

Skyrora SaxaVord AEE V5

Assessment of Environmental Effects

Client:	Skyrora Limited
Project/Proposal No:	4879
Version:	5
Date:	2024-05-24

Document Information

Project Name:	Skyrora SaxaVord AEE V5
Document Title:	Assessment of Environmental Effects
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Date:	2024-05-24
Version:	5
Project/Proposal Number:	4879
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Revision History

Version	Date	Authored	Reviewed	Approved	Notes
1.0	2022-05-27	Various	Ruth Fain	Gavin Bollan	Final for Issue
2.0	2022-10-05	Various	Ruth Fain	Gavin Bollan	Amended after CAA feedback
2.1	2022-11-18	Various	Ruth Fain	Gavin Bollan	Ch 2 changes after CAA feedback
3.0	2023-10-20	Various	Ruth Fain	Gavin Bollan	Inclusion of Skyrora Skylark L
4.0	2024-03-28	Various	Ruth Fain	Gavin Bollan	Amended after CAA RFI 3
5.0	2024-05-24	Various	Ruth Fain	Gavin Bollan	Amended after CAA RFI 4

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Abbreviations and Glossary

Abbreviations and Glossary
Skyrora SaxaVord AEE V5

Term	Expanded Term
AEE	Assessment of Environmental Effects
AADT	Annual Average Daily Traffic
AD	Alert Distance
AEE	Assessment of Environmental Effects
AIS	Automatic Identification System
Al	Aluminium
ALARP	As Low as Reasonably Practical
AOB	Apparently Occupied Burrows
AOD	Above Ordnance Datum
AON	Apparently Occupied Nests
AQAL	Air Quality Assessment Level
AQAP	Air Quality Action Plan
AQIA	Air Quality Impact Assessment
AQMA	Air Quality Management Area paragraph
AQOs	Air Quality Objectives
AQS	Air Quality Strategy
BAP	UK Biodiversity Action Plan
BBPP	Breeding Birds Protection Plan
BGS	British Geological Survey
BRRC	Blue Ridge Research and Consulting LLP
CAA	Civil Aviation Authority
CAFS	Cleaner Air for Scotland Strategy
CAR	Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended in 2018)
CCA	Coastal Character Areas
CCIA	Climate Change Impact Assessment
CCP	Climate Change Plan
CCS	Considerate Constructors Scheme
CCTs	Coastal Character Types
Cd	Cadmium
CH	Chain Home
CIEEM	Chartered Institute for Ecology and Environmental Management
CIRIA	Construction Industry Research and Information Association
CO	Carbon Monoxide

Term	Expanded Term
CO_2	Carbon Dioxide
COMAH	The Control of Major Accident Hazards Regulations (2015)
CoNaW Regs	The Control of Noise at Work Regulations
CoPA	The Control of Pollution Act
COSHH	The Control of Substances Hazardous to Health
CRTN	Calculation of Road Traffic Noise
Cu	Copper
Db	Decibel is a unit of measurement
DEFRA	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
DMRB	Design Manual for Roads and Bridges
DWQR	Drinking Water Quality Regulator
EC	European Commission
EcIA	Ecological Impact Assessment
ECoW	Ecological Clerk of Works
EEZ	UK Exclusive Economic Zone
EfT	Emissions factor Toolkit (Defra)
EHO	Environmental Health Officer
EIA	Environmental Impact Assessment
ELV	Exposure Limit Value
EMODnet	European Marine Observation and Data Network
END	Assessment and Management of Environmental Noise
EPS	European Protected Species
EPUK	Environment Protection UK
FCS	Favourable Conservation Status
FID	Flight Initiation Distance
GDL	Gardens and Designed Landscapes
GDP	Gross Domestic Product
GHG	Greenhouse Gas Emissions
GLVIA	Guidelines for Landscape and Visual Impact Assessment
GNSS	Global Navigation Satellite System
GPPs	Guidance for Pollution Prevention
GPS	Global Positioning System
GVA	Gross Value Added
GWDTE	Groundwater Dependent Terrestrial Ecosystems
H	Hydrogen
Ha	Hectares

Term	Expanded Term
He	Helium
Hepla	Hermitage Environmental Planning and Landscape Architecture Limited
HES	Historic Environment Scotland
Hg	Mercury
HGVs	Heavy Goods Vehicles
HRAs	Habitat Regulations Assessments/Appraisals
HSL	The Health and Safety Laboratory paragraph
Hu	Human
IAQM	Institute of Air Quality Management
ICAO	The International Civil Aviation Organisation
ICES	International Council for the Exploration of the Sea
IEMA	Institute of Environmental Management and Assessment
JIT	Just In Time
LAmax	A-weighted, maximum sound level
LAQM	Local Air Quality Management
Las	Local Authorities
LBAP	Shetland Local Biodiversity Action Plan
LCA	Coastal Edge Landscape Character Areas
LDP	Local Development Plan
LCTs	Landscape Character Types
LEAV	Lower Exposure Action Value
LGVs	Light Goods Vehicles
Li	Lithium
LLAs	Local Landscape Areas
LLDR	Local Landscape Designation Reviews
LRCC	Launch and Range Control Centre
LSPF	Launch Site Processing Facility
LUPS-GU31	Land Use Planning System Guidance Note 31
LVIA	Landscape and Visual Impact Assessment
m^3	Cubic meters
MCA	Marine Coastguard Agency
MCMS	Marine Case Management System
MERA	Marine Environmental Risk Assessment
MMO	Marine Management Organisation
MOD	Ministry of Defence
MPAs	Marine Protected Areas
m/s	Meters per second

Term	Expanded Term
N_2H_4	Hydrazine
NAMMCO	North Atlantic Marine Mammal Commission
NAQS	National Air Quality Strategy
NATO	North Atlantic Treaty Organisation
NBN	National Biodiversity Network
NCMPA	Nature Conservation MPAs
NCN	National Cycle Network Routes
NEAFC	North East Atlantic Fisheries Commission
NHZ	Natural Heritage Zone
NIEA	Northern Ireland Environment Agency
NIRs	Natura Impact Reports – information/Reports to inform an Appropriate Assessment, shadow habitats regulations assessment
NISs	Natura Impact Statements
NMF	National Modelling Framework
nmol/L	Nanomoles per litre
NMPi	Marine Scotland's National Marine Plan interactive
NMPs	Noise Monitoring Positions
NOAA	National Oceanic and Atmospheric Administration
NRA	Navigational Risk Assessment
NRW	Natural Resources Wales
NSA	National Scenic Area
NSRs	Noise Sensitive Receptors
NTS	Non-Technical Summary
NVC	National Vegetation Classification
ONS	Office for National Statistics
OS	Ordnance Survey
PAC	Pre-Application Consultation Report
PAHs	Polycyclic Aromatic Hydrocarbons
PAN	Planning Advice Note
PBDEs	Polybrominated Diphenyl Ethers
PCA	Peatland Condition Assessment
PCBs	Polychlorinated Biphenyls
PM_{10}	Particulate Matter with a diameter of 10 micrometers or less
$PM_{2.5}$	Particulate Matter with a diameter of 2.5 micrometers or less
PMP	Peat Management Plan
PPC	Pollution and Prevention Control
PPE	Personal Protective Equipment

Term	Expanded Term
PPGs	Pollution Prevention Guidance Documents
ppm	Parts per million
RAF	Royal Air Force
RBMP	River Basin Management Plans
RCAHMS	Royal Commission on the Ancient and Historical Monuments of Scotland
RCP	Representative Concentration Pathway
RIES	Reports on the Implications for European Sites
RSPB	Royal Society for the Protection of Birds
RTPI	Royal Town Planning Institute
Sabs	Scottish Annual Business Statistics
SACs	Special Areas of Conservation
SAs	Sustainability Appraisals
SAT	Shetland Amenity Trust
SBL	The Scottish Biodiversity List
SCA	Seascape Character Area
SEAs	Strategic Environmental Assessments
SEL	Sound Exposure Level
SENEL	Single Noise Exposure Level
SEPA	Scottish Environment Protection Agency
SIA	Space Industry Act
SIC	Standard Industrial Classification
SLM	Sound Level Meter
SLQ	Special Landscape Qualities Assessment
SM	Scheduled Monument
SNH	Scottish Natural Heritage
SoNA	Survey of Noise Attitudes Study
SPA	Special Protection Area
SPP	Scottish Planning Policy
SSC	Shetland Space Centre
SSSI	Site of Special Scientific Interest
SST	Sea Surface Temperature
STMP	Spectator Traffic Management Plan
SuDS	Sustainable Drainage Systems
SWBSG	Scottish Windfarm Bird Steering Group
TAN	Technical Advice Note
TEL	Transporter / Erector / Launcher Vehicle
TGN	Technical Guidance Note

Term	Expanded Term
UEAV	Upper Exposure Action Value
UKSA	UK Space Agency
VMEs	Vulnerable Marine Ecosystems
VSRs	Vibration Sensitive Receptors
W	Wildlife
WEWSA	Water Environment and Water Services (Scotland) Act
WFD	Water Framework Directive
WFDAs	Water Framework Directive Assessments
WHO	World Health Organisation
WHO ENG	World Health Organisation – Environmental Noise Guidelines for the European Region
ZTV	Zone of Theoretical Visibility
µg	Microgram
µm	Micrometers

Glossary

AEE	**Assessment of Environmental Effects** The systematic process of identifying, quantifying and evaluating the potential effects of the proposed activities on the environment. The purpose of AEE is *'to ensure that applicants for spaceport licences have considered the potential environmental effects of their intended activities and, if necessary, taken appropriate and proportional steps to avoid, mitigate or offset the risks and their potential effects'*. (CAA et. al. 2021).
AOD	**Above Ordnance Datum** In the British Isles, an ordnance datum or OD is a vertical datum used by an ordnance survey as the basis for deriving altitudes on maps. A spot height may be expressed as AOD for "above ordnance datum".
AQMA	**Air Quality Management Area** Since December 1997 each local authority in the UK has been carrying out a review and assessment of air quality in their area. This involves measuring air pollution and trying to predict how it will change in the next few years. The aim of the review is to make sure that the national air quality objectives will be achieved throughout the UK by the relevant deadlines. These objectives have been put in place to protect people's health and the environment. If a local authority finds any places where the objectives are not likely to be achieved, it must declare an Air Quality Management Area there. This area could be just one or two streets, or it could be much bigger. Then the local authority will put together a plan to improve the air quality - a Local Air Quality Action Plan.
AQS	**Air Quality Strategy** This strategy sets out the comprehensive actions required across all parts of government and society to improve airy quality. The strategy sets out how we will protect the nations health and protect the environment.
BBPP	**Breeding Bird Protection Plan** All birds, their nests and eggs are protected by the Wildlife & Countryside Act 1981 as amended by the Nature Conservation (Scotland) Act 2004
CAR	**Water Environment (Controlled Activities Regulations)** It details which activities are regulated by SEPA and what regulatory controls apply over activities which may affect Scotland's water environment.
COMAH	**The Control of Major Accident Hazards Regulations (2015)** The Control of Major Accident Hazards (COMAH) Regulations ensuring that businesses: "Take all necessary measures to prevent major accidents involving dangerous substances. Limit the consequences to people and the environment of any major accidents which do occur"
CoNaW Regs	**The Control of Noise at Work Regulations** The Control of Noise at Work Regulations 2005 place a duty on employers within Great Britain to reduce the risk to their employees health by controlling the noise they are exposed to whilst at work. ... The regulations replaced the 'Noise at work regulations 1989' which previously covered noise in the workplace.

DMRB	**Design Manual for Roads and Bridges** Information about current standards relating to the design, assessment and operation of motorway and all-purpose trunk roads in the UK.
ECoW	**Environmental Clerk of Works** The ECoW role involves monitoring to ensure that site-based construction activities are delivered. Working with site personnel, so as to avoid contravention of relevant wildlife law, and so that the works comply with planning consent commitments and the ecology elements of principal contractor documentation. Such works may also aid the discharge of planning conditions. The ECoW also pro-actively identifies and resolves ecological issues, however minor, that could otherwise give rise to third party criticism of the scheme and ensures that the workforce is aware of their responsibilities. This helps ensure that work proceeds in accordance with the project plan.
Effect	**Effect** The consequences for the receptor of an impact.
EHO	**Environmental Health Officer** Responsible for carrying out measures for protecting public health, including administering and enforcing legislation related to environmental health and providing support to minimise health and safety
EZI	**Environmental Zone of Influence** The Environmental zone of influence is the area whose environmental features could be affected by the specific launch(es) to be carried out under the prospective licence.
FCS	**Favourable Conservation Status** Conservation Status will be taken as Favourable when population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and the natural range of the species is neither being reduced nor is likely to be reduced.
FID	**Flight Initiation Distance** The distance at which a bird flees from perceived danger is defined as the flight initiation distance and could be used to designate separation distances between birds and stimuli that might cause disturbances.
GPPs	**Guidance for Pollution Prevention** GPPs provide environmental good practice guidance for the whole UK, and environmental regulatory guidance directly to Northern Ireland, Scotland and Wales only.
GVA	**Gross Value Added** Defined as output as basic prices minus intermediate consumption (purchaser prices), it is the balancing item of the national accounts' production. GVA can be broken down by industry and institutional sector.

GWDTE	**Groundwater Dependent Terrestrial Ecosystems** Groundwater Dependent Terrestrial Ecosystems (GWDTE) are wetlands which critically depend on groundwater flows or chemistries. As part of the assessment of groundwater status you have to assess if it has been significantly damaged and if the pressure causing this damage has happened via a groundwater body.
Impact	**Impact** The change experienced by a receptor (this can be beneficial, neutral or adverse)
Launch	**Launch** Causing a craft to take off.
Launch Vehicle	**Launch Vehicle** A launch vehicle or carrier rocket is a rocket propelled vehicle used to carry a payload from Earth's surface to space usually to Earth orbit or beyond.
NEAFC	**North East Atlantic Fisheries Commission** The North East Atlantic Fisheries Commission is a regional fisheries management organisation that maintains controls over fishing and fishing related acts in the North East Atlantic Ocean.
NMPI	**National Marine Plans Interactive** Is an interactive tool which is part of the Marina Scotland Open Data Network, and has been designed to assist in the development of national and regional marine planning. Allows you to view different types of information and, where appropriate, links have been provided to the related parts of Scotland's Marina Atlas, the National Marina Plan as well as links to data sources to facilitate data download.
Off-nominal Launch	**Off-nominal Launch** A launch event that proceeds beyond ignition but does not perform within expected/acceptable limits.
Orbital	**Orbital** An orbital flight circles the earth at least once, in a stable way.
PMP	**Peat Management Plan** Peat is a body of sedimentary material, usually dark brown or black in colour, comprising the partially decomposed remains of plants and organic matter that is preserved in anaerobic conditions within an essentially waterlogged environment. Peatlands hold large stocks of poorly protected carbon and excavation of peat will result in large carbon losses from the excavated peat and also the areas affected by drainage. In the majority of cases excavated peat will be regarded as waste in law and regulatory controls will apply to its storage and/or disposal.
Receptor	**Receptor** Used throughout the AEE process and is defined as the element in the environment affected by a development (e.g., a bird in the case of ornithology)
Scrubbed / Aborted Launch	**Scrubbed / Aborted Launch** A launch event in which the Applicant calls off the attempted launch prior to ignition.

SLM	**Sound Level Meter** Used for acoustic measurements, commonly handheld with a microphone. They provide readings on the noise level in an environment and usually return a measurement in decibels (dB).
SPA	**Special Protection Areas** A Special Protection Area is a designation under the European Union Directive on the Conservation of wild birds. Under the Directive, Member States of the European Union (EU) have a duty to safeguard the habitats of migratory birds and certain particularly threatened birds.
Space activity	**Space activity** Space activities are defined as: (a) launching or procuring the launch or the return to earth of a space object or of an aircraft carrying a space object (b) operating a space object, or (c) any activity in outer space They are also referred to as 'spaceflight activities'.
Spacecraft	**Spacecraft** A space object, a rocket or other craft that is capable of operating above the stratosphere or a balloon that is capable of reaching the stratosphere carrying crew or passengers, that is used for spaceflight activities. It includes satellites.
Space Object	**Space Object** The component parts of a space object, its launch vehicle and the component parts of that.
SPP	**Scottish Planning Policy** A statement of Scottish Government Policy on how nationally important land use planning matters should be addressed across the country.
SSSI	**Site of Special Scientific Interest** A Site of Special Scientific Interest (SSSI) is a formal conservation designation. Usually, it describes an area that's of particular interest to science due to the rare species of fauna or flora it contains - or even important geological or physiological features that may lie in its boundaries.
SST	**Sea Surface Temperature** Sea surface temperature (SST) is the water temperature close to the ocean's surface. The exact meaning of surface varies according to the measurement method used, but it is between 1 millimetre (0.04 in) and 20 metres (70 ft) below the sea surface.
Suborbital	**Suborbital** Suborbital flights may go into space, then their path (or trajectory) carries them back to earth.
Suborbital activity	**Suborbital activity** Launching, procuring the launch of, operating or procuring the return to earth of: (a) a rocket or other craft that is capable of operating above the stratosphere (b) a balloon that is capable of reaching the stratosphere carrying crew or passengers, or

	(c) an aircraft carrying such a craft but does not include space activity. The regulator uses the International Standard Atmosphere (47km) as the stratopause for the purposes of determining whether an activity is 'sub-orbital'. Sub-orbital activities are also referred to as 'spaceflight activities'.
SuDS	**Sustainable Drainage Systems** Sustainable drainage systems (also known as SuDS, SUDS, or sustainable urban drainage systems) are a collection of water management practices that aim to align modern drainage systems with natural water processes.
TAN	**Technical Advice Note** Technical Advice Notes provide guidance which may assist in the technical evaluation of noise assessment.
Test Launch	**Test Launch** A test launch event that proceeds beyond ignition and lift off and performs within expected/acceptable limits.
UEAV	**Upper Exposure Action Value** The upper exposure action value is set at a daily or weekly average noise exposure of 85 dB, above which the employer is required to take reasonably practicable measures to reduce noise exposure, such as engineering controls or other technical measures.
WFD	**Water Framework Directive** The Water Framework Directive (WFD) sets out objectives for the water environment. These include the protection, enhancement and restoration of surface water, groundwater and water dependent protected areas and prevention of deterioration. Environmental standards and conditions are needed to set the level of control to meet these objectives.
WHO	**World Health Organisation** WHO's primary role is to direct international health within the United Nations' system and to lead partners in global health responses.
WHO ENG	**World Health Organisation Environmental Noise Guidelines** The WHO guideline values are public health-oriented recommendations, based on scientific evidence of the health effects and on an assessment of achievable noise levels.
ZTV	**Zone of Theoretical Visibility** Also known as a Zone of Visual Influence, is a computer-generated tool to identify the likely (or theoretical) extent of visibility of a development. The elevation (or a set of elevations) of the development is tested against a 3D terrain model.

