Appendix 3.1 Outline Operational Environmental Management Plan

Shetland Space Centre

Outline Operational Environmental Management Plan

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Contents

1. Introduction

1.1 Overview

This Outline Operational Environmental Management Plan (OOEMP) refers to the operation of the proposed development, a vertical launch spaceport, by Shetland Space Centre Limited (hereafter referred to as 'the Applicant').

The proposed development will be operated by the Applicant and used to launch small satellites into either polar or sun-synchronous, low-earth orbits.

The Proposed Development comprises the following principal elements which are the subject of three separate planning applications:

- Proposed Launch Site – a launch area at Lamba Ness comprising three launch pads, a satellite tracking station, launch vehicle integration buildings, roadways (largely re-using existing roads), fuel storage and ancillary infrastructure;
- Proposed Launch and Range Control Centre (LRCC) at Saxa Vord;
- Proposed New Section of Access Road – a short stretch of new road at Northdale; and,
- Reuse of the existing Fuel Storage Area at Baltasound Airfield. (An integral part of the proposal; however, this does not form part of any one of the submitted planning applications as formal planning permission is not required for this element).

The OEMP is the environmental management tool for the operation of the proposed development.

The OEMP will be updated and finalised post consent in line with any relevant planning condition and in agreement with Shetland Islands Council, NatureScot and Scottish Environment Protection Agency (SEPA).

1.2 Scope and Objectives

The final OEMP will be a key document assisting the Applicant in complying with set planning conditions. The OEMP will be a live document, updated as required throughout the planning and operational process.

The purpose of this OOEMP is to provide an overview of potential environmental impacts of the proposed development, during its operational phase, and describe the management and mitigation measures to protect the environment and sensitive receptors, both on- and off-site, and minimise potential adverse impacts on the environment that will then be revised and updated as required and included in the final OEMP.

The objectives of this OOEMP are to provide:

- an overview of the proposed development operations;
- guidance on compliance with relevant environmental legislation and the Applicant's policies in the operational phase;
- a means of implementing appropriate mitigation measures for the key environmental issues (refer to supplementary Environmental Management Plans in Appendix 2);
- a working environmental management tool to follow during the operation phase of the Space Centre;
- definition of roles and responsibilities of the operational team;
- a guide for the interaction with relevant government authorities and other relevant stakeholders, including the community during the operational phase of the proposed development; and

- a basis for monitoring, reporting and maintaining compliance with regulatory requirements for the proposed development;

This OOEMP is a live document. The management strategies and control measures detailed within this document and the supplementary Environmental Management Plans will be reviewed and updated, where necessary, to reflect changes introduced by the Applicant’s operational team, site specific outcomes, non-conformances and recommendations arising out of inspections, meetings and audits.

1.3 Supporting Environmental Management Plans

A series of environmental management plans will be developed to support the OEMP following receipt of planning permission. Plans which will be included in the final version of the OEMP include:

- Visitor Management Strategy
- Operational Habitats Management Plan
- Operational Health and Safety Plan
- Operational Emergency Response Plan
- Operational Waste Management Plan

2. Statutory and Policy Considerations

The Applicant is committed to complying with all of its legal obligations and other voluntary commitments. Compliance with applicable regulatory requirements concerning the operations of the Space Centre will be achieved through:

- identifying and accessing legal and other requirements which are directly applicable to the organisation;
- consulting and involving relevant government agencies;
- internally communicating relevant information regarding legal and other requirements;
- regularly auditing, reviewing and upgrading systems, management plans and supporting documentation; and
- providing relevant training.

2.1 Legal and Other Requirements

A considerable quantity of environmental legislation applies to the operational stage of the proposed development. The expectation is that all relevant legislation, including requirements for licences, permits and / or consents shall be identified.

For each significant environmental aspect, the relevant applicable environmental legislation and regulations will be identified from, but not limited to, the list provided below:

- Town and Country Planning Act (Scotland) 1997 as amended by The Planning etc. (Scotland) Act 2006;
- The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017;
- Marine (Scotland) Act 2010;
- Civil Aviation Act 2012;
- The Environmental Authorisations (Scotland) Regulations 2018;
- Anti-Pollution Works (Scotland) Regulations 2003;
- Control of Substances Hazardous to Health (COSHH) Regulations 2002 (and amended 2003, 2004);
- The Waste (Scotland) Regulations 2011; and
- The Space Industry Act 2018.

The list of relevant legislation and its applicability to the proposed development will be reviewed and updated following receipt of planning permission.

2.2 Environmental Approvals

A list of required permits will be completed following receipt of permit to change airspace use from the Civil Aviation Authority, but is likely to include:

- Spaceport license – UK Space Agency (UKSA)
- Relevant Health and Safety permits
- OFCOM license
- Airspace change - CAA regulatory authority
- Maritime licenses - Marine Scotland

2.3 Management System

This section will be completed with relevant information from the Shetland Space Centre integrated management system once the system has been finalised.

2.4 Environmental Policies

This section will be completed with relevant information from the Shetland Space Centre integrated management system once the system has been finalised.

2.5 Operational Efficiency

This section will be completed with relevant information from the Shetland Space Centre integrated management system once the system has been finalised.

3. Proposed Development Operations

3.1 Site Setting

The proposed development is situated on Unst, Shetland, the most northerly of the Shetland Islands.

The proposed Launch Site is centred on reference point 466500 E, 1215500 N and occupies an area of approximately 80.8 hectares (ha). It comprises three launch pads, a satellite tracking station, launch vehicle integration buildings, roadways (largely re-using existing roads), fuel storage and ancillary infrastructure a vertical launch spaceport including a launch pad complex, mobile tracking stations and assembly/integration hangar buildings with associated security fencing, access and servicing.

The proposed LRCC is located approximately 2.4 km southwest of the proposed Launch Site, at the southwest of the Saxa Vord resort complex. The proposed LRCC site is currently occupied by a former brewery building, which is proposed to be repurposed to form the LRCC.

The proposed 510 m New Section of Access Road is located between two existing roads, across ground which rises up from the valley for the Burn of Norwick and runs southwest to northeast. The proposed New Section of Access Road is located approximately 1.6 km southwest of the proposed Launch Site.

3.2 Description

The proposed development comprises the construction of the following buildings and infrastructure, the impact of which have been considered in this CEMP:

- Launch Pad Complex: located on the Lamba Ness peninsula and comprising three launch sites, each incorporating a launch pad, ground services storage and control, lightning protection masts, liquid and compressed gas storage and water deluge tanks for launch operations;
- Satellite Tracking Station: an area of hardstanding housing satellite tracking and telemetry devices located on the Lamba Ness peninsula;
- Launch Site Processing Facility (LSPF) hangar buildings (two): located on the Lamba Ness peninsula, a building where the LVs are assembled and the payload (the satellites) integrated into the LVs;
- Administration Building, Pyrotechnics Store, and Hazardous Materials Store located adjacent to the LSPF on the Lamba Ness peninsula;
- Integration Hangar/TEL building: located on the Lamba Ness peninsula, a forward position building close to the launch pads housing the transporter erector launcher (TEL) and where the final integration activities take place as required;
- Support Infrastructure: located on the Lamba Ness peninsula including access, an internal track system and a series of small temporary buildings and a construction compound;
- Gate House, including a tourist information area, located on the Lamba Ness peninsula;
- Wildlife Hide: located on the Lamba Ness peninsula;
- Launch and Range Control Centre (LRCC): redevelopment of the former Valhalla brewery building at Saxa Vord to provide a facility where launch and range control activities will take place;
- New Section of Access Road: construction of a new section of access road at Northdale; and,

- Reuse of the existing Fuel Storage Area at Baltasound Airfield.

The proposed layout of the Launch Site is included as Appendix 1.

3.3 Operations Overview

The proposed development will be operated by the Applicant to launch small satellites into either polar or sun-synchronous, low-earth orbits. Polar orbit means that the trajectory of the satellite is over both the North and South poles. Sun-synchronous orbits are also polar, or nearly polar, but ahead of the sunrise, allowing a satellite's solar panels to function continuously. Launches will take place in a northerly direction over the sea. The design of the proposed development allows for launches by multiple launch service providers (LSPs) using a range of different rocket (launch vehicle - LV) types.

For safety reasons, rockets are not permitted to fly over inhabited areas and so the proposed development has a significant advantage over other sites considered as launches from Lamba Ness will avoid both the oil fields to the west and east of Shetland and void the Faroe Islands to the north-west.

Also, transatlantic air traffic over Unst is minimal, which means that there will be little or no need for in-flight re-routing and there are no Royal Navy or RAF training ranges nearby.

The SSC operational phase will commence with the delivery to the launch site of the following components:

- LVs
- Payloads
- Propellent and commodities

It will then continue into the assembly of LVs and loading with payloads; subsequently the LV will be transferred to the launch pad where it will be fuelled and prepared for the launch. The last operation includes the launch of the LV, including the payload, into orbit.

The integration of the LV and the payload will be manged by the LSP. The LSP will also manage the launch campaigns with the assistance of the Applicant's Launch Safety Officer (LSO). The LSO will be responsible for the operation of the site and managing range safety.

The duration of each launch campaign is expected to run for around four weeks, starting with delivery of the LV and ending with successful launch and facility clean down.

3.4 Representative Launch Operating Scenario

The proposed development is a facility which allows for launch operations by multiple LSPs using different LVs. For the purposes of the OOEMP, a representative launch operating scenario has been defined.

As described above, the operational phase will comprise: delivery of LVs, payloads, fuel and commodities to the proposed Launch Site; assembly of LV and integration of payload(s), transfer of the LV to the relevant launch pad, fuelling and preparation of the LV for launch at the launch pad, and the launch of the LV into a high inclination orbit, including polar and sun-synchronous orbits.

To achieve the launch of the satellites into the required orbits, the proposed trajectories of the LVs will be to the North.

3.4.1 Launch Exclusion Zone (LEZ)

In order to guarantee public safety, measures to control the launch exclusion zone (LEZ) will be implemented at specific periods of the launch campaigns, like at the run-up to and during launch. The LEZ will include an area around the launch pad and a downrange overflight exclusion zone.

In addition to the LEZ, downrange sea and air space exclusion zones will also be activated.

3.4.2 Launch Campaign

Each launch period will run for approximately four weeks, beginning with the delivery of the LV and payload to the site and ending with successful launch and deployment of the payload in orbit and clean-down of the facility. The key steps in a representative normal launch campaign are set out below.

It is anticipated there will be up to 30 launches per calendar year. Launches require specific conditions to allow them to succeed, therefore it is possible there could be night-time launches. It is expected that the number of launches will be lower in the first year, gradually increasing up to 30 launches per year.

3.4.3 LV Assembly

The LV and payload will be delivered to the proposed Launch Site separately by the LSP for assembly, integration and testing. It is anticipated that the LV and payload elements will be delivered to the proposed Launch Site by road in 40 foot road containers or vans. The LV integration process involves the assembly of the LV stages and the emplacement of payload into the fairing; and will be undertaken under controlled conditions within the Launch Site Processing Facility (LSPF).

3.4.4 Launch Site Operation

Once the LVs are integrated with payloads, they will be transported in a horizontal position from the LSPF to the relevant launch pad using the transporter erector launcher (TEL), normally between 24 hours and six hours before launch. Once in position on the launch pad, the LV will be raised to a vertical orientation using the TEL and connected to the launch pad electrical, fuel and communications systems through umbilical cables. This is expected to be completed approximately three hours before launch.

Once the LV is in a vertical position on the launch pad and prior to fuels being loaded, the LV tanks and overground fuel lines will be preconditioned using liquid nitrogen evaporation. Pressurant loading will then commence followed by loading of the fuels. Loading will be automated and controlled from the LRCC.

A 'wet dress rehearsal' may be carried out before launch. This will involve loading the LV with the fuels to function test the LV systems and then subsequently unloading the fuels. The fuels and liquid oxygen (LOX) will be returned to their relevant tanks, and any residual LOX will be released safely into the atmosphere. Once this has been successfully undertaken, the LV will be re-loaded with fuels prior to launch.

LEZ restrictions will be in place from the point the LV is brought to the launch pad with the intention to launch. All site personnel will move back beyond the LEZ for launch a few hours prior to the scheduled launch. Activation of the LEZ and the length of time when restrictions will prevail will be kept to the absolute minimum necessary.

3.4.5 Fuel Transportation

Fuel will be stored at the fuel depot at Baltasound, 10.5 km south from the proposed Launch Site. Fuel will be transported to the proposed Launch Site in ISO road containers when required. A delivery holding area will be located at the proposed Launch Site entrance, and containers held here before being taken to the respective launch pad. At the launch pad the containers are stored in the designated protected areas as shown on Drawings 3.5, 3.6 and 3.7.

Large volume fuel and gas containers will remain on their trailers for fuelling and de-fuelling. Fuel and gases will be piped to the LV above ground and in a below ground trench over the launch pad.

Small volumes of fuels and oils in containers will be off-loaded to the ground within the control areas of the launch pads to facilitate electrical and mechanical support during launches. These will be stored in accordance with best practice procedures, including being kept within a designated storage site in appropriate impermeable bunded containers/areas.

3.4.6 Countdown

The LV will be fuelled from approximately two hours before launch until approximately ten minutes before launch. During this time, the required airspace and sea space management and monitoring procedures will be activated to ensure the range safety compliance of the launch.

Approximately two minutes before launch, the LV will transition to its internal power source and continue to perform an autonomous series of preparatory configurations and status checks.

Approximately 20 seconds before launch the hold-down mechanism will be armed, and launch command control relinquished to the LV. First Stage ignition will occur at approximately two seconds before launch.

3.4.7 Launch, Ascent and Payload Deployment

The LV will lift off from the launch pad following the ignition of the First Stage engines. A few minutes after launch, First Stage engine cut-off will occur, followed shortly by First Stage separation and Second Stage engine ignition. The First Stage will fall back to earth within a previously identified ‘impact zone’. The Payload Fairing will separate shortly after Second Stage engine ignition. Second Stage engine cut off will occur several minutes after ignition, followed shortly afterwards by deployment of the payload. The Payload Fairing will separate shortly after Second Stage engine ignition. Second Stage engine cut off will occur several minutes after ignition, followed shortly afterwards by deployment of the payload.

The number of impact zones arising from a launch will depend on the number of stages in the LV, which may be one or two, and whether or not Stages/Fairings break up on re-entry. It is broadly anticipated that Stage 1 will remain intact upon returning to Earth, whereas the fairing will break-up. Taking into account the impact zone for the payload fairing, up to three impact zones are expected per launch (Stage 1, Stage 2 and the payload fairing). The impact zones are expected to occur at a minimum distance of 200 km from the proposed Launch Site, and up to a maximum distance of 1,100 km. The indicative locations of impact zones have been provided by the LSPs and assessed in Chapter 13. The impact zone(s) will be subject to Notice to Airmen and Mariners to warn third parties to remain clear.

3.4.8 Clean-down

The clean-down operation will start following the launch operation: the launch pad facilities would be cleaned down and commodities replenished for the next launch operation.

3.4.9 Launch Scrub Scenario

A launch scrub scenario occurs when there may be a requirement to reschedule a planned launch, for example if the weather conditions are not suitable. An on-pad scrub scenario can happen up to the point of engine ignition. In such situations it is usually the case that the LV can be re-used for a subsequent launch.

In this scenario, the LV would be de-fuelled by returning the fuel and LOX to their respective tanks and discharging any residual LOX to the atmosphere. The LV would then be returned to the horizontal position and transported back to the LSPF if required.

3.4.10 Abnormal Launch Scenario

An abnormal launch operating scenario is one where the launch operation does not proceed to plan (excluding the representative scrub operating scenario outlined above). Abnormal launch operating scenarios could occur on the launch pad before lift-off (e.g. a fire) or could occur in the air after lift-off (e.g. the LV deviating from the planned trajectory).

3.5 General Considerations

3.5.1 Access Controls

The Applicant will display signage to advise visitors and the general public that relevant areas of the proposed Launch Site are private and not for public use.

Additional signage across the proposed Launch Site will include:

- Directional and speed limit signs for vehicles; and,
- Adequate signage to satisfy work health and safety requirements.

Security will be maintained by fences with gates locked outside of operating hours. Fences will be inspected routinely for signs of damage and/or intruder entry.

3.5.2 Plant and Equipment Maintenance

All plant and equipment installed or used within the proposed development will be operated and maintained in accordance with Planning Conditions and requirements. This includes all processing infrastructure and pollution control equipment.

3.5.3 Fire Prevention

If an on-site fire occurs, all necessary measures to extinguish associated fires will be implemented immediately. Adequate fire prevention resources have been put in place, and all personnel are able to access fire-fighting equipment and manage fire outbreaks at any location at the proposed Launch Site in accordance with the guidance provided in the draft Emergency Response Plan (to be included in Appendix 2 on revision and update of the OOEMP).

3.5.4 Dangerous Goods Storage (TBC once CAA licence is obtained)

Fuels and gases will not be permanently stored at the proposed Launch Site, rather they will be brought to the launch pads from external storage, via road haulage, as required.

Large volume fuel and gas containers will remain on their trailers for fuelling and de-fuelling. Small volumes of fuels and oils in containers will be off-loaded to the ground within the control areas of the launch pads, to facilitate electrical and mechanical support during launches. These will be stored in accordance with best practice procedures, including being kept within a designated storage site in appropriate impermeable bunded containers/areas.

All other fuels or flammable solvents for general operational use will be appropriately stored in a secure and well-ventilated area in accordance with the planning conditions and COSHH requirements. This storage is located on unfilled land, and all flammable liquids stored within a bund of 110% capacity of the volume of those flammable liquids so that any release of raw or burning fuel do not cause a fire in the filled waste or impact on surface water. A Hazardous Substances and Dangerous Goods Register will be developed to record chemicals used at the proposed development.

3.5.5 Litter Control

Litter control will be carried out in accordance with the Waste Management Plan (to be included in Appendix 2 on revision and update of the OOEMP).

3.6 Key Environmental Issues and Management Measures

An assessment of the proposed development operational activities has identified the following potential environmental impacts:

- **Water:** The water deluge system may absorb small amounts of contaminants during the launch process. There is potential for accidental release of contaminated deluge water or fire water to be released.
- **Air:** During the operational phase potential impacts could arise from road traffic accessing the site and from the release of air pollutant emissions during the launch activities.
- **Noise:** Noise sources during the operational phase will include noise associated with launch vehicle propulsion systems during take-off and operational traffic.
- **Light:** It is expected that appropriate external lighting would be required at the launch pad and possibly other areas of the site to allow for night-time working during launch campaigns.

Further information on these key issues and appropriate management measures to be implemented are detailed below:

3.6.1 Water

When no launch activities are in operation, the penstock valve on the launch pit will be maintained open such that rainwater run-off from the launch pit will discharge into a filter trench prior to sea outfall.

Launch pad fuel storage areas, which will store mainly RP-1 Kerosene, will have a contained concrete surface with run-off into channels which will discharge into a full-retention alarmed interceptor, before discharging into either a filter drain or drainage ditch. The interceptor will be appropriately sized to accommodate a tanker cell burst.

Drainage from roofs (other than the Gatehouse and Integration Building), roads, hardstanding area and the satellite tracking area concrete pads will discharge into filter trench systems to provide Sustainable Drainage Systems (SuDS) treatment, prior to discharging into the existing ditch drainage system or newly created ditches to tie into the existing sea outfalls.

3.6.2 Air

Improvements to the existing public road network and the construction of the New Section of Access Road at Northdale will mitigate against congestion pinch points that can lead to an increase in vehicle emissions due to reduced speed and stop-start behaviour.

A staff travel plan will seek to maximise car sharing. Staff travelling to the proposed development will be collected by coach from the ferry terminals avoiding the generation of additional traffic numbers.

The Applicant intend to use electric vehicles to collect and transport visitors to and around the proposed development.

A Spectator Traffic Management Plan (STMP) will be developed to avoid congestion and encourage sustainable transport choices.

Generators proposed for the LSPF will be compliant with EU Stage IIIa emissions limits (FG Wilson, 2020), and all other generators across the proposed Launch Site will be fuel optimised to minimise NOx emissions. Generator stack heights will be designed to ensure compliance with the Chimney Height Memorandum as defined in the 1956 Clean Air Act and to ensure effective dispersion and avoidance of potential downwash effects.

In future, the Applicant intends to secure a permanent three phase power supply for the proposed Launch Site, enabling the number of diesel generators to be reduced significantly to two standby generators and two mobile generators supplying the deluge pump systems used during launch events.

