements is relatively high in and around the proposed works. Figure 6-2 above shows the annual average vessel density for all vessel types, within the vicinity of the site, with the image taken from the National Marine Plan Interactive (NMPi) map[27]. However, it is anticipated that there will be an increase in vessel movements as a result of the proposed works (as described in Section 3), albeit temporary and short term.

Increased vessel movements, dredging, drilling and blasting could result in altered distribution as a result of disturbance. It is not anticipated that there will be any disturbance to harbour seals or their habitats within the SAC itself. However, harbour seals are known to travel up to 50km between haul-outs and feeding areas, and there are four designated haul-out sites within 8km of works: Holm of Beosetter approximately 500m east, Eswick Holm approxiately 6.7km north, Hoo stack approximately 7.2km north and E South Shetland approximately 7.7km south of the proposed works. Hence, although the SAC is approximately 20km from the proposed development as the seal swims, it is possible seals from the SAC population could be present within waters surrounding the proposed works for foraging or utilising the haul-out sites nearby, specifically Holm of Beosetter.

[45] Phillips, B, Roberts, A., Buckland, L., Canning, S., Goulding, A., Mendes, S., Prior, A., De Silva, R., Stephenson, S., & McGarry, T. (2025) Evidence base for application of Acoustic Deterrent Devices (ADDs) as marine mammal mitigation (Version 5). JNCC Report 615. JNCC, Peterborough. ISSN 0963-8091. https://hub.jncc.gov.uk/assets/e2d08d7a-998b-4814-a0ae-4edf5d887a02
[46] The focus of these studies is on the continuous activation of devices (SELcum) over 24 hours, rather than in the context of SPLs.

General Disturbance

Quantitative data analysis was undertaken whereby a 6.5km radius buffer for disturbance was applied around the site, which was calculated by Subacoustech for a MIC 50kg, in conjunction with the latest density data for at sea usage, to quantify the number of individuals that may be disturbed as a result of works. Quantitative data identified a total of 69 harbour seals at sea within the disturbance area of the works[47]. These numbers are considered a 'worst case' scenario due to the range associated with MIC 50kg (6.5km) being used to determine the buffer distance. Therefore, the actual numbers would likely be lower. Thus, the potential for disturbance is considered to be limited. Based on the estimated number of individual harbour seals that could be disturbed equating to 69, in relation to the Mousa SAC[48] where there were 7 individuals during 2019 August counts, this would result in >100% of the population if all of those seals were to come from the Mousa SAC and in relation to the Yell Sound Coast SAC where there were 209 individuals during 2019 August counts, this would result in 33.5% of the population if all those seals were to come from the Yell Sound Coast SAC. However, it is considered unlikely that a large proportion of the seals associated with Mousa or Yell Sound Coast SACs would travel within the area of works, as telemetry studies have shown no strong connectivity. In addition, although the percentage of the population for Mousa and Yell Sound potentially affected is quite high, this data is based on a precautionary calculation, and in practice blasts would be limited to the most sensitive marine mammal hearing range (harbour porpoise initially assessed as reaching PTS at 1000m for a 30kg MIC) as well as the works to be undertaken being short term and temporary in nature. Furthermore, the results calculated to inform general disturbance buffers are likely to be a significant over-estimation of the real risk, due to the relatively shallow water at the site which will likely attenuate the noise more quickly than the calculation assumes. Therefore, the favourable conservation status of seals associated with the SACs will not be adversely impacted.

Disturbance to the haul-out site at Holm of Beosetter is feasible given the proximity of the disposal site, particularly on the south to west aspects of the island. However, this location would support only a very small proportion of the SAC population, and there are alternative haul out locations between the SAC and the proposed works (particularly E South Shetland) which are more likely to be used by the SAC population. In addition, harbour seals are known to habituate to some levels of disturbance over time (for example, the same boat passing by a haul-out every day). Vessel movements have more likelihood of causing disturbance to hauled out seals, however, it is noted that the Lerwick disposal grounds have been utilised for historic dredge spoil disposal and therefore seal associated with this haul out site are likely habituated to vessel movements in this area. Furthermore, works are not planned to occur within the sensitive breeding (June – July) and moulting (July – mid-September) periods for harbour seal, when they spend more time hauled out than usual, although winter pupping does occur on Holm of Beosetter and works are to be undertaken during this time. Therefore, it is recommended that vessels should stay at least 100m away from seals when on land to avoid disturbance, therefore with the disposal area being 500m from the haul out, a greater distance will be provided between seals on land and the vessels, as such the likelihood of disturbance is small and any disturbance to a small number of individuals at this location is unlikely to result in effects at the SAC population level, even when pupping occurs. As detailed in Section 6.2, the area within the proposed works is not estimated to be an area with a particularly high usage by harbour seal for foraging. The vessel movements to facilitate the proposed works are along established routes. As such, any seals already utilising the waters in this area will be somewhat habituated to vessel activity associated with the various industries at the Dales Voe base. If there is some displacement from areas of high activity, it is considered that there is sufficient alternative habitat for foraging and commuting in the wider area.

[47] 6.5km buffer, covers 10 grid squares. To obtain density estimates at sea per km^2. Mean Absolute Density estimates of 10 grid squares equates to 285.96 per $25km^2$. 285.96/ 10 (grid squares)/ 25 (km^2) = 1.14 per km^2. At sea area covered by 6.5km buffer equates to $60.11km^2$. Therefore, to calculate individuals within 6.5km at sea 1.14 per km^2 X $60.11km^2$ buffer area = 68.76 (69 individuals)

[48] August counts of harbour seals in the Seal Management Area 'Shetland' 2019 by Subunits. Mousa features in subunit 6

Dredging, drilling, blasting and increased vessel movements will result in underwater noise, behavioural responses to which include avoidance behaviours either by hauling out or moving away from the underwater noise source. These may result in reduced foraging time and/or increased energy expenditure. The effects of this will most likely be temporary displacement of individuals from the waters surrounding the proposed works. As detailed above, it is not considered that the habitat in the immediate vicinity of the works is particularly important for breeding, mating or resting and that there are sufficient alternative foraging areas for them to utilise.

As such, it is unlikely that disturbance will result in a significant effect on the distribution of harbour seal throughout the Mousa SAC or Yell Sound Coast SAC, and hence there will not be adverse effects on site integrity as a result of the proposed works.

6.3.3 Objective 2c. The supporting habitats and processes relevant to harbour seal are maintained.

There will not be habitat loss from the SAC as a result of the proposed works.

As described in NatureScot's Conservation and Management Advice Document for the Mousa SAC[18], the key supporting habitat, in the context harbour seal, relates to the characteristics of the haul-out areas used by harbour seals for breeding and moulting. The proposed works will not result in impacts to the haul-out areas in the vicinity of the works (the closest being Holm of Beosetter, approximately 500m east). However, they have been assessed as having the potential for LSEs as a result of pollutants potentially being released into the water, which could have an indirect effect on harbour seal if their prey availability is affected.

The dredge budget is anticipated to consist mainly of either sand or gravel sized fractions, with limited silt fractions (see Section 3 for full details). This will result in very localised and short-term plumes from dredging, with sands and gravels lost to the water column during dredging expected to fall out of suspension quickly. Therefore, the magnitude of the sediment discharge and dispersion from dredging works will be low within the dredge area and its immediate vicinity, and similarly, it is expected that the majority of deposited material will fall out of suspension quickly at the disposal site with limited lateral spread. Further, the BPEO report concluded that although one sample taken from Dales Voe contained a minor exceedance of RAL1, there is a low risk of the sediments impacting upon the overall ecological or chemical status classifications.

Therefore, any changes to water quality, which may have indirect effects on harbour seal prey availability, are anticipated to be localised, minor and temporary. Thus, the supporting habitats for harbour seal beyond the proposed works will be maintained in the long term, and there will be no adverse effects on site integrity in regard to this species.