Volume I Non-Technical Summary

Non-Technical Summary

Volume I – Non-Technical Summary

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1. Non-Technical Summary

1.1 Introduction

1.1.1 ITPEnergised has prepared this Assessment of Environmental Effects Report (AEE Report) on behalf of Skyrora Limited ('the Applicant') in regard to their application to the Civil Aviation Authority (the regulator) for licenses under the Space Industry Act 2018.

1.1.2 The Applicant intends to launch sub-orbital (Skyrora Skylark L) and orbital (Skyrora XL) Launch Vehicles from any one of three terrestrial vertical launch pads at the SaxaVord Spaceport situated at Lamba Ness on Unst, Shetland. For purposes of this AEE Report the proposed launch operations will be referred to as 'the Proposed Project'.

1.1.3 As set out in the National Space Policy (UK Government 2018) and the later National Space Strategy, the UK aims to become the European hub for commercial spaceflight and related sector technologies. The UK Government is committed to building one of the most innovative and attractive space economies in the world, supporting the growth of a robust and competitive commercial space sector growing the value of the UK Space Sector to £40 billion by 2030, representing approximately 10% of the global market.

1.1.4 Skyrora's mission is to realise the tangible benefits of responsive access to, and responsible exploration of space for the increased well-being of life on Earth.

1.1.5 Skyrora aims to provide a versatile, cost-effective, and environmentally responsible end-to-end space transportation service for global small satellite payloads. Skyrora sets out to address the growing demand of the global small satellite market, currently experiencing restricted access to Low Earth Orbit by designing, manufacturing, and operating an orbital launch vehicle (Skyrora XL).

Space Industry Act 2018

1.1.6 The Space Industry Act 2018 received Royal Assent on 15 March 2020 and provides a legal framework for the licensing of space activities, sub-orbital activities and associated activities carried out in the UK.

1.1.7 The Act requires that person or organisation wishing to undertake the following to obtain a relevant license:

- launch a launch vehicle from the UK;
- return a launch vehicle launched elsewhere than the UK to the UK landmass or the UK's territorial waters
- operate a satellite from the UK
- conduct sub-orbital activities form the UK
- operate a spaceport in the UK, or
- provide range control services from the UK.

1.1.8 As the Applicant wishes to become a spaceflight operator and launch Skyrora XL Launch Vehicles from the UK, they are required to apply for a launch operator licence, and as part of this application, submit an AEE of the proposed project.

Space Industry Regulations 2021

1.1.9 The Space Industry Regulations 2021 (the Regulations) set out in more detail the requirements for each licence the Regulators Licensing rules, which specify what information the CAA, the regulator, requires in support of an application.

Relevant Guidance

Guidance for the Assessment of Environmental Effects

1.1.10 The CAA, with the UK Space Agency, the Department for Business, Energy and Industrial Strategy and the Department for Transport, issued guidance note '*CAP 2215 Guidance for the Assessment of Environmental Effects*' in July 2021. The guidance sets out what is required by the regulator regarding assessment of environmental effects as part of a licence application under the Act.

1.1.11 The guidance describes the licence required by the Applicant as follows:

- *A launch operator licence means an operator licence within section 3 of the Act which authorises a person or organisation to carry out spaceflight activities… A person or organisation holding a launch operator licence is referred to as a spaceflight operator, or in some circumstances, launch operator licensee. If a launch operator licensee wishes to return a launch vehicle launched from the UK or the UK's territorial waters to land in the UK, it can apply to do so under the launch operator licence and does not need to apply for a separate return operator licence.*

1.1.12 AEE is relevant to applications for launch operator licences and so this document has been prepared in support of the launch operator licence application.

Guidance to the regulator on environmental objectives relating to the exercise of its functions under the Space Industry Act 2018

1.1.13 The Department for Transport issued its document '*Guidance to the regulator on environmental objectives relating to the exercise of its function under the Space Industry Act 2018*' in 2021, clarifying the government's environmental objectives relating to spaceflight and associated activities in the UK:

The environmental objective for spaceflight are to:

- *Minimise emissions contributing to climate change resulting from spaceflight activities*
- *Protect human health and the environment from the impacts of emissions on local air quality arising from spaceflight activities*
- *Protect people and wildlife from the impacts of noise from spaceflight activities*
- *Protect the marine environment from the impact of spaceflight activities.*

1.1.14 The objectives presented in the guidance are noted to be consistent with the environmental topics that must be addressed in an AEE. Consideration of the environmental objectives has been included as relevant in the AEE technical assessment chapters.

Location

1.1.15 The Proposed Project will operate at the SaxaVord Spaceport located at Lamba Ness on Unst, the most northerly of the Shetland Islands.

1.1.16 For the purposes of this AEE, the boundary of the Proposed Project has been assumed as the areas within SaxaVord Spaceport where the delivery, preparation and launch of the Skyrora XL Launch Vehicle will take place. The Proposed Project site boundary is shown on Drawing 3.1 in Volume III, centred approximately at N 60° 49' 0.0984, E -0° 46' 27.7104. The site occupies an area of approximately 33.5 hectares (ha). It is approximately 2.5 km north-east of the settlement of Norwick.

1.2 Approach to AEE

1.2.1 AEE is the systematic process of identifying, predicting and evaluating the environmental effects of a proposed project. The AEE Report sets out the conclusions of the AEE process undertaken in relation to the Proposed Project. Where appropriate, it also sets out mitigation measures designed to prevent, reduce and, if at all possible, offset significant effects. An assessment of residual effects, those expected to remain following implementation of mitigation measures, is also presented.

1.2.2 The key stages in the AEE process are presented in Chapter 2 of the AEE Report, with an overview of the specific methodology adopted for each technical study provided within the respective technical chapters (Chapters 4 to 12).

1.2.3 In line with the CAA guidance, effects on the following environmental features have been considered:

- Population and human health;
- Biodiversity (ecology and ornithology);
- Air quality;
- Noise and vibration;
- Water;
- Climate;
- Marine environment;
- Land, Soils and Peat;
- Landscape, Seascape and Visual Impact;
- Material assets and cultural heritage; and
- Accidents and Disasters.

1.2.4 Of these, due to the temporary nature of each proposed launch and the fact that the delivery, assembly and launch of the Skyrora XL Launch Vehicle will not have significant effect on ground condition due to the SaxaVord Spaceport infrastructure already in place, it is considered that the Proposed Project has no potential for significant effects on either the water environment or land condition. By extension, nor will the Proposed Project impact on material assets and cultural heritage. As such, these elements have been scoped out of the AEE.

1.3 Proposed Project

1.3.1 The Proposed Project comprises the preparation and launch of Skyrora Skylark L and Skyrora XL launch vehicles from any of three terrestrial vertical launch pads at the SaxaVord Spaceport situated at Lamba Ness on Unst, Shetland.

1.3.2 The Skyrora Skylark L suborbital Launch Vehicle is approximately 11.6 m long and comprises a guided suborbital Launch Vehicle powered by a single pressure fed, bi-liquid propellant engine. Launches will take place in a northerly direction over the sea and will be located on any of the three launch pads within the SaxaVord Spaceport.

1.3.3 The Skyrora XL orbital Launch Vehicle is an approximately 24 m long, three-stage liquid fuelled orbital launch vehicle intended to place customer payloads into sun synchronous or polar orbits. Launches will take place in a northerly direction over the sea and will be located on any of the three launch pads within the SaxaVord Spaceport.

1.3.4 The impact dispersion area from all launch pad complexes for both sub-orbital and orbital LVs is contained within the area demarcated as the orbital Environmental Zone of Influence (EZI) and is presented in Drawing 3.6.

1.3.5 The trajectories and likely impact zone for returning material from sub-orbital launches is spatially limited compared to orbital launches, as sub-orbital LVs are smaller and have a reduced range.

1.3.6 The composition and fuelling specifics of the two launch vehicles has been assessed by all technical leads working on the AEE and it has been confirmed that for all topics, the Skyrora XL Launch Vehicles will result in greater effects across all potential impact pathways. As such, for the purposes of this AEE, the Skyrora XL orbital Launch Vehicle has been assessed as the limiting case Launch Vehicle representing the limiting case scenario for Skyrora launches from the SaxaVord Spaceport.

1.3.7 The Applicant is applying for a maximum environmental budget of 16 launches per year which, from 2029 when maximum launch cadence is reached, will make up just over one half of SaxaVord Spaceport's own environmental budget of 30 launches per year.

1.3.8 The location of the Proposed Project is shown on Figure NTS-1 below.



Figure NTS-1 – Location of Proposed Project on Unst, Shetland

1.3.9 The infrastructure required for the Proposed Project will be provided by SaxaVord Spaceport, which is subject to regulation under the Act itself and has completed an AEE as part of its own Spaceport Operator Licence application (document reference LP-004-SAXA, application SR-APP-001019).

1.3.10 The Proposed Project will utilise the following existing SaxaVord Spaceport infrastructure:

- Launch Site: located on the Lamba Ness peninsula and comprising three launch pad complexes, 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;
- Integration Hangars –
    - Launch Site Processing Facility (LSPF) hangar buildings: located on the Lamba Ness peninsula, a building where the Skyrora XL Launch Vehicles will be assembled and the Payload (the satellites) integrated;
    - Administration Building, Pyrotechnics Store, and Hazardous Materials Store located adjacent to the LSPF on the Lamba Ness peninsula;
    - 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; and
- Support Infrastructure: located on the Lamba Ness peninsula including access, an internal track system and a series of small temporary buildings.

1.3.11 The Applicant will be able to utilise any of the three terrestrial launch pads located at the SaxaVord Spaceport and will be directed by the Spaceport operator as to which launchpad to use on a launch event by event basis dependant on availability. Layouts of the three launchpads are included for information as Drawings 3.3, 3.4 and 3.5 in Volume III.

1.3.12 Subject to securing the appropriate permissions, consents and licences, the intention is to initiate first demonstration launch in 2023 and then increase cadence to 16 launches per year by 2029.

1.3.13 The layout of the Proposed Project, within the context of the wider SaxaVord Spaceport, is shown on Figure NTS-2.

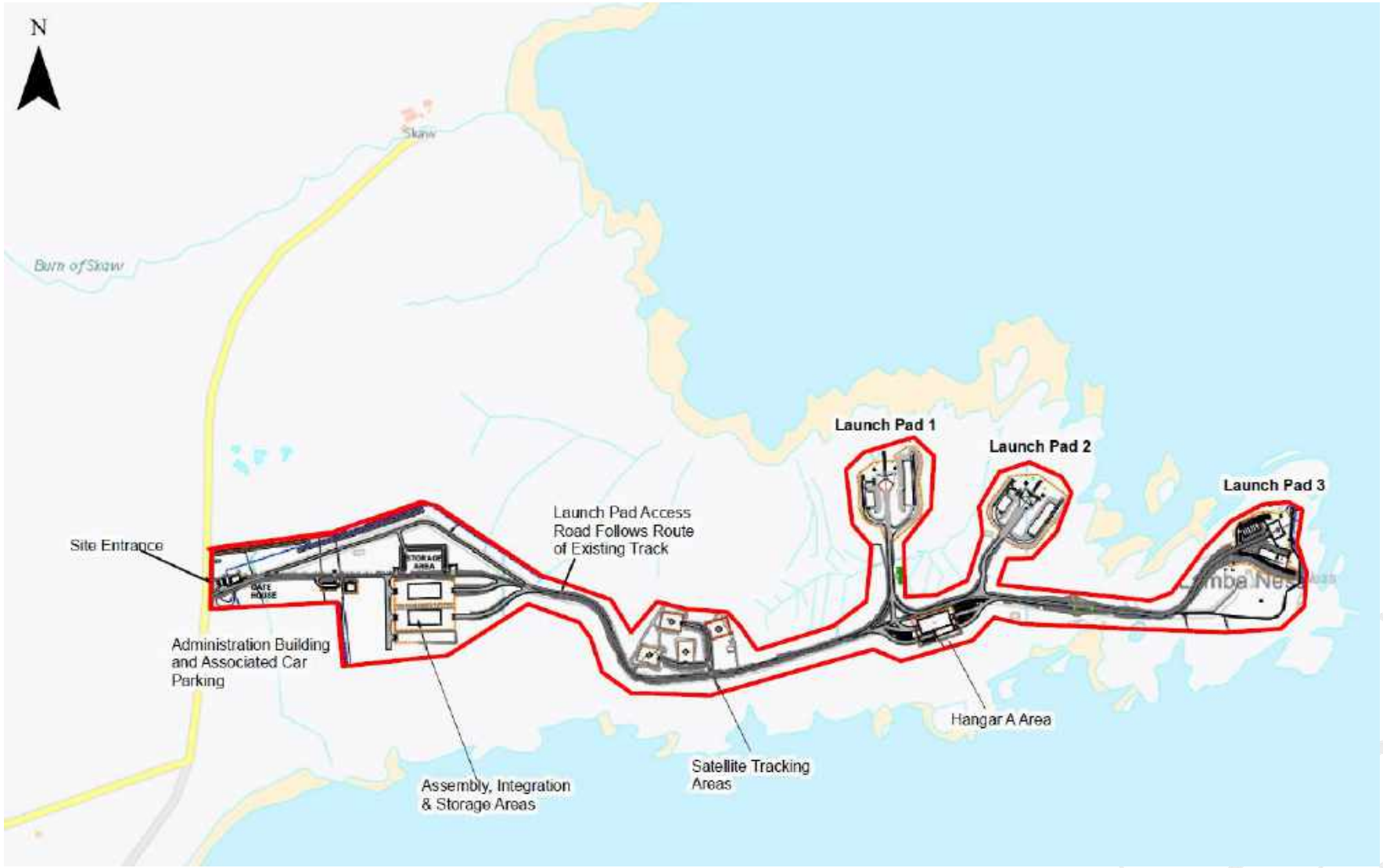

Figure NTS-2 Proposed Project Site Layout

1.4 Population and Human Health

1.4.1 The population of Unst has declined significantly over the last century to an estimated level of around 700 people and is expected to decrease further. The population decline has been caused in part by the closures of Baltasound Airport in 1996 and RAF Saxa Vord in 2006. These closures have also depressed job opportunities in Unst, and incomes in Unst and the North Isles tend to be lower than in other parts of the Shetland Islands. When compounded with higher living costs, this results in the area around the Proposed Project being one of the least affluent areas in the Shetland Islands.

1.4.2 Within the context of the wider SaxaVord Spaceport, the Proposed Project represents a transformational and much needed economic development opportunity for Unst and for the Shetland Isles and will generate significant beneficial local effects through:

- employment associated with operation of the Proposed Project;
- demand for goods and services to support the operation of the Proposed Project;
- hosting temporary workers and staff from the Applicant who will then utilise local shops, hospitality and other amenities; and,
- attracting tourists who will visit to watch launches and/or explore the SaxaVord Spaceport (including outside the current summer tourism season).

1.4.3 The predicted economic effects are considered to be major beneficial (significant) locally.

1.4.4 Full operation of the Proposed Project will see a maximum of 16 launches of the Skyrora XL Launch Vehicle per year. During operation, beneficial economic impacts are expected to arise from three main sources:

- employment associated with operation of the Proposed Project;
- accommodation for temporary workers during launches; and,
- space tourism activity.

1.4.5 It is estimated that employment associated with this level of activity will generate:

- £1.8 million GVA and support 37 jobs in Unst;
- £2.9 million GVA and support 64 jobs in The Shetland Islands; and,
- £3.4 million GVA and support 74 jobs across Scotland.

1.4.6 The total effect from operation of the Proposed Project is therefore assessed as being:

- major beneficial (significant) for Unst;
- minor beneficial for The Shetland Islands; and,
- negligible for Scotland.

1.4.7 The total effect from operation of the Proposed Project is therefore assessed as being:

- major beneficial (significant) for Unst;
- minor beneficial for The Shetland Islands; and,
- negligible for Scotland.

1.4.8 In addition, the Proposed Project is also expected to result in a series of wider, less quantifiable, benefits for the economies of Unst, the Shetland Islands and Scotland including:

- Making Scotland more competitive in the small satellite space sector, by contributing to the development and success of the SaxaVord Spaceport.
- Diversifying the economic base of Unst and the Shetland Islands towards the space sector.

- Offering a wider range of employment opportunities and new career paths available to young people in Unst and in the Shetland Islands.
- Acting as a catalyst for further investment; and,
- Encouraging investment in the tourism sector, as launches extend the tourism season and provide additional visitors to Unst and to the Shetland Islands.