3.6.3 Noise

No mitigation is possible to reduce instantaneous noise levels associated with launches; however, the following community engagement protocols will be followed to seek to minimise the potential for annoyance:

- The timing of launches will be advertised well in advance, in local media and online, such that local residents can avoid launch noise if they choose. Although predicted noise levels inside the closest dwellings will be substantially below the level at which discomfort or hearing damage would occur, so residents wanting to minimise their noise exposure may then choose to remain indoors when the launch is scheduled.
- Suggestions for appropriate community liaison are provided below:
  - Establish Liaison Group Forum;
  - Project update newsletter;
  - Media, website update, social media;
  - Briefings with site neighbours, landowners, community representatives, interest groups and other key stakeholders as identified;
  - Produce leaflet detailing upcoming activities;

- Send letters to stakeholders likely to be immediately affected;
- Hold public open days / exhibitions;
- Manage community helpline and general email contact;
- Attend parish and town community council meetings quarterly; and
- Manage complaints procedure.

3.6.4 Light

At night and during periods of darkness, directional security lighting will be used. Lighting will be selected and sited so as to minimise visual intrusion to local communities, whilst maintaining the safe and efficient operation of the proposed development.

Lighting design will comply with the requirements of the Environmental Protection Act (UK Government, 1990). As well as implementing relevant measures set out in the Guidance Notes for the Reduction of Obtrusive Light GN01:2011 (Institute of Lighting Professions, 2011) and SEPA guidance on Controlling Light Pollution and Reducing Lighting Energy Consumption (SEPA, 2007). Measures to reduce the impacts of artificial lighting include:

- Unnecessary lighting will be avoided and, following completion of the task, lighting will be switched off and/or removed. All lighting will be switched off during daylight hours;
- All lighting will be designed to avoid visual intrusion and/or light spillage. Lighting will be positioned and directed to avoid nuisance to residents and wildlife and/or causing distractions to drivers on adjacent roads. Lighting will also avoid spillage onto neighbouring habitats; and
- Where mobile lighting relies on portable diesel generators for power, the containment of the diesel will be monitored to check for leaks and spills. Spill kits will be made available and staff provided appropriate training.

4. Implementation of the OEMP

4.1 Structure, Roles and Responsibility

4.1.1 Roles and Responsibilities

All staff will be made aware of the manner in which the site is to be operated and managed, to ensure compliance with the OEMP. A summary of the authorities and environmental responsibilities of key personnel for the operation of the proposed development is outlined below:

4.1.1.1 Launch Site Manager

- Ensure that the site complies with relevant licenses, acts and regulations;
- Approve and implement the OEMP;
- Allocate resources to handle environmental issues;
- Authorize and confirm the implementation of mitigation measures;
- Ensure any subcontractors comply with requirements;
- Review the OEMP and associated documentation, as required;

4.1.1.2 Environmental Officer or Site nominee

- Undertake and/or co-ordinate environmental monitoring requirements specified within the OEMP;
- Ensure that environmental records and files are maintained;
- Identify non-conformances and notify the Launch Site Manager;
- Ensure that environmental non-conformances are recorded and actioned;
- Review and updates the OEMP and associated documentation, as required;
- Collate and maintain records of complaints and respond accordingly.

4.1.1.3 Subcontractors

- Comply with all legal and contractual requirements;
- Comply with management / supervisory directions; and
- Participate in induction and training as directed.

4.1.1.4 All Personnel

- Comply with the relevant Acts, Regulations and Standards;
- Comply with Applicant policies and procedures;
- Promptly report any non-conformances and/or environmental incidents to management; and
- Undergo induction and training in environmental awareness as required.

4.2 Training

All employees and subcontractors (as necessary) will receive suitable environmental training, to ensure they are aware of their responsibilities and are competent to carry out their work. Training will be provided during site inductions and on an ongoing basis as required. All inductions and ongoing training shall be recorded. Training will include the following areas:

- SSC environmental and sustainability policy;
- OEMP and related documents;

- Significant risks, environmental aspects, impacts and controls;
- Emergency procedure and response; and
- Understanding legal obligations.

4.3 Communication and Consultation

The Applicant is committed to meaningful stakeholder engagement and will work in collaboration with relevant consultees and the local community to resolve any issues that impact local environmental amenity as a result of operation of the proposed development.

4.3.1 Government Bodies

The following government agencies will be consulted with in relation to the operations of the proposed development and the requirements of this OEMP:

- UK Civil Aviation Authority;
- Shetland Islands Council;
- SEPA;
- NatureScot;
- Historic Environment Scotland; and
- Marine Scotland.

4.3.2 Community

The Applicant will ensure that the local community is kept informed of the progress of the project in a pro-active and responsive manner. This will be by way of local newsletters, leaflets, newspaper advertisements, and community notice boards to include information such as:

- Operating hours;
- Contact details (telephone number);
- Launch campaign timings and any major changes to program; and
- Any major proposed works which may impact the community.

The Applicant will also prepare and circulate an annual community newsletter providing an overview of operations at the proposed development.

Key objectives of the community consultation program include:

- To understand any concerns of local community groups;
- Community consultation activities including:
  - a dedicated SSC webpage, offering general information; and
  - a community telephone line to provide a central point of contact for community enquiries;

4.3.3 Complaints Handling

Close liaison will be maintained between residences near the proposed Launch Site to provide effective feedback in regard to perceived problems.

A community telephone line and or email contact will be used to receive public feedback, including complaints.

Complaints or adverse reports received from any external source will be recorded and the Launch Site Manager and/or Environmental Officer will be notified for response. Records of all complaints will be kept for at least four years after the complaint was made.

All received public complaints (either written or verbal) will be documented to record the:

- Nature and extent of the complaint;
- Method by which the complaint was made;
- Name and address of the person lodging the complaint;
- Details of all related factors including location, dates, frequency, duration, site conditions and effects of the complaint; and
- Action taken to address the complaint including follow up contact with the complainant.

The Launch Site Manager and/or Environmental Officer will record the details of all complaints received in an up-to-date log-book to ensure that a response is provided to the complainant within 24 hours or as soon as practicable.

The Launch Site Manager, or their nominee, shall investigate and determine appropriate corrective/preventive actions to be taken to address all complaints. The complainant will be informed in writing of the results of the investigation and action to be taken to rectify or address the matter(s). Where no action is taken the reasons why are to be recorded.

Corrective actions may involve supplementary monitoring to identify the source of the non-conformance, and/or may involve modification of operational techniques to avoid any recurrence or minimise its adverse effects.

4.4 Incident and Emergency Response

A key objective of this OEMP is to identify potential risks, and to develop, and maintain measures to manage them.

The Applicant 's approach to incident and emergency response management includes:

- Risk Analysis - The identification of hazards and risks that could impact the community, environmental and operational implications.
- Prevention – The planning and documentation of prevention and mitigation activities for all major hazards, and allocation of responsibility for their implementation.
- Preparedness – The development, implementation and review of specific incident management plans and processes to manage identified risks, the training of staff, and establishment of facilities to ensure the Applicant can respond effectively to any incident.
- Response – The issue of warnings and establishment of processes for effective notification of incidents, and mobilisation of resources to combat the incident or threat.
- Recovery – The return to normal operations, management of debriefs, and implementation of lessons learnt from the response process.

The following priorities will be adopted when dealing with an incident / crisis:

- Protection of human life and welfare;
- Protection of the environment; and
- Protection of the Applicant's assets.

Potential threats to the environment or public health that may arise in relation to the operation of the proposed Launch Site:

- fire;
- deflagration of flammables;
- overflow / spillage;

- structural damage;
- power or other utility failure;
- natural disaster;
- surface water contamination, and;
- traffic accident.

4.4.1 Emergency Response Management

The Applicant will operate an Emergency Response Plan (to be included in Appendix 2) whenever an incident, emergency or crisis could lead to public health, safety or environmental issues.

5. Monitoring and Review of the OEMP

5.1 Monitoring and Reporting

Regular environmental inspections will be undertaken to ensure that environmental controls have been implemented, meet specification, and are being maintained in accordance with the current legislations as summarised in Table 5.1 below.

Table 5.1 SSC Environmental Testing and Inspection schedule

Plant/Process/Substance	Type	Frequency	Responsibility
TBC			

At completion of each inspection, any corrective actions required will be recorded and managed in a timely manner (Table 5.2).

Table 5.2 Correction Action Timetable

Priority	Action	Timeframe
Low	May not require immediate action. Monitor situation and schedule control action	Action typically required within 15 to 29 days
Medium	Control actions as soon as possible	Action typically required within 7 to 14 days
High	Significant and immediate control	Action typically required within 1-7 days

Compliance with all environmental regulatory criteria is a priority for the Applicant. Specific compliance obligations will be detailed and controlled in the supporting Environmental Management Plans to be included in Appendix 2 this OEMP. Environmental non-compliances will be managed on a case-by case basis depending on the severity of the incident as described in Table 5.3. Appropriate response process will be developed and included in the final OEMP.

Table 5.3 Incident Categories

Incident Category	Descriptor
Category 1	Major, serious, persistent and/or extensive impact or effect on the environment, people and/or property
Category 2	Significant impact or effect on the environment, people and/or property
Category 3	Minor or minimal impact or effect on the environment, people and/or property
Category 4	Substantiated incident with no impact - No measurable adverse impacts.

5.1.1 Environmental Audits

Audits will be undertaken on a regular basis to ensure that the Applicant meets compliance objectives, as well as to support continuous improvement. The audits will:

- assess the effectiveness of the OEMP in meeting operational policies and legislative and industry standards;
- determine whether the measures and/or corrective actions carried out conform to the objectives of the OEMP;
- assess the adequacy of implemented controls to minimise high risk environmental issues or operational activities; and
- identify areas for continuous improvement.

Audit reports will be maintained to enable non-conformances and opportunities for improvement identified to be recorded, reported and responded to.

5.2 Management Review

Management reviews of the OEMP will be scheduled annually to assess the continuing suitability, adequacy and effectiveness of the measures implemented.

The inputs to the management review process shall include (but not be limited to):

- audit findings; and
- incident management and investigation of non-conformance events, incidents, near misses and management of all complaints received.

The output from the management review shall include any decisions and actions related to:

- possible changes to the management plans, procedures, practices, objectives and targets associated with the environmental management of the proposed development;
- improvement of the effectiveness of the management system and its processes; and
- resource needs.

5.3 Environmental Monitoring Program

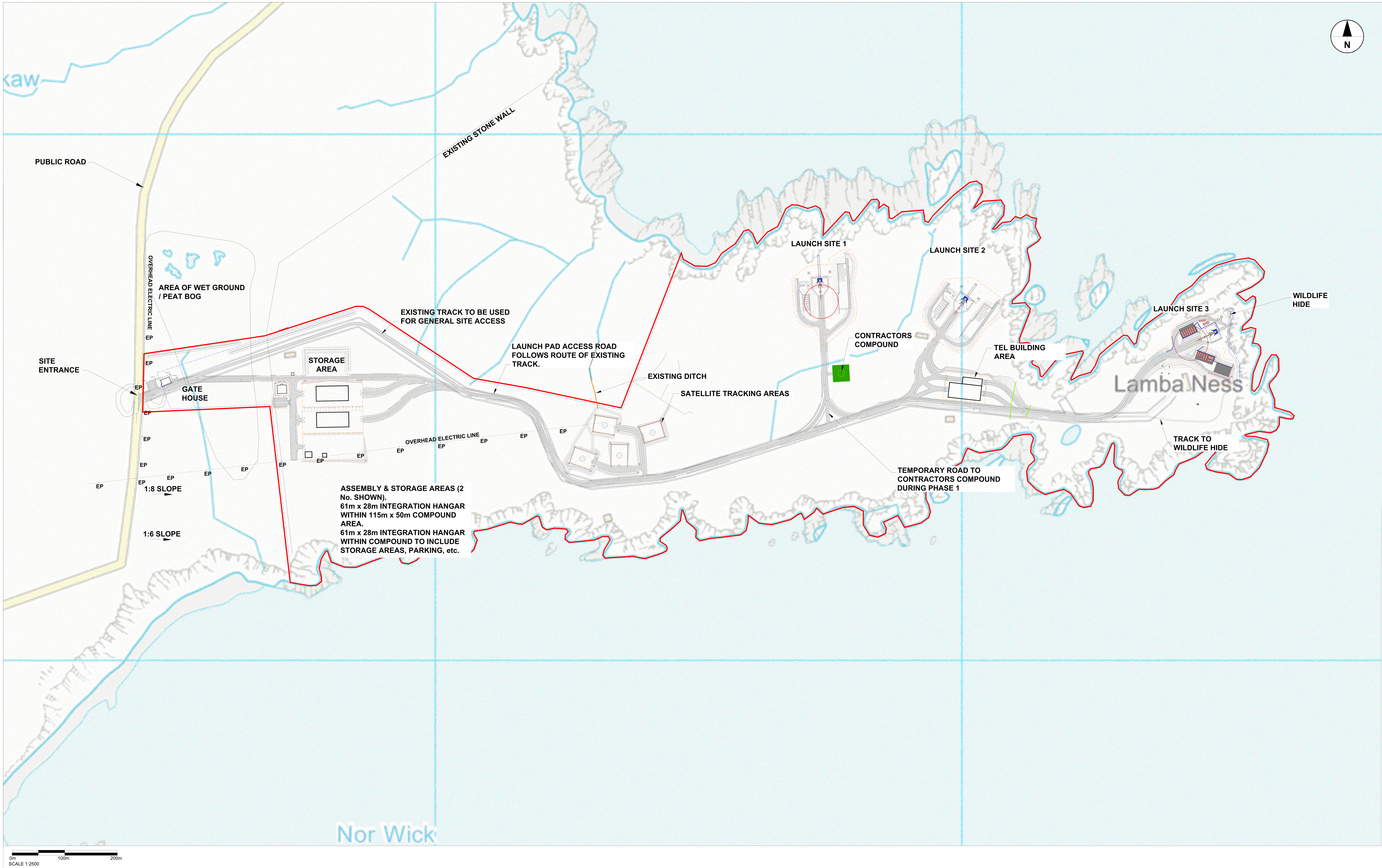
The implementation of monitoring requirements will be the responsibility of the Launch Site Manager or nominee.

Relevant monitoring requirements will be established on revision of the OOEMP and included as Appendix 3.

All sampling strategies and protocols undertaken as part of the monitoring program will be conducted in line with industry best practices. Monitoring will be performed by the Environmental Manager or other relevant party in accordance with the requirements set out in this OEMP and supporting EMPs.

Where monitoring and measuring devices are used, these will be calibrated in accordance with the manufacturer's recommendations. Records of calibration will be maintained, and the calibration status of the device will be clearly communicated.

Appendix 1 Launch Site Layout



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Notes

- PLANNING APPLICATION SITE BOUNDARY
- PROPOSED 2.44m HIGH SITE BOUNDARY FENCE
- PROPOSED 2.4m HIGH COMPOUND \ LAUNCH PAD SECURITY FENCE

Key Plan

Purpose Of Issue

FOR PLANNING

Project Number

60617516

Sheet Title

PROPOSED LAUNCH SITE LAYOUT

Sheet Number

Drawing 3.2

Scale: 1:2500@A0 **Rev:**

Appendix 2 Supporting Environmental Management Plans

(To be included on revision)

Appendix 3 Environmental Monitoring Program

(To be included on revision)

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Appendix 5.1 Breeding Bird Survey report

Appendix 5.1 Shetland Space Centre Breeding Bird Survey Non-confidential version

Alba Ecology Ltd.

2020

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Introduction

A proposal for a satellite launch facility has been made by the Applicant in north Unst, Shetland - known as the ‘Shetland Space Centre’ (SSC). As part of this proposal, Alba Ecology Ltd. was commissioned in 2017 to conduct breeding bird surveys targeted around the proposed planning application boundary on Unst. The proposed development involves the following three elements:

- Proposed Launch Site – a launch area at Lamba Ness comprising three launch pads, a satellite tracking station, launch vehicle integration buildings, roadways (largely re-using existing roads), fuel storage and ancillary infrastructure;
- Proposed Launch and Range Control Centre (LRCC) at Saxa Vord; and
- Proposed New Section of Access Road – a short stretch of new road at Northdale.

Aim

To inform the proposed development in Unst, Shetland a breeding bird survey with four main stages was undertaken.

- Survey site selection;
- Survey methodology agreed with Scottish Natural Heritage (SNH, now NatureScot);
- Breeding bird surveys of potentially affected areas; and
- Breeding bird survey report.

Survey methodology consultation

On 06/02/18 SNH was approached and consulted on the scope and scale of ecological and ornithological surveys to support a planning application for a satellite launch site at Lamba Ness, Unst by Alan Farningham of Farningham Planning Ltd. Jonathan Swale of SNH responded on 16/02/18 stating that “*Our advice on the survey work proposed by Alba Ecology and on the scope of any environmental impact assessment is set out below. As we don’t yet have full details of the proposed development and operation, this is offered on the basis of the information provided to date and without prejudice to further consideration when more details become available*”.

Jonathan Swale reported that *“the environmental assessment should consider the impacts on breeding birds of operation of the launch site, as well as its construction, so surveys should cover the area likely to be affected. Rocket launches could cause disturbance over a large area, but without information on the expected noise levels we aren’t able to advise on the likely extent of disturbance nor on the area that should be surveyed to carry out the impact assessment. It may be necessary to assess possible impacts on seabirds within Hermaness, Saxa Vord and Valla Field SPA but this will not require additional survey work as we have recent data that can be used”.*

Consideration of whimbrels within the Hill of Colvadale and Sobul SSSI was also recommended for potential works near that designated site. However, this area did not feature in the planning application boundary and so is not reported on. SNH advised that the cliffs around Lamba Ness were likely to support nesting fulmar, shag, black guillemot and possibly gulls and that these species should therefore be surveyed too.

Methods

Survey site selection

Assessing the potential effects of disturbance on bird species is a complex issue which varies depending on the type of disturbance (e.g. routine/predictable verses unusual/unexpected), topography, vegetation and the behaviour/tolerance of the bird species and even different individuals within species. Therefore, identifying a one-size-fits-all Study Area over which all potentially affected breeding bird species could be surveyed is challenging. Consequently, this was considered in a number of different ways, which are outlined below.

In Scotland, all wild birds are legally protected, but some species are considered more sensitive to human disturbance than others and they are specially protected under European, UK and Scottish legislation. Disturbance can have adverse effects on birds' breeding success, e.g. through chilling, overheating and desiccation of eggs or chicks and starvation of chicks and ultimately the abandonment of a territory. Therefore, the distance over which disturbance might potentially occur was considered particularly important when determining the breeding bird Study Area.

Very little work has taken place on the impact of disturbance on most of the species potentially present within habitats on north Unst. However, for two of these species, some guidance has been published on the distances at which they are likely to be affected by disturbance. In Ruddock and Whitfield (2007), 80% of expert opinions estimated static disturbance occurred at 500-750 m for nesting and chick-rearing red-throated divers and expert opinion suggested 'safe working distances' could exceed 500m. Ruddock and Whitfield (2007) suggested that breeding red-throated divers are sensitive to human activity, visual disturbance and sudden noise events over relatively large distances (up to 500m). Evidence from Viking Wind Farm studies in Shetland indicated that some individuals (perhaps habituated) appear to tolerate moderate levels of disturbance in some situations. The size of waterbodies also has an impact; breeding birds are more easily disturbed and fly from smaller nesting lochans (where they presumably feel more vulnerable) than larger nesting lochs, where they have the ability to swim away, without taking flight.

Similarly, breeding merlins are considered sensitive to human activity, visual disturbance and sudden noise events over large distances (up to 500 m) (Ruddock and Whitfield 2007) particularly prior to egg laying and during incubation in Shetland (the late Mark Chapman, *pers comm.*). However, individual merlins appear to tolerate moderate levels of disturbance in some situations. For example, merlins appear to be able to nest relatively close to public roads in Shetland, where regular (predictable) disturbance occurs.

Based on Ruddock and Whitfield (2007), there is some evidence and expert opinion that sudden noise events up to 500-75 0m away from two potentially affected species could be detrimental. Based on this, it might have been possible to recommend a 1 km survey buffer around the launch facilities. However, none of the potentially affected target species had been monitored in relation to sudden, relatively short-duration loud noise events of the magnitude of a satellite launch. Furthermore, at the time of Pre-app scoping (2018) and determination of the ornithological Study Area, there was no information on predicted noise levels available. Consequently, this 1 km survey buffer was not considered an adequate basis on which determine the size of the breeding bird Study Area.

EIA best practice guidance (and the EIA Regulations) requires consideration of worse-case and best-case scenarios and the subsequent reporting of *likely* effects. There is no standard guidance on potential disturbance (and so survey) distances for satellite launch facilities compared to other large-scale developments e.g. wind farms. At the time of pre-app scoping, it was not possible, based on previous experience or published information, to determine what *likely* might be in the context of this development and so a precautionary approach to determining the size of the Study Area was considered and adopted.