6.3.4 Objective 1. To ensure that the qualifying features of Mousa SAC are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status

It is predicted that, with mitigation, there will be no significant impacts on Conservation Objectives 2a, 2b and 2c. Therefore, the favourable condition of harbour seal in the Mousa SAC and Yell Sound Coast SAC will be maintained, and there will be no adverse effects on site integrity.

7 MITIGATION

It is anticipated that potential impacts described above could be avoided by the implementation of standard best practice mitigation measures.

- The Lerwick Port Authority implements speed restrictions on vessels within Shetland waters. Vessel captains should adhere to agreed routes, speed limits, and consideration of the Scottish Marine Wildlife Watching Code[49] should be in place ahead of construction works commencing (inclusive of dredging)[50];
- The following good practice guidelines shall be adhered to:
  - GPP 5: Works and maintenance in or near water;
  - GPP 6: Working at construction and demolition sites;
  - PPG 7: Safe Storage – The safe operation of refuelling facilities;
  - GPP 21: Pollution and incident response planning; and
  - GPP 22: Dealing with spills.
- ADDs will be utilised during adaptive management drilling and blasting trial, and may be used during works where considered appropriate (during blasting). ADDs should only be implemented in conjunction with visual and/or acoustic monitoring (PAM) and for as short a period as necessary to minimise the introduction of additional noise. When ADD is considered necessary, the following should be implemented:
  - ADDs should be positioned in the water in close proximity to the explosive source installed.
  - MMOs should ensure seals are not present within a 1000m range of the ADD ahead of switching on, to avoid PTS (this can be done with the assistance of PAM and MMO pre-works searches).
  - If a seal is identified prior to ADD being switched on, ensuring that the animal is given appropriate time to leave the 1km mitigation zone is required (again this can be supported by PAM and MMO searches). If the seal is not detected again within 20 minutes, it can be assumed that it has left the area and ADD use may commence.
  - ADDs should be switched on for a pre-determined number of emissions during the pre-works search and turned off immediately once the works/ detonations have commenced (ADDs should be utilised proportionately).
  - The MMO(s) should maintain a post-works search within the mitigation zone for at least 15 minutes after the works have commenced/ last detonation, to look for any evidence of injury to marine life, including fish kills. Any unusual observations should be noted in the report.
  - Clear communication channels should exist between MMO(s) / PAM operators and personnel undertaking works/ detonating the explosives. It is recommended that communication channels should be established and in place before the activity commences, with these matters discussed and agreed at a pre-mobilisation meeting.
- Suitably qualified Marine Mammal Observers (MMO), competent in the identification of marine mammals, will be present during dredging and blasting activities to monitor for the presence of harbour seal (and other marine mammals) in the vicinity of the proposed works. An MMO Protocol will be put in place prior to works, which should include (but may not be limited to) the following, as per JNCC guidance[51] [52]:

[49] https://www.nature.scot/doc/scottish-marine-wildlife-watching-code-smwwc

[50] Identified in a project team meeting that 4 knots isn't a safe/practical speed for dredging vessels, and isn't considered necessary as vessels will be using established shipping routes to reach the licensed sea deposit site.

[51] JNCC Statutory Nature Conservation Agency Protocol for Minimising the Risk of Injury to Marine Mammals from Piling Noise (2010) available at: http://jncc.defra.gov.uk/pdf/JNCC_Guidelines_Piling%20protocol_August%202010.pdf [Accessed July 2024]

[52] JNCC Guidelines for minimising the risk of injury to marine mammals from explosive use in the marine environment (2025) available at: https://data.jncc.gov.uk/data/24cc180d-4030-49dd-8977-a04ebe0d7aca/jncc-guidelines-marine-mammals-and-explosive-use.pdf [Accessed July 2025]

  - For dredging, a 500m mitigation zone, and for blasting up to a 1km mitigation zone, will be implemented. This represents the area in which the MMO will monitor visually for the presence of seals (and other marine mammals) prior to dredging and blasting activities. The MMO will be situated on either the dredge vessel or a safe, pre-determined location for blasting to ensure effective coverage of the mitigation zone.
    - As part of the drilling and blasting trial, MMOs will monitor the area at both 500m and 1000m with the support of PAMs and noise monitoring equipment, analysing the data to determine TTS and PTS associated with the blasting. JNCC guidance recommends a 1,000 m exclusion zone for underwater blasting, however this distance may be impractical in the context of the site due to spatial and operational constraints and is considered precautionary. The suitability of this will be determined by evaluation of the trial blast underwater noise monitoring as detailed within the drilling and blasting method statement[53]. Depending on the outcome of this, it is considered that there may be potential for the mitigation zone to be reduced, in discussion with the MMOs. If the size of the mitigation zone is adjusted for any reason, this will be stipulated within the works consent or licence conditions and must be agreed with statutory bodies before being implemented.
  - The mitigation zone will be monitored visually by the MMO for a minimum of 30 minutes prior to dredging or 60 minutes prior to blasting commencing. Dredging or blasting should not commence if seals (or other marine mammals) are detected within the mitigation zone, or until 20 minutes after the last detection.
  - If there is a pause in dredging of a period of greater than 10 minutes, then the pre-dredging search procedure will be repeated before dredging recommences.
  - The MMO will compile appropriate reports which should include, but may not be limited to: Marine Mammal Reporting Forms (MMRFs), details of works (date, location, duration), soft-start techniques implemented, occasions where dredging was delayed or stopped due to the presence of harbour seals, watches conducted and instances of non-compliance.
- The deployment of an ornithologist to monitor works during daylight hours around Dales Voe out to 500m (for dredging) and 1000m (for drilling and blasting) and record behavioural responses from SPA qualifying species. Should Great Northern Diver and Red-throated Diver still be present in this zone around the time that blasting is planned, it is recommended that a small vessel be used to encourage them out of the area. An ornithologist (or marine ornithology advisor) will be present on the boat to monitor effectiveness. Post works, a report will be prepared to evaluate the success and effectiveness of this method.
- All personnel on the site should be made aware of the environmental sensitivities of the site (proximity to designated sites) via the site induction and additional task specific toolbox talks as required.

It is considered that if the above mitigation is implemented, it will be sufficient to avoid LSEs on any of the qualifying interests identified as being impacted by works. As such, there will be no adverse effects on site integrity for the designated sites that these features are qualifying interests of.

[53] Lerwick Port Authority – Lerwick Harbour & Dales Voe Dredging, Drill & Blast Dredging Trial Blast – Proposed Underwater Acoustic Monitoring Method Statement (2025).pdf

8 CONCLUSIONS

There is potential for LSE to arise on qualifying features of the East Mainland Coast, Shetland SPA, which is partially within the proposed works area, and Mousa and Yell Sound Coast SACs (harbour seal), which are hydrologically connected to the site. If no mitigation is implemented, there could be adverse effects on site integrity of these designated sites. However, it is anticipated that any potential impacts could be avoided by the implementation of standard best practice mitigation measures. No impacts to the favourable conservation status of any of the designated sites or their qualifying features are therefore anticipated.