1.5 Ornithology

1.5.1 Targeted and licensed breeding bird surveys were undertaken following agreed standardised survey methods between 2018 and 2020 within the ornithological study area. A total of 135 bird species were recorded during breeding bird surveys. There was direct evidence of potentially sensitive and specially protected bird species breeding within, and adjacent to, the Proposed Project boundary.

1.5.2 Ornithological designated site interests on the Hermaness, Saxa Vord and Valla Field SPA (and overlapping Hermaness SSSI and Saxa Vord SSSI) and the following non-designated wider countryside ornithological birds are taken forward for assessment: red-throated diver, merlin, black guillemot, common guillemot, puffin, razorbill, shag, kittiwake, fulmar, ringed plover, golden plover, whimbrel, curlew, dunlin, Arctic tern, Arctic skua, great skua and a confidential Schedule 1 species.

1.5.3 To understand potential impacts of loud, short duration noise events, a background literature review of noise impacts on relevant bird species was undertaken. This literature review looked at how impulsive noise (from various sources including aircraft, fireworks, military ranges and rocket launches) impacted on birds in order to help assess the potential noise impacts of the launches.

1.5.4 Potential impacts from the Proposed Project (preparation and launch of the Skyrora XL Launch Vehicle) have been assessed. The magnitude of predicted operational effects is either 'no effect' or 'negligible' for all bird species considered except one. Minor operational impacts are predicted for a confidential Schedule 1 breeding species. All likely effects are assessed as non-significant, apart from a confidential Schedule 1 species, where minor magnitude operational effects are considered likely to be significant in the absence of mitigation.

1.5.5 Mitigation measures, confirmed by planning conditions, are outlined in Appendix 5.3: Habitat Management Plan and comprise of the following elements that will benefit ornithological receptors: large-scale peatland restoration, creation of native broadleaved riparian woodland, coastal grassland management, offsite red-throated diver lochan habitat restoration/protection, habitat creation for a Schedule 1 breeding bird and whimbrel chick habitat creation.

1.5.6 After mitigation, all residual effects are predicted likely to be not significant.

1.6 Ecology

1.6.1 Targeted and licensed baseline ecology surveys, following best practice guidance, were undertaken between 2018 and 2020.

1.6.2 The Habitats Study Area was dominated by four Phase 1 habitats: wet modified bog/wet heath, wet modified bog, coastal grassland, and semi-improved acid grassland.

1.6.3 Numerous otter field signs were recorded during targeted surveys. There were six-seven otter holts within the Otter Study Area and up to four additional otter holts within the 500 m buffer. The holts were invariably within inaccessible cliff locations, between boulders or inside caves/crevices. Scats and footprints, including those of adults and young, were also recorded in the abandoned buildings across Lamba Ness. Otter use of an underpass was particularly noticeable. It was considered likely that otters use this underpass as a regular route to cross from the north to south side of Lamba Ness (and vice versa) and so is likely to be functionally important to otter use of the Lamba Ness area.

1.6.4 No evidence of freshwater pearl mussels was found in the Burn of Norwick Study Area.

1.6.5 Potential impacts of the Proposed Project on potential receptors were assessed.

1.6.6 The assessment does not predict any likely significant ecological residual effects associated with the Proposed Project.

1.7 Air Quality

1.7.1 Consideration has been given to the potential effects of the Proposed Project on local air quality. Potential impacts have been predicted at representative ecological and human health receptors in proximity to the Proposed Project and associated transportation routes.

1.7.2 Proposed project-generated traffic is predicted to have an effect of negligible significance on air quality, therefore resulting in no likely significant effect.

1.7.3 Launch emissions are predicted to have no perceptible impact at any identified receptors under prevailing wind directions. The maximum predicted impact at a sensitive receptor is predicted to occur with north-easterly winds which occur typically for less than 10 % of the year. The maximum predicted 8-hour concentration of CO is 0.55 % of the AQS. Emissions from launches are therefore considered to negligible effect on air quality**,** therefore resulting in no likely significant effect.

1.8 Noise

1.8.1 Potential noise and vibration effects associated with the Proposed Project have been robustly assessed with regard to launches and associated non-launch activities.

1.8.2 Noise effects associated with road traffic and non-launch activities have been assessed as not significant, resulting in no likely significant effect.

1.8.3 Noise during engine tests (should they occur – not currently planned) and launches will be audible at NSRs within and beyond the study area and levels will exceed the criterion for community annoyance associated with aircraft noise. Instantaneous noise levels will be below the threshold at which damage to hearing may occur.

1.8.4 The short duration of audible noise 'events' associated with engine tests and launches, and their infrequent occurrence, will reduce the associated levels of annoyance to below that which may be associated with aircraft noise from conventional airports. Accordingly, adverse health effects are not anticipated. Noise at NSRs associated with launches is below the level at which the potential for cosmetic damage to structures is likely. Noise effects launches have therefore been assessed as not significant, resulting in no likely significant effect.

1.8.5 Vibration (air overpressure) associated with launch events has been evaluated and found to result in a low likelihood of damage complaints and has therefore been determined to be not significant, resulting in no likely significant effect.

1.8.6 Standard mitigation has been considered in the derivation of effect significance. Committed mitigation measures include a commitment to meeting noise limits for fixed and mobile plant items and assisting SaxaVord Spaceport in maintaining good communications with the local community with regard to all activities of the Proposed Project.

1.9 Climate Change

1.9.1 An assessment of the potential effects of GHG emissions associated with the Proposed Project on climate change has been undertaken.

1.9.2 The assessment considered emissions arising from the operation of the Proposed Project including transportation and combustion of Skyrora XL Launch Vehicle fuel.

1.9.3 A climate resilience assessment has been carried out to assess the vulnerability of the Proposed Project to climate change.

1.9.4 The assessment evaluated the impact of climatic variables such as wind speed, precipitation and temperature on sensitive receptors associated with the Proposed Project.

1.9.5 The climate baseline was characterised using Met Office climate data for the period 1981-2001.

1.9.6 Potential climate change effects caused by GHG emissions associated with the Proposed Project should be considered significant in accordance with IEMA best practice guidance. These GHG emissions in the context of overall annual emissions by the Shetland Islands are considered of minor significance.

1.9.7 Mitigation measures including the development of low carbon kerosene substitutes and the continued decarbonisation of passenger and freight transport will contribute to reducing GHG emissions.

1.9.8 Climate resilience impacts on the Proposed Project associated with high temperatures are considered to be of negligible significance.

1.9.9 High wind speeds are predicted to have an effect of minor significance on the Proposed Project.

1.9.10 The effects of heavy precipitation on the Proposed Project are considered to be of minor significance.

1.9.11 Standard mitigation has been considered in the inference of effect significance. Committed mitigation measures include suspending activities during extreme weather events and providing personnel with appropriate PPE.

1.10 Marine and Transboundary Effects

1.10.1 An assessment of the potential effects of environmental effects associated with the Proposed Project on marine and transboundary receptors, including Arctic sea ice has been undertaken.

1.10.2 The assessment includes consideration of effects associated with the orbital EZI for the Skyrora XL Launch Vehicle Stage 1, fairings, and Stage 2 components, and the proposed trajectory of the Skyrora XL Launch Vehicle which will have an overall northerly direction from SaxaVord Spaceport.

1.10.3 The EZI falls within the jurisdiction of several countries including Scotland, Norway, Faroe Islands (Denmark), Iceland, and Greenland (Denmark). It also falls within areas beyond national jurisdiction. The northern part of the EZI (Stage 2) lies within the Arctic Circle, of which the southern limit is at a latitude of 66˚N. The EZI lies mostly within OSPAR Region 1: Arctic Waters, with the waters up to 200 km north of Shetland falling within Region II: Greater North Sea.

1.10.4 The EZI comprises mostly deep water with a small amount of continental shelf and many bathymetric features. The water quality of the EZI is high, in that it does not have significant local input of anthropogenic contaminants such as metals, microplastics, and hydrocarbons. The EZI supports numerous marine biota such as plankton, benthic habitats, fish and shellfish, seabirds, and marine mammals. The EZI has few marine protected areas (Drawing 10.3).

1.10.5 In the EZI, human activities are concentrated in the southern portion (as far as the Faroe Islands to the north). This includes shipping and navigation, oil and gas cables and pipelines, and commercial fishing (Drawings 10.4 – 10.6). There is occasional use of the area for military activities. Marine archaeology is poorly known and so assumed to be present. There is presence of oil and gas infrastructure, subsea cables and pipelines, marine renewable energy, dredge disposal sites, tourism, and marine archaeological features as shown on Drawings 10.4 – 10.6.

1.10.6 Launches have the potential to affect the aforementioned water quality, biodiversity and human activities. The pathways of effect have been identified: impacts from the presence of the Skyrora XL Launch Vehicle and associated materials, such as metals, microplastics, and hydrocarbons; impacts from direct strike and impact at the seabed from when the returning debris objects come to rest.

1.10.7 All environmental effects associated with the Proposed Project on marine (including sea ice) and transboundary receptors (alone and in-combination) resulted in no more than minor effects, with more than half resulting in negligible effects. These assessments were determined to not require any mitigation measures, with all resulting in no likely significant effects.

1.11 Landscape, Seascape and Visual Impact Assessment

1.11.1 A Landscape and Visual Impact Assessment has been undertaken for the Proposed Project, within the context of the wider SaxaVord Spaceport. It sets out the predicted effects on the landscape, which, in the context of Shetland and this assessment, also includes effects on coastal and seascape character.

1.11.2 The assessment includes consideration of effects upon designated landscapes including the Shetland National Scenic Area and other locally designated landscapes such the draft Local Landscape Areas.

1.11.3 From a visual perspective, the assessment considers effects upon residents at settlements, users of roads and recreational routes, which include tourists. This was informed by assessment of visual effects at a series of representative viewpoints, which were agreed with NatureScot and Shetland Islands Council.

1.11.4 The assessment of in-combination effects between the component parts of the Proposed Project is incorporated into the main assessment of landscape and visual effects. Some limited in-combination interactions will occur.

1.11.5 The proposed launches will need to be lighted at night for a short term during individual launch cycles for reasons of safety. The lighting will extend visual effects into hours of darkness for local visual receptors.

1.11.6 A number of significant effects are predicted including significant landscape effects on the landscape character of the site and its surroundings, visual effects on residents at settlements and tourists including recreational walkers.

1.11.7 Effects on the fabric of the landscape will be limited in extent.

1.11.8 The Proposed Project is focussed away from the scattered settlement and coastal crofting land and is positioned on the Lamba Ness peninsula. The SaxaVord Spaceport site has previously been the focus for the large-scale development of the wartime Skaw Radar Station with many of the original structures, buildings and tracks remaining evident in this coastal landscape. Whilst the effects of the Proposed Project, within the context of the wider SaxaVord Space, will be significant locally to the site and for some visual receptors in local views to the site, it is considered that these can be accommodated in this open, diverse coastal landscape.

1.12 Accidents

1.12.1 A list of potential events was drawn up based on the expected activities at the Proposed Project.

1.12.2 Natural disasters including flooding and tectonic activity are considered highly unlikely given the location of the Proposed Project. Extreme weather effects have been addressed in the Climate Change Chapter 9 of this AEE Report and it is considered that the proposed infrastructure design provides sufficient resilience to the effects of extreme weather events over the design life of the Proposed Project.

1.12.3 Accident events were subcategorised into failure of containment of kerosene and high-test peroxide (HTP – hydrogen peroxide), loss of gases, ignition of kerosene and off-nominal launch scenarios. The effects on generic on-site human and wildlife receptors and off-site designated habitat sites were considered for each of these events.

1.12.4 Failures of containment were generally considered to be minor or moderate significance and largely restricted to the areas immediately within the vicinity of the release point, given the quantities in use and the rapid expected evaporation and/or dispersion and/or chemical decomposition of the majority of bulk liquids and gases used. Mitigation will be through management procedures, robust containment and restrictions on the quantities stored at the site of the Proposed Project.

1.12.5 Again, noting the environmental context, ignition events are considered to be major with potential for significant effects inasmuch as damage to health or loss of life to human and wildlife receptors would be possible if in close proximity to the event. In the unlikely event that ignition of kerosene occurred, the initial blast radius would be relatively small (well within the spaceport boundary at which the Proposed Project is to be located) and the subsequent blaze limited in duration by the quantities stored and used. Mitigation will be through the restriction of ignition sources from flammable materials through standard operating practices. Uncontrolled ignition events during launches are managed via the Launch Vehicle design process and integrity checks.

1.12.6 Off-nominal launch scenarios are considered to be of major significance should a ground strike take place, with potential for severe damage to human, wildlife and habitat receptors from impact and subsequent ignition of remaining propellant. Water strikes were considered of moderate significance as wildlife habitats and receptors could potentially be impacted; this is covered in the Marine Effects Chapter 10. Mitigation is inherent to the remote, northerly launch site location and exclusively northward launch trajectories to be used.

Volume II AEE Report

Chapter 1 Introduction

1. Introduction

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1. Introduction

1.1 Introduction

1.1.1 ITPEnergised has prepared this Assessment of Environmental Effects Report (AEE Report) on behalf of Skyrora Limited ('the Applicant') in regard to their application to the Civil Aviation Authority (the regulator) for licenses under the Space Industry Act 2018.

1.1.2 The Applicant intends to launch suborbital (Skyrora Skylark L) and orbital (Skyrora XL) Launch Vehicles from any one of three terrestrial vertical launch pads at the SaxaVord Spaceport situated at Lamba Ness on Unst, Shetland and as such is applying to the UK Civil Aviation Authority (CAA) for a launch operator licence as required by the Space Industry Act 2018.

1.1.3 For purposes of this AEE Report the proposed launch operations will be referred to as 'the Proposed Project'.

1.1.4 The location of the Proposed Project is shown on Drawing 3.1 in Volume III.

1.1.5 Schematics of the Skyrora Skylark L and Skyrora XL Launch Vehicles are included below as Figures 1.1 and 1.2 respectively. The Proposed Project is summarised in section 1.5 and described in full in Chapter 3.

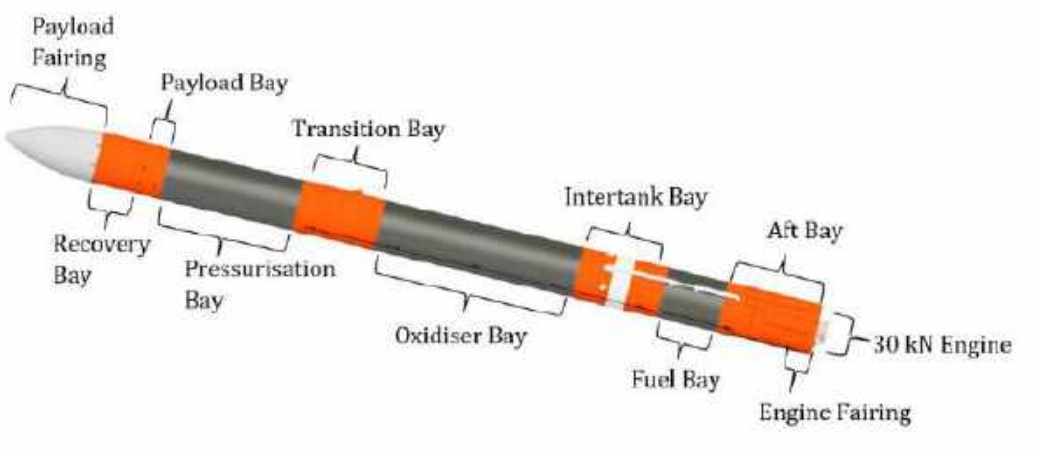

Figure 1.1 Skyrora Skylark L Suborbital Launch Vehicle



Figure 1.2 Skyrora XL Orbital Launch Vehicle

1.2 The Applicant

1.2.1 The Applicant for the Proposed Project is Skyrora Limited (Skyrora).

1.2.2 Skyrora was established in 2017 with the intention of designing, manufacturing, and deploying rockets to facilitate access to space for small satellite manufacturers. Headquartered in Edinburgh with facilities located across Europe, Skyrora is developing launch vehicle technology to ensure that the life-changing benefits of space are realised on Earth.

1.2.3 Skyrora is a limited company incorporated in Scotland (SC569511) with its registered office at 7 Drum Mains Park, Cumbernauld, Glasgow, Scotland, G68 9LD.

1.3 Background

1.3.1 Growth in demand for meteorological, telecommunications, earth observation and Global Navigation Satellite Systems (GNSS) satellite services has led to rapid growth and diversification within the space industry and a marked shift from state to private provision. In the UK in 2018 the industry was worth more than £16 bn (annual growth exceeds three per cent) and comprised around 1,000 companies and organisations (UK Government, 2018). Glasgow produces more satellites than any other European city. However, currently, the "missing link" for the UK is launch capability.

1.3.2 As set out in the National Space Policy (UK Government 2018) and the later National Space Strategy (UK Government, 2021), the UK aims to become the European hub for commercial spaceflight and related sector technologies. The UK Government is committed to building one of the most innovative and attractive space economies in the world, supporting the growth of a robust and competitive commercial space sector growing the value of the UK Space Sector to £40 billion by 2030, representing approximately 10% of the global market.

1.3.3 Skyrora's mission is to realise the tangible benefits of responsive access to, and responsible exploration of space for the increased well-being of life on Earth.

1.3.4 Skyrora aims to provide a versatile, cost-effective, and environmentally responsible end-to-end space transportation service for global small satellite payloads. Skyrora sets out to address the growing demand of the global small satellite market, currently experiencing restricted access to Low Earth Orbit by designing, manufacturing, and operating an orbital launch vehicle (the Skyrora XL).