During pre-app scoping, there was no planning application boundary, only an indicative boundary area. As a result, an arbitrary, but very large precautionary Study Area, was selected for breeding bird surveys. According to expert opinion (Ruddock and Whitfield, 2007), the greatest distance any UK species was predicted to be affected by human induced disturbance was 1.5-2 km (for breeding golden eagle – which does not occur on Unst). Given the lack of any empirical evidence or guidance, it was decided that doubling the greatest possible disturbance distance for any UK breeding bird, i.e. a 4 km buffer from the proposed launch facility, was a legitimate precautionary basis on which to proceed with breeding bird surveys. Consequently, the size of the breeding bird Study Area (EIA Report Drawing 6.1) was much larger than the final planning application boundary area and it was centred on indicative launch site locations provided by the Applicant during Pre-app scoping discussions in 2018.

Breeding bird survey methodology

Reconnaissance

A preliminary site visit by Dr Peter Cosgrove in late autumn 2017 determined that the proposed development area was predominantly open coastal/upland habitat characterised by peatland, grassland, cliffs and plus some old military buildings.

The principal land use of the Study Area was sheep grazing through crofting and common grazings. There was potential for several specially protected bird species to be present so breeding bird surveys were conducted under a SNH Schedule 1 licence.

Photo 1. Typical view of the satellite launch facility part of Study Area, taken from Ward of Norwick, overlooking Swartling and Inner Skaw east towards The Garths and Lamba Ness.

Moorland breeding bird surveys

The modified Brown and Shepherd (1993) Moorland Breeding Bird survey is the standard survey technique for moorland/upland breeding birds (Gilbert *et al*., 1998) and is described in the SNH online guidance (e.g. SNH 2005; and subsequent updates). The Brown and Shepherd methodology is based on a constant search method involving spending 25 minutes in each 500 m × 50 0m quadrant, within the study area. This equates to spending 100 minutes for every km^2. Each quadrant was walked to ensure that all parts were approached to within 100m. At regular intervals, the surveyor paused, scanned the area for species and listened out for calls and songs. All registrations were marked on a 1:25,000 scale map using British Trust for Ornithology symbols with a note of the species activity. The main habitat was defined as open moorland so this survey technique was used across all parts of the Study Area. However, there were some wetter/marshy areas in the Study Area which were observed from the nearest edge.

Population estimates of birds in the Study Area were derived by comparing the summary maps for each of the breeding survey visits. Registrations/territories plotted during each period were considered to be separate from one another if more than approximately 500m apart for larger species, 300 m in the case of smaller species. If there was any doubt about whether more than one pair of birds was present in an area, the surveyor would sit quietly nearby and observe the behaviour, gender and number of birds present as per Brown and Shepherd's 1993 survey methodology. When compiling figures of breeding birds, the approximate central location of all registrations recorded from different visits is used to identify a notional territory centre (the species 'dot' on the relevant figure) where a nest was not discovered. Surveys were undertaken in 2018 and 2019 as per consultation agreement with SNH.

Breeding raptor surveys

SNH provides clear guidance in relation to raptor sensitivities and survey effort (2005; and subsequent updates). The only regularly occurring and widespread breeding raptor in Shetland is merlin, although both kestrel and peregrine are occasionally recorded breeding in Shetland and in 2018-2019 sparrowhawk was recorded breeding in Shetland for the first time (Shetland Bird Club, 2020). Breeding raptor surveys were undertaken to determine the location of any breeding merlins within the Study Area using standardised merlin survey methods (e.g. as per Hardey *et al*., 2013). These surveys also covered potential breeding habitats of kestrel and peregrine, were they to be present. Surveys were undertaken in 2018 and 2019 as per agreement with SNH.

Breeding red-throated diver surveys

Searches were made for breeding red-throated divers within the Study Area. Following SNH guidance, searches for nesting red-throated divers were undertaken on all potentially suitable waterbodies within the Study Area. The waterbodies were visited at least twice during the breeding season if nothing was present. However, if the water body was occupied, sites were revisited later in the breeding season to determine nest locations and breeding success. Surveys were undertaken in 2018 and 2019 as per agreement with SNH.

Black guillemot

Black guillemots breed on the coast, preferentially near shallow water and their nests are typically in natural holes, crevices, caves and boulder beaches (Gilbert *et al*., 1998). Black guillemots usually nest in pairs or in small groups scattered along the coast and so surveys should therefore aim to cover sections of coastline rather than discrete 'colonies'. The standard survey methodology for this species highlights that '*nest-sites are difficult to count with any accuracy because of their scattered distribution and inaccessibility. Carefully timed counts of individual adults provide the most accurate* [survey] *method*' (Gilbert *et al*., 1998).

The black guillemot survey methodology requires two survey visits a week or more apart, preferably during the first three weeks of April, although counts later in April or early May also acceptable (Gilbert *et al*., 1998). Two survey visits were undertaken in April 2018 and 2019 (as per agreement with SNH). The surveys were conducted from first light until particular defined cliff reaches were surveyed, during suitable, calm and clear weather conditions (as per Gilbert *et al*., 1998).

The surveyor was specifically required to make a note of any substantial cliff reaches where land-based surveys were not possible due inaccessibility or health and safety considerations. As it turned out, most of the potentially suitable black guillemot breeding habitat could be surveyed from land (which SNH advised would likely be the case) and so surveys proceeded on that basis. The surveyor, who was familiar with the Study Area, moved along the coast counting all black guillemots on the sea, within about 300 m of the shore and any that were on land. Repeat counts were also undertaken in the afternoon for some reaches for comparative purposes.

Cliff nesting seabirds

Other cliff nesting seabirds were potentially present and required survey: fulmar, shag, guillemot, razorbill, puffin and possibly gulls. The standard method for surveying cliff nesting seabirds requires the number of individual adult birds per visit recorded (also known as max number of Apparently Occupied Nests (AON) from any one visit), which can be summed, and a mean produced over different survey visits undertaken. The standard survey guidance recommends between two to five survey visits. Given the nature of the Study Area, with no low tide beach below the steep cliffs, boat-based counts were undertaken between the eastern edge of the Hermaness, Saxa Vord and Valla Field SPA (approximately Virdik) and The Nev (southeast of Hill of Clibberswick), as per agreement with SNH. No climbing down a cliff to count breeding birds was undertaken.

Puffins are difficult to census due to their use of burrows, often in inaccessible locations. The most reliable way they are monitored is by long-term monitoring of Apparently Occupied Burrows (AOB) from sample areas, rarely possible in Shetland due to the steep and inaccessible nature of the terrain (Mitchell *et al.,* 20014). When these burrows cannot be accessed, as was the case within the Study Area, the standard survey methodology is to count individual birds on land, which provides a rough estimate of numbers present. However, in Shetland such previous counts have taken place at the same time as the optimal count for other cliff nesting seabirds in June, when it is known that non breeders also attend colonies and so can inflate numbers of presumed breeders present (Owen *et al.,* 2018).

The razorbill, guillemot and shag standard survey methods recommend surveys in the first three weeks of June in north of Scotland in 'normal years' (June or July for gannets, June for fulmar, early-mid June for kittiwake). Consequently, boat-based surveys were scheduled for the first three weeks of June given the main species likely to be present on the cliffs (and well-spaced across these 3 weeks). The two main sources of seabird survey guidance were followed: Gilbert *et al*., (1998) and JNCC Seabird Monitoring Handbook (Walsh *et al*., 2011).

Following this best practice guidance, the following measures were undertaken:

- Suitable health and safety measures were enacted, and the boat was operated by an experienced and trained skipper and life jackets were worn at all times.
- The boat was manoeuvred a suitable distance offshore for surveying to ensure that count position was not close enough to disturb the cliff nesting seabirds.
- For ease of counting, each area of cliff was defined into distinct units for monitoring and recording purposes. These were marked on a map to aid recording purposes.
- Counts were undertaken during the day between 0900 and 1600.
- Counts were replicated, by two highly experienced ornithological surveyors (David Cooper and Brydon Thomason) at the same time.
- The first and third boat-based trips were counted from south to north and the second from north to south in an attempt to reduce any potential 'time of day' bias.
- Foggy and/or wet and windy conditions were avoided. Surveys were planned for, and undertaken on, calm days with good visibility.
- Any parts of the cliff survey area that were not visible for survey were noted.

Further methodological detail on how each seabird species was counted is provided within the JNCC Seabird Monitoring Handbook (Walsh *et al*., 2011). These survey methods and proposed personnel were discussed and agreed with Glenn Tyler at SNH (in a phone call on 24/05/18). Glen Tyler agreed that this approach was suitable and that three-separate boat-based surveys spread across the first three weeks of June during suitable weather conditions was standard and '*sounded ideal*', given the information available at the time. Surveys were undertaken in 2018 as per agreement with SNH.

During data sharing with SNH in 2020 it became apparent that existing bird data for the SPA did not exist for the whole Hermaness, Saxa Vord and Valla Field SPA area. The SPA extends to Virdik but only the marine extension – it does not include the cliffs, which is the only section SNH monitors. Consequently, a gap in cliff nesting seabird data for the area between Virdik and Ura was identified. Fortuitously, this data gap was identified in May 2020, allowing boat-based seabird surveys to be organised for the relevant section of cliff in June 2020, which also coincided with the relaxation of COVID-19 restrictions for outdoor work. The same surveyors who undertook the 2018 boat-based seabird surveys conducted three boat-based seabird surveys between Virdik and Ura in June 2020.

Results

The Study Area was surveyed under SNH Schedule 1 licence for breeding birds in 2018 and 2019 by David Cooper. David Cooper and Brydon Thomason undertook boat-based seabird counts in 2018 and 2020. In 2020 David Cooper surveyed the Application Boundary during the breeding season to inform summer survey visits by SSC staff and other non-ornithological surveyors e.g. archaeologists. Both David Cooper and Brydon Thomason are highly experienced and locally based ornithologists and used the relevant standard breeding bird survey methods during suitable weather conditions.

A total of 135 bird species were recorded in the Study Area during 2018 and 2019 breeding bird surveys. For full list of species recorded, see Appendix 1 to this report; this report focusses on potential target species requiring consideration in the context of the proposed development.

Target species are considered individually below:

Whooper swan *Cygnus cygnus*

Amber List, Schedule 1, Annex 1 species. No evidence of breeding in the Study Area.

A single adult was seen in flight, flying east over Millfield on 21st April 2018. No whooper swans were recorded during 2019 surveys.

Barnacle goose *Branta leucopsis*

Amber List, Annex 1 species. No evidence of breeding in the Study Area.

A flock of five were seen at Lamba Ness on 7th May 2018. A flock of ten were seen in flight, flying northwest over Saxa Vord hill on the 10th May 2018. A singleton was seen at Lamba

Ness on the 9th June 2018. A pair was seen at Hill of Clibberswick and Millfield on the 9th June 2018 but on no other dates. No Barnacle geese were recorded during 2019 surveys.

Long-tailed duck *Clangula hyemalis*

Schedule 1 species. No evidence of breeding in the Study Area.

A single drake in summer plumage was seen at Skaw throughout June 2018. No records of long-tailed duck during 2019 surveys. In all but three years since 1970, the species has been recorded into at least June in Shetland. In many years, occasional singletons have been seen in July and August, but there has never been any suggestion of breeding (Pennington *et al*., 2004).

Quail *Coturnix coturnix*

Amber List, Schedule 1 species. Evidence of potential breeding in the Study Area.

No birds heard or seen in 2018. Two records of singing birds heard on territory during June 2019, but not further evidence of potential breeding was recorded.

Red-throated diver *Gavia stellata*

Amber List, Schedule 1, Annex 1 species. Evidence of multiple pairs breeding in the Study Area.

Two breeding attempts in the Study Area in 2018 and 2019 (EIA Report Confidential Drawing 1).

Numerous encounters were logged across the whole site including at Lamba Ness, Norwick and Skaw, involving display flights and typical noisy aerial territorial disputes seen throughout both summer breeding seasons.

Black-throated diver *Gavia arctica*

Amber List, Annex 1 species. No evidence of breeding in the Study Area.

A single adult in summer plumage was seen at Lamba Ness and Norwick on the 1st June 2018. No records of black-throated diver were recorded during 2019 surveys.

Great northern diver *Gavia immer*

Amber List, Annex 1 species. No evidence of breeding in the Study Area.

Numerous encounters logged on the sea in 2018 including at Lamba Ness, Norwick and Skaw spanning the months April to June, with a maximum of three individuals together seen at Lamba Ness in April. A lone individual was seen in Norwick in June in summer plumage.

Great northern divers were recorded each month between April and July in Norwick Bay in 2019.

Black guillemot *Ceppus grylle*

Two black guillemot surveys were undertaken in both 2018 and 2019. In 2018, the first was on 10-12th April 2018 and the second on 18-20th April 2018. In 2019, the first was on 11-13th April and the second on 28-30th April 2019. The locations of black guillemots are presented in EIA Report Drawing 6.3. The maximum count in 2018 was 84 black guillemots with 101 individuals in 2019.

Cliff nesting seabirds

The summary results in Table 1 refer to three boat-based counts undertaken on 13th, 17th and 29th of June 2018. These surveys covered the coast/cliffs from Virdik, east and southwards down to The Nev (southeast of Hill of Clibberswick). EIA Report Drawings 6.4-6.9 present individual seabird counts in relation to the distance from proposed launch sites.

Table 1. Boat-based seabird cliff counts, Virdik to The Nev, Northeast Unst, June 2018

Species	AON 13/06/18	AON 17/06/18	AON 29/06/18
Shag *Phalacrocorax aristotelis*	55	42	42
Fulmar *Fulmarus glacialis*	3,460	3,895	4,330
Kittiwake *Rissa tridactyla*	53	55	55
Great black-backed gull *Larus marinus*	2	1	1
Guillemot *Uria aalge**	48	80	62
Razorbill *Alca torda**	6	11	8
Puffin *Fratercula arctica**	18	49	41

*Total number of individual adults on land recorded – not AON.

The summary results in Table 2 refer to three boat-based counts undertaken on 10th, 13th and 24th June 2020. These surveys covered the coast/cliffs from Virdik, west to Ura (immediately south of The Noup).

Table 2. Boat-based seabird cliff counts, Virdik to Ura, Northeast Unst, June 2020

Species	AON 10/06/20	AON 13/06/20	AON 24/06/20
Shag	22	25	26
Fulmar	2,495	2,601	2,657
Kittiwake	0	0	0
Great black-backed gull	5	6	6
Herring gull *Larus argentatus*	5	5	4
Guillemot*	9	17	20
Razorbill*	2	4	0
Puffin*	76	37	38

*Total number of individual adults on land recorded – not AON.

Black kite *Milvus migrans*

Annex 1 species. No evidence of breeding in the Study Area.

No records of black kite during 2018 surveys. Single record of a black kite in April 2019 at Battles Kirk, Northwick.

White-tailed eagle *Haliaeetus albicilla*

Red List, Schedule 1 species. No evidence of breeding in the Study Area.

No records of white-tailed eagle during 2018 surveys. Two records of a single individual in May 2019 in Norwick and Ward of Norwick.

Marsh harrier *Circus aeruginosus*

Amber List, Annex 1 species. No evidence of breeding in the Study Area.

A single immature male was seen at Norwick on the 24th April 2018. Three records of marsh harrier in April 2019 in Skaw, with a single female recorded in June 2019 at Northdale.

Merlin *Falco columbarius*

Amber List, Schedule 1, Annex 1 species. Evidence of breeding probably near to the Study Area.

One nearby successful breeding attempt in 2018. A brood of three fledged recorded around Northdale. Despite searching, no merlin nest was recorded within the Study Area and it is not known where the fledged brood came from.

One nearby successful breeding attempt in 2019. A female with fledged juveniles was recorded between Skaw and Inner Skaw. Despite searching, no merlin nest was recorded within the Study Area and it is not known where the fledged brood came from.

Peregrine *Falco peregrinus*

Schedule 1, Annex 1 species. No evidence of breeding in the Study Area.

A single female was seen at Hill of Clibberswick, Norwick and Swartling on 25th May 2018. A total of three single individuals were recorded during 2019 breeding season surveys between months of April and June in Skaw and Ward of Norwick.

Crane *Grus grus*

Amber List, Annex 1 species. No evidence of breeding in the Study Area.

A single individual was seen at Feall on the 20th April 2018 and in flight over Millfield on the 21st April 2018. No records of common crane during 2019 surveys.

Ringed plover *Charadrius hiaticula*

Red List species. Evidence of multiple pairs breeding in the Study Area.

Nine breeding pairs were recorded in 2018 and ten breeding pairs recorded in 2019 (EIA Report Drawing 6.10). Most of the pairs were found at Skaw, Lamba Ness and Norwick.

Golden plover *Pluvialis apricaria*

Amber List, Annex 1 species. Evidence of multiple pairs breeding in the Study Area.

Seven breeding pairs were recorded in 2018 and 13 pairs in 2019 in the Study Area (EIA Report Drawing 6.12). Breeding pairs were distributed throughout the Study Area including at Saxa Vord, Sothers Field, Northdale, Housi Field, Hill of Clibberswick and Swartling.

Whimbrel *Numenius phaeopus*

Red List, Schedule 1 species. Evidence of multiple pairs breeding in the Study Area.

There were five breeding territories in 2018 and four in 2019 (EIA Report Confidential Drawing 2).

Curlew *Numenius arquata*

Red List species. Evidence of multiple pairs breeding in the Study Area.

There were circa.16 breeding territories in 2018 and circa 13 in 2019 (EIA Report Drawing 6.14). Given the distances breeding curlews can move, it is possible that some territories have been double-counted and without colour ringing it is not possible to be certain. Nevertheless, in areas where multiple territories have been plotted close together e.g. Norwick Meadows, there was direct evidence of multiple pairs being present within a relatively small area.

Dunlin *Calidris alpine*

Amber List, Annex 1 race (*C. a. schinzii*). Evidence of breeding in the Study Area.

Five breeding territories were recorded in 2018 and four breeding territories recorded in 2019 (EIA Report Drawing 6.16). Breeding territories were located in areas including Saxa Vord hill, Southers Field, Skaw, Lamba Ness and Housi Field.

Black-tailed godwit *Limosa limosa*

Red List, Schedule 1 species. No evidence of breeding in the Study Area.

A single individual was recorded in suitable breeding habitat, but no evidence of breeding was recorded.

Greenshank *Tringa nebularia*

Amber List, Schedule 1 species. No evidence of breeding in the Study Area.

A single individual was seen along the coast at Wick of Skaw in June 2019. No records of greenshank during 2018 surveys.

Wood sandpiper *Tringa glareola*

Amber List, Annex 1 species. No evidence of breeding in the Study Area.

A single individual was seen at Millfield on the 30th July 2018. No records of wood sandpiper during 2019 surveys.

Arctic skua *Stercorarius parasiticus*

Red List species. Evidence of multiple pairs breeding in the Study Area.

Five pairs of arctic skua recorded breeding in the Study Area in 2018 and 2019 (EIA Report Drawing 6.19). Pairs occupied territories both years in areas including Hill of Clibberswick, Ward of Norwick and Inner Skaw.

Great skua *Stercorarius skua*

Amber List. Highly variable numbers of great skua were recorded during surveys breeding in the Study Area, reflecting the social nature of this species.

Large numbers of non-breeding great skua can hold territory in apparently suitable breeding habitats, making accurate estimates of actual number breeding difficult and with a high degree of uncertainty. It is considered that the number of breeding pairs within the Study Area is likely to be in the low tens, with breeding birds mainly concentrated over 3 km away from the nearest launch pad (EIA Report Drawing 6.21). Great skua numbers were concentrated around Saxa Vord hill e.g. with minimum 17 nests recorded in June 2018 and groups of presumed non-breeders numbering up to 90 individuals. Additionally, within the 3 km to 4 km buffer, smaller numbers of great skua were recorded at Sothers Field and Housi Field.

Sandwich tern *Sterna sandvicensis*

Amber List, Annex 1 species. No evidence of breeding in the Study Area.

A single individual was seen offshore at both Norwick and Skaw on five dates from the 31st March 2018 until the 16th July 2018. No records of sandwich tern during 2019 surveys.

Common tern *Sterna hirundo*

Amber List, Annex 1 species. No evidence of breeding in the Study Area.

The first returning individual was noted at Norwick on the 8th May 2018. Whilst there were then multiple sightings typically of single individuals at Haroldswick and Norwick throughout the summer breeding was never proven. In 2019, individuals were recorded in Wick of Skaw in May and July, but breeding was never proven.

Arctic tern *Sterna paradisaea*

Amber List, Annex 1 species. Multiple pairs breeding in the Study Area.

Several small breeding colonies were present within the Study Area (EIA Report Drawing 6.18) with one pair on Hill of Clibberswick in 2018, two pairs in 2018 and three pairs in 2019 on Norwick beach and six pairs in 2018 and ten pairs in 2019 at Skaw.

Red-backed shrike *Lanius collurio*

Red List, Schedule 1, Annex 1 species. No evidence of breeding in the Study Area.

A female was present at Haroldswick on 26th May 2018. A male was present at Inner Skaw and Swartling on 28th and 29th May 2018. A pair were present (the male was singing) at Northdale for a few days from the 28th May 2018. Three records of red-backed shrike were recorded in 2019, a female in May at Clibberswick, a female in June at Inner Skaw and two females in Northdale in June.