A LOCATION OF PROPOSED WORKS

Point	OSGB36 Easting	Northing	WGS84 Lat	Long
101	445456.903	1145715.658	60° 11.599' N	1° 10.924' W
102	445500.701	1145742.944	60° 11.613' N	1° 10.877' W
103	445536.595	1145724.278	60° 11.603' N	1° 10.838' W
104	445643.818	1145806.603	60° 11.647' N	1° 10.721' W
105	445755.215	1145873.644	60° 11.682' N	1° 10.600' W
106	445829.561	1145910.570	60° 11.702' N	1° 10.519' W
107	445895.202	1146014.175	60° 11.757' N	1° 10.446' W
108	445905.243	1145935.172	60° 11.714' N	1° 10.436' W
~~109~~	~~445872.543~~	~~1145891.233~~	~~60° 11.691' N~~	~~1° 10.472' W~~
~~110~~	~~445886.592~~	~~1145877.735~~	~~60° 11.683' N~~	~~1° 10.457' W~~
~~111~~	~~445816.235~~	~~1145792.369~~	~~60° 11.638' N~~	~~1° 10.535' W~~
~~112~~	~~445800.232~~	~~1145805.481~~	~~60° 11.645' N~~	~~1° 10.552' W~~
113	445755.973	1145752.596	60° 11.617' N	1° 10.600' W
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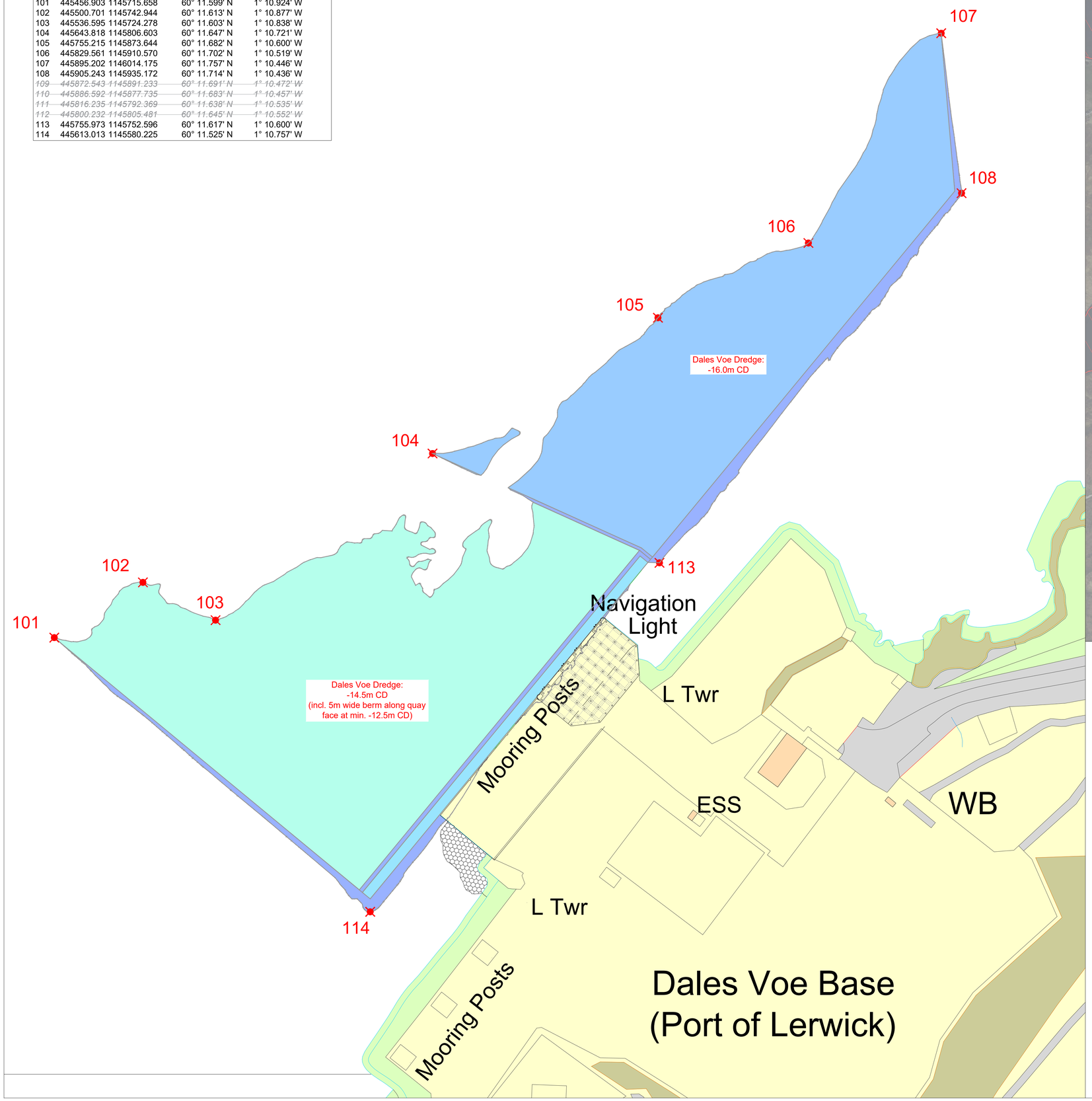
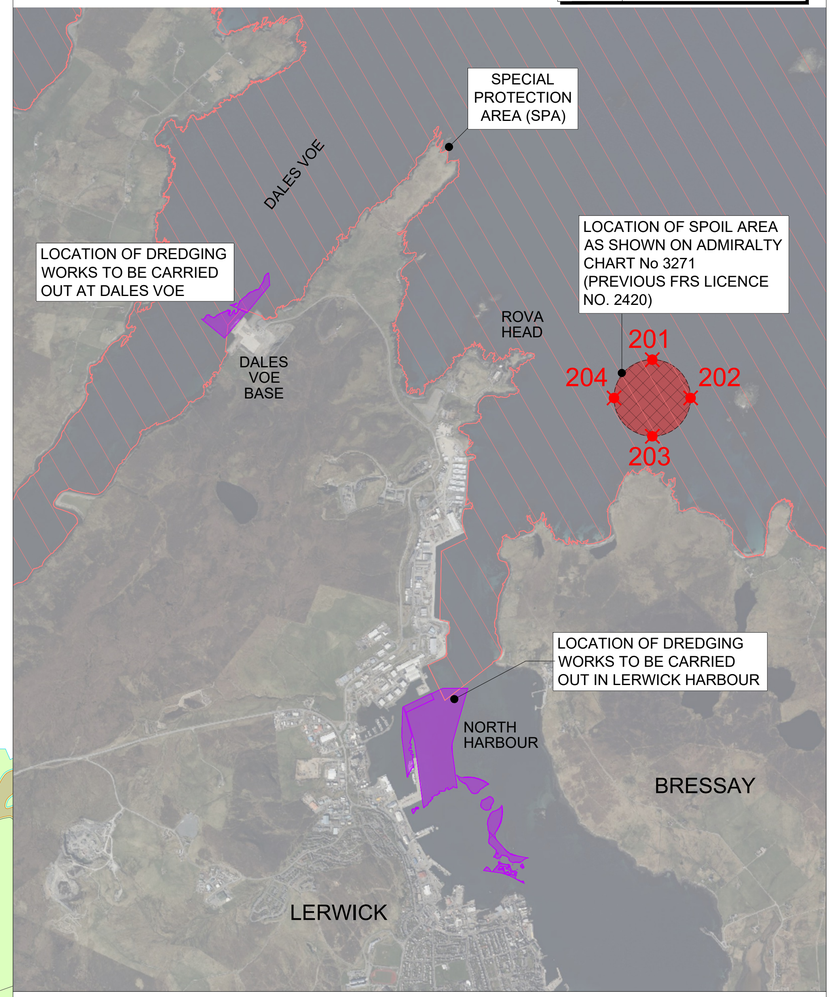


DENOTES SPECIAL PROTECTION AREA (SPA)



LOCATION PLAN
Scale 1: 20,000

0 750 1500 Metres

N

DALES VOE DREDGING WORKS COORDINATES
Scale 1: 1,000

0 50 100 Metres

REV	DATE	REVISION	DRN	CHK
A	12.05.2025	ITT -16.0mCD dredge pocket removed	PRN	SSJ
-	16.12.2024	Invitation to Tender	PRN	APS

Arch Henderson 1919
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PROJECT :
Lerwick Port Authority
Lerwick Harbour Dredging