1.3.5 Skyrora builds upon innovative UK engineering, enhanced with practical experience from personnel who have participated in international orbital launch campaigns and vehicle development programs. This provides a strong foundation for development and operation of Skyrora's launch vehicles.

1.3.6 Skyrora has thus far invested significant resources into innovative solutions for the space sector. This includes development and verification of the Skyrora XL's Third Stage, which can perform multiple engine ignitions to orbit multiple payloads. The Third Stage forms the basis for the Skyrora Space Tug, which is designed to de-orbit existing debris in space.

1.4 Regulatory Requirements and Guidance Documents

Space Industry Act 2018

1.4.1 The Space Industry Act 2018 received Royal Assent on 15 March 2020 and provides a legal framework for the licensing of space activities, suborbital activities and associated activities carried out in the UK.

1.4.2 The Act requires that person or organisation wishing to undertake the following to obtain a relevant license:

- launch a launch vehicle from the UK;

- return a launch vehicle launched elsewhere than the UK to the UK landmass or the UK's territorial waters;
- operate a satellite from the UK;
- conduct suborbital activities form the UK;
- operate a spaceport in the UK; or
- provide range control services from the UK.

1.4.3 As the Applicant wishes to become a spaceflight operator and launch Skyrora Skylark L and Skyrora XL Launch Vehicles from the UK, they are required to apply for a launch operator licence, and as part of this application, submit an AEE of the proposed project.

Space Industry Regulations 2021

1.4.4 The Space Industry Regulations 2021 (the Regulations) set out in more detail the requirements for each licence and the regulators licensing rules, which specify what information the CAA, the regulator, requires in support of an application.

Relevant Guidance

Guidance for the Assessment of Environmental Effects

1.4.5 The CAA, with the UK Space Agency, the Department for Business, Energy and Industrial Strategy and the Department for Transport, issued guidance note '*CAP2215 Guidance for the Assessment of Environmental Effects*' in July 2021. The guidance sets out what is required by the regulator regarding assessment of environmental effects as part of a licence application under the Act.

1.4.6 The guidance describes the licence required by the Applicant as follows:

- *A launch operator licence means an operator licence within section 3 of the Act which authorises a person or organisation to carry out spaceflight activities… A person or organisation holding a launch operator licence is referred to as a spaceflight operator, or in some circumstances, launch operator licensee. If a launch operator licensee wishes to return a launch vehicle launched from the UK or the UK's territorial waters to land in the UK, it can apply to do so under the launch operator licence and does not need to apply for a separate return operator licence.*

1.4.7 AEE is relevant to applications for launch operator licences and so this document has been prepared in support of the launch operator licence application.

Guidance to the regulator on environmental objectives relating to the exercise of its functions under the Space Industry Act 2018

1.4.8 The Department for Transport issued its document '*Guidance to the regulator on environmental objectives relating to the exercise of its function under the Space Industry Act 2018*' in 2021, clarifying the government's environmental objectives relating to spaceflight and associated activities in the UK:

The environmental objectives for spaceflight are to:

- *Minimise emissions contributing to climate change resulting from spaceflight activities*
- *Protect human health and the environment from the impacts of emissions on local air quality arising from spaceflight activities*
- *Protect people and wildlife from the impacts of noise from spaceflight activities*
- *Protect the marine environment from the impact of spaceflight activities.*

1.4.9 The objectives presented in the guidance are noted to be consistent with the environmental topics that must be addressed in an AEE. Consideration of the environmental objectives has been included as relevant in the AEE technical assessment chapters.

1.5 The Proposed Project

1.5.1 The Proposed Project comprises the preparation and launch of Skyrora Skylark L suborbital Launch Vehicles and Skyrora XL orbital Launch Vehicles from any of three terrestrial vertical launch pads at the SaxaVord Spaceport situated at Lamba Ness on Unst, Shetland.

1.5.2 The Skyrora Skylark L suborbital Launch Vehicle is approximately 11.6 m long and comprises a guided suborbital Launch Vehicle powered by a single pressure fed, bi-liquid propellant engine. Launches will take place in a northerly direction over the sea and will be located on any of the three launch pads within the SaxaVord Spaceport.

1.5.3 The Skyrora XL orbital Launch Vehicle is approximately 24 m long, three-stage liquid fuelled orbital launch vehicle intended to place customer payloads into sun synchronous or polar orbits. Launches will take place in a northerly direction over the sea and will be located on any of the three launch pads within the SaxaVord Spaceport.

1.5.4 For the purposes of this AEE, the Skyrora XL orbital Launch Vehicle has been determined to be, and assessed as, the limiting case Launch Vehicle. Commentary on the justification for this is provided in AEE Report Volume II, Chapter 2. A full description of the Proposed Project and the Skyrora XL orbital Launch Vehicle are provided in AEE Report Volume II, Chapter 3 with a summary provided below for information.

1.5.5 The Proposed Project consists of the following, and where appropriate throughout, the term "Proposed Project" shall mean all of the following elements:

- Preparation of the Skyrora Skylark L / Skyrora XL Launch Vehicle;
- Storage and Handling of launch vehicle Propellants;
- Operation of Ground Segment and Launch Complex; and
- Launch of Skyrora Skylark L / Skyrora XL Launch Vehicle (including assessment of discarded Stage impact zones).

1.5.6 The Proposed Project will utilise the following existing SaxaVord Spaceport infrastructure:

- Launch Site: located on the Lamba Ness peninsula and comprising three launch pad complexes, 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;
- Integration Hangars –
  - Launch Site Processing Facility (LSPF) hangar buildings (two): located on the Lamba Ness peninsula, a building where the Skyrora Skylark L / Skyrora XL Launch Vehicles will be assembled and the payload(s) integrated;
  - 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; and
- Support Infrastructure: located on the Lamba Ness peninsula including access, an internal track system and a series of small temporary buildings.

1.5.7 A full description of the Proposed Project is provided in AEE Report Volume II, Chapter 3.

1.5.8 Subject to securing the appropriate permissions, consents and licences, the intention is to initiate first demonstration launch in 2023 and then increase cadence to 16 launches per year by 2029 as shown in Figure 1.3.

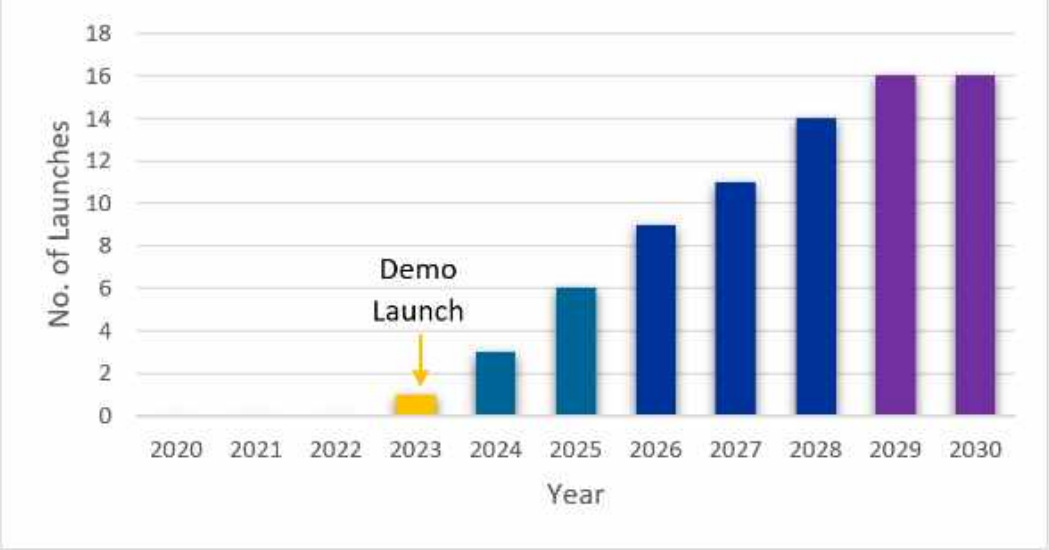

Figure 1.3 Skyrora Proposed Launch Cadence

1.5.9 This AEE has been carried out assuming the maximum 16 launches of the Skyrora XL Launch Vehicle per year and a total of 428 launches over the assumed operational period of 30 years .

1.6 Environmental Budget

1.6.1 The Applicant is applying for a maximum environmental budget of 16 launches per year which, from 2029 when maximum launch cadence is reached, will make up just over one half of the SaxaVord Spaceport environmental budget of 30 launches per year.

1.6.2 Of the total proposed 16 launches per year, when taking into account the no-launch window agreed between mid-May to the end of June, the Applicant anticipates that in any one month there may be up to two launch events.

1.6.3 Whilst the Applicant has not yet determined a specific timeframe for launch operations, when required for the purposes of this AEE an operational period of 30 years (equating to 428 launches) has been assumed, aligning with the current land lease for the SaxaVord Spaceport. This applies in particular to the process of calculating total mass of returning components, required for the Marine and Transboundary assessment (Chapter 10).

1.6.4 For other technical disciplines the appropriate timeframe for assessment varies – for example for ecology/ornithology the appropriate timeframe is considered generally to be a year due to breeding seasonality, and similarly cumulative noise effects are assessed over the period of a year. Whereas for air quality, due to the fact that only one launch will occur at any given time and launches will be phased with time enough for the EZI to return fully to the baseline state for all environmental topics between launches (i.e., no more than one launch within a 24-hour period) the appropriate assessment period is considered to be a single launch. Due to this variance between technical disciplines, appropriate timescales for assessment are detailed in each technical chapter.

Precautionary Approach

1.6.5 This AEE is based on the limiting case of maximum 16 Skyrora XL Launch Vehicle launches per year and a total of 428 launches over the assumed operational period of 30 years from the Proposed Project. Launches of suborbital Skyrora Skylark L Launch Vehicles present much less significant effects due to their size and nature and are considered to be adequately assessed within this limiting case.

1.7 Site Description

1.7.1 The Proposed Project will operate at the SaxaVord Spaceport located at Lamba Ness on Unst, the most northerly of the Shetland Islands.

1.7.2 For the purposes of this AEE, the boundary of the Proposed Project has been assumed as the areas within SaxaVord Spaceport where the delivery, preparation and launch of the Skyrora XL Launch Vehicle will take place. The Proposed Project site boundary is shown on Drawing 3.1 in Volume III, centred approximately at N 60° 49' 0.0984, E -0° 46' 27.7104. The site occupies an area of approximately 33.5 hectares (ha). It is approximately 2.5 km north-east of the settlement of Norwick.

1.7.3 There are no residential properties located within the boundary of Proposed Project or that of SaxaVord Spaceport, with the closest property, the Haa, located approximately 0.6 km away. The Haa is uninhabited and will remain so for the duration of operation of the Proposed Project as it is unfit for habitation. Accordingly, it has not been considered as a residential receptor and the closest residential receptors are therefore the properties in Norwick, located approximately 2.5 km south-west of the Proposed Project.

1.8 Designated Sites

1.8.1 A plan showing relevant designated sites within the vicinity of the Proposed Project is included as Drawing 1.1.

Ecological Designations

1.8.2 There are no statutorily designated sites relevant to ecology within the boundaries of the Proposed Project.

1.8.3 There are a number of national and international statutorily designated sites relevant to ecology in the vicinity of the Proposed Project, with 10 designated sites within 10 km as follows:

- Hermaness, Saxa Vord and Valla Field Special Protection Area (SPA) - Designated for breeding birds: fulmar (Fulmarus glacialis), gannet (Morus bassanus), great skua (Stercorarius skua), common guillemot (Uria aalge), kittiwake (Rissa tridactyla), puffin (Fratercula arctica), red-throated diver (Gavia stellata), shag (Phalacrocorax aristotelis) and breeding bird assemblages;
- Keen of Hamar Special Area of Conservation (SAC) - Designated for upland habitats: base rich scree, dry heath and grasslands on soils rich in heavy metals;
- Keen of Hamar Site of Special Scientific Interest (SSSI) - Designated for Calaminarian grassland and serpentine heath and vascular plant assemblages;
- Hill of Colvadale and Sobul SSSI - Designated for Arctic sandwort (Arenaria norvegica), breeding Arctic skua (Stercorarius parasiticus), whimbrel (Numenius phaeopus), calaminarian grassland and serpentine heath and breeding bird assemblages;
- Valla Field SSSI - Designated for breeding great skua and red-throated diver;

- Crussa Field and Heogs SSSI - Designated for breeding Arctic skua, whimbrel, vascular plant assemblages, Calaminarian grassland and serpentine heath and breeding bird assemblages;
- Hermaness SSSI - Designated for breeding gannet, great skua, guillemot, puffin and breeding seabird colony;
- Saxa Vord SSSI - Designated for breeding fulmar, guillemot and breeding seabird colony;
- Norwick Meadows SSSI - Designated for sand dune habitats and valley fen wetlands; and,
- Fetlar to Haroldswick Marine Protection Area - Designated for aggregation of breeding birds: black guillemot (Cepphus grylle), horse mussel beds, circalittoral sand and coarse sediment communities and kelp and seaweed communities on sublittoral sediment.

1.8.4 The Hermaness, Saxa Vord and Valla Field SPA lies approximately 1.5 km west of the Proposed Project along the northern Unst coastline. The SPA consists of 100-200 m high sea cliffs and adjoining areas of grassland, heath and blanket bog, and the seaward extension extends approximately 2 km into the marine environment to include the seabed, water column and surface. The boundary of the SPA is coincident with that of the Saxa Vord SSSI and Hermaness SSSI which are located approximately 3 km and 4 km north-west of the Proposed Project respectively.

1.8.5 The high cliffs and stacks of the Hermaness SSSI support large colonies of nesting seabirds, with some species individually reaching numbers of national importance. Inland from the cliffs, the bog and heath vegetation provide nesting habitat for one of the largest colonies of great skua in the world, representing over 3 % of the global population.

1.8.6 The Saxa Vord SSSI contains several skerries which, along with the sea cliffs, support a wide range of seabirds. This SSSI site is notified for its nationally and internationally important breeding fulmar and guillemot populations and for the seabird colony as a whole. The site supports a breeding colony of fulmar and guillemot contributing to 1.2% and 0.4% of the British population respectively.

Landscape Designations

1.8.7 Seven small areas of coastal landscape in Shetland have been identified as being of outstanding scenic interest. These designated areas make-up the Shetland National Scenic Area (NSA) and comprise Shetland's scenic highlights and epitomise the range of coastal forms varying across the Island group.

1.8.8 One NSA sub-unit, Hermaness, is located within the landscape and visual impact assessment environmental zone of influence (EZI) for the Proposed Project. The identified special qualities of the Hermaness sub-unit are as follows:

- the stunning variety of the extensive coastline;
- the hidden coasts;
- the effects and co-existence of wind and shelter;
- a sense of remoteness, solitude and tranquillity;
- the notable and memorable coastal stacks, promontories and cliffs;
- the distinctive cultural landmarks; and,
- northern light.

1.8.9 Three Local Landscape Areas (LLAs) are identified within the EZI, of which only one has the potential to be affected by the Proposed Project to a level that could result in significant effects: the LLA at Haroldswick and Skaw.

1.9 Environmentally Sensitive Periods of Time

No-launch Window

1.9.1 Following consultation with NatureScot during the planning application stage for the Spaceport, SaxaVord committed to a no-launch window whereby no satellite launches or static tests will be carried out between mid-May and the end of June so as to avoid disturbing birds during the critical incubation and early brooding period. The Applicant is aware of this operational constraint and will not schedule launches within the defined mid-May to end of June window.

Night-time Operations

1.9.2 Night-time effects are relevant to the noise impact assessment. For the purposes of this AEE the night-time period has been assumed to be 23:00 – 07:00, as defined in Noise Guidance Document PAN1/2011 TAN.

1.9.3 Of the proposed 16 launches per year, when taking into account the no-launch window agreed between mid-May to the end of June, the Applicant anticipates that in any one month there may be up to two launch events. As discussed in Chapter 8, given the proposed frequency of launches and the short duration of the associated noise events, and with reference to the 2006 Basner study which states that restricting additional awakenings due to aircraft noise to a maximum of one event per night is anticipated to have no adverse effect on human health, adverse effects associated with sleep disturbance due to night-time launches are considered to be minimal, resulting in no likely significant effect.

1.10 Purpose of Assessment of Environmental Effects (AEE)

1.10.1 The AEE process is the systematic process of identifying, predicting and evaluating the environmental effects of a proposed project. This AEE Report sets out the conclusions of the AEE process undertaken in relation to the Proposed Project. Where appropriate, it also sets out mitigation measures designed to prevent, reduce and, if at all possible, offset significant effects. An assessment of residual effects, those expected to remain following implementation of mitigation measures, is also presented.

1.10.2 The main findings and conclusions of the AEE Report are summarised in a Non-Technical Summary (NTS) presented in Volume I.

1.11 AEE Project Team

1.11.1 The assessment has been undertaken by ITPEnergised supported by external consultants as shown in Table 1.1. CVs for the AEE team are included in Appendix 1.1.