Black redstart *Phoenicurus ochruros*

Schedule 1 species. No evidence of breeding in the Study Area.

Single record of a black redstart at Saxa Vord in April 2019. No records of black redstart during 2019 surveys.

Bluethroat *Luscinia svecica*

Annex 1 species. No evidence of breeding in the Study Area.

A single male was singing at Millfield on 11-12th May 2018 and a single was recorded in May 2019. A single male was present at Valyie and Norwick beach on the 14-15th May 2018.

DISCUSSION

Scottish Planning Policy requires that the presence (or potential presence) of legally protected bird species such as Schedule 1 and Annex 1 species is factored into the planning and design of development proposals, and that any impacts on such protected species are fully considered prior to the determination of planning applications.

There is direct evidence from the Study Area of potentially sensitive and specially protected target bird species breeding within, and adjacent to, the proposed planning application boundary (Table 3) and so these need to be considered further in relation to the proposed development.

Table 3. Regularly recorded, potentially sensitive and specially protected breeding birds (2018-2020) within 4 km of SSC launch sites (approximately between Ura and The Nev).

Species	Within 0.5km of launch sites	0.5-1km of launch sites	1-2km of launch sites	2-3km of launch sites	3-4km of launch sites
Red-throated diver pairs	2018 = 0 2019 = 0	2018 = 0 2019 = 0	2018 = 0 2019 = 0	2018 = 1 2019 = 0	2018 = 1 2019 = 2
Black guillemot individuals	2018 = 14 2019 = 13	2018 = 8 2019 = 12	2018 = 27 2019 = 25	2018 = 25 2019 = 26	2018 = 10 2019 = 25
Puffin individuals	2018 = 2	2018 = 6	2018 = 27	2018 & 2020 = 23	2018 & 2020 = 67*
Guillemot individuals	2018 = 0	2018 = 0	2018 = 27	2018 & 2020 = 20	2018 & 2020 = 53*
Razorbill individuals	2018 = 0	2018 = 0	2018 = 0	2018 & 2020 = 2	2018 & 2020 = 13*
Shag AON	2018 = 1	2018 = 0	2018 = 5	2018 & 2020 = 24	2018 & 2020 = 51*
Kittiwake AON	2018 = 0	2018 = 0	2018 = 50	2018 & 2020 = 0	2018 & 2020 = 5*
Great black-backed gull AON	2018 = 0	2018 = 0	2018 = 2	2018 & 2020 = 2	2018 & 2020 = 3*
Herring gull AON	2018 = 0	2018 = 0	2018 = 0	2018 & 2020 = 2	2018 & 2020 = 3*
Fulmar AON	2018 = 430	2018 = 740	2018 = 1,465	2018 & 2020 = 2,645	2018 & 2020 = 1,707*
Ringed plover pairs	2018 = 3 2019 = 3	2018 = 0 2019 = 0	2018 = 4 2019 = 5	2018 = 2 2019 = 1	2018 = 0 2019 = 1
Golden plover pairs	2018 = 0 2019 = 1	2018 = 0 2019 = 0	2018 = 2 2019 = 3	2018 = 1 2019 = 5	2018 = 4 2019 = 4
Whimbrel pairs	2018 = 1 2019 = 1	2018 = 1 2019 = 1	2018 = 1 2019 = 1	2018 = 2 2019 = 1	2018 = 0 2019 = 0
Curlew pairs	2018 = 0 2019 = 1	2018 = 0 2019 = 0	2018 = 3 2019 = 2	2018 = 5 2019 = 5	2018 = 8 2019 = 5
Dunlin pairs	2018 = 0 2019 = 1	2018 = 0 2019 = 0	2018 = 2 2019 = 2	2018 = 1 2019 = 0	2018 = 2 2019 = 1
Red-necked phalarope nests	2018 = 0 2019 = 0	2018 = 0 2019 = 0	2018 = 1 2019 = 1	2018 = 0 2019 = 0	2018 = 0 2019 = 0
Arctic skua pairs	2018 = 0 2019 = 0	2018 = 1 2019 = 1	2018 = 1 2019 = 2	2018 = 3 2019 = 2	2018 = 0 2019 = 0
Arctic tern pairs	2018 = 0 2019 = 0	2018 = 0 2019 = 0	2018 = 8 2019 = 13	2018 = 1 2019 = 0	2018 = 0 2019 = 0

*Does not include a very small part of the SPA i.e. from Ura northwards to the Luig, the ca. 4km Study Area boundary.

Note, the individual cliff nesting seabirds recorded between Ura and The Nev are considered 'wider countryside species' and not part of the nearby SPA.

Without doubt, potentially sensitive and specially protected breeding birds could be adversely affected by the proposed satellite launch facility and so a Breeding Birds Protection Plan will be required to be implemented. At the time of writing this report (July 2020) there was no information on likely noise levels from the launch facility. Consideration of potential impacts of satellite launches will be considered within the Environmental Impact Assessment Report (EIA Report). In the meantime, all bird figures/drawings produced have 0.5km, 1 km, 2 km, 3 km and 4 km buffers illustrated to help estimate distances from the proposed launch facilities.

The magnitude of potential effects from the proposed Saxa Vord and Northdale road extension areas is considered likely to be typical of any standard type of construction development and will be considered as such within the EIA Report.

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APPENDIX 1 – BIRD SPECIES RECORDED IN SCC STUDY AREA APRIL-JULY 2018/19

1. Mute swan, *Cygnus olor*
2. Whooper swan, *Cygnus cygnus*
3. Pink-footed goose, *Anser brachyrhynchus*
4. White-fronted goose, *Anser albifrons*
5. Greylag goose, *Anser anser*
6. Canada goose, *Branta canadensis*
7. Barnacle goose, *Branta leucopsis*

8. Shelduck, *Tadorna tadorna*
9. Wigeon, *Anas penelope*
10. Teal, *Anas crecca*
11. Green-winged teal, *Anas carolinensis*
12. Mallard, *Anas platyrhynchos*
13. Pintail, *Anas acuta*
14. Shoveler, *Anas clypeata*
15. Eider, *Somateria mollissima*
16. Long-tailed duck, *Clangula hyemalis*
17. Common scoter, *Melanitta nigra*
18. Red-breasted merganser, *Mergus serrator*
19. Goosander, *Mergus merganser*
20. Red grouse, *Lagopus lagopus*
21. Quail, *Coturnix coturnix*
22. White-billed diver, *Gavia adamsii*
23. Red-throated diver, *Gavia stellata*
24. Black-throated diver, *Gavia arctica*
25. Great Northern diver, *Gavia immer*
26. Slavonian grebe *Podiceps auritus*
27. Fulmar, *Fulmarus glacialis*
28. Manx shearwater, *Puffinus puffinus*
29. Shag, *Phalacrocorax aristotelis*
30. Grey heron, *Ardea cinerea*
31. Black kite, *Milvus migrans*
32. White-tailed eagle, *Haliaeetus albicilla*
33. Marsh harrier, *Circus aeruginosus*
34. Hen harrier, *Circus cyaneus*
35. Sparrowhawk, *Accipiter nisus*
36. Osprey, *Pandion haliaetus*
37. Kestrel, *Falco tinnunculus*
38. Merlin, *Falco columbarius*
39. Peregrine, *Falco peregrinus*
40. Water rail, *Rallus aquaticus*
41. Moorhen, *Gallinula chloropus*
42. Coot, *Fulica atra*
43. Crane, *Grus grus*
44. Oystercatcher, *Haematopus ostralegus*
45. Ringed plover, *Charadrius hiaticula*
46. Golden plover, *Pluvialis apricaria*
47. Lapwing, *Vanellus vanellus*
48. Knot *Calidris canutus*
49. Sanderling, *Calidris alba*
50. Dunlin, *Calidris alpine*
51. Jack snipe, *Lymnocryptes minimus*
52. Snipe, *Gallinago gallinago*
53. Woodcock, *Scolopax rusticola*
54. Black-tailed godwit, *Limosa limosa*
55. Whimbrel, *Numenius phaeopus*
56. Curlew, *Numenius arquata*
57. Redshank, *Tringa tetanus*
58. Greenshank, *Tringa nebularia*

59. Green sandpiper, *Tringa ochropus*
60. Wood sandpiper, *Tringa glareola*
61. Common sandpiper, *Actitis hypoleucos*
62. Turnstone, *Arenaria interpres*
63. Arctic skua, *Stercorarius parasiticus*
64. Long-tailed skua, *Stercorarius longicaudus*
65. Great skua, *Stercorarius skua*
66. Black-headed gull, *Chroicocephalus ridibundus*
67. Common gull, *Larus canus*
68. Lesser black-backed gull, *Larus fuscus*
69. Herring gull, *Larus argentatus*
70. Great black-backed gull, *Larus marinus*
71. Kittiwake, *Rissa tridactyla*
72. Sandwich tern, *Sterna sandvicensis*
73. Arctic tern, *Sterna paradisaea*
74. Common tern, *Sterna hirundo*
75. Guillemot, *Uria aalge*
76. Razorbill, *Alca torda*
77. Black guillemot, *Cepphus grille*
78. Puffin, *Fratercula arctica*
79. Rock dove, *Columba livia*
80. Woodpigeon, *Columba palumbus*
81. Collared dove, *Streptopelia decaocto*
82. Long-eared owl, *Asio otus*
83. Short-eared owl, *Asio flammeus*
84. Skylark, *Alauda arvensis*
85. Shore lark, *Eremophila alpestris*
86. Sand martin, *Riparia riparia*
87. Swallow, *Hirundo rustica*
88. House martin, *Delichon urbicum*
89. Meadow pipit, *Anthus pratensis*
90. Rock pipit, *Anthus petrosus*
91. Grey wagtail, *Motacilla cinerea*
92. Pied/white wagtail, *Motacilla alba*
93. Robin, *Erithacus rubecula*
94. Wren, *Troglodytes troglodytes*
95. Dunnock, *Prunella modularis*
96. Bluethroat, *Luscinia svecica*
97. Black redstart, *Phoenicurus ochruros*
98. Redstart, *Phoenicurus phoenicurus*
99. Whinchat, *Saxicola rubetra*
100. Stonechat, *Saxicola torquatus*
101. Wheatear, *Oenanthe Oenanthe*
102. Ring ouzel, *Turdus torquatus*
103. Blackbird, *Turdus merula*
104. Fieldfare, *Turdis pilaris*
105. Song thrush, *Turdus philomelos*
106. Redwing, *Turdus iliacus*
107. Sedge warbler, *Acrocephalus schoenobaenus*
108. Marsh warbler, *Acrocephalus palustris*
109. Icterine warbler, *Hippolais icterina*

110. Blackcap, *Sylvia atricapilla*
111. Garden warbler, *Sylvia borin*
112. Lesser whitethroat, *Sylvia curruca*
113. Whitethroat, *Sylvia communis*
114. Greenish warbler, *Phylloscopus trochiloides*
115. Chiffchaff, *Phylloscopus collybita*
116. Willow warbler, *Phylloscopus trochilus*
117. Goldcrest, *Regulus regulus*
118. Spotted flycatcher, *Muscicapa striata*
119. Pied flycatcher, *Ficedula hypoleuca*
120. Red-backed shrike, *Lanius collurio*
121. Jackdaw, *Corvus monedula*
122. Rook *Corvus frugilegus*
123. Hooded crow, *Corvus cornix*
124. Raven, *Corvus corax*
125. Starling, *Sturnus vulgaris*
126. House sparrow, *Passer domesticus*
127. Tree sparrow, *Passer montanus*
128. Chaffinch, *Fringilla coelebs*
129. Brambling, *Fringilla montifringilla*
130. Twite, *Linaria flavirostris*
131. Common rosefinch, *Carpodacus erythrinus*
132. Lapland bunting, *Calcarius lapponicus*
133. Snow bunting, *Plectrophenax nivalis*
134. Black-headed bunting, *Emberiza melanocephala*
135. A confidential Schedule 1 species

Appendix 5.2 Background Literature Review

Appendix 5.2 Background Literature Review of Potential Noise Impacts on Birds for the Shetland Space Centre

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Background literature review of potential noise impacts on birds for the Shetland Space Centre

Can loud noises from rocket launches kill birds? There is no evidence found from the published literature, with lots of photos demonstrating that the noise from much larger rockets than those proposed at the Shetland Space Centre has not instantly killed the birds in the pictures (note a very small number of birds have been killed during launches due to direct collision with the rocket). Two examples of typical launch photos from on-line are provided below.


There are two components to noise, frequency measured in Hertz (Hz) and loudness measured in decibels (dB). The decibel scale is logarithmic, so the difference between the noise at 90dB is ten times that of 80dB, and 100dB is 100 times louder than 80dB.

The general structure of birds' ears shows little variation between species (Encyclopaedia Britannica, 2020). Birds hearing is sensitive, with birds able to detect shorter and lower sounds than humans. The hearing range of a typical bird is between 100Hz to 8-10kHz, sensitivity at 0-10dB, hearing best between 1-4kHz (Beason, 2004) with some species hearing range extending up to 12kHZ (Cotanche, 2008). For comparison, human hearing range is typically between 20 to 20kHz. Data on hearing range is available for one of the species of interest to the proposed development; puffin (*Fratercula arctica*) which has a hearing range 500Hz to 8kHz (Mooney *et al.* 2019). As rockets launch noise is concentrated in the low to mid frequencies (Lubert, 2017), well within both puffin and a typical birds' hearing range, it is fair to conclude that rocket/satellite launch noise frequencies will be audible to all species potentially impacted by the proposed Shetland Space Centre (SSC) development.

Noise in general has been shown to impact on wildlife populations, reducing biodiversity including birds, causing for example stress and affecting productivity and immune function (Wolfenden, 2017). Additionally, proximity to infrastructure (and perhaps associated noise) has been shown to reduce breeding productivity in some species; for example, red-necked phalarope (*Phalaropus lobatus*) breeding in Alaska (Liebezeit *et al.* 2009). Response to noise will depend on how far away an animal is from the noise source, as noise attenuates (i.e. reduces) over distance (Bowles, 1995).

Much of the literature available on noise has studied the effect of chronic noise on bird populations. Chronic and frequent noise interferes with an organism's ability to detect important sound (Francis & Barber, 2013) and has been demonstrated to reduce reproductive success in for example great tit (*Parus major*), a common woodland species (Halfwerk *et al.* 2011). In addition to a reduction in reproductive success, long term exposure to road traffic noise can cause oxidative stress. In nestling tree swallow (*Tachycineta bicolor*) oxidative stress is associated with ageing and an increased risk of disease, thus both the increased oxidative stress and smaller nestling size from road noise demonstrates the potential for exposure to loud noise to result in long term impacts for an individual which may ultimately be seen at a population level (Injaian *et al.* 2018). Behaviour may be adapted to offset the effects of chronic noise, for example, chiffchaff (*Phylloscopus collybita*) reduce the frequency of their song in response to chronic airport noise (Wolfenden *et al*. 2019) to facilitate communication.

Although the impacts of chronic noise are relatively well studied, chronic noise studies may be of limited relevance in considering the impact of much louder impulsive occasional noise (a short duration noise event that occurs over a range of frequencies) experienced during rocket/satellite launches. Loud noise events are often reacted to as a threat by birds (Francis & Barber, 2013), causing them to alter behaviour in response. As such impulsive events by their nature are infrequent, and so habituation to these events is considered less likely.

Impacts of impulsive noise can be divided into lethal, sub-lethal and trivial/non-existent effects. Lethal effects may occur when a loud noise results in mortality, for example if the startled 'flight' response to a stimulus leads to a collision with a nearby object. Increased noise intensity will increase the severity of the likely response (Francis and Barber, 2013). Dependant young are more likely than adults to suffer lethal effects through exposure, interruption in provision of care or, in extreme cases, being knocked out the nest during a parent's startled/frightened reaction. 'Flight' responses causing startled animals to alter their behaviour including fleeing is similar to, for example, an organism's response to a predation risk event. Most noise startle events will not result in mortality to adults, but instead sub-lethal effects may possibly be observed e.g. by reducing fecundity or increasing stress. Sub-lethal effects of loud noises additionally could involve temporary damage to the birds' hearing structure, however, birds unlike humans are able to regenerate damaged auditory hair cells. Physical trauma to the ear is more commonly the result of impulse noise rather than continuous noise as continuous noise loud enough to cause permanent damage is rarer than similarly loud impulsive noise (Larkin *et al*. 1996). The noise level that causes damage and the extent of damage varies depending on the species of bird (Beason, 2004).

Birds, unlike in humans, are able to regenerate damaged auditory (cochlear) hair cells and so any damage to auditory hair cells is potentially reversible. Hair cells are regenerated following a process called apoptosis, which is programmed cell death in response to inhospitable environments. Cells adjacent to those undergoing apoptosis are able to produce new hair cells within a matter of days through both direct trans-differentiation and mitotic regeneration (Cotanche, 2008) to replace those dying cells. This process of regeneration takes approximately two months to complete depending on the extent of the damage (Bowles, 1995). Given that the proposed schedule of SSC satellite launches are at least monthly throughout the year, were significant damage to occur to a birds' hearing, then insufficient time would likely occur between launches to allow for full repair/recovery between launches.

This literature review aims to look at how impulsive noise (from various sources including aircraft, fireworks, military ranges and rocket launches) impacts on both bird populations and individual behaviour and breeding success in order to help assess the potential noise impacts of the proposed SSC. To do this, the review has attempted to focus on identifying impulsive noise studies for the species of interest on Unst and with the ornithological study area. A variety of freely available data bases were searched including ResearchGate and Google Scholar. References considered included both peer-reviewed published scientific papers and grey literature reports. However, relevant literature was at best limited and so a wider literature search was conducted looking at other species including where possible analogous birds to those present in the SSC ornithological study area.

Helicopter and aircraft noise including military (Jet flyover at 100ft – ~103dB)

Aircraft movements have been shown to alter time-activity budgets of various species of waterfowl as a result of alert responses and increased locomotion in response to noise stimulus (Pepper *et al.* 2003). In response to sudden onset high amplitude noise from military jets (>100dB), harlequin ducks (*Histrionicus histrionicus*) decreased courtship for 1.5 hours and increased agnostic interactions for 2 hours following noise despite direct behavioural responses (head up, startle – flushing, agitated, diving) at the time of the flyovers generally lasting under a minute (Gougie & Jones, 2004).

A study on peregrine falcons (*Falco peregrinus*) found low military jet training had no impact on breeding success rates (Roby *et al*. 2002). However, this study highlighted that impacts of noise on a species may differ between sex; a reduction in male attendance at eyrie's with high jet activity was observed, albeit compensated for by increased female attendance. It was speculated that resultant changes to the female's time budgets may have long term implications for individual fitness. Elsewhere, a study on Wilson's plover (*Charadrius wilsonia*) reported military flights increased birds alertness and scanning behaviour, but with no evidence of effect on heart rate or incubation, or direct evidence of this behavioural response reducing reproductive success (Derose-Wilson *et al.* 2015).

Arctic tern (*Sterna paradisaea*) incubating behaviour is impacted by both fixed-wing aircraft and helicopters, with helicopters causing more disturbance to birds than fixed-wing aircraft, however human presence had a larger effect than aircraft disturbance (reviewed in Manci *et al*. 1988).

Sound levels are important in the determination of whether or not a species is going to respond to a noise stimulus; a small proportion of a colony (<20%) of crested terns (*Sterna bergii*) nesting on the Australian great barrier reef exhibited behaviour indicating that they were preparing to fly away (or actually flying away) in response to aircraft noises when louder than 85dB (Brown, 1990). Such 'upflights' lead to an increase in predation risk of young or eggs, exposure of eggs/chicks to temperature extremes in addition to the energetic cost of the flight to the adult bird.

Not all studies report a reaction to aircraft noise; a study exploring the possibility that increased air traffic associated with oilfields off north-east Scotland was impacting breeding seabirds recorded the reactions of a mixed colony of fulmars (*Fulmarus glacialis*), shags (*Phalacrocorax aristotelis*), herring gulls (*Larus argentatus*), kittiwakes (*Rissa tridactyla*), common guillemot (*Uria aalge*), razorbills (*Alca torda*) and puffins on the Buchan cliffs in relation to aircraft flying within 100m of breeding cliffs. Virtually no behavioural reaction was reported as a result of the flyovers to within 100m of the colony conducted during early egg laying and early nestling periods (Dunnet, 1977). Most of these species are present in, and therefore directly relevant to, the SSC ornithological study area.

The apparent lack of behavioural changes does not necessarily mean there was no impact on fitness; studies of heart rate response to visitor disturbance on kittiwakes and shags (i.e. study not specifically looking at noise) found increased heart-rates of up to 50% with individuals showing extreme variation following disturbance (Beale, 2007); such increases in heart-rate may have implications for energy budgets and thus individual fitness. However, it is worth noting that increased heart rates and stress from, for example, being trapped and handled by licensed bird ringers is not generally considered important in terms of individual (or population level) energy budgets and fitness for most species of birds.