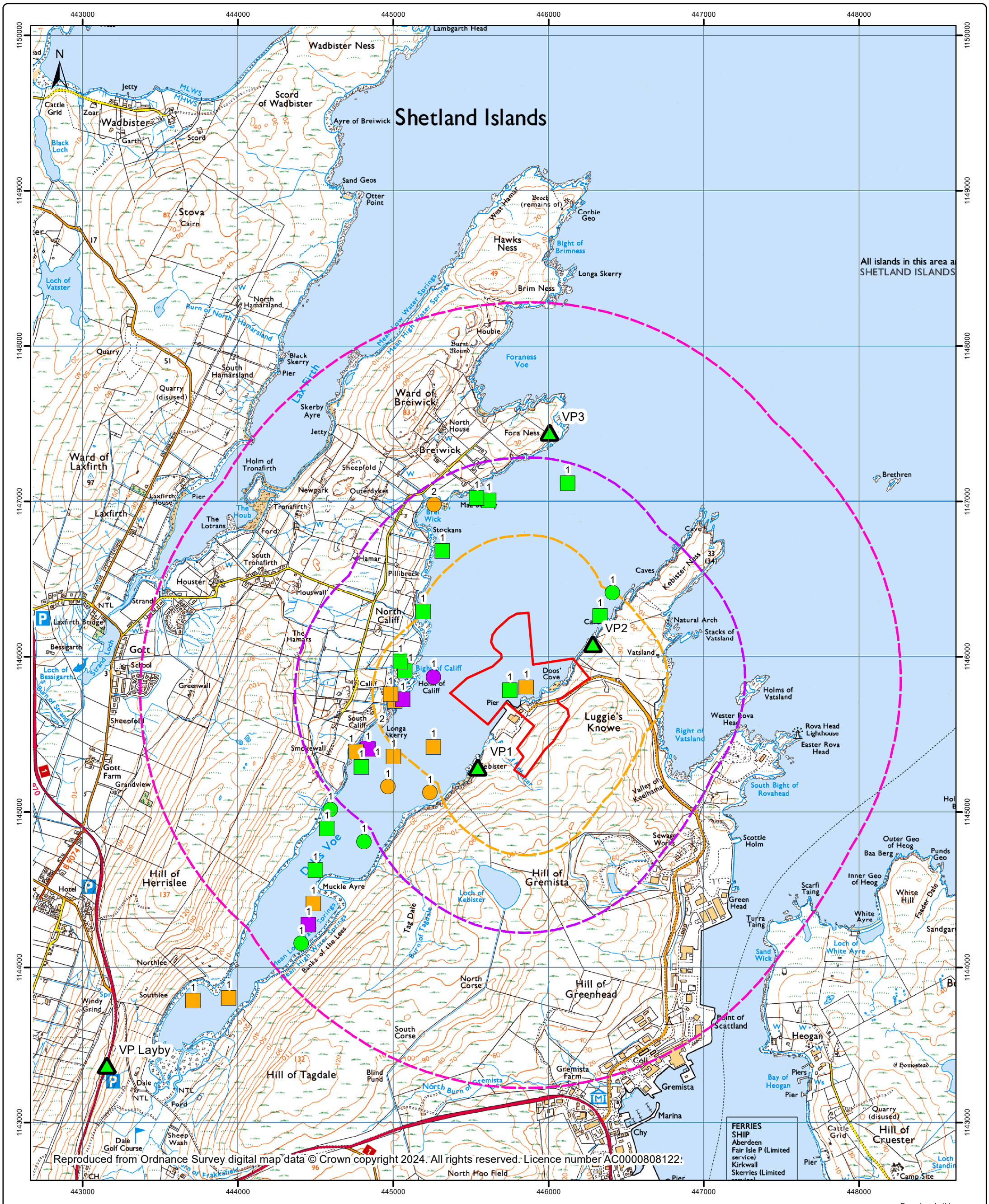
TITLE :
ITT
Dales Voe Dredging Coordinates

DRAWN :	DATE :	CHECKED :	APPROVED :
PRN	Dec 2024	APS	SSJ

SCALE : (A1)	DRAWING STATUS :
1:2,500	ITT

DRAWING No : 232029-ITT-204 REV : A

B SEAL SIGHTINGS DURING VANTAGE POINT BIRD SURVEYS FOR DALES VOE 2023-2025



Do not scale this map

Legend

- UDWQ Project Boundary
- Vantage Points
- Common Seal, 2023/24
- Common Seal, 2024/25
- Grey Seal, 2023/24
- Grey Seal, 2024/25
- Unidentified Seal, 2023/24
- Unidentified Seal, 2024/25
- Boundary Buffer (500m)
- Boundary Buffer (1km)
- Boundary Buffer (2km)

Client
Arch Henderson LLP

Project
Dales Voe

Title
Seal Sightings during Oct 2023 and Sept 2025 Surveys
Dales Voe
Full View

Scale
1:22,000 @A3
0 110 220 440 660 Metres

Status
FINAL

Drawing No.	Revision	Date
681966-GIS014	-	30 Oct 2025
Drawn	**Checked**	**Approved**
MMF	HA	GN

Rev	Date	Amendment	Initials
-	-	-	-

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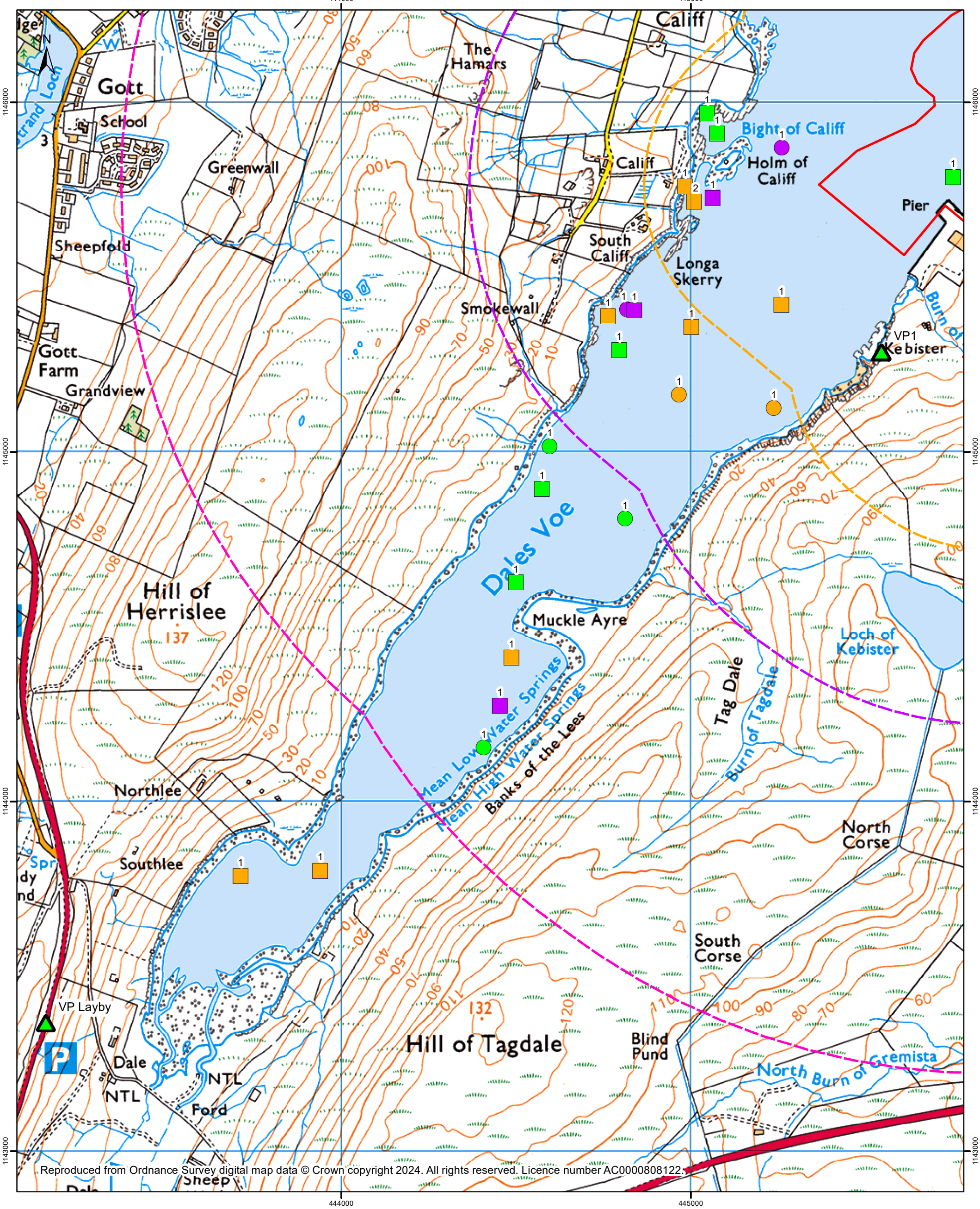