Table 1.1 – AEE Team

Discipline	Lead Specialist	Qualifications	Accreditations	Professional Experience (years)
Population and Human Health	Graeme Blackett, BiGGAR Economics	BA (Hons) Economics, University of Strathclyde	Member Economic Development Association Scotland Member Institute for Economic Development	30+
Ornithology	Dr Peter Cosgrove, Alba Ecology Ltd	PhD Ornithology	FCIEEM	25+
Ecology	Dr Kate Massey, Alba Ecology Ltd	PhD Ecology	MCIEEM	13+
Noise and Vibration	Michael James, Blue Ridge Research and Consulting LLC	B.S., Mechanical Engineering, Virginia Tech M.S, Mechanical Engineering, Virginia Tech	BRRC founding member and principal. >50 military, civilian aviation, rockets, weaponry and blast noise studies including NASA and SpaceX	20+
	Simon Waddell, ITPEnergised	BSc (Hons) Environmental Geoscience, University of Edinburgh Post-graduate Diploma Acoustics and Noise Control, Institute of Acoustics	Member Institute of Acoustics (MIOA)	12+
Air Quality	Annie Danskin, ITPEnergised	BEng (Hons) Environmental Engineering	Member of the Institution of Environmental Sciences (MIEnvSc)	20+
Marine Effects / Transboundary Considerations	Ian Reach, MarineSpace Ltd	BSc. (Hons) Marine Biology with Fish Biology	Professional Member of the Marine Biological Association UK	28+

Discipline	Lead Specialist	Qualifications	Accreditations	Professional Experience (years)
Climate Change	Gavin Bollan, ITPEnergised	BSc(Hons) Environmental Science	Member of the Institution of Environmental Sciences, Fellow of the Institute of Air Quality Management, Chartered Scientist, Chartered Environmentalist	25+
Accidents				
Landscape, Seascape and Visual Impact	Peter Dunmow, Hepla	BA (Hons) Landscape Architecture Dip LA, Landscape Architecture MA (Hons) Landscape Architecture	Chartered Member of the Landscape Institute	28+
AEE co-ordination, introductory and concluding Chapters	Ruth Fain, ITPEnergised	MGeol. (Hons) Environmental Geology	Chartered Scientist (CSci) Member of the Institution of Environmental Sciences (MIEnvSc) NEBOSH General Certificate	19+

1.12 Availability of the AEE Report

1.12.1 On submission of the AEE, the CAA will undertake a formal public consultation process. The CAA will provide the opportunity for representations to be made on the Proposed Project via the CAA consultation hub: https://consultations.caa.co.uk/. All representations will be taken into account before making decisions on the application. Any representations on this AEE Report or the licence applications, should be made directly to the CAA.

1.13 References

Literature

DEIMOS Space UK Limited et. al. (2017) *SCEPTRE Site Assessment Report* [online]. Available at https://www.hie.co.uk/media/6626/sceptre-final-report-february-2017.pdf

CAA et. al. (2021) *CAP2215 Guidance for the Assessment of Environmental Effects* [online]. Available at https://publicapps.caa.co.uk/docs/33/(CAP2215)%20Guidance%20for%20the%20assessment%20of%20environmental%20effects.pdf

Department for Transport. (2021) *Guidance to the regulator on environmental objectives relating to the exercise of its function under the Space Industry Act 2018* [online]. Available at *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/995153/guidance-to-the-regulator-on-environmental-objectives-relating-to-the-exercise-of-its-functions-under-the-space-industry-act-2018.pdf*

Websites

UK Government. (2018).*Size and Health of the UK Space Industry 2018* [online]. Available at https://www.gov.uk/government/publications/uk-space-industry-size-and-health-report-2018

Legislation

UK Government. (2015). National Space Policy [online]. Available at https://www.gov.uk/government/publications/national-space-policy

UK Government. (2018). Space Industry Act 2018 [online]. Available at https://www.legislation.gov.uk/ukpga/2018/5/contents/enacted

UK Government. (2021). National Space Strategy [online]. Available at https://www.gov.uk/government/publications/national-space-strategy

UK Government. (2021b). The Space Industry Regulations 2021 [online]. Available at

https://www.legislation.gov.uk/uksi/2021/792/contents/made

Chapter 2 Approach to AEE

2. Approach to AEE

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2. Approach to AEE

2.1 Introduction

2.1.1 This AEE Report comprises a Non-Technical Summary (NTS), the main AEE Report text, accompanying drawings and technical appendices.

2.1.2 The Proposed Project comprises the preparation and launch of Skyrora Skylark L suborbital Launch Vehicles and Skyrora XL orbital Launch Vehicles from any of three terrestrial vertical launch pads at the SaxaVord Spaceport situated at Lamba Ness on Unst, Shetland. The project will be regulated under the Space Industry Act 2018 ('the Act').

2.1.3 The Proposed Project consists of the following elements:

- Preparation of Skyrora Skylark L / Skyrora XL Launch Vehicle;
- Storage and Handling of launch vehicle Propellants;
- Operation of Ground Segment and Launch Complex; and
- Launch of Skyrora Skylark L / Skyrora XL Launch Vehicle (including assessment of discarded Stage impact zones).

2.1.4 The Applicant is applying for a maximum environmental budget of 16 launches per year.

2.2 Limiting Case Launch Vehicle

2.2.1 The Skyrora Skylark L suborbital Launch Vehicle is approximately 11.6 m long and comprises a guided suborbital Launch Vehicle powered by a single pressure fed, bi-liquid propellant engine. Launches will take place in a northerly direction over the sea and will be located on any of the three launch pads within the SaxaVord Spaceport.

2.2.2 The Skyrora XL orbital Launch Vehicle is an approximately 24 m long, three-stage liquid fuelled orbital launch vehicle intended to place customer payloads into sun synchronous or polar orbits. Suborbital launches of the Skyrora Skylark L Launch Vehicle will take place along a due north (000°) azimuth from the launch site and will only be allowed to occur when meteorological conditions are such that no southerly movement of the launch vehicle is possible, considering both nominal and off-nominal launch event sequences.

2.2.3 Orbital (Skyrora XL) and suborbital (Skylark) launches are predicted to occur from the SaxaVord Spaceport. The impact dispersion area from all launch pad complexes for both suborbital and orbital Launch Vehicles is contained within the area demarcated as the orbital Environmental Zone of Influence (EZI) and is presented in Drawing 3.6. The trajectories and likely impact zone for returning material from suborbital launches is spatially limited compared to orbital launches, as suborbital Launch Vehicles are smaller and have a reduced range. The area of impact for nominal suborbital launches is therefore encompassed within the larger EZI.

2.2.4 A comparison of the two launch vehicles is included as Appendix 2.1. The composition and fuelling specifics of the two launch vehicles has been assessed by all technical leads working on the AEE and it has been confirmed that for all topics, the Skyrora XL Launch Vehicles will result in greater effects across all potential impact pathways.

2.2.5 As such, for the purposes of this AEE, the Skyrora XL orbital Launch Vehicle has been assessed as the limiting case Launch Vehicle representing the limiting case scenario for Skyrora launches from the SaxaVord Spaceport.

2.3 Legislation, Policy and Guidance

2.3.1 Section 11 of the Space Industry Act 2018 ('the Act') stipulates that all applicants for a launch operator licence are required to submit an assessment of environmental effects (AEE) as part of their licence application. The regulator, the Civil Aviation Authority (CAA), is required to take the AEE into account when deciding whether to grant a licence and what, if any, conditions should be attached to such a licence, and cannot grant a launch operator licence until the AEE has been submitted.

2.3.2 Under section 11(4) of the Act the regulator can permit applicants to submit an equivalent assessment, prepared previously, as part of the AEE.

2.3.3 Whilst this AEE Report is issued as a standalone AEE submission and all effects have been assessed in terms of Proposed Project, the assessment does refer out to, and as relevant include as appendices, previous relevant assessments and documents submitted to Shetland Islands Council as part of the planning application for the SaxaVord Spaceport (reference 2021/005/PPF) or to the CAA as part of the subsequent SaxaVord Spaceport operator licence application (reference SR-APP-001019) where operational phase elements of the reports relate directly to the AEE and it was considered disproportionate to duplicate these assessments as stand-alone AEE only assessments.

2.3.4 Appendices which were submitted to Shetland Islands Council as part of the planning application for the SaxaVord Spaceport, in their original format, including those used to discharge a planning condition, and which can therefore be considered 'equivalent assessments' include:

- Appendix 5.1a Shetland Space Centre Breeding Bird Survey, 2020. The document has been reviewed by Shetland Islands Council and relevant statutory consultees. Document unchanged since then – equivalent assessment. Also included in SaxaVord Spaceport AEE V3 as submitted previously to the CAA.
- Appendix 5.2 - Background Literature Review. Submitted to Shetland Islands Council with the planning application. Document unchanged since then – equivalent assessment. Also included in SaxaVord Spaceport AEE V3 as submitted previously to the CAA.
- Appendix 5.3 - Detailed Habitat Management Plan, February 2022 – document produced subsequent to receipt of planning consent as part of pre-commencement conditions. The document has been reviewed by Shetland Islands Council and relevant statutory consultees. Document unchanged since then – equivalent assessment. Also included in SaxaVord Spaceport AEE V3 as submitted previously to the CAA.
- Appendix 6.1 – Natural Heritage Desk Study. Submitted to Shetland Islands Council with the planning application. Document unchanged since then – equivalent assessment. Also included in SaxaVord Spaceport AEE V3 as submitted previously to the CAA.
- Appendix 6.2 – Phase 1 Habitat, NVC and GWDTE Survey Report. Submitted to Shetland Islands Council with the planning application. Document unchanged since then – equivalent assessment. Also included in SaxaVord Spaceport AEE V3 as submitted previously to the CAA.
- Appendix 6.3a Otter Species Protection Plan, March 2022 - document produced subsequent to receipt of planning consent as part of pre-commencement conditions. The document has been reviewed by Shetland Islands Council and relevant statutory consultees. Document unchanged since then – equivalent assessment. Also included in SaxaVord Spaceport AEE V3 as submitted previously to the CAA.

- Appendix 6.3b Pre-construction Otter Survey Report, March 2022 - document produced subsequent to receipt of planning consent as part of pre-commencement conditions. The document has been reviewed by Shetland Islands Council and relevant statutory consultees. Document unchanged since then – equivalent assessment. Also included in SaxaVord Spaceport AEE V3 as submitted previously to the CAA.
- Appendix 6.4 – Freshwater Pearl Mussel Survey Report. Submitted to Shetland Islands Council with the planning application. Document unchanged since then – equivalent assessment. Also included in SaxaVord Spaceport AEE V3 as submitted previously to the CAA.
- Appendix 8.1 - BRRC Noise Study. Submitted to Shetland Islands Council with the planning application. Document unchanged since then – equivalent assessment. Also included in SaxaVord Spaceport AEE V3 as submitted previously to the CAA.
- Appendix 8.3 – Noise Baseline Survey. Submitted to Shetland Islands Council with the planning application. Document unchanged since then – equivalent assessment. Also included in SaxaVord Spaceport AEE V3 as submitted previously to the CAA.
- Appendix 8.4 – Noise Traffic Flow Data. Submitted to Shetland Islands Council with the planning application. Document unchanged since then – equivalent assessment. Also included in SaxaVord Spaceport AEE V3 as submitted previously to the CAA.

2.3.5 Appendices which were submitted to the CAA as part of the SaxaVord Spaceport AEE V3, in their original format, and which can therefore be considered 'equivalent assessments' include:

- Appendix 1.1 – CVs. Included in SaxaVord Spaceport AEE V3 as submitted previously to the CAA.
- Appendix 6.5 – SaxaVord AEE V3 Chapter 9 Water. Included in SaxaVord Spaceport AEE V3 as submitted previously to the CAA. Document unchanged since then – equivalent assessment.
- Appendix 8.2 – Summary of Guidance - Included in SaxaVord Spaceport AEE V3 as submitted previously to the CAA. Document unchanged since then – equivalent assessment.
- Appendix 10.1 – Planning Policy Screening - Included in SaxaVord Spaceport AEE V3 as submitted previously to the CAA. Document unchanged since then – equivalent assessment.
- Appendix 10.2 – Summary of Baseline - Included in SaxaVord Spaceport AEE V3 as submitted previously to the CAA. Document unchanged since then – equivalent assessment.

2.3.6 The following appendices have been created or updated during the Skyrora SaxaVord AEE process and would not therefore be considered 'equivalent assessments':

- Appendix 2.1 – Launch Vehicle Comparison. Generated during the Skyrora SaxaVord AEE process.
- Appendix 5.1b – Shetland Space Centre Breeding Bird Survey 2022. Document generated as part of post-planning reporting activity during production of this AEE. Whilst not specific to Skyrora operations; this update should be noted by the Regulator and so document has been included for reference.
- Appendix 7.1 – Traffic Assessment. Document based on the calculation's method included in the SaxaVord Spaceport AEE V3 but updated to reflect 2022 background data.

- Appendix 7.2 - Launch Emissions Assessment. Document based on the calculation's method included in the SaxaVord Spaceport AEE V3 but updated to reflect Skyrora XL emissions.
- Appendix 9.1 - GHG Calculations. Document based on the calculation's method included in the SaxaVord Spaceport AEE V3 but updated to reflect Skyrora XL emissions.
- Appendix 10.3 - Risk matrices. Document based on the risk assessment included in the SaxaVord Spaceport AEE but updated to reflect Skyrora XL operations.
- Appendix 10.4 - Risk matrices. Document based on the risk assessment included in the SaxaVord Spaceport AEE but updated to reflect Skyrora XL operations.
- Appendix 11.1 – LVIA methodology. Document based on the assessment included in the SaxaVord Spaceport AEE but updated to reflect review and inclusion as part of Skyrora AEE at the request of the CAA.
- Appendix 11.2 – Landscape Character Types within the EZI. Document based on the assessment included in the SaxaVord Spaceport AEE but updated to reflect review and inclusion as part of Skyrora AEE at the request of the CAA.
- Appendix 11.3 – Coastal Character Types withing the EZI. Document based on the assessment included in the SaxaVord Spaceport AEE but updated to reflect review and inclusion as part of Skyrora AEE at the request of the CAA.
- Appendix 11.4 – Seascape Character Types withing the EZI. Document based on the assessment included in the SaxaVord Spaceport AEE but updated to reflect review and inclusion as part of Skyrora AEE at the request of the CAA.
- Appendix 11.5 – Special Landscape Qualities Assessment. Document based on the assessment included in the SaxaVord Spaceport AEE but updated to reflect review and inclusion as part of Skyrora AEE at the request of the CAA.

2.3.7 Other than changes specific to the Skyrora XL and Skyrora Skylark launch vehicles, which are detailed in full in this AEE (with relevant changes made to appended documents as listed in 2.3.6 above). there have been no materially significant changes to the design of SaxaVord Spaceport or the operational activities between submission of the SaxaVord Spaceport planning application / AEE V3 and preparation and submission of this associated Launch Operator AEE and therefore the original appendix documents listed in 2.3.4 and 2.3.5 are considered valid for the purposes of this AEE.

2.3.8 There are no regulations for the AEE, however, under section 11(6) of the Act, the regulator is required to issue guidance. The AEE therefore follows the requirements set out in '*CAP2215 Guidance for the Assessment of Environmental Effects'* (CAA et. al. 2021).

2.3.9 In addition to this guidance, in undertaking the AEE, the established framework for conducting environmental impact assessments, required by the Town and Country Planning (Environmental Impact Assessment) Regulations 2017 and Marine Works (Environmental Impact Assessment) Regulations 2017 have been considered. Within that framework, consideration has been given to the following:

- Guidelines for Environmental Impact Assessment, Institute of Environmental Management and Assessment (IEMA, 2006);
- A Handbook on Environmental Impact Assessment Version 5 (Scottish Natural Heritage, 2018); and
- Shetland Outdoor Access Strategy (Shetland Islands Council, 2019).

2.4 The AEE Process

2.4.1 The purpose of AEE is *'to ensure that applicants for launch operator licences have considered the potential environmental effects of their intended activities and, if necessary, taken appropriate and proportional steps to avoid, mitigate or offset the risks and their potential effects'* (CAA et. al. 2021).

2.4.2 AEE is the systematic process of identifying, quantifying, and evaluating the potential effects of the proposed activities on the environment. The key stages in the AEE process are presented in this chapter, with an overview of the specific methodology adopted for each technical study provided within the respective technical chapters (Chapters 4 to 12).

2.4.3 As stated in the CAA guidance document, the process of AEE can be broken down into four main stages as shown in Figure 2.1.

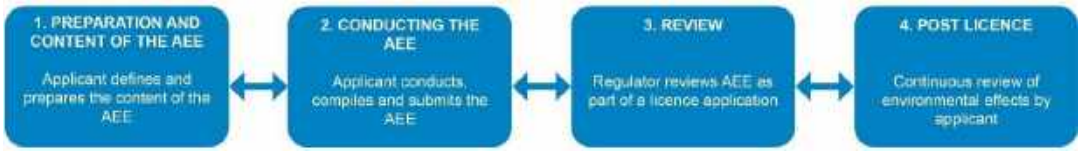

Figure 2.1 Overview of the AEE Process

2.5 Scope of the AEE

Environmental Zone of Influence

2.5.1 The environmental zone of influence (EZI) of the AEE, in other words the spatial scope or geographical coverage of the assessment, takes into account of a number of factors, in particular:

- the extent of the Proposed Project (refer to Drawing 3.1);
- the nature of the baseline environment, sensitive receptors and the likely impacts that could arise; and,
- the distance over which predicted effects are likely to remain significant and, particularly, the existence of pathways which could result in the transfer of effects to a wider geographical area than the extent of proposed physical works.

2.5.2 For the purposes of this AEE, the EZI is based on and comprises the proposed launch flight corridor and all study areas required for the technical disciplines included in the AEE.

2.5.3 Within the EZI, the study area(s) required for each technical discipline assessed vary and as such the rationale for each study area has been included in relevant technical chapter. Individual study areas are shown in detail on Drawing 2.1.