Drawing firm conclusions from one study e.g. the lack of an impact recorded in Dunnet's 1977 north-east Scotland study may not always be replicated elsewhere because individuals from the same species can vary in terms of responses. A recent study on airplane disturbance in California on common murres (aka common guillemot) found that 57% of aeroplane flyovers resulted reactions including head bobbing and flushing (Rojek *et al.* 2007). Guillemots found helicopter flyovers significantly more disturbing with 83% of flyovers resulting in observable disturbance in the same study, despite aircraft being louder, leading to lost eggs and chicks. Extensive head bobbing occasionally resulted in the loss of eggs or chicks, but most egg/chick lost were dislodged during flushing. Reactions to flyovers were dependant on the time of year with guillemots more prone to flushing in the pre-egg and early egg-laying periods than after egg-laying is well underway (Rojek *et al.* 2007). It is worth noting that such egg losses may have been focussed on those nest sites close to cliff edges in sub-optimal locations which may have failed naturally regardless. In other words, such egg losses may not have been additive.

There are several studies on raptor responses to disturbance/noise events. For example, Grubb *et al.* (2010) investigated the response of incubating golden eagles (considered by expert opinion to be the most sensitive UK bird species to disturbance; Ruddock & Whitfield, 2007) to heli-skiing and military helicopters in northern Utah, USA. They watched 303 helicopter passes between 0–3,000m (horizontal distance) in 22 nesting territories and found no effect on early courtship, nest repair or subsequent nesting success. No response occurred in 66% of passes and incubating birds watched helicopters in 30% of observations. Whilst this and other raptor studies are in themselves interesting, their relevance to the situation on Unst is unclear.

The literature does not show any significant difference between bird responses when considering the height of the passing over event; perhaps because substantial adverse responses are so rarely recorded. Elsewhere, helicopters are considered to have more impact on birds than fixed-wing aircraft (despite aircraft being louder), however, it is unclear as to what aspect of the noise is most disturbing to birds (Bowles, 1995), but perhaps due to the slower nature of helicopter flight. Curlew (*Numenius arquata*) roosting on grassland fields are sensitive to helicopter overflights at less than 200m overhead (Smit & Visser, 1993).

Sudden blasts including fireworks & military shooting ranges (fireworks ~ 145dB)

A study of northern cardinal (*Cardinalis cardinalis*), a north American songbird, breeding on military bases (thus exposed to noise disturbance including firing guns, artillery, and ordinance) found no evidence for decreased offspring provisioning or reproduction success between areas of high military activity (tenfold difference on disturbance) and areas elsewhere with lower military activity (Barron *et al.* 2012). Cardinal abundance was not formally tested but was considered similar between high and low disturbance areas. No efforts were made to quantify the levels of noise exposure, thus both sites may have had the same maximum dB levels, just less frequent loud noises in the low activity area, therefore, it's possible that both high and low activity sites were considered equally disturbed to cardinals - the study would have benefited from a non-military control site. The same study provided evidence that the presence of the military activity suppressed crow activity with use of low activity areas five times that of high activity areas (Barron *et al.* 2012) demonstrating that not all species are equally affected by disturbance.

Golden plover (*Pluvialis apricaria*), a species present in the SSC study area, breeding on Otterburn firing range in England increased from 25 pairs in 1994 to 34 pairs in 1998 despite noise disturbance (Forsdyke, 2004). Despite the increase in breeding numbers, individual golden plover displayed adverse behavioural responses: "*a flock of approximately 50 (non-breeding) golden plover were startled into flight approximately 1,000m ahead of the launcher* *and exhibited a pattern of irregular flight movements characteristic of predator evasion*" in response to missile launches (Forsdyke, 2004).

Occasionally, fleeing behaviour following loud noise exposure can result in breeding failure. For example, adult prairie falcons (*Falco mexicanus*) fleeing nests in response to loud noise (construction blasting) caused some eggs to be knocked from the nest (as reviewed in Larkin *et al.* 1996).

Mass mortality events associated with fireworks have been reported, for example, an estimated 5,000 passerines including European starlings (*Sturnus vulgaris*), common grackles (*Quiscalus quiscula*), red-winged blackbirds (*Agelaius phoeniceus*) and brown-headed cowbirds (*Molothrus ater*) fell to the ground in a 30 minute period in a square mile area in Bebe, Arkansas on one winters' day. Testing conducted by the National Wildlife Health Centre concluded the birds died after suffering from 'blunt-force trauma' following being flushed from roost sites by professional grade (i.e. loud) fireworks and crashing into objects including trees and buildings (National Geographic, 2011).

This phenomenon of being flushed from roost sites following fireworks has also been reported elsewhere, e.g. in Poland where a study of roosting magpies (*Pica pica*) throughout winter found a marked reduction in the numbers roosting following nearby use of fireworks; 30 individuals roosting on New Year's Eve reduced to 5 the day following the fireworks (Karolewski *et al.* 2014). Although no direct mortality was reported, the loud noise impacted the bird's choice on returning to the area over a temporal scale beyond 24 hours, suggests a possibility of breeding territory abandonment in response to sufficiently loud noise impulsive.

Although most of the above cases relate to passerines, this phenomenon of loud bangs from fireworks causing disturbance has also been reported for some waterbirds (Shamoun-Baranes *et al.* 2011) and auks (Weigand & McChesney, 2008). Monitoring by U.S. Fish and Wildlife Service and the Bureau of Land Management of pelagic cormorants (*Phalacrocorax pelagicus*), pigeon guillemots (*Cepphus columba*), western gulls (*Larus occidentalis*), black oystercatchers (*Haematopus bachmani*) and Brandt's cormorants (*Phalacrocorax penicillatus*) nests on costal rocks in California found some nests were abandoned, following a nearby fireworks display (Weigand & McChesney, 2008).

Non-breeding curlew on the Humber estuary in England at a high tide roost changed behaviour (alertness etc.) in response to an experimental blast noise but not taking flight at noise levels of approx. 72dB, taking off but returned quickly at noise levels of approx. 76dB, taking off and leaving the area at values of 80dB (Wright *et al.* 2010). High levels of individual variation were observed in responses to the airhorn blast noise stimulus. Golden plover appear more sensitive than curlew to the airhorn blasts, changing behaviour (alertness etc.) but not taking flight at noise levels of approx. 69dB, taking off but returning quickly at noise levels of approx. 74dB and taking off and leaving the area at values of 80dB (Wright *et al.* 2010). Note these wader responses were measured outwith the breeding season, thus perhaps the birds were not as invested in the location as they would be if on their breeding territory. Breeding birds have been shown to be tolerant of much louder blasts e.g. an experimental 138dB trial blast on Christmas Island in the vicinity of red-footed boobies (*Sula sula*) (a species similar to gannet) recorded no behavioural response other than an increase in the apparent vigilance of chicks (Environment Australia, 2000). This blast was carried out as part of and EIA for a proposed rocket launch facility.

Space centres and birds

Space centres can hold good breeding populations of birds, many of them declining species and conservation priorities. For example, the land immediately adjacent to the Kennedy Space Centre in Floirida, USA, is home to large breeding populations of wetland/wading birds (Smith & Breininger, 1995), despite being exposed to irregular loud impulsive noise events.

Populations of certain species of birds are considered problematic at the Kennedy Space Centre; following a bird strike (by a vulture) damaging a launching shuttle's external tank after liftoff, NASA implemented a policy of removing roadkill on the infrastructure leading towards the space center in order to reduce the numbers of vultures in the area (Schlierf *et al.* 2007). Monitoring of reproductive success rates of endangered Florida scrub jay (*Aphelocoma coerulescens*) breeding near launch pads found comparable success to those further away (Breininger *et al*. 1994). An Environmental Assessment for heavy launch vehicle programs from a space launch complex at East Vandenberg Air Force Base, California reviewed the literature on the impact of noise on western snowy plover (*Charadrius nivosus nivosus*) (a similar species to ringed plover). It concluded wintering western snowy plover during Titan IV launches (130dBA) did not exhibit any adverse reactions to the launch, and monitoring during the breeding season recorded no injury or mortality to adults, young, or eggs following smaller launches and concluded behaviour was not adversely affected by launch noise or vibrations (Space Exploration Technologies, 2011). However, impacts of rocket launch noise have been demonstrated for some species; a launch in California in July 1997 resulted in losses of least tern (*Sternula antillarum*) eggs and chicks including 4-5 nests on eggs and one nest containing two chicks breeding within 650m of the launch site (Schultz, 1997). The severe disturbance of the launch combined with predation attempts by owls likely contributed to the observed early seasonal departure from the site by the remaining adult least terns.

SSC noise and birds

Taking into account evidence from the literature above, it is apparent that loud infrequent noise associated with rocket launches could be expected to impact on birds in the vicinity of the proposed development. Less clear, are the ecological effects and consequences of the short duration loud disturbance impacts on birds. Birds closer to the launches are predicted to be at higher risk of noise impact. Depending on how far away individuals are from the noise, the birds can be expected to either not react (best-case scenario), freeze, and/or become agitated or flee and die (worse-case). The short-term loud noises experienced during a rocket launch could potentially result in either or both physiological and behavioural changes in those individuals experiencing the noise. However, most studies consider potential impacts and do not show or demonstrate long-term population level effects or consequences.

Changes in behaviour may lead to longer term impacts on the local population (although this is rarely, if ever, empirically demonstrated in published studies) if breeding failure or a reduction in success occurs. Behavioural responses are expected to vary according to species, and even within a species. For example. individual variation in response to human disturbance has been documented in red-throated divers (*Gavia stellata*) (Bundy, 1976), a species present in the SSC ornithological study area. The infrequent nature of the event should reduce the potential magnitude of the impacts, conversely, the irregularity of the noise might prevent the birds from becoming habituated to the disturbance.

The impact of noise disturbance has potential to negatively impact breeding attempts. The following impacts on breeding birds may occur; reduced suitability of breeding habitat in vicinity of the launch facility, deterring birds from settling to breed and increased risk of breeding attempt abandonment (temporarily or permanently) through startle events. Such startle events causing parents to flee may result in increased predation risk in nests temporarily unattended, crushing or dislodgement to both eggs or nestlings, loss of eggs/chicks following exposure to adverse weather, reduced numbers of young fledging or reduced quality (e.g. weight) of young fledging impacting on post fledging survival. The time period for which these affects may occur will be dependent on the breeding phenology of each species in relation to the time of satellite launches, with impacts during egg-laying and incubation likely to be more severe than during chick rearing, when adult parents have developed familial bonds with their offspring. Although empirical data to back this up is limited, the available literature suggests noise impacts may be greatest during the early breeding season when parental investment in the breeding attempt is low.

The loud noise from the launch itself is not expected to directly result in hatching failure through mechanical damage to eggs, an experiment carried out on 20 hen and 20 quail eggs exposed to a loud noise peaking at over 170bD showed no physical damage/cracking (Bowles *et al.* 1991). Additionally, the same experiment found no significant difference in hatching success rate or weights compared to control eggs. Hatch weights have been demonstrated to be important to whimbrel (*Numenius phaeopus*) breeding on Shetland where heavier brood weight was found to be associated with the proportion of the brood surviving to fledging during two breeding seasons (Grant, 1991). Although there is no direct evidence of mechanical damage to eggs due to loud noise, the absence of research regarding the effect of exposure to loud noises on developing embryos hearing has been highlighted (Larkin *et al.* 1996).

Rocket launches in Scottish Special Protection Areas (SPA)

The following two locations are operational military sites in Scotland where live fire exercises have taken place for decades. Both locations lie within and adjacent to internationally important designated sites for birds that are also present within the SSC ornithological study area.

<u>Hebrides Range (Benbecula)</u>

South Uist missile range (also known as Hebrides Range) lies on the northwest part of the island of South Uist, together with its local radar tracking station, immediately to the south of the island of Benbecula. According to Jimmy Slaughter (Operations Support – Ground, Shetland Space Centre and a former Artillery Officer, who has fired at Hebrides Range), "*the MOD fire Rapier missiles at the Hebrides ranges on Benbecula and also the HVM (High Velocity Missile) system has been fired there in the past. The Navy do test fire some of their air defence missiles, but these will be fired from the sea. The RAF also test fire over the sea: they fire the Meteor (which is fired from the Typhoon) and ASRAAM (an air-to-air missile) nearby. The range is in use roughly 35 weeks of the year*". The use of the Hebrides Ranges appears to have risen recently, in terms of the number of different types of missiles launched (https://www.pressandjournal.co.uk/fp/news/1634218/natos-growing-use-of-island-missile-testing-range-revealed/). Data released to the Press and Journal in 2019 shows that 12 different types of missile were used at the facility in 2017/18. The Hebrides Range includes part of the South Uist Machair and Lochs SPA, a 5,027ha designated site for birds.

According to SNH SiteLink (accessed August 2020) "*South Uist Machair and Lochs SPA is a complex site along the west coast of South Uist. The west coast of South Uist is of outstanding importance for its transition of habitats from the acidic moorland to the* *calcareous coastal plain, and for the transition from freshwater habitats to saltwater habitats. This complex includes outstanding examples of (moving seawards), relict woodland, moorland and blanket bog, large oligotrophic lochs, acidic blacklands, wet and dry machair with eutrophic machair lochs, freshwater marsh, saltmarsh, coastal dunes and sandy and rocky shores. These areas are of outstanding importance for their populations of wintering and breeding waterfowl and for their breeding population of corncrakes associated with traditional crofting practices*".

"South Uist Machair and Lochs SPA qualifies under Article 4.1 by regularly supporting populations of European importance of the Annex 1 species: corncrake (1992 to 1994, 20 calling males, 4% of the GB population); little tern (1986 to 1990, 31 pairs, 1% of the GB population) and dunlin (1995, 357 pairs, 4% of the GB population).

"South Uist Machair and Lochs SPA further qualifies under Article 4.2 by regularly supporting populations of European importance of the migratory species: ringed plover (1995, 393 pairs, 3% of the Europe/Northern Africa biogeographic population; and, during 1993/94 and 1994/95, up to 490 wintering individuals, 1% of the same biogeographic population); redshank (2007, 379 pairs, 1.3% of the Eastern Atlantic biogeographic population); oystercatcher (2007, 629 pairs, 0.2% of the Europe & Northern/Western Africa biogeographic population, and selected as one of the most suitable sites for oystercatcher in GB with 0.6% of the GB population) and sanderling (2004, 667 wintering individuals, 0.6% of the Eastern Atlantic/Western & Southern Africa biogeographic population, and selected as one of the most suitable sites for sanderling in GB with 4% of the GB population)".

According to SNH SiteLink, aside from land acquisition for a 0.2ha area called Stilligarry, there are no management agreements for this site, which presumably means that the military activity undertaken (rocket launches, live fire etc.) within the SPA is not seen as threat to the designated site bird species or site integrity. Dunlin and ringed plover are both present within the SSC ornithological study area.

Cape Wrath (Sutherland)

According to Jimmy Slaughter (Operations Support – Ground, Shetland Space Centre and a former Artillery Officer, who has fired at Cape Wrath) "*Naval and Artillery live firing does take place there as well as mortar fire from time to time too. All ammunition natures (high explosives, smoke and illumination) are fired. An Garbh-eilean (Garvie Island), just off the coast, also gets a fair share of high explosives courtesy of numerous NATO air forces, including our own. In addition, small arms firing takes place at Cape Wrath*". Firing takes place during the bird breeding season (https://www.gov.uk/government/publications/scotland-firing-times; accessed August 2020). "*The RAF drop 1,000lbs bombs on to Garvie Island*", which is within the Cape Wrath SPA, a 6,737ha site (although the island itself is within the SPA, it appears excluded from the designated site map).

According to SNH SiteLink (accessed August 2020) "*Cape Wrath SPA covers two stretches of Torridonian sandstone and Lewisian gneiss cliff around Cape Wrath headland in north west Scotland. These cliffs support large colonies of breeding seabirds. The boundary of the SPA overlaps with the boundary of Cape Wrath SSSI, and the seaward extension extends approximately 2km into the marine environment to include the seabed, water column and surface*".

"*Cape Wrath SPA qualifies under Article 4.2 by regularly supporting in excess of 20,000 individual seabirds. It regularly supports 50,000 seabirds including nationally important populations of the following species: kittiwake (9,700 pairs, 2% of the GB population), common guillemot (13,700 individuals, 1% of the GB population), razorbill (1,800 individuals,* *1% of the GB population), puffin (5,900 pairs, 1.3% of the GB population) and fulmar (2,300 pairs, 0.4% of the GB population)*".

According to SNH SiteLink, there are no management agreements for this site, which presumably means that the military activity undertaken (rocket launches, live fire, including bombing etc.) within the SPA is not seen as threat to the designated site bird species or site integrity. Kittiwake, common guillemot, razorbill, puffin and fulmar are all present within the SSC ornithological study area.

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Appendix 5.3 Detailed Habitat Management Plan

SaxaVord Spaceport:
Detailed Habitat Management Plan Part I
Non-confidential elements

Alba Ecology Ltd.

Loomer Shun peatland restoration area

February 2022

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Introduction

Unst Space Port Ltd., is committed to establishing, implementing and funding an agreed Habitat Management Plan (HMP) for the lifetime of the proposed SaxaVord Spaceport (formerly called Shetland Space Centre). The detailed HMP has been prepared to set out how the Applicant will enhance ecological interests through the construction and operation of SaxaVord Spaceport and is based on the Outline Habitat Management Plan (OHMP) which was prepared and submitted to Shetland Island Council (SIC) as part of the Environmental Impact Assessment Report (EIAR) in 2021.

Whilst priority biodiversity has been the main focus of the HMP actions, they also afford substantial opportunities for tie-ins with carbon offsetting, wildlife-related tourism and local community enjoyment of nature.

SaxaVord Spaceport provides the basic infrastructure for space vehicle launches which may in the future conceivably develop and evolve with emerging technologies and commercial demands. Although the development does not have a pre-determined operational lifespan, it is anticipated to be operational for at least 30 years. When decommissioning of the SaxaVord Spaceport eventually takes place, a separate Decommissioning Management Plan will be prepared (using current best practice at that time) that will commit SaxaVord Spaceport to ensure that the decommissioning works can be completed so as to continue to deliver the objectives of the approved HMP.

Having considered the potential and likely impacts and effects of the proposal, we believe this HMP provides sufficient ecological benefits to offset adverse ecological impacts for a potential development of this nature and scale and that it provides additional wide-ranging ecological enhancements that supports relevant policy objective e.g. SPP and NPF4.

The SaxaVord Spaceport has promoted the inclusion of a planning condition that will secure the development and implementation of the HMP and ensure its full and effective delivery.

Aims and Objectives

The HMP has the following overall aims:

- Aim 1: To enhance habitats for species of importance present on, or linked to, the Study Area (as defined in the EIAR).
- Aim 2: Restore important habitats and associated species.

These aims were given an objective in the OHMP which were:

- Objective 1: Create a wildlife watching hide on Lamba Ness.
- Objective 2: Peatland restoration.
- Objective 3: Create native riparian broadleaf tree/scrub cover.
- Objective 4: Coastal grassland habitat management.

All potential HMP management areas have been surveyed and assessed for suitability and to ensure that any existing important biodiversity is protected and considered when developing and implementing the approved HMP. Most HMP works will be undertaken between September and late March (inclusive) to prevent the possibility of disturbing nesting birds. However, if works do take place outside this period, then measures will be put in place to ensure no significant disturbance of sensitive/legally protected species occurs.

Objective 1. Create a wildlife watching hide on Lamba Ness

Current situation

The eastern most tip of Lamba Ness has long been recognised as one of the best locations in Shetland to watch seabirds and cetaceans. During informal discussions with local birdwatchers and whale watchers a concern was raised that access to the favoured tip of Lamba Ness might be curtailed by the development of SaxaVord Spaceport. The existing and best wildlife watching location is at HP 67502 15654 and is very exposed to the elements, with the only shelter (which is partial) provided by one of the existing old RAF buildings, which itself would be within the SaxaVord Spaceport fenced off area and so not utilisable in the future.

The suggestion was made by local birdwatchers that a purpose built wildlife watching hide, with guaranteed access (except around launch days) would allay such fears and be a welcome addition to facilities on Unst. The proposed hide location needs to be as close to the edge of the rocky area identified below as possible and would be partly on the rocky projection and the also party on the grass (Photo 1). The arrows marked on the following series of photos show the indicative direction looking out of the hide.