Do not scale this map

Legend

- UDWQ Project Boundary
- Vantage Points
- Common Seal, 2023/24
- Common Seal, 2024/25
- Grey Seal, 2023/24
- Grey Seal, 2024/25
- Unidentified Seal, 2023/24
- Unidentified Seal, 2024/25
- Boundary Buffer (500m)
- Boundary Buffer (1km)
- Boundary Buffer (2km)

Client
Arch Henderson LLP

Project
Dales Voe

Title
Seal Sightings during Oct 2023 and Sept 2025 Surveys
Dales Voe
Inner

Scale
1:10,000 @A3 (0 50 100 200 300 Metres)

Status
FINAL

Drawing No.	Revision	Date
681966-GIS014	-	30 Oct 2025
Drawn	**Checked**	**Approved**
MMF	HA	GN

Rev	Date	Amendment	Initials
-	-	-	-

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Shetland Islands

All islands in SHETLAND

Broch (remains of)
West Hamar
Corbie Geo
Hawks Ness
Bight of Brimness
Longa Skerry
Brim Ness
Low Water Springs
Mean High Water Springs
Houbie
Burnt Mound
Foraness Voe
Ward of Breiwick
North House
Fora Ness
VP3
Breiwick
Maa Skerry
Brei Wick
Stockans
Pillibreck
Cave
Caves
Kebister Ness
33 (34)
Cave
Natural Arch
Stacks of Vatsland
VP2
Vatsland
Bight of Califf
Holm of Califf
Doos' Cove
Pier
Luggie's
Holms of Vatsland
Wester Rova Head
Rova Head Lighthouse
Brethren

Do not scale this map

Legend

- UDWQ Project Boundary
- Vantage Points
- Common Seal, 2023/24
- Common Seal, 2024/25
- Grey Seal, 2023/24
- Grey Seal, 2024/25
- Unidentified Seal, 2023/24
- Unidentified Seal, 2024/25
- Boundary Buffer (500m)
- Boundary Buffer (1km)
- Boundary Buffer (2km)

Client
Arch Henderson LLP

Project
Dales Voe

Title
Seal Sightings during Oct 2023 and Sept 2025 Surveys
Dales Voe
Outer

Scale
1:12,500 @A3 (0, 62.5, 125, 250, 375 Metres)

Status
FINAL

Drawing No.	Revision	Date
681966-GIS014	-	30 Oct 2025
Drawn	**Checked**	**Approved**
MMF	HA	GN

Rev	Date	Amendment	Initials
-	-	-	-

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C SUBACOUSTECH REPORT

Andy Sandison

Arch Henderson

Stewart Building,

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11th December 2025

Re: Lerwick Port Authority – Lerwick Harbour & Dales Voe Dredging. Underwater noise generated by drill and blast operations. *Subacoustech Report Ref. P438LR0103*

Please note that this report issue is a revision to Subacoustech's previous report ref. P438LR0101, to include results for harbour porpoise. Additions to the text are highlighted in blue.

Additional revisions are included in this report issue, updating the previous P438LR0102 regarding whales, dolphins, and the inclusion of NOAA Level B impulsive thresholds for disturbance, with additions highlighted in green.

Introduction and basic environmental underwater noise concepts

Works under Marine Licences MS-00011195 and MS-00011213 for dredging Lerwick Harbour and Dales Voe with the Magnor back-hoe dredger are now complete. Although the dredger was able to extract much of the substrate at each site, there is some hard rock that it is unable to remove, and for this, blasting is proposed to loosen the rock to enable its removal. This is currently proposed over five weeks at Lerwick Harbour and 2.5 weeks at Dales Voe. The use of the explosives in drilled boreholes will necessarily generate underwater noise, which has the potential to adversely affect marine species in the vicinity.

It is well understood that there is limited data publicly (and privately) available for the underwater noise caused by borehole blasting, making a confident assessment of this noise and its effect on the environment challenging. This letter report will consider the most suitable underwater noise data available to Subacoustech Environmental to provide the best estimate for the potential impacts in the two locations. During initial test blasting activities, underwater noise monitoring will be undertaken which will confirm the amount of noise generated at each site and contribute to the overall knowledge base.

The following letter report will primarily consider the situation at Dales Voe and Lerwick Harbour in the context of recent measurements Subacoustech took of drill and blast activities at Singapore Harbour in 2024, also undertaken for the removal of hard rock sections of a waterway during channel deepening works. Results from this exercise will also be compared with predictions using Soloway and Dahl (2014)[1].

[1] Soloway, A. G., & Dahl, P. H. (2014). Peak sound pressure and sound exposure level from underwater explosions in shallow water. The Journal of the Acoustical Society of America, 136(3), EL219-EL223. http://dx.doi.org/ 10.1121/1.4892668

The following basic concepts should be understood. Borehole blasting for the clearance of rock 'overburden' (the top layer of rock in a sea or riverbed) requires a grid of boreholes of various lengths and diameters to be drilled, into which are placed an explosive 'pack' which are detonated in sequence, with a delay of a few milliseconds between each. The amount of explosive in each hole will have a 'charge weight' in kilograms, each is likely to be different, but from a noise perspective, this leads to a serious of individual 'peaks' of noise in the blast sequence. The greatest individual noise 'peak' will tend to be associated with the largest charge, known as the Maximum Instantaneous Charge, or MIC. The total charge weight detonated in a sequence will contribute to an overall noise exposure. Both of these elements are relevant in the assessment of noise impact.

It is estimated that the MIC required at Dales Voe will be no more than 110 kg in any location, with an average of 34-64 kg; at Lerwick Harbour, the estimated MIC is up to 130 kg, with an average of 33-60 kg. An indicative upper total charge weight in all holes in a sequence is suggested to be around 700 kg, based on an upper extent of the estimated 400 kg-1250 kg over two sequences provided in the "Trial Blast – Proposed Underwater Acoustic Monitoring Method Statement" (Arch Henderson doc. No. 232029-MD-LOT-D&B).

All species have different hearing capabilities and sensitivities, but although the greatest concern in both locations is potential for harm to the harbour seal, the following assessment will consider all marine mammal species categories. Harbour porpoise are noted as being the most sensitive species to noise, and there is a small risk that individuals could be present, although it is noted in the Marine Mammal Risk Assessment (Envirocentre doc. no. 15428) that between 2023 and 2025 the nearest animals were sighted approximately 14 km from the Dales Voe site. No individuals were seen in the proposed development site. In order to mitigate the risk, Marine Mammal Observers will be used to ensure no marine mammals are present within 1 km of the blast location. The assessment will be made such that there should be no risk of Permanent Threshold Shift (PTS)[2], or damage to the hearing ability of a seal, outside of this 1 km range. There must be consideration of the maximum instantaneous (peak sound pressure level, SPL_{peak}[3]) noise level, controlled by the MIC, and the total noise exposure (sound exposure level, SEL[4]), controlled by the total charge weight detonated in the sequence. Guidance considers these 'dual criteria' where both are relevant, and the 'impact range' should be whichever represents the worst case.