Temporal Scope

2.5.4 The baseline year used for the assessment of effects has been taken as 2023, with the assumption that the SaxaVord Spaceport is fully constructed and operational. However, appropriate technical disciplines have carried out pre-assessment studies and/or literature reviews from wider timeframes, for example, ecology and ornithology surveys have been undertaken in 2018, 2019 and 2020 and the climate and marine and transboundary effects chapters refer to datasets spanning the period 1970 – 2020 as relevant.

Environmental Budget

2.5.5 The Applicant is applying for a maximum environmental budget of 16 launches per year which, from 2029 when maximum launch cadence is reached, will make up just over one half of the SaxaVord Spaceport environmental budget of 30 launches per year.

2.5.6 Whilst the Applicant has not yet determined a specific timeframe for operations, when required for the purposes of this AEE an operational period of 30 years (equating to 428 launches) has been assumed, aligning with the current land lease for the SaxaVord Spaceport. This applies in particular to the process of calculating total mass of returning components, required for the Marine and Transboundary assessment (Chapter 10).

2.5.7 For other technical disciplines the appropriate timeframe for assessment varies – for example for ecology/ornithology the appropriate timeframe is considered generally to be a year due to breeding seasonality, and similarly cumulative noise effects are assessed over the period of a year. Whereas for air quality, due to the fact that only one launch will occur at any given time and launches will be phased with time enough for the EZI to return fully to the baseline state for all environmental topics between launches (i.e., no more than one launch within 24 hour period) the appropriate assessment period is considered to be a single launch. Due to this variance between technical disciplines, appropriate timescales for assessment are detailed in each technical chapter.

2.6 AEE Preparation and Content

2.6.1 This AEE looks to identify, describe, and assess the potential direct and indirect significant effects of the Proposed Project.

2.6.2 A launch operator AEE is described in section 11(3)(b) of the Act:

'Assessment of environmental effects… In relation to an operator licence authorising launch of spacecraft, means an assessment that those launches are expected to have on the environment.'

2.6.3 As required by the CAA guidance, this launch operator AEE covers all operations and activities intended to be carried out that may have an environmental effect. Effects on the following environmental features have been considered:

- Population and human health;
- Biodiversity (ecology and ornithology);
- Air quality;
- Noise and vibration;
- Water;
- Climate;
- Marine environment;
- Land, Soils and Peat;
- Landscape, Seascape and Visual Impact;
- Material assets and cultural heritage; and
- Accidents and Disasters.

2.6.4 Of these, due to the temporary nature of each proposed launch and the fact that the delivery, assembly and launch of the Skyrora XL Launch Vehicle will not have significant effect on land condition due to the SaxaVord Spaceport infrastructure already in place, it is considered that the Proposed Project has no potential for significant effects on either the water environment or the condition of underlying land, soils or peat. As such, these elements have not been considered further withinthis AEE.

2.6.5 Due to the small number of launches proposed by the Applicant (maximum 16 per year), the temporary nature of each proposed launch and the fact that the delivery, assembly and launch of the Skyrora Skylark L and Skyrora XL Launch Vehicles will not have significant effect on material assets and cultural heritage due to the SaxaVord Spaceport infrastructure already in place, it is considered that the Proposed Project in isolation has no potential for significant effects on material assets and cultural heritage. As such, these elements have not been considered further in this AEE.

2.6.6 The likely significant cultural heritage effects of overall operation of the SaxaVord Spaceport (and within that, therefore, operation of the Proposed Project) are inherently associated with the land-take and infrastructure required for the construction of the Spaceport and were carried over into the SaxaVord Spaceport AEE for assessment only by nature of the continued operation of the Spaceport infrastructure. Cultural heritage effects of the Spaceport overall have been assessed by Shetland Islands Council and the relevant statutory consultees (including HES, NatureScot and SEPA) during the planning stage of the SaxaVord Spaceport and the Spaceport (and, by extension, associated future operations of Launch Operators) found to be suitable for development. Heritage plans and mitigation measures outlined within the Environmental Statement submitted with the Spaceport planning application have been included in the planning consent for the SaxaVord Spaceport as conditions and accepted as being appropriate from a planning perspective. No further assessment for the purposes of this AEE is required.

2.6.7 It is acknowledged that in relation to the wider spaceflight activities / environmental budget of the SaxaVord Spaceport, the SaxaVord Spaceport AEE includes a commitment to monitoring vibration during the operational phase; however, this is the responsibility of the Spaceport Operator, not of the Applicant or any other individual Launch Operator. Information on the monitoring program for the Spaceport is detailed in Chapter 14 of the SaxaVord Spaceport AEE, included for reference as Appendix 2.2. The Applicant is committed to complying with any related monitoring required by SaxaVord Spaceport.

2.6.8 A detailed programme for the conservation management and monitoring of cultural heritage assets in the vicinity of the Saxavord Spaceport has been supplied to Historic Environment Scotland and to Shetland Island Council to meet mitigation requirements of Scheduled Monument Consent and planning permission for the SaxaVord Spaceport respectively. This conservation management plan, which is the responsibility of SaxaVord Spaceport, sets out a programme for ongoing condition monitoring of heritage assets over the operational lifespan of the spaceport, in consultation with Historic Environments Scotland and Shetland Islands Council.

Consultation

2.6.9 Although there is no statutory requirement for applicants to undertake scoping, pre-application consultation with the CAA has been undertaken, with the scope of this AEE as outlined above discussed with the CAA on 1 February 2022.

2.6.10 Some of the consultation with statutory and non-statutory consultees in regard to operation of the SaxaVord Spaceport during the planning application phase for that is considered relevant to this AEE and therefore, as applicable, details of consultation responses have been included in the technical chapters, alongside comments on subsequent additional post-planning consultations and any pertinent planning conditions arising from the SaxaVord Spaceport planning consent.

Conducting the AEE

2.6.11 The Applicant has engaged competence experts, as details in Chapter 1, to conduct the AEE.

2.6.12 The main steps in each of the technical impact assessments for the Proposed Project are as follows:

- Baseline surveys (where appropriate) to provide information on the existing baseline condition of the existing site and surrounding area.
- Consideration of the possible interactions between the Proposed Project and the existing and predicted future site conditions. These interactions or effects are assessed using stated criteria based on accepted guidance and best practice.
- Using robust design parameters for the Proposed Project, assessment of the likely significant effects, including direct effects and any indirect, secondary, short, medium, and long-term, permanent and temporary, positive and negative effects.

- Identification of any uncertainties inherent in the methods used, the predictions made, and the conclusions drawn during the assessment process.
- Identification of mitigation measures designed to avoid, reduce or off-set any significant adverse effects identified as well as enhancement measures that could result in beneficial effects.
- Assessment of the significance of any residual effects after mitigation, in relation to the sensitivity of the feature impacted upon and the magnitude of the effect predicted, in line with the relevant methodology.
- Reporting of the results of the AEE in this AEE Report.

Assessing Significance

2.6.13 Throughout the assessment, a distinction has been made between the term 'impact' and 'effect'. The Act refers to the requirement to report the significance of "effects". An impact is defined as the likely change to the characteristics/nature of the receiving environment as a result of the Proposed Project (e.g., noise from a launch), whereas the 'effect' relates to the significance of the impact (e.g., a significant residual noise effect on residential properties). These terms have been adopted throughout this AEE Report to present a consistent approach to the assessment and evaluation of effects and their significance.

2.6.14 The exception to this is the landscape and visual impact assessment which classifies the level of physical and perceptual change to the receiving environment as the "magnitude of change" in line with the recommendations of the Guidelines for Landscape and Visual Impact Assessment third edition (Landscape Institute et al., 2013). However, this terminology should be considered interchangeable with "magnitude of impact".

2.6.15 To determine whether the potential effects of the Proposed Project are likely to be 'significant' a number of criteria are used. Criteria vary between topics but generally include:

- international, national, and local designations or standards;
- relationship with planning policy and guidance;
- sensitivity of the receiving environment;
- magnitude of impact;
- reversibility and duration of the effect; and,
- inter-relationship between effects.

2.6.16 Effects that are considered to be significant prior to mitigation but following the implementation of best practice are identified within this AEE Report. The significance attributed to the resultant effect is informed by an exercise of professional judgement in relation to the sensitivity of the affected receptor(s) and the nature, duration, frequency, and magnitude of the predicted changes/impacts. For example, a major adverse change/impact on a feature or site of low importance will have an effect of lesser significance than the same impact on a feature or site of high importance.

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2.6.19

2.6.20 Table 2.1 below is used as a guide to the relationship between the sensitivity of the identified receptor and the anticipated magnitude of an impact/change. Professional judgement is however

equally important in establishing the suitability of this guiding 'formula' to the assessment of the significance of each individual effect.

Table 2.1 Inter-Relationship between Magnitude of Impact and Sensitivity of Receptor

		Sensitivity of Receptor / Receiving Environment to change			
		High	Medium	Low	Negligible
Magnitude of Impact / change	High	Major	Moderate to Major	Minor to Moderate	Minor to Negligible
	Medium	Moderate to Major	Moderate	Minor	Negligible
	Low	Minor to Moderate	Minor	Negligible to Minor	Negligible
	Negligible	Minor to Negligible	Negligible	Negligible	Negligible

2.6.21 The following terms are used in this AEE Report, unless otherwise stated, to determine the level of effects predicted to occur:

- significant beneficial or adverse effect – where the Proposed Project would result in a significant improvement (or deterioration) to the existing environment;
- moderate beneficial or adverse effect – where the Proposed Project would result in a noticeable improvement (or deterioration) to the existing environment;
- minor beneficial or adverse effect – where the Proposed Project would result in a small improvement (or deterioration) to the existing environment; and,
- negligible effect – where the Proposed Project would result in no discernible improvement (or deterioration) to the existing environment.

2.6.22 Using professional judgement and with reference to the Guidelines for Environmental Impact Assessment (IEMA, 2006), the majority of the assessments within this AEE Report consider effect levels of moderate or major to be significant, and effect levels of minor or negligible to be non-significant. If there are deviations from this, these are clearly stated within the individual technical chapters.

2.6.23 Summary tables that outline the predicted pre-mitigation effects associated with an environmental issue, the mitigation measures proposed to address those, and the subsequent residual effect significance are provided in Chapter 13.

Assessing Cumulative Effects

2.6.24 Cumulative effects can be either inter-project or intra-project effects.

2.6.25 Inter-project cumulative effects are those where an environmental topic/receptor is affected by impacts from more than one project at the same time and the impacts act together.

2.6.26 Due to the location of SaxaVord Spaceport, from where the Proposed Project will operate, on the north coast of Unst, the most northerly of the Shetland Islands, for all but one of the technical disciplines assessed there are no potential inter-project cumulative effects as there are no other existing or proposed developments in the relevant EZI. The exception to this is the marine and transboundary assessment (Chapter 10) wherein the EZI extends across a large area and therefore the Proposed Project has the potential to interact with offshore wind, marine renewables, oil and gas, other Scottish spaceports and subsea cable developments.

2.6.27 The potential for inter-project cumulative effects from separate launch service providers within the envelope of the SaxaVord Spaceport Operations and environmental budget is considered at length in SaxaVord Spaceport AEE V3 submitted to the Civil Aviation Authority (CAA) in 2022 (reference SR-APP-001019); the conclusion of which is *"that there are no significant operational effects of concern from the* [SaxaVord Spaceport] *Proposed Project* [i.e., launching of suborbital, sounding rockets and small satellites into either polar or sun-synchronous, low-earth orbits… by multiple launch service providers using a range of different launch vehicle types… up to 30 m in height] *and that the proposed activities will comply with statutory requirements and environmental policy objectives."*

2.6.28 Intra-project cumulative effects are those where an environmental topic/receptor is affected by more than one impact from the same Proposed Project and the impacts act together.

2.6.29 Given that between environmental topics there is little overlap (for example air quality impacts have no effect on noise impacts etc.,) and because only one launch will occur at any given time, and launches will be phased with time enough for the EZI to return fully to the baseline state for all environmental topics between launches (i.e., no more than one launch within 24 hour period), for all but three of the technical disciplines assessed there are no potential intra-project cumulative effects. The exceptions to this are:

- the ornithology and ecology assessments (Chapters 5 and 6) wherein effects on birds and wildlife of noise impacts associated with satellite launches (Chapter 8) have been assessed;
- the marine and transboundary assessment (Chapter 10) wherein the potential additive effects of multiple launches have been assessed through time; and
- the landscape and visual impact assessment (Chapter 11) wherein the assessment of in-combination (equivalent to intra-project cumulative) effects is incorporated into the main LVIA, with separate judgements for the combined effects presented within each of the tables throughout, for each landscape and visual receptor.

2.6.30 Within this AEE Report, therefore, cumulative effects for each technical discipline are covered as required on a chapter by chapter basis.

Assessing Mitigation Measures

2.6.31 The AEE presents a description of the measures proposed to avoid, reduce and, if possible, offset significant adverse effects. Wherever reasonably practicable, mitigation measures have been proposed for each significant environmental effect predicted, taking various forms including:

- changes to Proposed Project design;
- physical measures applied; and,
- measures to control particular aspects of the operation of the Proposed Project.

2.6.32 Where none of the above have been deemed practicable, the Proposed Project design includes measures to offset any significant adverse effects.

2.6.33 Monitoring measures may also be proposed, where appropriate, to examine the mitigation measures to ensure that they have the desired outcomes.

2.6.34 Mitigation measures and monitoring requirements are committed to in order to ensure a level of certainty as to the environmental effects of the Proposed Project. For the avoidance of any doubt, the Applicant is committed to implementing all mitigation measures and monitoring requirements identified in this AEE Report.

Review of the AEE

2.6.35 Following submission of the AEE, the regulator will review the document to satisfy itself that the applicant's assessment is sufficiently robust and provides adequate protection of the environment.

2.6.36 As part of the review, the regulator will take into account comments received from the public or other organisations throughout the consultation process. The regulator can then:

- Determine that the environmental effects as set out in the AEE are acceptable and continue with its assessment of the licence application;
- Request that the applicant revisits some areas of the AEE and then resubmit it;
- Determine whether to impose licence conditions.

Post Licence

2.6.37 The licensee will be responsible for required monitoring of environmental effects across all environmental zones of influence throughout operation of the Proposed Project.

2.7 Assumptions, Limitations and Uncertainty

2.7.1 The AEE process is designed to enable informed decision-making based on the best available information about the environmental implications of a Proposed Project. However, it is acknowledged there will always be some uncertainty inherent in the scale and nature of the predicted environmental effects as a result of the level of detailed information available at the time of assessment, the potential for minor alterations to the Proposed Project following completion of the AEE Report and/or the limitations of the prediction processes.

2.7.2 Several assumptions have been made during the AEE process and are described below:

- The principal land uses adjacent to the Proposed Project will remain unchanged during the Proposed Project's lifetime.
- Information provided by third parties, including publicly available information and databases, are correct at the time of submission.

2.7.3 Specific assumptions may also be made with regard to the individual technical disciplines. As applicable, these are detailed within each chapter.

2.7.4 Any limitations to the AEE are summarised in each technical chapter, where relevant, together with the means proposed to mitigate these.

2.8 AEE Report

2.8.1 The AEE Report is comprised of four volumes:

- Volume I – Non-Technical Summary;

- Volume II – Main AEE Report;
- Volume III – Drawings; and
- Volume IV – Technical Appendices.

2.8.2 As suggested in the guidance document (CAA et.al. 2021), the AEE Report includes:

- a Non-Technical Summary (AEE Report Volume I);
- an Introduction (AEE Report Volume II, Chapter 1);
- Scope of the Assessment (this Chapter)
- description of the Proposed Project (AEE Report Volume II, Chapter 3);
- a description of the environmental baseline conditions, EZI, assessment methodology and conclusions on likely significant effects, including cumulative effects, of the Proposed Project on the environment (AEE Report Volume II, Chapters 4 to 12); and
- a description of the features of the Proposed Project and any measures envisaged to avoid, prevent, or reduce and, if possible, offset likely significant adverse effects (AEE Report Volume II, Chapters 4 to 12 and summarised in Chapter 13).

2.8.3 References are included within each Chapter in Volume II.

2.8.4 Volume III contains the associated drawings that inform the AEE Report.

2.8.5 Volume IV contains relevant supporting reports and information for each of the technical disciplines prepared to inform the AEE chapters in Volume II of the AEE Report.

2.9 References

Chartered Institute of Ecology and Environmental Management. (2018). *Ecological Impact Assessment Guidelines.*

Civil Aviation Authority et. al. (2021) *CAP2215 Guidance for the Assessment of Environmental Effects*. Available at

Department for Transport. (2021) *Guidance to the regulator on environmental objectives relating to the exercise of its function under the Space Industry Act 2018* [online]. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/995153/guidance-to-the-regulator-on-environmental-objectives-relating-to-the-exercise-of-its-functions-under-the-space-industry-act-2018.pdf

IEMA. (2006). *Guidelines for Environmental Impact Assessment, Institute of Environmental Management and Assessment.*

HMSO. (2017b). *Marine Works (Environmental Impact Assessment) Regulations 2017*

HMSO. (2018). *The Space Industry Act 2018.*

Landscape Institue et al. (2013). *Guidelines for Landscape and Visual Impact Assessment - third edition .*

Scottish Natural Heritage. (2018). *A Handbook on Environmental Impact Assessment Version 5 .*

Scottish Government. (2014a). *Scottish Planning Policy.*

Scottish Government. (2014b). *National Planning Policy.*

Shetland Islands Council. (2019). *Shetland Outdoor Access Strategy .*

Shetlands Islands Council. (2014). *Shetland Local Development Plan .*

Chapter 3 Description of Proposed Project

3. Description of Proposed Project

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3. Description of Proposed Project

3.1 Introduction

3.1.1 The Space Industry Act 2018 requires any organisation wishing to operate as a launch operator in the UK to obtain a relevant licence.