Wildlife hides in the wrong place or facing in the wrong direction are not usable and a wasted opportunity. Based on hundreds of hours of bird and whale observations, the hide must be at this precise location (HP 67502 15654) and face the direction illustrated on photos for it to work observationally. There are no worthwhile alternative locations due to the greater height of the cliffs, access, direction/angle of the sun and geographical position of all other potential locations. Currently, whale watchers and bird watchers sit on the grassy step (broadly where the base of the arrow marked in Photo 3 is) and look out to sea. Most seabirds pass this point very closely and bypass the other areas in and around Lamba Ness. The whales and dolphins tend to congregate in the zone of water mixing ca. 300m off this location, although killer whales/orcas are usually much closer in, hunting seals along the shoreline.

Photo 1. View onto downslope proposed hide location, 2020.

Photo 2. Angled view from south looking onto proposed hide location, 2020.

The hide location is regularly used by local residents and visitors for bird and whale watching currently. The shelter afforded by a hide in this windswept and exposed location means it would be well used and very likely to become a valued community and tourist facility. Given visiting groups of up to 12 people would likely use the sea-watching hide, it should aim to be able to accommodate ca. 12-15 people.

Photo 3. Angled view from north onto proposed hide location, 2020.

Photo 4. Reverse view from proposed hide location, looking back inland towards existing old RAF buildings, 2020.

Delivery

The provision of a wildlife hide along with a footpath/track have been included in the design layout (Figure 1).

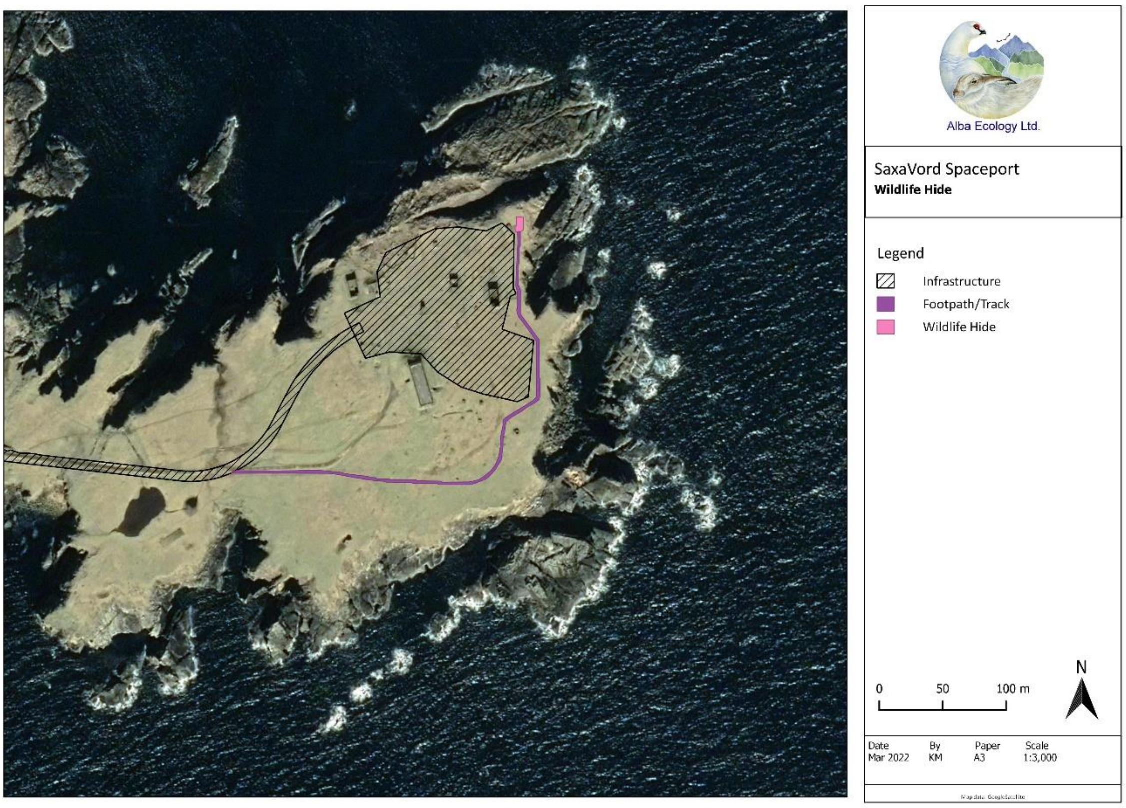


Figure 1: Location of Wildlife Hide on Lamba Ness

The location of the proposed wildlife hide is on land managed by SaxaVord Spaceport and so the work will be guaranteed to be taken forward. The Applicant has been willing, and continues to be open to potential community ownership of the wildlife hide whilst contributing to an annual maintenance budget for hide repairs and improvements. A footpath along the edge of the Saxa Vord Spaceport boundary fence will provide access from the public road (Figure 1).

Ideally, a wildlife hide should enable easy and ample viewing for seated observers using both binoculars and telescopes not looking through glass. Designs of sea-watching hides are varied, but whatever design is used, it needs to be robust to withstand the autumn and winter storms on Unst. Typical ‘standard’ wooden bird hides would not be suitable as they would likely be damaged or destroyed during storms. Consequently, some sort of stone structure will probably be necessary. Detailed plans of a sea-watching hide recently constructed at Flamborough Head, Yorkshire can be viewed here. A few more sea-watching hide designs can be viewed here. The stone-built wildlife hide at Whitburn, County Durham was purpose built in 1990 and has withstood the tests of time and weather since then.

In summer 2022, SaxaVord Spaceport will consult with local stakeholders e.g. Unst resident birders and whale watchers and agree a suitable design for the wildlife hide, after which, the hide will be built as soon as suitable materials are available in 2022.

Objective 2. Peatland restoration

Areas of blanket bog within north Unst have historically been subject to peat cutting and other pressures such as grazing by sheep combined with extreme weather. This has led to a noticeable deterioration in the condition of the blanket bog habitat, with erosion features and impacts of drainage on the blanket bog reducing its ability to support species of conservation importance such as red-throated diver.

The OHMP identified peatland restoration as a key objective. In the intervening time between the OHMP being written and consent being granted the location and type of peatland restoration has been amended. In February 2022 an outline of proposed peatland restoration plan was provided in a confidential document entitled "*A Summary Report Outlining Peatland Restoration Proposals for Unst Space Port*".

Three indicative peatland restoration areas were identified in north Unst (Figure 2). Loomer Shun was identified as suitable for peatland restoration and peat re-use from the construction of the Saxa Vord Spaceport. Peat re-use is considered in more detail in the Peat Management Plan (PMP). Skaw Paet Hoose and Ritten Hamar were both sites identified for peatland restoration (without peat re-use from the construction of the SaxaVord Spaceport).

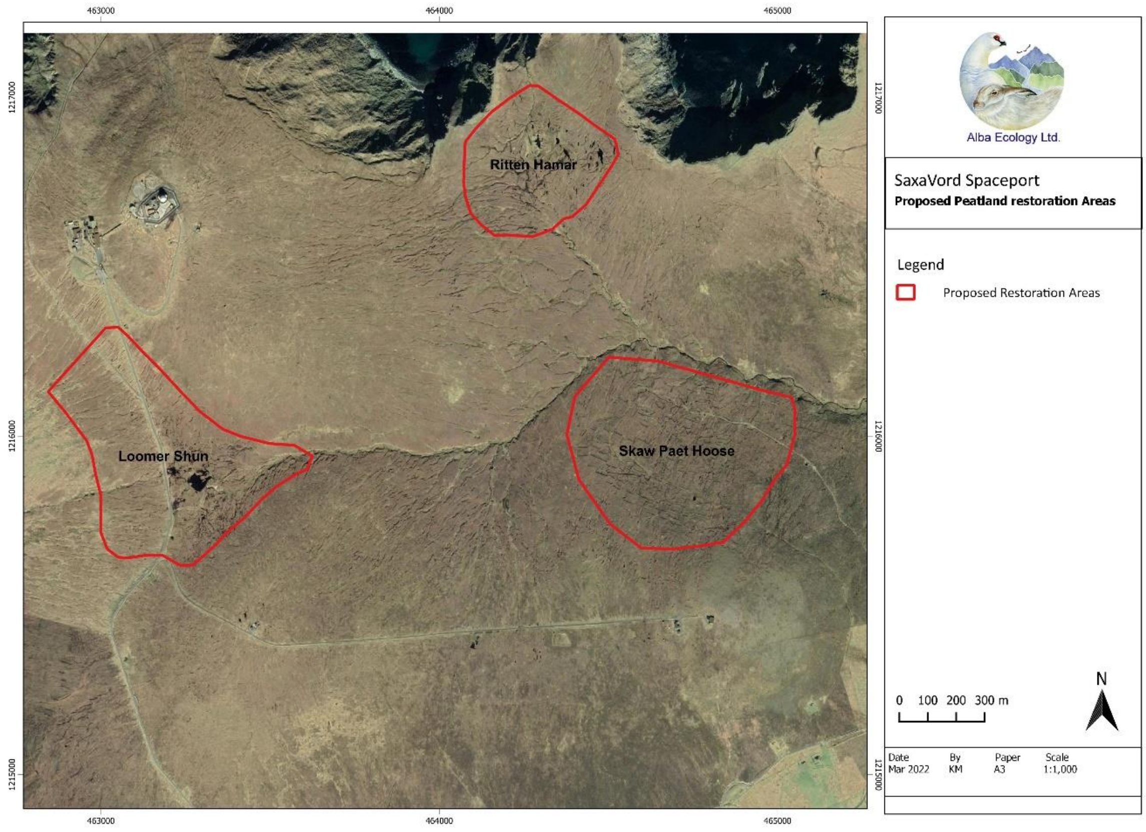


Figure 2: Indicative Peatland Restoration Areas

Current situation – Loomer Shun

The area that is termed 'Loomer Shun' in Figure 2 is a ca. 20.7ha area between the hills of Saxa Vord and Sothers Field. It is made up of modified bog habitat which has been widely cut for peat, both historically and more recently. The recently cut peat had bare peat faces are ca.1m-1.5m in height with fresh exposed peat on the face and for ca. 1m on the cut base. Where the peat had been historically cut there was evidence of further wind and rain erosion resulting in undercuts with dry vegetation overhanging the cuttings. Sheep clearly use the cuttings as shelter during inclement weather and whilst doing so have caused erosion locally around the lochan area. Further down the hillslope, to the east, the bog vegetation appeared to have a more naturally eroded pattern from wind and rain action likely exacerbated from sheep. As detailed in the OHMP, the lochan at Loomer Shun is considered to be at risk of being lost through water drainage.

Photo 5: Loomer Shun, peat cut and eroded to mineral soil in the foreground. Older peat cuttings and erosion in the background.

Baseline conditions – Loomer Shun

A site visit and Peatland Condition Assessment (PCA) was undertaken at Loomer Shun in February 2022.

PCA surveys are a standardised, if basic, method for assessing the condition of peatland habitats. The PCA bases the condition of blanket bog on indicators such as bog-moss cover, extent of bare peat and evidence of management activities such as grazing, peat cutting and burning (Peatland Action, 2016). The PCA recognises four categories of peatland condition:

1. Near-Natural - peat forming bog-mosses dominant, with no recent fires, little or no grazing pressure and little or no bare peat, heather is not dominant.
2. Modified – bare peat is in small patches, fires may be recent, grazing impacts are evident, bog-mosses are absent or rate, extensive cover of heather or purple moor-grass.
3. Drained – within 30m either side of an artificial drain or a revegetated hagg or gully system.
4. Actively Eroding – actively eroding hagg/gully system, extensive continuous bare peat surfaces.

Figure 3 provides an indicative PCA map (based on a site visit and aerial photos). All of the peatland was classified as Modified and Drained, largely through peat cutting but also through some more natural erosion features, likely from a combination of sheep and wind and rain action. There were areas that were actively eroding and this included the cut faces and erosion feature faces which had exposed peat.

The total length of peat cuttings at Loomer Shun (based on aerial photos) was estimated to be ca. 3.2km[1].

The total length of erosion features at Loomer Shun (based on aerial photos) was estimated to be ca. 0.8km.

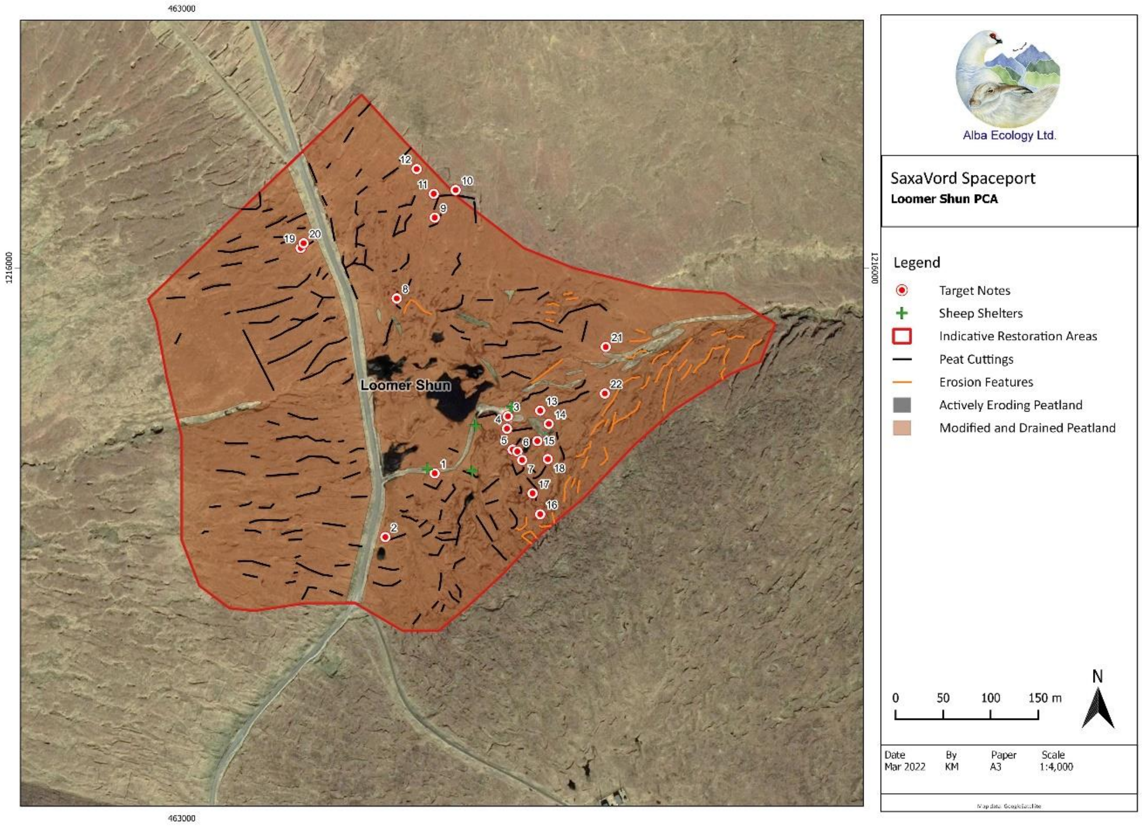


Figure 3: PCA and Target Note locations for Loomer Shun

There were three key habitat types mosaiced within the peatland at Loomer Shun;

- Modified and drained bog at the original bog surface;
- Modified bog that had revegetated at the base of the cut surface where the remaining peat was >0.5m; and
- Acid grassland/wet heath vegetation that had revegetated at the base of the cut surface where the peaty soils peat was <0.5m.

The modified bog at the original bog surface was usually dry, with heather and crowberry common with common cottongrass and species such as glittering wood moss. Patches of bog-

[1] Note that these metrics and locations shown in Figure 3 are based on aerial images, viewed between 1:2,000 and 1:4,000 and have not been fully ground truthed. It is possible some 'peat cuttings' are actually 'erosion features' and visa versa. Lengths are estimates only.

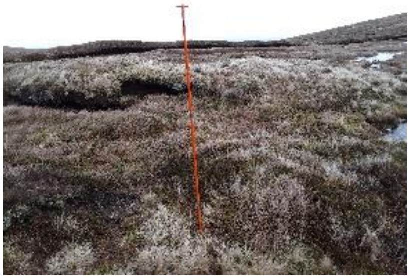
moss were occasional. This was the original surface, where peat has been cut away, leaving exposed drying and eroding edges or in some places more natural forms of erosion were present. It was hydrologically disconnected from other section of bog habitat, due to the peat cutting; this results in a form of dry heath vegetation forming over the deep peat.

The modified bog that had revegetated at the base of the cut surface where the remaining peat was >0.5m was generally damper underfoot than the original bog surface vegetation. Common cottongrass was the dominant vascular plant, but there was also heather and hare's-tail cottongrass. Bog-mosses were frequent and included red bog-moss and papillose bog-moss.

The acid grassland/wet heath vegetation that had revegetated at the base of the cut surface where the peaty soils peat was <0.5m was generally dominated by either mat grass or heather with common cottongrass, depending on the thickness of the peaty substate. In some places these areas went down to mineral soils.

Table 1 provides details of the baseline through a series of Target Notes of the peatland habitats at Loomer Shun. The locations of the Target Notes are shown in Figure 3.

TG	Grid	Note	Photo
1	HP 63266 15784	Recent peat cutting area, which was ca. 15m x 15m in size. The cut face was ca. 1m high. There was ca. 0.3m of soil below the cut surface which had revegetation to form wet heath with abundant bog-moss. It is considered that this is suitable for infilling with peat. The level of revegetation, post peat cutting, demonstrates that the bog will likely recover from restoration and the current sheep densities have not prevented the natural revegetation of these areas.	 
2	HP 63214 15717	Peat cutting is common in this area. This old cutting was well vegetated. It was ca. 0.5m high. Bog mosses were present at the base of cuttings.	

TG	Grid	Note	Photo
3	HP 63343 15844	In the central area, where the vehicle track ends, the peat had been historically cut leaving shallow soils (0-0.5m deep) with acid grassland, wet heath or bare mineral soils/bedrock. There was remanent dry bog surrounding this area demonstrating where the original bog surface would have been. The cut faces were ca. 1m-2m high and actively eroding.	 
4	HP 63342 15831	Recently cut peat. The cut face was ca. 0.5m-1m deep. Potential area for filling with peat from construction. There were shallow soils at the cut surface which had revegetated with acid grassland and wet heath. The surrounding, original bog has been drained from the cut feature. There was heather, common cottongrass and crowberry with occasional patches of bog-mosses present in this area.	 

TG	Grid	Note	Photo
5	HP 63348 15809	Although much of this area is not the original bog surface, some pools were formed within the cut surface. This wet area was ca. 0.5m deep. There were cutting features ca 1.5m high around this feature, showing where the peat had been historically removed. The regenerating vegetation on the cut surface demonstrates the potential for bog vegetation to re-establish successfully.	 
6	HP 63353 15807	Ca. 10m x 10m patch of bare peat. Eroded to mineral soil at the lower end, and 5m deep at the top end. The bare exposed peat was actively eroding.	
7	HP 63358 15798	Views of peat cuttings across Loomer Shun. The cuttings in the distance look appropriate for infilling. The surface vegetation will be lifted up first, suitable peat added and then the surface will be laid back down. The PMP provides more information for this peat re-sue.	 

TG	Grid	Note	Photo
8	HP 63226 15968	This area had old cuttings. The cut faces of the cutting had eroding edges giving a more 'natural' look. Between these peat cuttings there was deep peat (ca. 1.5m deep), with bog-moss rich vegetation. These areas would be suitable for reprofiling, to prevent drying and hydrologically link the bog.	 
9	HP 63266 16053	This old peat cutting was ca. 1m in height. There was deep peat (ca. 1m) below the cut surface, which had revegetated with some small hummocks of bog-moss.	
10	HP 63288 16082	Deep peat underlies the cut surface vegetation. The remaining peat was ca. 1m deep and there were wet areas. The cuttings were ca. 1m deep. This demonstrates that the bog vegetation will establish successfully after restoration.	
11	HP 63265 16078	View across Loomer Shun.	

TG	Grid	Note	Photo
12	HP 63247 16104	This recent peat cutting was ca. 1.5m deep and ca. 10m long. There was 0.5m of peat at the cut surface. The cut surface had revegetated with acid grassland and wet heath.	
13	HP 63377 15850	There was a large bowl-shaped historic cutting area which was ca. 30m x 50m in size. The cut faces were ca. 1m-2m in height reaching to the original bog. The cut surface had ca. 0.5-0.6m deep peaty soils which was revegetated. Suitable for infilling.	
14	HP 63386 15836	There were occasional pools with feathery bog-moss in them. However, this one was only ca. 0.5-0.6m deep.	
15	HP 63374 15818	Here the peat cutting went down to mineral soil. This was within the main bowl-shaped historic peat cutting. The original bog surface was ca. 2m higher. Suitable for infilling.	

TG	Grid	Note	Photo
16	HP 63377 15741	Peat cutting. Generally shallow soil at base of cutting, cut faces ca. 1m in height.	 
17	HP 63369 15763	Infilling would be suitable in all this modified bog habitat.	
18	HP 63385 15799	This area was clearly modified through peat cutting and subsequent drying of the original bog surface. Common cottongrass, heather and crowberry were the most common species with patches of flat-topped bog-moss. There was ca. 1m of peat below the cut surface, which was in generally good condition, demonstrating that the bog vegetation would recover successfully after restoration.	
19	HP 63125 16021	There were number of old peat cuttings on this side of the road. There was ca. 1m of peat below the cut surface, which was well vegetated. The cuttings were ca. 1m high with the original bog surface lined with heather demonstrating an associated drying effect of the cutting.	