Predictions using Soloway and Dahl (2014)

Soloway and Dahl (2014) sets out calculations for the prediction of noise from detonations of explosives underwater, with a specific focus on UXO (i.e. unconstrained detonation in the water column). MTD 96/101 also states that the explosive peak pressure of explosions in rock reduces to approximately 5% of the value for freely suspended charges, or 30% for total exposure. Following the prediction in Soloway and Dahl (2014), which itself follows Arons (1954)[5], and including the correction for explosives in rock noted in MTD 96/101, predicts a noise level of 191.6 dB SPL_{peak} at 1000 m from a blast with MIC of 130 kg, which is substantially below the threshold of instantaneous PTS onset for seals of 223 dB SPL_{peak}. It is also well below the 202 dB

[2] Note that in NMFS (2024), PTS is considered under the wider category of Auditory Injury.
[3] SPL_{peak} metric is commonly referred to using $L_{P,pk}$ in contemporary underwater noise reporting but SPL_{peak} has been used in the document for the purposes of familiarity with readers.
[4] SEL metric is commonly referred to using $L_{E,p}$ in contemporary underwater noise reporting, but SEL has been used in this report for the purposes of familiarity with readers.
[5] Arons A. B. (1954). Underwater explosion shock wave parameters at large distances from the charge. J. Acoust. Soc. Am. 26, 343–346

SPL_{peak} threshold for harbour porpoise, as per NMFS (2024)[6]. The estimated distance at which 223 dB SPL_{peak} (harbour seal) is predicted to occur is approximately 45 m from the blast location using this methodology; 202 dB (harbour porpoise, VHF weighted as per Southall *et al.,* 2019[7]) would occur at 350 m. The total charge weight of 700 kg (including the 30% correction for embedded charges) leads to a noise level of 183 dB SEL (PCW weighted, as per Southall *et al*., 2019[7]) at 1000 m, marginally below the 185 dB SEL limit for PTS onset in seals[8]. For harbour porpoise, the total charge weight (with the correction) leads to a noise level of 165 dB SEL at 1000 m, which is somewhat in excess of the 155 dB SEL PTS threshold for this species (155 dB SEL is estimated at 2.4 km).

Note that calculations are based on a charge weight of TNT and charge weights of relevant explosive should be converted using TNTeq (TNT equivalent). Based on Simoens *et al.* (2011)[9], the emulsion explosives proposed at the Shetlands sites (and also used in Singapore, below), have a TNTeq conversion factor of 1 for peak pressure and 0.7 for exposure. For reasons of precaution (and simplicity) a TNTeq with a 1:1 ratio has been used in the calculations.

Comparison with measurements at Singapore Harbour, 2024

The most recent and comprehensive dataset for underwater noise measurements taken during drill and blast operations was taken in June 2024 in Singapore Harbour[10] by Subacoustech, where nine charge sequences were sampled successfully. The charges measured at the Singapore Harbour site are similar to those proposed here (although at some locations the MIC could be higher in Shetland sites). This location had a similar depth to the Shetland sites, up to 20 m, although much of the Shetland sites are shallower, which is beneficial for restricting sound transmission with distance.

The MICs deployed for the project in Singapore were smaller than those proposed at the Shetland sites, with a highest value of 50 kg compared to 110 kg to 130 kg, although 50 kg is representative of a typical MIC charge weight rather than the absolute maximum.

The results shown in Figure 1 and Figure 2 were obtained from the measurements at Singapore Harbour. A range of distances were sampled, between 580 m and 2000 m (most at 800 m to 1000 m), and the measurements were normalised using a simple acoustic principle (15.log[r]), as if all measurements were sampled at 1000 m and the only variable was the charge weight.

[6] National Marine Fisheries Service (NMFS) (2024). *2024 update to: Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (version 3.0): Underwater and in-air criteria for onset of auditory injury and temporary threshold shifts.* U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-71.
[7] Southall B L, Finneran J J, Reichmuth C, Nachtigall P E, Ketten D R, Bowles A E, Ellison W T, Nowacek D P, Tyack P L (2019). *Marine mammal noise exposure criteria: Updated scientific recommendations for residual hearing effects.* Aquatic Mammals 2019, 45 (20, 125-232) DOI 10.1578/AM.45.2.2019.125.
[8] Note that criteria for PTS onset based on the instantaneous SPL_{peak} threshold use the NMFS (2024) guidance, whereas the SEL criteria use the older Southall *et al.* (2019) guidance. This is because the SPL_{peak} thresholds are straightforward to update, whereas the species-weighted SEL thresholds would require considerable reanalysis of the Singapore data to update and enable a direct comparison. Subacoustech's analysis previously of the difference between seal criteria in Southall *et al.* (2019) and NMFS (2024) indicate that the overall difference between the two criteria is relatively small.
[9] Simoens B, Lefebvre M H, Minami F (2011) *Influence of Different Parameters on the TNT-Equivalent of an Explosion.* Central European Journal of Energetic Materials, 2011, 8(1), 53-67
[10] Mason T and Morgan I (2024) *Underwater noise monitoring, drilling and blasting in Temasek Fairway, Singapore*. Subacoustech report ref. P398R0102

This analysis suggests that all charges sampled at Singapore Harbour were lower than the instantaneous PTS onset threshold, although noting again that the MIC for the Singapore campaign was limited to 50 kg and the trend is indicative of an increase above the instantaneous limit at higher MICs.

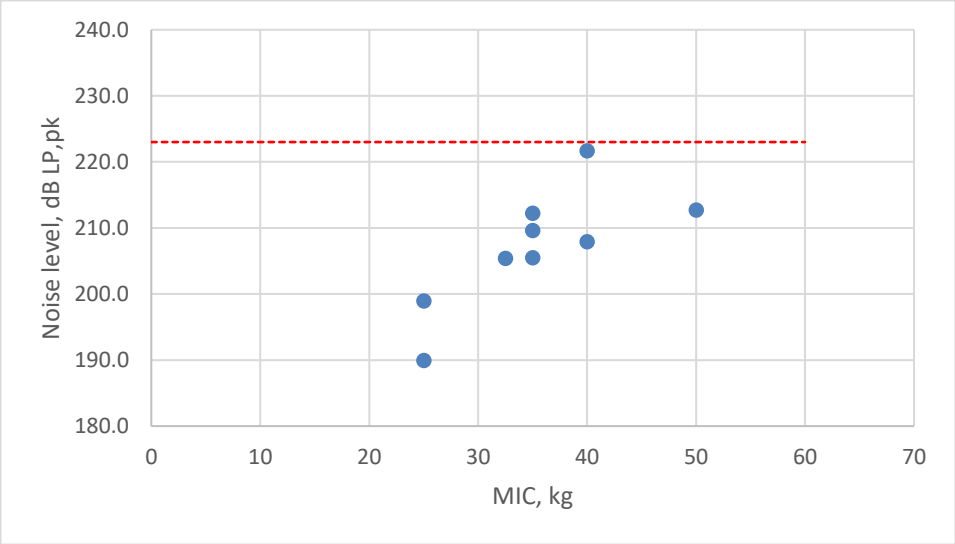

Figure 1 – SPL_{peak} measurements against MIC size, normalised to 1000 m, with seal instantaneous PTS threshold marked (223 dB SPL_{peak}, as per NMFS, 2024 threshold).

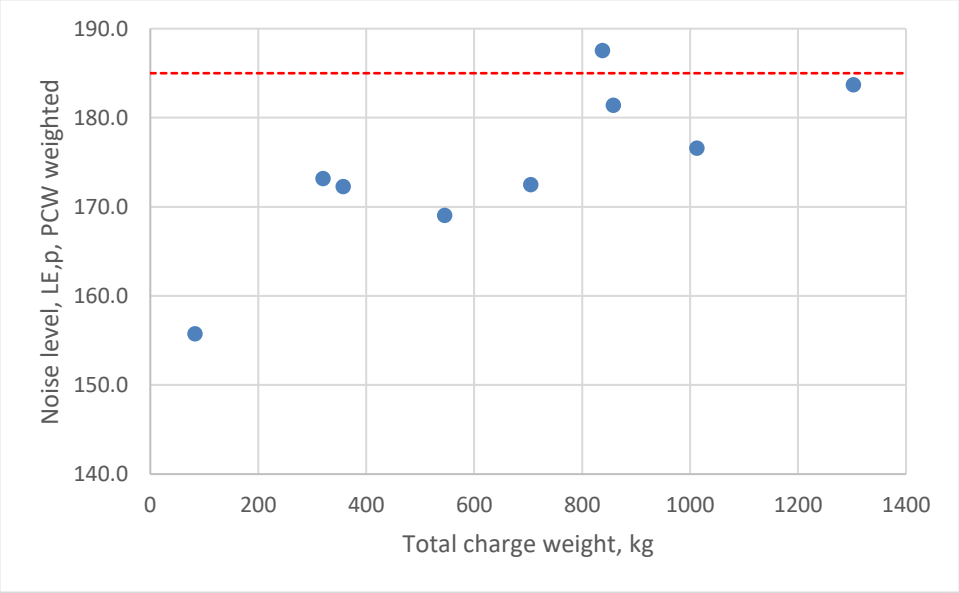

Figure 2 – SEL measurements against total charge weight, normalised to 1000 m, with seal PTS exposure threshold marked (185 dB SEL, as per Southall et al., 2019 threshold).