3.1.2 The Proposed Project comprises the preparation and launch of the Skyrora XL Launch Vehicle from any of three terrestrial vertical launch pads at the SaxaVord Spaceport situated at Lamba Ness on Unst, Shetland. The Applicant is applying for a maximum environmental budget of 16 launches per year which, from 2029 when maximum launch cadence is reached will make up just over one half of the SaxaVord Spaceport environmental budget of 30 launches per year, and as such is applying to the UK Civil Aviation Authority (CAA) for a launch operator licence as required by the Space Industry Act 2018.

3.1.3 Section 11 of the Act stipulates that all applicants for a launch operator licence are required to submit an assessment of environmental effects (AEE) as part of their licence application. The CAA is required to take the AEE into account when deciding whether to grant a licence and what, if any, conditions should be attached to such a licence.

3.2 Background

3.2.1 Skyrora aims to provide a versatile, cost-effective, and environmentally responsible end-to-end space transportation service for global small satellite Payloads. The company sets out to address the growing demand of the global small satellite market, currently experiencing restricted access to Low Earth Orbit.

3.2.2 The Proposed Project will be operated to launch suborbital (Skyrora Skylark L) and orbital (Skyrora XL) Launch Vehicles. All launches will take place in a northerly direction over the sea. For safety reasons, the Skyrora Skylark L and Skyrora XL Launch Vehicles will not fly over inhabited areas such as the Faroe Islands and Iceland to the north-west and Norway, to the north-east. Jan Mayen, located north north-west of Shetland and which is temporarily inhabited during the summer months, will also be a flight exclusion zone. The Applicant is committed to constraining launch trajectories in order to avoid nominal jettisoned separated components impacting inhabited land masses, or waters within 12 miles of those coastlines, in compliance with international treaties.

3.2.3 Suborbital launches of the Skyrora Skylark L Launch Vehicle will take place along a due north (000°) azimuth from the launch site and will only be allowed to occur when meteorological conditions are such that no southerly movement of the launch vehicle is possible, considering both nominal and off-nominal launch event sequences.

3.2.4 As detailed in Chapter 2, for the purposes of this AEE the Skyrora XL orbital Launch Vehicle has been determined to be, and assessed as, the limiting case Launch Vehicle.

3.2.5 The Skyrora XL Launch Vehicle will carry small satellites into either polar or sun-synchronous orbits. It is approximately 24 m long and comprises a three-stage liquid fuelled orbital launch vehicle. All three stages of the Skyrora XL Launch Vehicle use a propellant mixture of High-Test Peroxide (HTP) (90%) and Jet A-1 Kerosene, which are non-cryogenic and therefore require lower system complexity and offer more operational flexibility. Quantities of propellants contained within the Skyrora XL Launch Vehicle are detailed below:

- HTP (90%) – approximately 49,200 kg
- Kerosene – approximately 7,300 kg
- Helium – approximately 45 kg
- CO_2 – approximately 12 kg

3.3 Proposed Project Location

3.3.1 The Proposed Project will operate at the SaxaVord Spaceport located at Lamba Ness on Unst, the most northerly of the Shetland Islands. The location of the Proposed Project is shown on Drawing 3.1 in Volume III.

3.3.2 For the purposes of this AEE, the boundary of the Proposed Project has been assumed as the areas within SaxaVord Spaceport where the delivery, preparation and launch of the Skyrora Skylark L and Skyrora XL Launch Vehicles will take place. The Proposed Project site boundary is shown on Drawing 3.1 in Volume III, centred approximately at N 60° 49' 0.0984, E -0° 46' 27.7104. The site occupies an area of approximately 33.5 hectares (ha). It is approximately 2.5 km north-east of the settlement of Norwick.

3.4 Proposed Project Infrastructure

3.4.1 The infrastructure required for the Proposed Project will be provided by SaxaVord Spaceport, which is subject to regulation under the Act itself and has completed an AEE as part of its own Spaceport Operator Licence application (document reference LP-004-SAXA, application SR-APP-001019). The Proposed Project site layout plan shows the infrastructure of the SaxaVord Spaceport is included as Drawing 3.2 in Volume III.

3.4.2 The Proposed Project will utilise the following existing SaxaVord Spaceport infrastructure:

- Launch Site: located on the Lamba Ness peninsula and comprising three launch pad complexes, 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;
- Integration Hangars –
    - Launch Site Processing Facility (LSPF) hangar buildings: located on the Lamba Ness peninsula, a building where the Skyrora XL Launch Vehicles will be assembled and the Payload (the satellites) integrated;
    - Administration Building, Pyrotechnics Store, and Hazardous Materials Store located adjacent to the LSPF on the Lamba Ness peninsula;
    - 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; and
- Support Infrastructure: located on the Lamba Ness peninsula including access, an internal track system and a series of small temporary buildings.

3.4.3 The Applicant will be able to utilise any of the three terrestrial launch pads located at the SaxaVord Spaceport and will be directed by the Spaceport operator as to which launchpad to use on a mission by mission basis dependant on availability. Layouts of the three launchpads are included for information as Drawings 3.3, 3.4 and 3.5 in Volume III.

3.4.4 Subject to securing the appropriate permissions, consents and licences, the intention is to initiate first demonstration launch in 2023 and then increase cadence to 16 launches per year by 2029.

3.5 Environmental Zone of Influence

3.5.1 For the purposes of this AEE, the EZI is based on and comprises the proposed launch flight corridor and all study areas required for the technical disciplines included in the AEE.

3.5.2 The EZI is presented on drawings 3.6.

3.5.3 Within the EZI, the study area(s) required for each technical discipline assessed vary and as such the rationale for each study area has been included in relevant technical chapter. Individual study areas are shown in detail on Drawing 2.1.

3.6 Environmental Budget

3.6.1 The Applicant is applying for a maximum environmental budget of 16 launches per year which, from 2029 when maximum launch cadence is reached, will make up just over one half of the SaxaVord Spaceport environmental budget of 30 launches per year.

3.6.2 Whilst the Applicant has not yet determined a specific timeframe for operations, when required for the purposes of this AEE an operational period of 30 years (equating to 428 launches) has been assumed, aligning with the current land lease for the SaxaVord Spaceport. This applies in particular to the process of calculating total mass of returning components, required for the Marine and Transboundary assessment (Chapter 10).

3.6.3 For other technical disciplines the appropriate timeframe for assessment varies – for example for ecology/ornithology the appropriate timeframe is considered generally to be a year due to breeding seasonality, and similarly cumulative noise effects are assessed over the period of a year. Whereas for air quality, due to the fact that only one launch will occur at any given time and launches will be phased with time enough for the EZI to return fully to the baseline state for all environmental topics between launches (i.e., no more than one launch within a 24-hour period) the appropriate assessment period is considered to be a single launch. Due to this variance between technical disciplines, appropriate timescales for assessment are detailed in each technical chapter.

3.7 Proposed Project Operations

Launch Frequency and Duration

3.7.1 The Applicant's environmental budget is for a maximum of 16 launches per year. In terms of launch frequency, it is anticipated that there will be no more than two launches per month, and launches at all carried out between mid-May to end of June each year.

3.7.2 The duration of each Skyrora XL launch campaign is expected to run for around four weeks, starting with delivery of the Skyrora XL Launch Vehicle and ending with successful launch and demobilisation of equipment. Timings included in this section are based on current understanding of the process and may be subject to change; however, an assumption of four weeks operational campaign around each launch is considered appropriate.

3.7.3 The Applicant's launch timeline has Skyrora arriving at SaxaVord Spaceport 21 days prior to any proposed launch window with the component parts of the Skyrora XL and all associated commodities and payloads delivered in standard road containers. Propellants and fuels will be delivered by ISO tanker/container lorries by road.

Launch Preparation

3.7.4 The Skyrora XL Launch Vehicle will be assembled and integrated with the payload within the Integration Hangar before being transported to the relevant launch pad for additional fuelling and final checks.

3.7.5 The Skyrora XL Launch Vehicle will be placed on a Transporter Erector Launcher (TEL) vehicle for transfer to the relevant launch pad.

3.7.6 The Skyrora XL Launch Vehicle will then be launched, following which all Skyrora equipment will be demobilised. The timeline for demobilisation is currently anticipated to be seven days.

3.7.7 All operations by the Applicant will be required to align with the SaxaVord Spaceport Operational Environmental Management Plan to minimise environmental effects.

Launch Exclusion Zone

3.7.8 The public will be restricted from accessing the Proposed Project site during launches, and at all times, launch pads and integration buildings will be fenced off from public access both to protect against livestock and for security reasons.

3.7.9 In order to provide public safety, measures to control a launch exclusion zone (LEZ) will be implemented by the Spaceport Operator at specific periods of the launch, including the run-up to and during launch. The LEZ will include an area around the launch pad and a downrange sea and overflight exclusion zone.

3.7.10 The dimensions of the LEZ for the Skyrora XL launch vehicle are detailed fully in the Skyrora XL Flight Safety Analysis document submitted as part of the launch operator licence application and summarised below for information.

3.7.11 The area identified by the applicant for overflight exclusion during launches is shown in Figure 3.1.

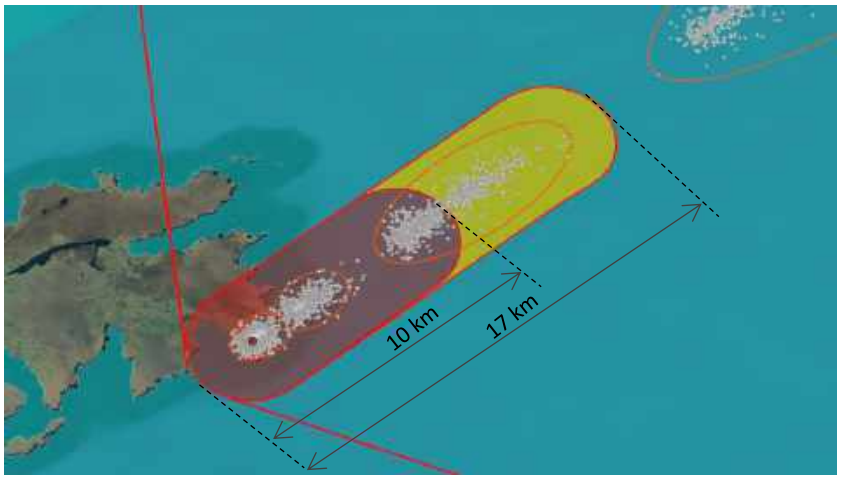

Figure 3.1 Skyrora XL Overflight Exclusion Zone

3.7.12 Figure 3.2 shows the intended closure area from the associated SaxaVord Spaceport application, highlighting that the LEZ provided by the Spaceport satisfies the applicant's requirements.

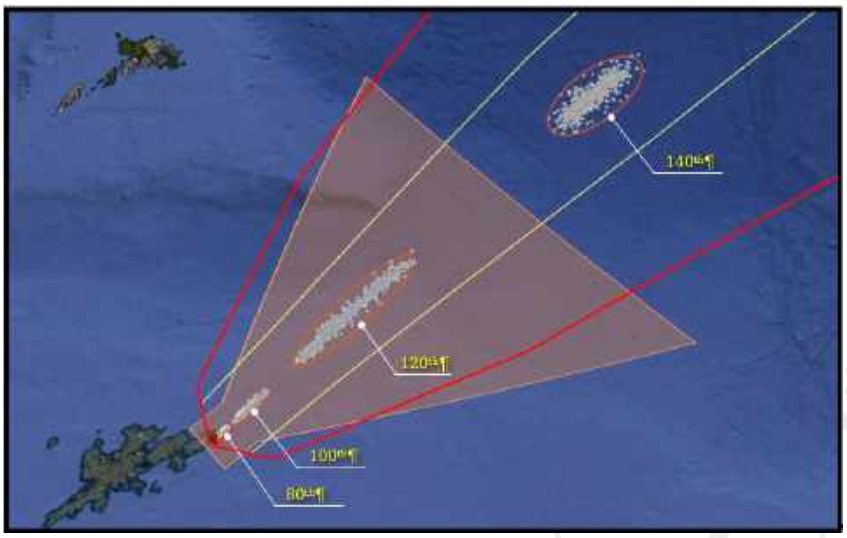

Figure 3.2 SaxaVord Spaceport LEZ

Launch Pads

3.7.13 Annotated launch pad layout plans are provided for Launch Pads 1, 2 and 3 as Drawings 3.3, 3.4 and 3.5 respectively.

3.7.14 Each launch pad comprises a concrete slab with a launch pit sunk into it and a stool on which the Skyrora XL Launch Vehicle will sit for launch.

3.7.15 Adjacent to each launch pad is a water tank / pump house to deliver water inundation during launches. The water deluge system will only be used during the launch and is designed to deliver a large quantity of water to dampen acoustic loading on the Skyrora XL Launch Vehicle and the launch pad during lift-off. The water also acts to reduce the temperature of exhaust gases, protecting the launch pad infrastructure.

3.7.16 The launch pad concrete slab is surrounded on three sides by a wall to contain any deluge water, if required. The slab falls towards the launch pit, such that any surface and deluge water will run-off into the launch pit. The launch pit is connected to a culvert via a manhole with a penstock valve permitting water to be diverted to an interceptor/storage tank (for collection and removal for off-site treatment) during fuelling and launch activities. 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.

3.7.17 The launch pads include areas for storage of fuels and gases using ISO road containers to allow the site to be cleared between launches. Launch pad fuel storage areas have a contained concrete surface with run-off into channels which discharge into a full-retention alarmed interceptor, before discharging into either a filter drain or drainage ditch.

3.7.18 Permanent lightning masts are positioned either side of the launch pads, comprising telescopic towers which will be extended during a launch to their operational height of 46 m. At all other times the lightning masts will be retracted to their un-extended configuration of 25 m.

Skyrora XL Launch Vehicle

3.7.19 The Skyrora XL launch vehicle is approximately 24 m long, three-stage liquid fuelled orbital launch vehicle intended to place customer payloads into sun synchronous or polar orbits.



Figure 3.3 Skyrora XL Launch Vehicle

3.7.20 Each stage contains its own engines (the First Stage has nine 70 kN engines, the Second Stage has one vacuum optimised 70 kN engine and the Third Stage has one low earth orbit (LEO) engine), fuel and oxidizer. The satellite payload(s) is carried at the top of the Skyrora XL Launch Vehicle and are protected by Fairings. Once the Skyrora XL Launch Vehicle is outside of the majority of the atmosphere these Fairings are jettisoned to reduce weight.

3.7.21 All three stages of the Skyrora XL use a propellant mixture of High-Test Peroxide (HTP) (90%) and Jet A-1 Kerosene, which are non-cryogenic and therefore require lower system complexity and offer more operational flexibility. Quantities of propellants contained within the Skyrora XL Launch Vehicle are detailed below:

- HTP (90%) – Approx. 49,200 kg
- Kerosene – Approx. 7,300 kg
- Helium – Approx. 45 kg
- CO2 – Approx. 12 kg

First Stage

3.7.22 The First Stage of the Skyrora XL Launch Vehicle is the largest item measuring approximately 15 m x 2.2 m. It primarily contains the First Stage propellent tanks and engines. As such, this stage may contain residual amounts of HTP/kerosene. The initial mass of the First Stage is approximately 4000 kg.

Fairings

3.7.23 The Payload Fairings consists of fairing halves which are a protective aerodynamic shell to protect the payload from aerodynamic heating and atmospheric effects. These items are constructed from composite layers, primarily involving carbon fibre and measure approximately 5.7 m in length with a combined diameter of 2.2 m.

Second Stage

3.7.24 The Second Stage of the Skyrora XL Launch Vehicle measures approximately 5.3 m x 2.2 m and consists mainly of propellent tanks and engine, as such this stage may contain residual amounts of HTP/kerosene. The composite materials within the Second Stage will burn up in the dense parts of the atmosphere with thermal simulations reaching temperatures of up to 4695 ^{0}C. Elements of the Second Stage constructed from steel will likely return to Earth with simulations providing an approximate total mass of 300 kg, from the initial mass of approximately 1200 kg, impacting the surface and consisting of maximum 30-40 kg masses impacting at 125-130 m/s.

Third Stage

3.7.25 The Third Stage of the Skyrora XL Launch Vehicle carries the Customer Payload into orbit and upon completion of spacecraft separation, the Third Stage is planned to re-enter the atmosphere on a trajectory that will result in complete burn-up with no significant masses reaching the surface.

Launch Operations

3.7.26 The duration of each mission is expected to run for around four weeks, starting with delivery of the Skyrora XL Launch Vehicle and ending with successful launch and demobilisation of equipment. Launches of Skyrora XL Launch Vehicle may occur at any time, with time of launch dependent on the orbital parameters required by the payload customer.

3.7.27 Full details of launch operations carried out during a Skyrora XL mission are contained within the Skyrora XL Concept of Operations document included separately as part of the launch operator licence application. The key steps in a representative typical mission are set out below.

Launch Vehicle and Payload Processing

3.7.28 The Skyrora XL Launch Vehicle and Payload will be delivered to SaxaVord Spaceport for assembly, integration, and testing. The integration process involves integration of the separate stages of the Skyrora XL Launch Vehicle and the integration of the Payload with the Launch Vehicle.

3.7.29 Assembly, integration, and testing activities will primarily be undertaken under controlled conditions within the Integration Hangar.

3.7.30 Operations with Skyrora XL's Third Stage and the Payload will be carried out within the cleanrooms located within the integration hangar. After integration of the Third Stage and Payload, the Third Stage will be fuelled and then encapsulated by the Payload Fairing, resulting in a fully integrated Payload Module.