TG	Grid	Note	Photo
20	HP 63128 16026	There were peat cuttings along the road for ca. 400m and ca. 50m wide from the road. The cuttings were regularly cut to ca. 1m–1.5m. The remaining cut surface was well vegetated, demonstrating a high chance of successful restoration. There was ca. 1.2m peat below the cut surface.	 
21	HP 63446 15917	There were what appeared to be 'natural' erosion features at this location. They were ca. 1m-2m in height. There was bare exposed, eroding peat of the hagg face. Suitable for reprofiling.	 
22	HP 63445 15868	There was a ca. 2m high erosion feature at this location with exposed peat actively eroding.	

Table 1: Target notes for Loomer Shun

Delivery – Loomer Shun

There is suitability at Loomer Shun for careful and sensitive peatland restoration, including around the main lochan (as detailed in the OHMP) and more widely, particularly in the areas of current and historic peat cutting. This peatland restoration would include effectively re-using peat extracted from the construction of SaxaVord Spaceport.

In addition to plugging the outflow areas of the main lochan to prevent water draining away, two main peatland restoration techniques will be suitable at Loomer Shun:

i. Infilling the peat cut areas with peat from the construction of SaxaVord Spaceport; and
ii. Reprofiling of cut peat edges.

Best practice techniques for peatland restoration techniques have been developing rapidly, therefore discussions with an experienced peatland restoration team is recommended prior to restoration work commencing. The peatland restoration techniques of infilling and reprofiling were discussed in detail on-site and off-site with local crofters at Loomer Shun. At least one of the local crofters (contact details available upon request) has completed practical peatland restoration work across Viking Wind Farm for the last 1.5 years using the best practice peatland restoration techniques discussed and he considered the proposed methods to be appropriate and suitable for Loomer Shun.

Loomer Shun is considered suitable for peat re-use from the construction of SaxaVord Spaceport for both ecological and practical reasons. There is a public road which provides access from the construction area to the Loomer Shun peatland restoration area ensuring that peat can be quickly and effectively moved without the need for road construction. The peatland restoration which re-uses the peat from construction of SaxaVord Spaceport is detailed further in the PMP.

Infilling: The vegetation on the historically cut bog surface would be carefully stripped ensuring there was sufficient material to retain roots. Peat won from the construction of SaxaVord Spaceport would be used to infill the cutting, raising the level of cutting back to the height of the original bog surface and meeting the height of the surrounding bog. The stripped vegetation would then be carefully placed back on top of the peat. In some areas careful contouring will be required to ensure levels meet the surrounding surfaces. This infilling technique would be particularly suitable where peat has been cut/eroded to the underlying mineral soil layer. Also, this technique would lend itself to historically cut areas where the remaining vegetation and peaty soils/peat depths were relatively shallow.

Photo 6: Recent peat cutting at Loomer Shun suitable for infilling.

Photo 7: A view of historic peat cuttings at Loomer Shun suitable for infilling.

Reprofiling: The edges of historical peat cuttings and erosion features can be reprofiled. Reprofiling is a mechanism for lowering the gradient of the hagg or cut face, and covering the bare peat of the hagg or cut face with vegetation, stretched from nearby existing vegetation (i.e. using the vegetation on adjacent bog at the top of the hagg/cutting and stretching this over the hagg/cutting face). Appendix 1 provides some details on best practice peatland restoration techniques including reprofiling.

Photo 8: A peat cut area at Loomer Shun with deep peat remaining and bog vegetation established. Suitable for reprofiling or infilling.

These peatland restoration techniques will deliver a series of ecological benefits to the Loomer Shun area. They will: halt the current erosion on bare peat faces through wind and rain erosion; halt the bare peat faces losing mass through microbial decomposition; and reduce drying out of the remnant adjacent blanket bog. This will stop the Loomer Shun area from being an atmospheric carbon source. Furthermore, these restoration techniques will wet-up and hydrologically link the existing bog vegetation, which is currently fragmented, and allow a more natural surface pattern and hydrology to develop. In turn, this will benefit the species that rely on wet bog vegetation such as craneflies and other insects, which further benefit associated bird species. This hydrologically linked wet bog will likely deliver additional carbon sequestration as the bog-mosses and bog vegetation form peat over a wider area, locking carbon into the peatland habitat. Hence, the Loomer Shun area would be transformed from being a source of carbon, to potentially an area with widespread carbon sequestration (i.e. a carbon sink).

The crofters (who we understand hold the peat cutting rights to this area) have agreed to a permanent cessation of peat cutting at Loomer Shun. This secures the long-term effectiveness of restoring the peat and blanket bog in this currently degraded area.

The crofters currently have a low level of sheep grazing across Loomer Shun and the wider hill area (estimated at about one ewe per ha by the crofters in 2022). Current grazing levels are not having a noticeable detrimental impact on the wider bog vegetation. For example, there was no evidence of sheep causing or widening bare peat areas and there was wide-scale evidence of the blanket bog restoring itself within the historical peat cuttings. Current sheep impacts are limited to around the lochan and locally at the edges of the peat cutting faces.

Peat cutting removes the bog surface and leaves bare peat. However, much of Loomer Shun, which has clearly been peat cut for generations, was revegetated demonstrating that the current grazing conditions are suitable for revegetation. This was particularly evident where deep peat remained in the cut areas and blanket bog vegetation had re-established and included a variety of bog-moss species. Therefore, it is considered unnecessary to further reduce sheep numbers, although a written commitment to not increase sheep numbers from current base-line levels would ensure the maintenance of low levels of grazing.

Sheep clearly use the erosion/cutting features as shelter in the not inconsiderable winds, particularly around the lochan. Therefore, ensuring shelter for sheep present at Loomer Shun would be essential. This could be achieved by carefully contouring some of the erosion features to be vegetated but still provide shelter, alternatively, or in combination, it could be achieved by providing man-made shelters. Manmade sheep shelters are used commonly across Shetland, including on Unst. An example from Unst is shown in Photo 9.

Photo 9: A artificial sheep shelter designed to provide shelter from different wind directions, Norwick, Unst.

Indicative locations for sheep shelters are provided in Figure 3, although this should be discussed and agreed with crofters and the contractors at the time of the restoration works.

Careful consideration of the timing of this work will be needed to avoid breeding bird disturbance and to prevent further erosion from the wind exposure. Works for peatland restoration at Loomer Shun are scheduled to begin in August-September 2022, after the bird breeding season.

Peatland restoration work at Loomer Shun will be undertaken under the supervision of an appropriately trained ecologist.

A baseline monitoring survey measuring species composition, vegetation height, peat depth and areas of bare peat will be undertaken prior to the peatland restoration beginning at a range of monitoring and control sites around Loomer Shun. The changes to the vegetation/peat will then be monitored at regular intervals, using standardised systematic methods.

The specific objective for the peatland restoration will be to:

1. Reduce bare peat areas at cutting and erosion faces;
2. High overall vegetation cover;
3. Increase in the number of bog-mosses, particularly at the original bog surface;
4. Increase in the species richness of blanket bog species; and
5. Increase in wetness of the blanket bog, e.g. an increase in bog pools.

Current situation – Skaw Paet Hoose

The indictive area identified as Skaw Paet Hoose in Figure 2 is ca. 28.6ha in size. It is situated on the north slope of the Ward of Norwick, above the Burn of Skaw has been historically and extensively cut for peat. The historical peat cuttings were between ca.1m and 2m in height. There was little evidence of recent peat cuttings, and, as at Loomer Shun, the low sheep levels had allowed wide-scale revegetation on the bases of historically cut surfaces. The tops of the peat cuttings were dry, and heather dominated, and there were many exposed bare peat areas on the faces of the cuttings. These cut faces continue to release carbon through wind and rain erosion and microbial decomposition, along with reducing drying out of the remnant adjacent blanket bog.

Photo 10: Peat cutting around the 'Paet hoose'

Baseline – Skaw Paet Hoose

A site visit and PCA was undertaken at Skaw Paet Hoose in February 2022.

Figure 4 provides an indicative PCA map (based on a site visit and aerial photos). All of the peatland was classified as Modified and Drained, largely through peat cutting but also through some erosion features. The peat cuttings faces and erosion feature faces were considered to be actively eroding in most instances, although some exceptions are noted in the Target Notes (Table 2).

The total length of peat cuttings at Skaw Paet Hoose (based on aerial photos) was estimated to be ca. 3.7km[2].

The total length of erosion features at Skaw Paet Hoose (based on aerial photos) was estimated to be ca. 1.0km.

[2] Note that these metrics and locations shown in Figure 4 are based on aerial images, viewed between 1:2,000 and 1:4,000 and have not been fully ground truthed. It is possible some 'peat cuttings' are actually 'erosion features' and visa versa. Lengths are estimates only.

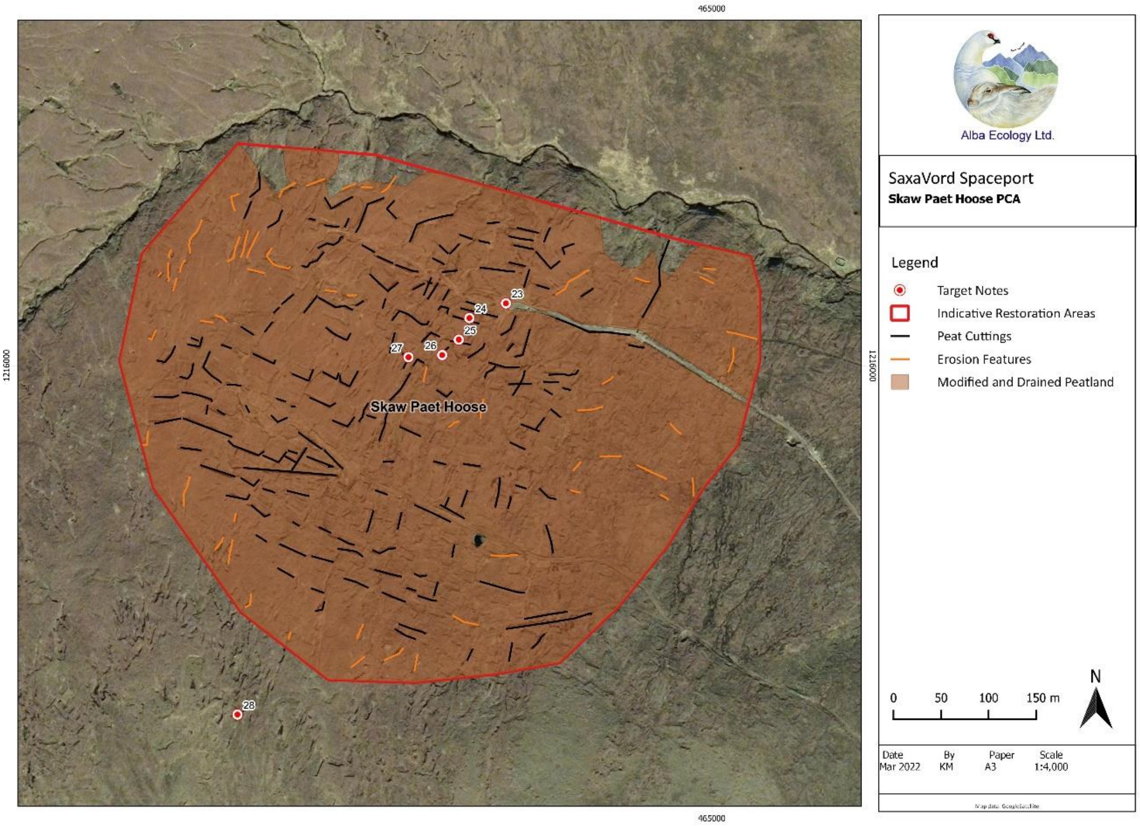


Figure 4: PCA and Target Note locations for Skaw Paet Hoose

The habitats were similar to those at Loomer Shun with a similar array of species present and the type of habitat dependent on the impact of peat cuttings. There was modified bog at the original bog surface which was usually dry particularly at the edges of peat cuttings. Heather, crowberry, common cottongrass, hare's-tail cottongrass, red bog-moss and glittering wood moss were the most common species.

The modified bog that had revegetated at the base of the cut surface where the remaining peat was >0.5m was generally damper underfoot than the original bog surface vegetation with occasional bog pools. There were patches of bare peat at the base of some erosion features.

Wet heath, dominated by heather and common cottongrass was present where vegetation had formed at the base of the cut surface where the peaty soils were <0.5m.

Unlike at Loomer Shun, some of the peat cuttings at Skaw Paet Hoose had collapsed over and fully revegetated, leaving little sign of the cutting except a raised profile. This demonstrates the sort of reprofiling that is anticipated and shows that revegetation is not only possible but is happening naturally in some areas, albeit at a slow rate of change. It is unclear how long this process has taken to naturally occur, but the peat cuttings in some places appear to be very old.

Table 2 provides details of the baseline through a series of Target Notes of the peatland habitats at the Paet Hoose. The Locations of the Target Notes are shown in Figure 4.

TG	Grid	Note	Photo
23	HP 64783 16065	Historic peat cutting. There was generally revegetation on the cut surface and on some cut edges. Suitable for reprofiling to connect the peat, re-wet the original bog surface and to form hydrological connectivity.	 
24	HP 64745 16050	Example of a historic peat cutting. It was ca. 1m high, with dry, heather dominated vegetation sloping over the edge. There was evidence of continued erosion from undercutting. The cut surface was well vegetated with common cottongrass and heather, forming a wet heath vegetation over ca. 0.5m of peaty soils.	
25	HP 64733 16027	Another example of a historic peat cutting. It was ca. 1.5m high. There were some patches of bare peat along the base of the cutting face. These were ca. 2m x 2m in size and were actively eroding. The cut surface had blanket bog vegetation over deep peat with occasional pools and patches of bog-mosses present.	

TG	Grid	Note	Photo
26	HP 64716 16011	This historic peat cutting was fully revegetated with areas of acid grassland and dry heath.	
27	HP 64680 16008	A more recent peat cutting. It was ca. 1.5m high and 20m long with evidence of active erosion and drying influences seen on the top.	
28	HP 64501 15633	A view of the area around Skaw Paet Hoose.	

Table 2: Target Notes for Skaw Paet Hoose

Delivery – Skaw Paet Hoose

There is suitability at Skaw Paet Hoose for careful and sensitive peatland restoration of the historic peat cuttings. Re-using peat extracted from the construction of the SaxaVord Spaceport is not anticipated as access is along an un-made track, unsuitable for taking large loads of peat along, but suitable for driving Argo cats and diggers on caterpillar tracks for the purpose of restoration.

Reprofiling would be undertaken as described for Loomer Shun and detailed in Appendix 1. The reprofiling would halt the current erosion on bare peat faces through wind and rain erosion; halt the bare peat faces losing mass through microbial decomposition; and reduce drying out of the remnant adjacent blanket bog. This will stop areas of Skaw Paet Hoose from being a carbon source. Furthermore, reprofiling the peat cuttings will wet-up and hydrologically link the existing bog vegetation, which is currently fragmented, and allow a more natural surface pattern and hydrology to develop. In turn, this will benefit the species that rely on wet bog vegetation such as craneflies and other insects, which further benefit associated bird species. This hydrologically linked wet bog will likely deliver additional carbon sequestration as the bog-mosses and bog vegetation form peat over a wider area, locking carbon into the peatland habitat. Hence, the Skaw Paet Hoose area would be transformed from being a source of carbon, to potentially an area with widespread carbon sequestration (i.e. a carbon sink).

Photo 11: A peat cutting at Skaw Paet Hoose suitable for reprofiling

The crofters (who we understand hold the peat cutting rights to this area) have agreed to a permanent cessation of peat cutting at Skaw Paet Hoose. This secures the long-term effectiveness of restoring the peat and blanket bog in this currently degraded area.

Similar to Loomer Shun, Skaw Paet Hoose has a low level of sheep grazing which is evidenced in the revegetation of the degraded bog habitat. Securing an agreement not to increase sheep levels would be beneficial.

Careful consideration of the timing of this work will be needed to avoid breeding bird disturbance and to prevent further erosion from the wind exposure. Works for peatland restoration at Skaw Paet Hoose are not scheduled until at least 2023/2024 and would be completed outside the bird breeding season.

Peatland restoration work at Skaw Paet Hoose will be undertaken under the supervision of an appropriately trained ecologist.

A baseline monitoring survey measuring species composition, vegetation height, peat depth and areas of bare peat will be undertaken prior to the peatland restoration beginning at a range of monitoring sites within Skaw Paet Hoose. The changes to the vegetation/peat will then be monitored at regular intervals, using standardised systematic methods.

The specific objective for peatland restoration and Skaw Paet Hoose will be to:

1. Reduce bare peat areas at peat cuttings;
2. High overall vegetation cover;
3. Increase in the number of bog-mosses, particularly at the original bog surface;
4. Increase in the species richness of blanket bog species; and
5. Increase in wetness of the blanket bog, e.g. an increase in bog pools.

Current situation – Ritten Hamar

Ritten Hamar, as identified in Figure 2, is an area of blanket bog in the very north of Unst and is ca. 14.3ha in size. It is characterised by numerous small lochans and widespread erosion features. Erosion is likely to have been due to a combination of sheep grazing and the extreme exposure to wind and rain erosion in the very exposed location. The erosion was active and noticeable. For example, in some areas the drier surface vegetation had been lifted and folded over in the wind (e.g. Photo 13).

Photo 12: Erosion features at Ritten Hamar

Photo 13: Surface vegetation lifted and folded over in the wind, exposing bare peat.

Baseline – Ritten Hamar

A site visit and PCA was conducted at Ritten Hamar in February 2022.

Figure 5 provides an indicative PCA map (based on a site visit and aerial photos). All of the peatland was classified as Modified and Drained. At Ritten Hamar the drainage was from erosion features rather than peat cutting. Active erosion was present along most the erosion features, which reached up to 3m in height. These had bare peat, exposed on the faces and exposed along the base of the erosion features.

The total length of erosion features at Ritten Hamar (based on aerial photos) was estimated to be ca. 3.6km[3].

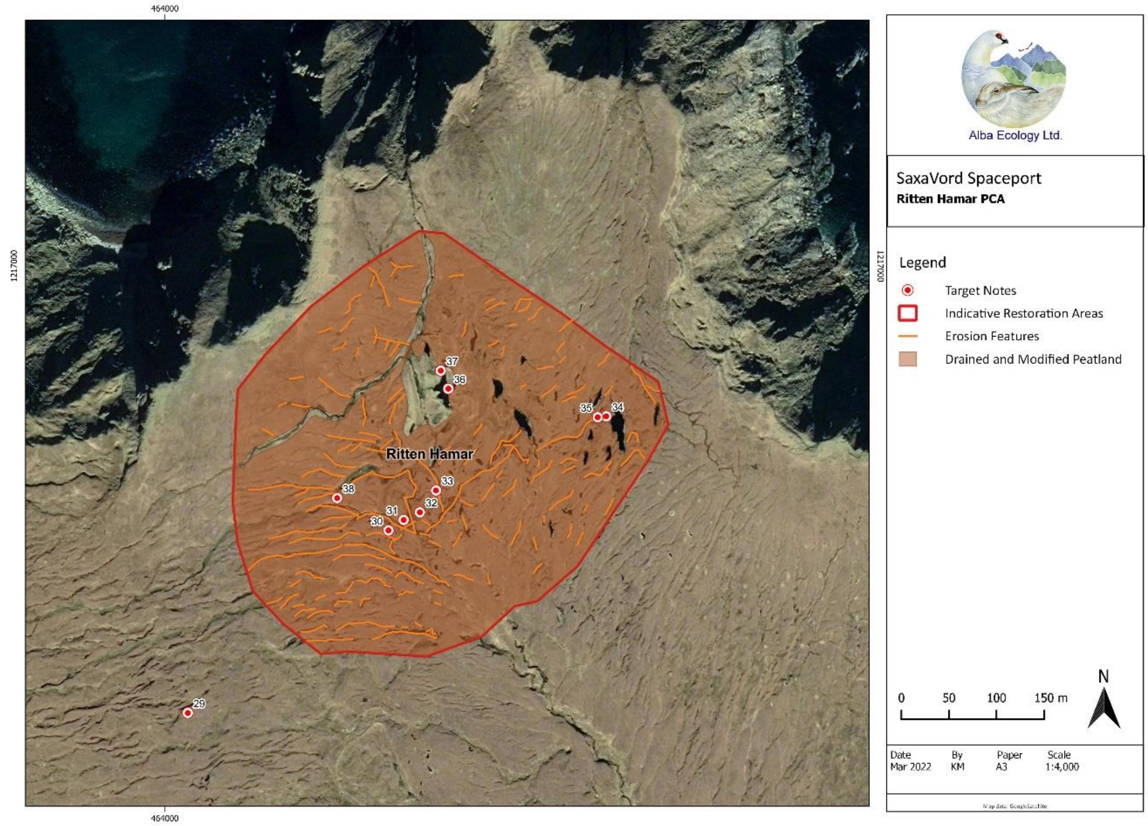


Figure 5: PCA and Target Note locations for Ritten Hamar

The vegetation across the wider area seen whilst walking to Ritten Hamar, where the bog was more intact, was blanket bog with heather, common cottongrass, crowberry, and a little hare's-tail cottongrass being the most common plants and making up the bulk of the vegetation. Mosses most frequently encountered were red bog-moss and glittering wood-moss. Heather was more common on drying edges of the erosion features. Around the numerous bog pool bog-mosses were more common and the ground was noticeably wetter.