Here, the 700 kg estimated total charge weight in a detonation sequence is within the boundaries of the measurements sampled and is expected to be likely just below the PTS onset threshold. However, due to the

variability of the measurements, indeed explosive measurements generally, there is still a risk of exceedance at the highest total combined charge weights.

The equivalent charts have been extracted for harbour porpoise, again showing the measurements of blast noise normalised to 1000 m using the SPL_{peak} and SEL metrics.

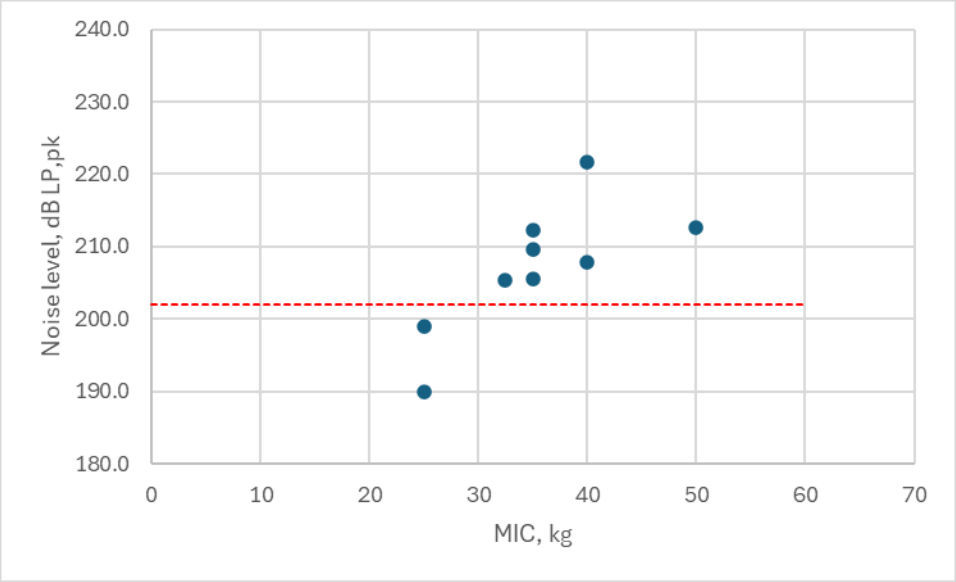

Figure 3 – SPL_{peak} measurements against MIC size, normalised to 1000 m, with harbour porpoise instantaneous PTS threshold marked (2 dB SPL_{peak}, as per NMFS, 2024 threshold).

It is clear here that at an MIC in excess of approximately 30 kg, the measurements exceed the harbour porpoise SPL_{peak} PTS threshold (202 dB SPL_{peak}) at 1000 m. Thresholds for all other species hearing groups are 222 dB SPL_{peak} or greater[11], and so are not exceeded.

[11] Summary of NMFS, 2024 auditory injury SPL_{peak} thresholds: 222 dB (LF cetacean, e.g. minke whale), 230 dB (HF cetacean, e.g. Risso's dolphin), 202 dB (VHF cetacean, e.g. harbour porpoise), 223 dB (PCW, pinnipeds in water, e.g. harbour seal)

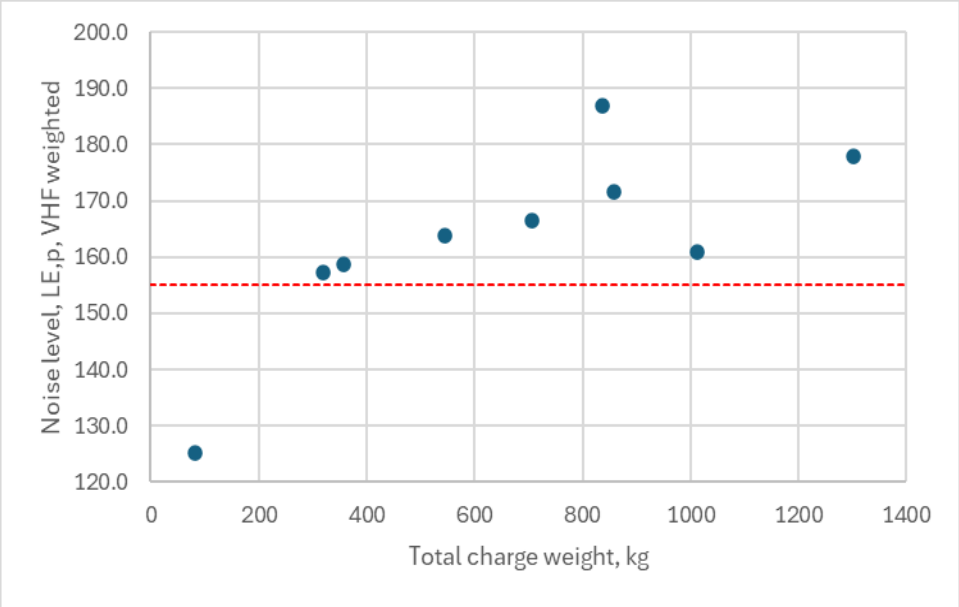

Figure 4 – SEL measurements against total charge weight, normalised to 1000 m, with harbour porpoise PTS exposure threshold marked (155 dB SEL, as per Southall et al., 2019 threshold).

Again here we can see that using the total charge weights measured, most larger explosive quantities exceed the Southall *et al.* (2019) harbour porpoise SEL threshold at 1000 m.

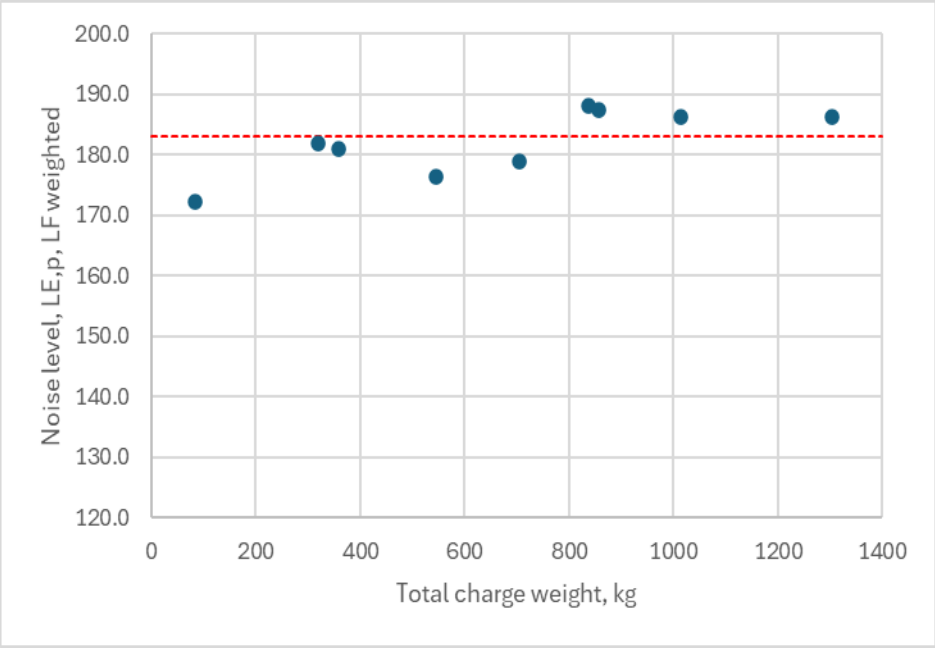

Figure 5 – SEL measurements against total charge weight, normalised to 1000 m, with low frequency cetacean (i.e. minke whale) PTS exposure threshold marked (183 dB SEL, as per Southall et al., 2019 threshold).