Table 3 provides details of the baseline through a series of Target Notes of the peatland habitats at the Ritten Hamar. The locations of the Target Notes are shown in Figure 5.

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[3] Note that these metrics and locations shown in Figure 5 are based on aerial images, viewed between 1:2,000 and 1:4,000 and have not been fully ground truthed. It is possible some 'erosion features' are actually other features in the landscape. Lengths are estimates only.

TG	Grid	Note	Photo
29	HP 64024 16530	View of Ritten Hamar. Erosion features evident from a distance. These were not from peat cutting but were likely formed from a combination of sheep grazing and climatic impacts. The surround blanket bog was in reasonable condition, with old features revegetating in places.	
30	HP 64235 16722	Erosion feature was ca. 1.5m high and 5m wide. It had a bare peat face and base which was actively eroding. It was very exposed and on a fairly shallow gradient. Therefore, it is considered that reprofiling and blocking this erosion feature would be possible using only peat from Ritten Hamar.	
31	HP 64251 16733	The erosion gully at this location was ca. 3m high and actively eroding. It was suitable for reprofiling. It was on a shallow gradient and may require blocked, but peat may be sufficient. There was a small pool at the base of this erosion feature. It was on shallow soil (ca. 0.3m), but with bog mosses present.	 
32	HP 64268 16741	Erosion gully going on a slightly steeper gradient. Some rocks may be required to block this gully. The erosion features were ca.1.2m high and would be suitable for reprofiling.	

TG	Grid	Note	Photo
33	HP 64285 16764	Illustrative photos from Ritten Hamar. The erosion features were ca. 1.2m high. Photos show the views from the east, south then west.	  
34	HP 64464 16842	An erosion gully suitable for blocking and reprofiling. It was at a shallow gradient so peat blocking may be sufficient.	
35	HP 64455 16841	There were also some small erosion features. This one was ca. 0.5m high.	

TG	Grid	Note	Photo
36	HP 64298 16871	Example of surface vegetation lifted and folded over in the wind, exposing bare peat.	
37	HP 64290 16890	Another example of surface vegetation lifted and folded over in the wind, exposing bare peat.	
38	HP 64181 16756	The vegetation across this area was made up of heather, common cottongrass, crowberry, and a little hare's-tail cottongrass. Snow cover prevented a clear view of the moss layer although there appeared to be a red bog-moss and glittering wood-moss component. The vegetation was generally short and open. There was an erosion feature nearby which was ca. 1m high and 3m wide. There was some bare peat exposed to mineral soil at the base.	  

Table 3: Target Notes for Ritten Hamar

Delivery – Ritten Hamar

Peatland restoration is recommended for Ritten Hamar. The erosion features should be restored through reprofiling and where appropriate gully blocking. Peatland restoration is often most effective if it is concentrated within a catchment area or hydrologically linked area. Ritten Hamar is ideal because it is at a watershed location and so the restoration work would support not only the bog habitat but also the associated lochans.

Erosion gullies could be blocked or re-profiled following best practice guidelines (e.g. Appendix 1). The exact location and number of dams required will necessarily be determined on the ground by the contractors. Blocking the gullies will be dependent on the size and the slope of the gully or erosion feature. Small gullies on shallow gradients may be able to be blocked with peat dams from adjacent areas in Ritten Hamar. However, as some of the haggs and gullies were large, stone dams may be required in some circumstance to ensure that water would be dammed and to prevent further erosion (see Appendix 1 for more details and best practice guidelines). Hagg reprofiling would be suitable for all the haggs >0.5m. A form of hagg reprofiling, called cross tracking, may be suitable for haggs and erosion features <0.5m.

The peatland restoration will deliver a series of benefits to the Ritten Hamar area, including halting the degradation, improving the hydrological connectivity and improving the area for wide bog species such as invertebrates and birds. The long-term outcome would be turning the areas from a carbon source to a carbon store and sink through carbon sequestration.

There is no direct road, or track access to Ritten Hamar. Therefore, bringing rocks (or other materials) to Ritten Hamar may be logistically challenging and restoration plans for this work element will need to consider how to do this work. The sea cliffs surrounding Ritten Hamar are ca. 80-100m high. Therefore, the beach at Wick of Skaw would be the closest location to bring the materials via the sea. Likewise, bringing materials by road, would likely to Skaw. Moving material from Skaw to Ritten Hamar may require either Argo cats or in some circumstances may may need to be lifted in by helicopter.

Similar to Loomer Shun and Skaw Paet Hoose, Ritten Hamar appeared to have a low level of sheep grazing. Securing an agreement not to increase sheep levels would be beneficial.

Careful consideration for the timing of this work will need to be taken into account to avoid breeding bird disturbance, but also to prevent further erosion from the wind exposure. The peatland restoration work at Ritten Hamar is not anticipated to begin until 2024/2025 and will take place outwith the bird breeding season.

Peatland restoration work at Ritten Hamar will be undertaken under the supervision of an appropriately trained ecologist.

A baseline monitoring survey measuring species composition, vegetation height, peat depth and areas of bare peat will be undertaken prior to the peatland restoration beginning at a range of monitoring sites within Ritten Hamar. The changes to the vegetation/peat will then be monitored at regular intervals, using standardised systematic methods.

The specific objective for the peatland restoration at Ritten Hamar will be to:

1. Reduce bare peat areas erosion features;

2. High overall vegetation cover;
3. Increase in the number of bog-mosses;
4. Increase in the species richness of blanket bog species; and
5. Increase in wetness of the blanket bog, e.g. an increase in bog pools.

Objective 3. Create native riparian broadleaf tree/scrub cover

Current situation

Given historical clearance of all native woodland on Unst, there is now little woodland cover anywhere on the island outside of private residential gardens. Such cover, as it exists, is highly fragmented and offers very limited opportunities to benefit resident and migrant bird species.

Delivery

The Burn of Skaw lies within is a sheltered west to east facing valley. Many of the bends are well sheltered and contained old planticrubs (small circular dry-stone enclosures formerly used for growing crops in) which provided soil, shelter from the sheep and also, to some extent wind. There is no woodland this far north in Unst and the creation of several small, but discrete planted up areas of native broadleaves on the sheltered bends of the Burn of Skaw would create Britain's most northerly woodland, albeit mainly scrub and localised in nature.

Such woodland/scrub expansion will likely benefit a range of songbird species, which should occur in greater numbers/densities and which also form the main basis of merlin prey, which although not breeding, do forage in this area.

Figure 6 indicates the area intended for planting as part of the HMP, which totals ca. 8ha. Table 4 gives the baseline conditions for this area.

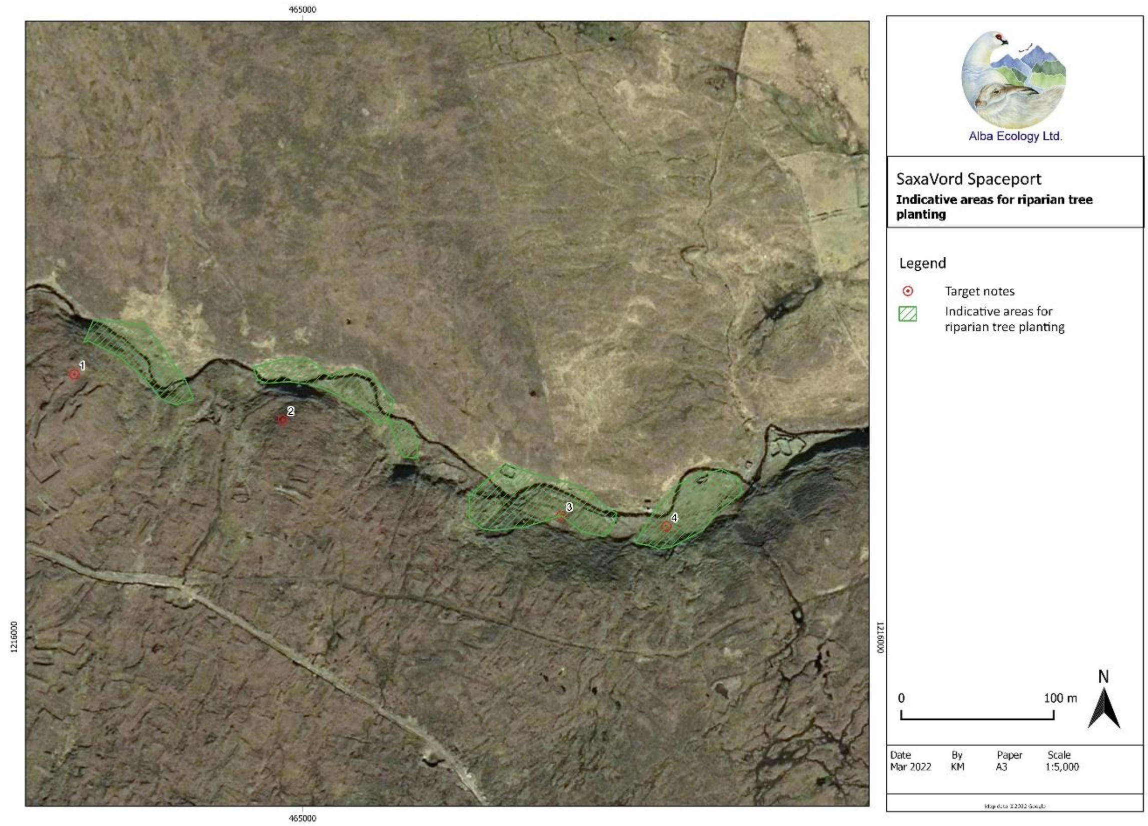

Figure 6: The indicative area for tree riparian tree planting along the Burn of Skaw

TG	Grid	Note	Photo
1	HP 64850 16173	Sheltered valley with suitable areas for planting riparian species along the site of the Burn of Skaw. The existing riparian vegetation was sheep grazed acid grassland.	
2	HP 64987 16143	The flat areas, beside the Burn of Skaw, were relatively sheltered from the prevailing wind.	

TG	Grid	Note	Photo
3	HP 65170 16080	This fenced area with a broken sheiling was considered ideal for planting. It was primarily acid grassland with bent grasses, mat grass, heather, heath bedstraw and tormentil. There were patches of heather and soft rush. The fenced area was ca. 10m wide and 20m long.	
4	HP 65239 16073	This small flat area alongside the Burn of Skaw was considered ideal for riparian tree planting. It was made up of acid grassland with tormentil, bent grasses and mat grass with some soft rush also present. It was c. 10m x 10m is size.	

Table 4: The target notes for the areas identified for riparian tree planting, Burn of Skaw.

The location of the native riparian planting along the Burn of Skaw is on land on which SaxaVord Spaceport have a long-term management agreement on and so the work will be guaranteed to be taken forward.

The riparian corridor along the Burn of Skaw was heavily grazed by sheep and native broadleaved scrub woodland would not survive without effective stock-proof fencing. There will need to be gaps between planted areas to facilitate sheep access across the valley. The indicative areas for planting and fencing are shown in Figure 6. In addition to providing habitat for species which would form part of merlin diet, this action will also allow heather to increase in height which could provide cover and suitable habitat for nesting.

Following discussions in 2020 with the Shetland Amenity Trust on planting trees in Shetland, downy birch, with a mix of other species in appropriate locations including alder, hazel, grey willow, rowan and aspen will be planted in the areas indicated in Figure 6. It is considered that the most appropriate species for planting here are likely to be downy birch, grey willow and alder. The Shetland Amenity Trust will be commissioned to grow and plant trees within this area during the appropriate time of year in 2023-2024.

Objective 4. Coastal grassland habitat management

Current situation

The coastal grassland habitat on the cliff tops of Lamba Ness and The Garths meets Annex 1 habitat and Scottish Biodiversity List (SBL) descriptions and so is of conservation interest (e.g. Photo 14). The coastal grasslands were dominated by red fescue with a variety of maritime species such as thrift, plantains and a variety of wild flowers at varying abundances (e.g. Photo 15).

These types of coastal grasslands are dependent on low-intensity, traditional farming (PlantLife, 2014). Low-intensity sheep grazing, where animals are removed in late spring and returned in autumn, is extremely important to maintain the community and species richness. Abandoning these traditional management practices is considered the key threat to coastal grasslands across the UK (PlantLife, 2014). Without seasonal grazing, the coastal grassland habitats tend to become less species rich as micro habitats close up. This means fewer opportunities for the rarer species to seed or spread (PlantLife, 2014).

Photo 14. Example of coastal grassland at Lamba Ness

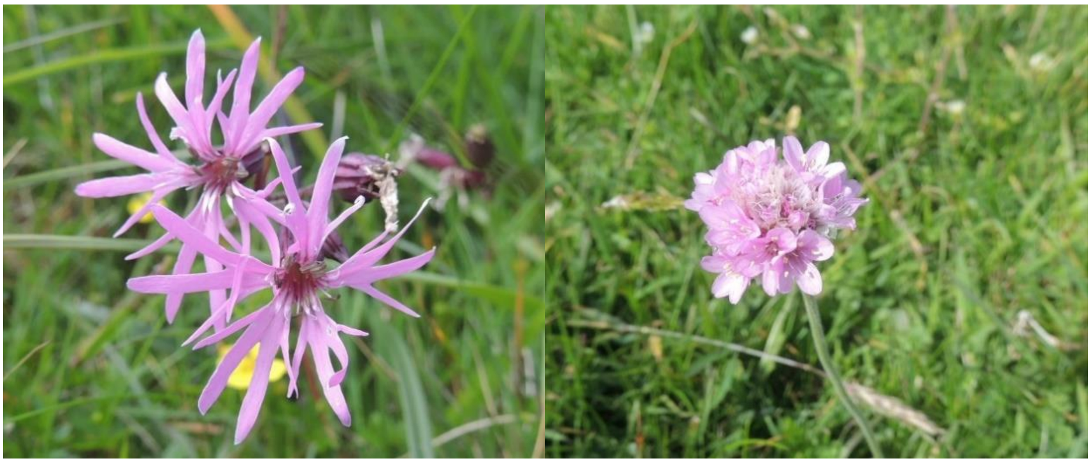

Photo 15. Wildflowers in the coastal grassland - ragged robin and thrift

Delivery

With careful sheep management the coastal grassland habitats can be maintained and enhanced. It is known that "*Traditional grazing regimes use sheep to maximise flowering success. This means grazing in winter with short exclusions during the summer to allow plants to flower and set seed (roughly May - September). Heavy grazing in the autumn is important as it removes the year's crop of grasses and herbs. Ideally this should take place from September when the grasses and herbs are still nutritious. Lighter grazing until April produces the ideal conditions for many plants to survive in healthy populations"* (PlantLife, 2014).

Sheep grazing on Lamba Ness will continue and will follow traditional management regimes. The number of sheep and timing of sheep grazing will follow traditional grazing management regimes and be agreed in consultation interested parties (e.g. NatureScot, SIC).

An agreement will been made with the crofters for a suitable grazing regime on Lamba Ness between mid-September and April once the construction of SaxaVord Spaceport has been delivered.

Monitoring

In order to monitor progress of the HMP, it will be necessary to regularly monitor the effectiveness and success of the restoration measures implemented. To do this an initial assessment of baseline conditions would be required (establishing the baseline, including photos), followed by regular post restoration monitoring (including photos)

Table 5 displays the type of monitoring that should be considered for each restoration technique, before and after implementation.

The most commonly used methods for the pre and post restoration monitoring will be moorland breeding bird surveys, vegetation quadrat assessments and assessment of the planted trees.

Moorland breeding bird survey

The modified Brown and Shepherd (1993) Moorland Breeding Bird survey is the standard survey technique for moorland/upland breeding birds (Gilbert *et al*., 1998). The Brown and Shepherd methodology is based on a constant search method involving spending 25 minutes every 500m × 500m quadrant. This equates to spending 100 minutes for every km^2. The restoration area would be split into a number of 500m x 500m quadrants. Each quadrant would be walked to ensure that all parts were approached to within 100m. At regular intervals, the surveyor will pause, scanned the area for species and listened out for calls and songs. All registrations will be marked on a 1:25,000 scale map using British Trust for Ornithology symbols with a note of the species activity. The main habitat is broadly defined as open moorland so this survey technique was used across all parts of the Study Area.

Vegetation quadrat assessment

Quadrat data will be taken in a standard 2×2m quadrat. All higher plants and common mosses will be identified and their percentage cover assessed. The height of heather and bog mosses will be assessed in each quadrat with a tape measure, six times per quadrat. Quadrat data will provide details on the NVC communities present and any changes in the NVC community. Height data will provide a measure of the structural changes with e.g. reduced grazing pressure.

Tree assessment

Visual inspection for tree/scrub mortality and general will be undertaken on a regular bases. Any dead or dying trees will be replaced. Replanting. The integrity and effectiveness fencing will also be assessed regularly.

Objective	Type of monitoring	Method	Why	Frequency (Years)
Objective 1. Sea-watching hide	Hide maintenance	Vigilance by local community users	To ensure repairs are undertaken promptly	Ongoing
Objective 2. Blanket bog/peatland habitat restoration	Birds	Breeding Bird surveys	To demonstrate whole ecosystem change	Pre restoration, 1, 2, 3, 5, 10, 15, 20, 25 and 30.
	Vegetation	The percentage cover of bog-moss and indicator plant species, bare peat and vegetation height with the use of quadrats, including within control areas not under favourable management	To demonstrate any changes in species composition and structure	Pre restoration, 1, 2, 3, 5, 10, 15, 20, 25 and 30.
Objective 3. Native broadleaf woodland	Vegetation	Visual inspection for tree/scrub mortality (replanting if necessary) and measures of tree height	Ensuring that the planted trees are growing successfully	Pre restoration, 1, 2, 3, 5, 10, 15, 20, 25 and 30.
	Monitoring of exclosures	Visual inspection of integrity of fences and exclosures	To ensure tree/scrub growth takes place	2-3 times annually
Objective 4. Coastal grassland habitat management	Vegetation	Assessment of species richness through quadrats	To demonstrate successful maintenance and enhancement of coastal grassland habitats.	Pre restoration, 1, 2, 3, 5, 10, 15, 20, 25 and 30.

Table 5: The type of ecological/ornithological monitoring recommended for the approved HMP

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Appendix1: Peatland Restoration techniques

Restoration technique	***Description***	***Best practice guidelines***	***Logistics/Constraints***	***Photograph***
Hagg reprofiling	Hagg reprofiling is a process of reducing the steepness of the edge of the hagg, revegetating the bare peat with the use of diggers. • Roll back vegetation from the top of the hagg. • Remove the newly exposed peat and make a gentle slope (33-45º angle). • Replace the vegetation, stretching it across the bare peat. • Take vegetation from 'vegetation borrow pits' in the blanket bog at the top of the hagg to cover any gaps. • Compact the peat and newly laid vegetation with the digger. • Stretch the vegetation around the vegetation borrow pits to ensure there are no areas of bare peat. • Large stone would likely be needed to block large gullies in some areas, these would need to be placed at ca. 5-10m interval in large gullies.	NatureScot guidelines	At a minimum two diggers would need to work together, with at least one of them being a large 14 tonne digger. Once the diggers have accessed the site, they would be able to reprofile approximately 0.5-1km of hagg per day (i.e. 250-500m each). The foreman/project manager should be experienced and have a good understanding of peatland systems, peatland vegetation and peatland hydrology. Digger drivers would require suitable training and experience of peatland restoration, e.g. working in remote areas and driving/digging on the peatlands.	 *Two diggers reprofiling a large erosion gully*
Blocking erosion gullies	Erosion gullies can be blocked and reprofiled with the aim of restoring the natural water table, reduce erosion and allowing re-vegetation. Peat dams are best for shallow gradients, whereas other materials such as plastic, are more effectives on steeper gradients. Wide gullies can be reprofiled as well as dammed to maximize effectiveness.	Some details of best practice guidelines are available from Peatland Action and Moors for the Future.	Gully blocking would have similar requirements as the hagg reprofiling; including large diggers and a competent foreman.	 A digger creating a peat dam.