All detonations at or below 700 kg total charge weight were less than the criterion.

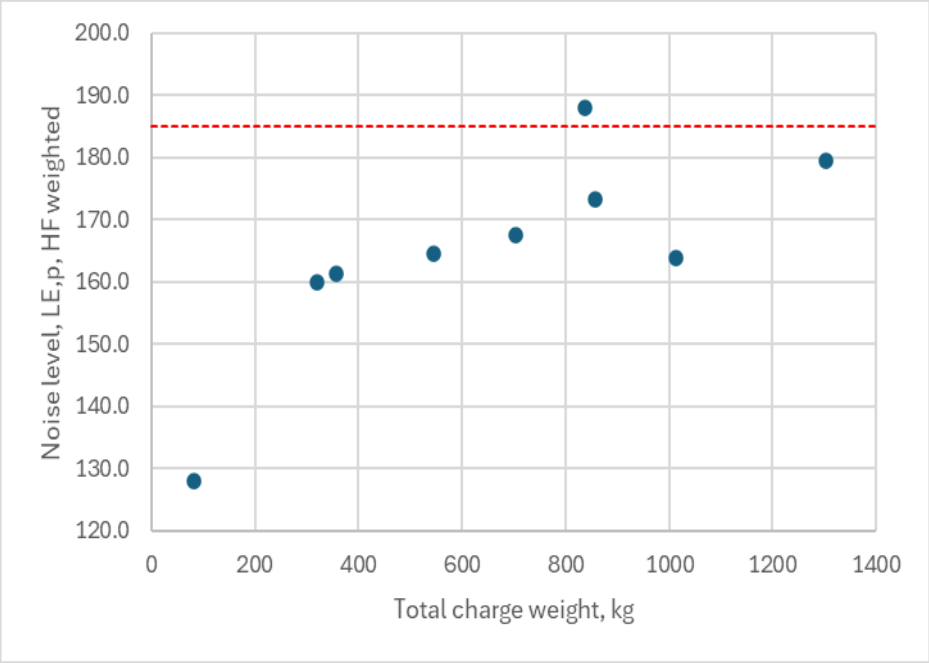

Figure 6 – SEL measurements against total charge weight, normalised to 1000 m, with high frequency cetacean (i.e. Risso's dolphin) PTS exposure threshold marked (183 dB SEL, as per Southall et al., 2019 threshold).

The measured noise levels at or normalised to 1000 m for all detonations (aside from one outlier) were below the PTS noise criterion.

Estimation of disturbance

The National Marine Fisheries Service (NMFS) in the United States has used a concept of Level B Harassment to identify a noise level at which disturbance could occur in marine mammals. For impulsive noises this is often quoted as 160 dB SPL_{rms} but crucially this threshold is not intended for explosive noise. However, in their Summary of Acoustic Thresholds (2025)[12], NMFS provides a series of weighted SEL behavioural thresholds for explosions considering multiple detonations for relevant species groups. These thresholds are provided alongside the calculated result for a selection of charge weights (with embedded charge correction).

Table 1 – Behavioural thresholds for underwater explosives, NMFS (2025) and predicted impact ranges. Note these use the NMFS (2024)[6] marine mammal weightings and linked thresholds, dB re 1 µPa²s

Hearing Group	Example species	Threshold, weighted	20 kg	30 kg	50 kg	700 kg
LF Cetaceans	Minke whale	163 dB SEL	20 km	24 km	30 km	93 km
HF Cetaceans	Risso's dolphin	173 dB SEL	110 m	140 m	170 m	520 m
VHF Cetaceans	Porpoise	139 dB SEL	3.4 km	3.6 km	3.9 km	5.4 km
Phocid pinnipeds	Seal	163 dB SEL	4.2 km	5.1 km	6.5 km	20 km

[12] https://www.fisheries.noaa.gov/s3/2025-09/MM-Acoustic-Thresholds-508-secure-SEPT-2025-OPR1.pdf

The long-range results calculated for LF cetaceans is likely to be a significant over-estimation of the real risk, due to the relatively shallow water at the sites which will likely attenuate the noise more quickly than the calculation assumes. It is worth also being mindful of the context: a widespread clearance of an area would be much more likely where high noise levels are present for an extended period. For a single detonation (effectively also a single collection of detonations) lasting less than a second, with many hours between the explosive events, it is hard to localise the sound and so this is thought most likely to lead to a startle reaction in individuals rather than causing a displacement of marine mammals.

Discussion

There is clearly a divergence in the theoretical and empirical results. While the theoretical calculations for the instantaneous SPL_{peak} indicate that there is significant headroom before reaching the seal PTS onset threshold at 1 km, they are very close to (but still beneath) the threshold based on SEL exposure. Despite this, the measurements in Singapore Harbour indicate a risk of exceedance at the maximum MIC proposed at the Shetland sites for the instantaneous PTS SPL_{peak} thresholds at 1 km. Using the total exposure (rather than instantaneous) threshold, the predicted noise appears to be just beneath the threshold, in line with the theory. Considering harbour porpoise however, their greater sensitivity to noise shows that at the larger MICs and total exposures, their PTS thresholds would be exceeded at 1 km using both theoretical and empirical measures for all except theoretical instantaneous calculation.

In some ways divergence between theoretical and empirical measures is not surprising; every detonation is different. This is especially true where the explosives are drilled into rock, and the depth and structure of the particular rock type will affect the noise ultimately transmitted into the water. However on the basis of the measurements available, no exceedance was found at 1 km for MICs up to 50 kg for seals, although an exceedance for harbour porpoise is more likely. All other species group had a lower sensitivity and a lower risk of PTS. In terms of noise transmission over 1 km, the slightly shallower depths around the Lerwick sites are likely to lead to slightly lower noise levels, although its real effect is more complicated to predict and beyond the scope of this report. There is a potential for behavioural disturbance in seals of 6.5 km with a charge weight of 50 kg or up to 20 km for a total charge weight of 700 kg, but due to the single event nature of explosive detonations, it is thought likely that this would lead to a short-term startle reaction rather than individuals leaving the area.

It should be borne in mind that the instantaneous SPL_{peak} PTS calculations use the maximum MIC proposed at the Shetland sites, and so the risk from the majority of the detonations is anticipated to be lower for most of the sites and times. The real risk to harbour porpoise should not be overestimated either, due to the small population in the area and the low likelihood of an individual being present near to the blast sites, especially due to the elevated noise levels from drilling prior to blasting.

It is understood that a major part of the mitigation proposed for the drill and blast works at the sites will be the use of marine mammal observers and underwater noise monitoring at the sites. Measurements will start with lower MICs and incrementally increase until or in case there is a clear exceedance of the impact thresholds. It is suggested that, as the worst case theoretical calculations and empirical measurements indicate that the seal PTS is expected to remain below the threshold for SEL (total charge weights), then there is some comfort that available data show that the threshold using this metric is unlikely to be exceeded at the Shetland sites. However, there remains greater uncertainty based on the SPL_{peak} thresholds, and the ultimate impact is likely to be dependent on the specific conditions at the Shetland sites; indeed a comparison between the noise levels produced at the two sites and the existing data will be useful. The underwater noise monitoring exercise will

be important to confirm the particular characteristics from blasting at various charge weights at the two sites and provide confidence in the underwater noise levels in comparison with the theoretical data and those acquired at a different location.