3.7.31 Operations with Skyrora XL's First and Second stages shall be carried out within the general assembly area of the Integration Hangar. Integration of First Stage, Second Stage, and Payload Module shall be carried out within the general assembly area, resulting in a fully integrated Launch Vehicle.

3.7.32 The integrated Skyrora XL Launch Vehicle will then be placed on the TEL vehicle and transferred to the relevant launch pad.

3.7.33 At the launch pad, all required connections between the Skyrora XL Launch Vehicle and ground equipment will be made. The Skyrora XL Launch Vehicle will then be verticalised and undergo final tests and verifications prior to launch. Final operations involve filling the First and Second stages with propellant and filling pressurant tanks.

3.7.34 The ground segment and associated equipment required to launch the Skyrora XL Launch Vehicle shall be containerised, where practicable, into standard ISO containers which form a modular, easily transportable, and minimal footprint launch complex. Skyrora XL Launch Vehicle's launch complex consists of:

- Oxidiser filling system;
- Fuel filling system;
- Compressed gas supply system;
- Launch pad (launch frame with integrated flame deflector);
- Launch control centre (remote operational control of launch activities);
- Thermostatting system (environmental regulation within Payload Fairing); and
- Other ground support equipment (primarily including equipment used to support activities at the Integration Hangar).

Fuel and Propellant Transportation and Storage

3.7.35 Fuels and propellants will be transported to SaxaVord Spaceport in ISO road containers and stored in the Spaceport delivery holding area located at the Spaceport entrance prior to being taken to the Integration Hangar and relevant launch pad. At the launch pad the containers are stored in the designated protected areas as shown on Drawings 3.3, 3.4 and 3.5.

3.7.36 Propellants include HTP and kerosene which will be stored at the launch pad in separate containers located a safe distance from one another. This distance is calculated according to the Federal Aviation Administration (FAA)'s regulations for Launch Sites, specifically 14 CFR 420.

- HTP (90%) – 50 tons (50 tons located on secondary site)
- Kerosene – 16 tons
- Up to 350 bar storage:
  - 120 W cylinders nitrogen
  - 32 W cylinders helium

Launch Vehicle Propellant Loading

3.7.37 After all final tests and verifications have been conducted at the launch pad prior to launch, the First and Second stages of the Skyrora XL Launch Vehicle will be loaded with pressurant and propellant, the third stage already having been fuelled within the Integration Hangar.

3.7.38 Pressurant tanks on all stages will be loaded with helium.

3.7.39 The propellant tanks and lines will then be purged with nitrogen, followed by loading of fuel and oxidiser on the First and Second stages of the Skyrora XL Launch Vehicle.

Safety Clear Zones

3.7.40 An LEZ will be implemented at appropriate times to ensure the safety of the operation. The length of time restrictions are in place will be kept to the practicable minimum.

Launch, Ascent, Payload Deployment and Jettisoning of Objects

3.7.41 The Skyrora XL Launch Vehicle will be fuelled from approximately two hours before launch. During this time, the required airspace and sea space management and monitoring procedures will be activated to ensure the flight safety compliance of the launch.

3.7.42 A few minutes before launch, the Skyrora XL Launch Vehicle will transition to its internal power source and continue to perform an autonomous series of preparatory configurations and status checks.

3.7.43 A few seconds before launch the hold-down mechanism will be armed and launch command control relinquished to the Skyrora XL Launch Vehicle. After that, First Stage ignition will occur, and the Skyrora XL Launch Vehicle will launch.

3.7.44 The Skyrora XL is a single use Launch Vehicle which discards spent stages along its flight trajectory. Discarded items consist of:

- First Stage
- Payload Fairings
- Second Stage

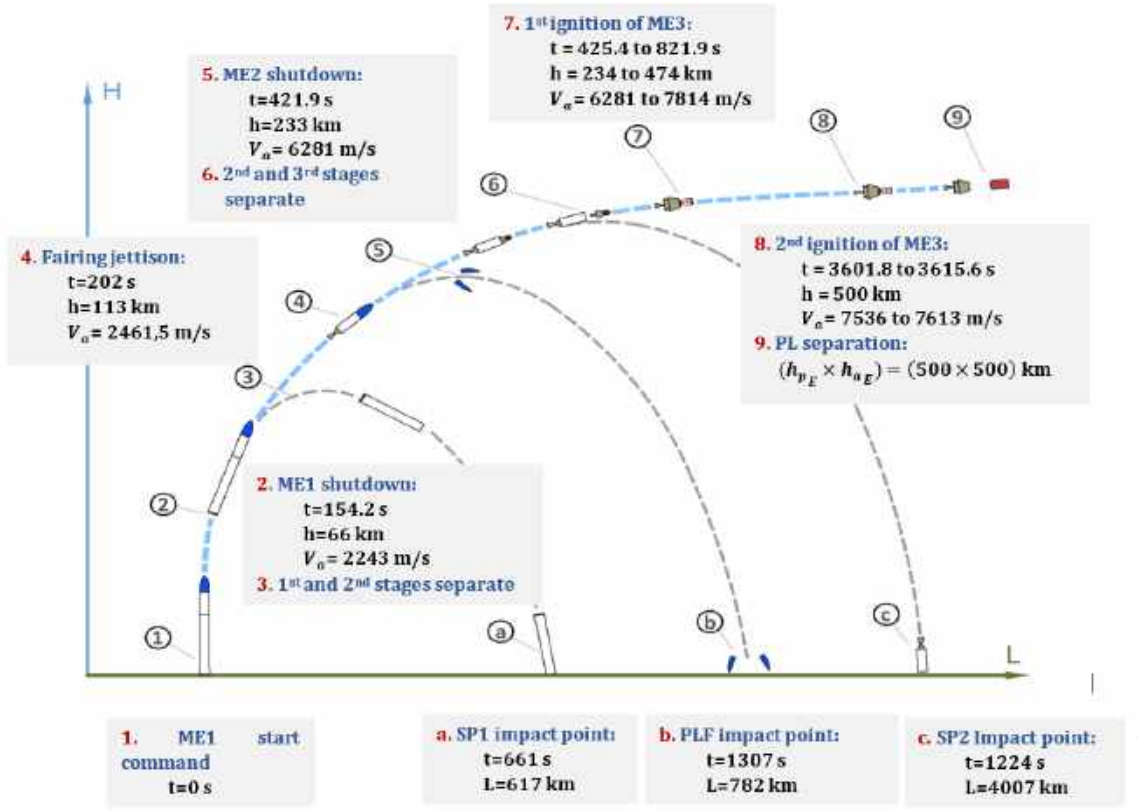

Figure 3.4 Skyrora Launch Vehicle Typical Flight

3.7.45 Locations of impact points for the First Stage, Payload Fairings, and Second Stage are shown in Figure 3.5.

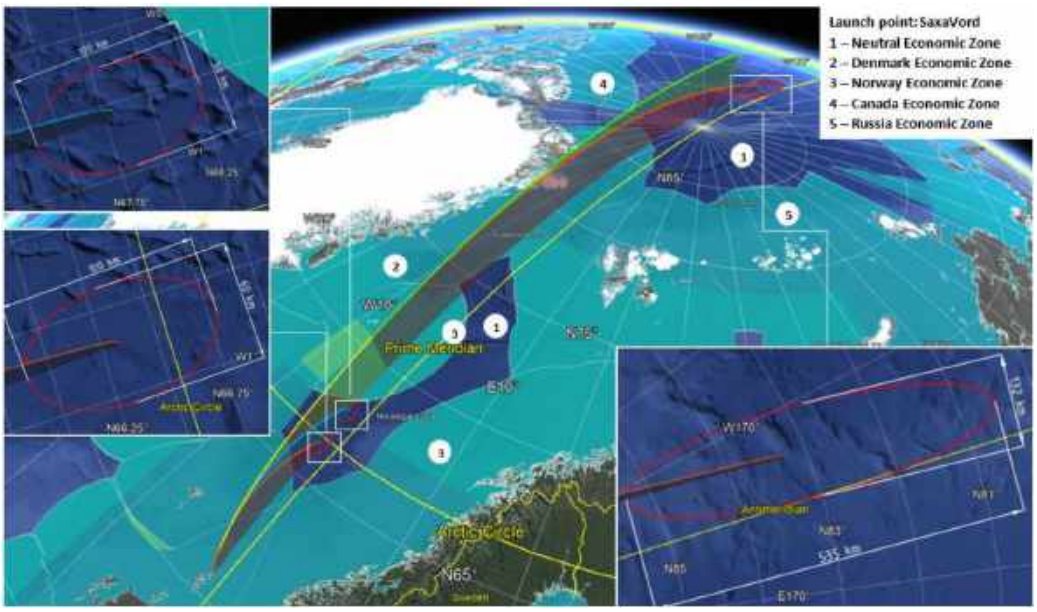

Figure 3.5 Typical Impact Areas of Skyrora XL Launch Vehicle Separated Parts (First Stage Impacts first, followed by Payload Fairings, followed by Second Stage)

Post Launch Operations

3.7.46 Post launch operations involve the inspection, demobilisation, and movement of all Skyrora equipment into storage or onto transporters.

Launch Trajectory and Recovery Operations

3.7.47 The proposed trajectory of the Skyrora XL Launch Vehicle will have an overall northerly direction from the SaxaVord Spaceport. Considering the impact zone for the payload fairing, up to three impact zones are expected per launch (Stage 1, the payload fairing, and Stage 2). The third stage carries the payload into orbit and will be on a trajectory that will result in burn-up upon re-entry into the atmosphere.

3.7.48 The impact zones are expected to occur at an approximate minimum distance of 617 km from the launch site (Stage 1), and up to an approximate maximum distance of 4,007 km (Stage 2).

3.7.49 The trajectory and impact zones EZI (as described further in Chapter 10) falls within the jurisdiction of several countries including Scotland, Norway, Faroe Islands (Denmark), Iceland, and Greenland (Denmark). It also falls within areas beyond national jurisdiction.

3.7.50 Noting the conditions of the Memoranda of Understanding currently in place between the UK Government and the Governments of The Faroe Islands and Iceland respectively, the Applicant will carry out the following activities:

- Prior to any launch activity, the Applicant will provide copies of any relevant Notices to Aviators or Notices to Mariners issued for the launch activity to the Government of The Faroe Islands and the Government of Iceland.
- On the day of launch, the Applicant will monitor the publicly available Automatic Identification Systems (AIS) information, to ensure that no fishing activity within the territories of the Faroes Islands is placed at risk by the Applicant's activities.
- Should any portion of the Skyrora XL Launch Vehicle descend into the sea within the Icelandic Exclusive Economic Zone, the Applicant will contract commercial recovery services to attempt to locate any debris and recover it. This recovery effort shall be co-ordinated with the relevant agencies of the Icelandic government to ensure that all parties are informed of the results of these efforts.

3.7.51 Other than for components returning to earth within the Icelandic Exclusive Economic Zone there are currently no recovery operations planned to recover First or Second Stages or Fairings from the Skyrora XL Launch Vehicle.

3.7.52 Within the Icelandic Exclusive Economic Zone, best endeavours will be made to recover Skyrora XL Launch Vehicle components. The Skyrora XL Launch Vehicle will transmit telemetry during flight and whilst on the surface once returned to earth; allowing for a rough search location to be established. In addition, components will carry location transponders (similar to those used to track cetaceans) and diepacks to provide localised visibility. Aerial searching from the last known position using a drone spiralling search technique will be undertaken to establish the location of the Skyrora XL Launch Vehicle components and, if considered appropriate and safe to do so, a recovery vessel then deployed to recover the components. The recovery effort will be co-ordinated with the relevant agencies of the Icelandic government. Any recovered components will be shipped back to Skyrora's laboratory for review.

3.7.53 Recovery activities will comprise localised searching using one or two shipping vessels only. Environmental effects from recovery operations are considered negligible in the context of the wider AEE and as such are considered to result in no significant effect.

3.7.54 Recovery is not proposed for components falling outside of the Icelandic EEZ because recovery of stages is an expensive and often dangerous operation involving specialised equipment, multiple sea craft, personnel, and logistics. The Applicant considers that:

- The stages will be jettisoned at a minimum distance of 12 nautical miles from the nearest coastline.
- There are inherent risks associated with recovery. Factors such as adverse weather conditions and working far out at sea pose significant threats to the safety of the recovery team.
- Once at the bottom of the ocean, the stages will start an artificial reef and serve as a habitat for marine life, contributing to biodiversity in the areas (as assessed in more detail in Chapter 10).
- The cost of retrieving all hardware from any given launch operation would be make launching out of the UK cost prohibitive.

3.7.55 The Applicant is aware of the intergovernmental agreements with Jan Mayen and Norway that there should be no dropped debris within 12 nautical miles of the coasts of both Jan Mayen and Norway and confirms that planned trajectories and drop zones will be designed such that no debris falls within 12 nautical miles of the coast.

3.7.56 Recovery of the Skyrora Skylark L suborbital Launch Vehicle is anticipated by the Applicant. Details of the recovery operations for this smaller Launch Vehicle are included in Appendix 2.1.

Test Launches

3.7.57 For the purposes of this AEE, test launches (a test launch event that proceeds beyond ignition and lift off) have been considered as full launches within the Applicant's environmental budget.

Off-Nominal Launch Scenarios

3.7.58 Scrubbed or aborted launches (launch events where the Applicant calls off the attempted launch prior to ignition) inherently have no significant environmental effects and therefore are not considered further in the AEE.

3.7.59 Off-nominal launch scenarios (when the launch event proceeds beyond ignition but does not perform within expected/acceptable limits) are considered at length in Chapter 10 (Marine and Transboundary) and Chapter 12 (Accidents) of this AEE Report.

3.7.60 It is anticipated that the deflagration following ignition of propellant during any launch failure would create a short-lived initial fireball potentially extending several tens of metres from the pad, with the residual propellant rapidly burning off over several minutes.

3.7.61 The initial deflagration radius is not expected to extend beyond the boundary of the Proposed Project and the duration of any subsequent propellant burn-off would be minimal in the open air.

3.7.62 Peat depth and condition surveys have now completed at SaxaVord Spaceport. The NatureScot classification of peatland at the Spaceport is Class 5 (peat soil with areas of bare soil), which is consistent with data obtained during site surveys. The expectation is that the relative flammability of the substrate will be low, and that it will not be at risk of ignition following a rocket propellant deflagration.

3.7.63 Firefighting water will be limited to damping / suppression and hence not of a volume sufficient to mobilise any combustion products. Foam is highly unlikely to be deployed given the rapid burnout of any fires.

Chapter 4 Population and Human Health

4. Population and Human Health

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4. Population and Human Health

4.1 Introduction

4.1.1 Effects on Human Health from the Proposed Project are discussed in detail in the relevant technical chapters of this AEE Report - Air Quality (Chapter 7) and Noise (Chapter 8) and a summary of the findings presented in this Chapter for information.

4.1.2 The main focus of this chapter is the effect of the Proposed Project on population, and in particular the socio-economic effects including the economic impacts associated with its operation. Whilst in reality the Proposed Project must be considered as one part of the wider SaxaVord Spaceport development its associated environmental budget of 30 launches per year; in the context of this assessment effects on population have been assessed in isolation i.e., as the direct and in-direct effects arising solely from 16 launches of the limiting case Skyrora XL Launch Vehicle from the SaxaVord Spaceport in any given year.

4.1.3 The population of Unst has declined significantly over the last century to an estimated level of around 700 people and is expected to decrease further. The population decline has been caused in part by the closures of Baltasound Airport in 1996 and RAF Saxa Vord in 2006. These closures have also depressed job opportunities in Unst, and incomes in Unst and the North Isles tend to be lower than in other parts of the Shetland Islands. When compounded with higher living costs, this results in the area around the Proposed Project being one of the least affluent areas in the Shetland Islands. Within the context of the wider SaxaVord Spaceport, the Proposed Project represents a transformational and much needed economic development opportunity for Unst and for the Shetland Islands.

4.1.4 This chapter is structured as follows:

- Section 4.2 sets out relevant legislation, policy and guidelines;
- Section 4.3 summarises the effects of the Proposed Project on human health;
- Section 4.4 describes the assessment methodology and significance criteria for other effects on population;
- Section 4.5 considers the baseline socio-economic and tourism conditions;
- Section 4.6 lists the receptors brought forward for assessment;
- Section 4.7 assesses potential effects;
- Section 4.8 considers any mitigation required;
- Section 4.9 assesses residual effects;
- Section 4.10 describes any cumulative impacts; and,
- Section 4.11 provides a summary of the chapter's findings.

4.2 Legislation, Policy and Guidelines

Legislation

Space Industry Act

4.2.1 The Space Industry Act (2018) regulates all spaceflight activities carried out in the United Kingdom, and associated activities. The Act requires any person or organisation to obtain the relevant licence to:

- launch a launch vehicle from the UK;

- return a launch vehicle launched elsewhere than the UK to the UK landmass or the UK's territorial waters;
- operate a satellite from the UK;
- conduct suborbital activities from the UK;
- operate a spaceport in the UK; or
- provide range control services from the UK.

Policy Documents

4.2.2 Whilst there is no policy specific to the assessment of the economic impacts of launch operations at spaceports, given the Proposed Project's characteristics, it is possible to follow existing guidance on the economic impacts from the planning regime. The economic analysis therefore follows the guidance set out in the Scottish Government's Draft Advice on Net Economic Benefit and Planning (Scottish Government, 2016).

Scottish Government Economic Strategy

4.2.3 In March 2022, the Scottish Government published its National Strategy for Economic Transformation (Scottish Government, 2022). The ten-year strategy provides a set of key priorities and actions with a vision of achieving a wellbeing economy that is prosperous for all of the country's people and places. A wellbeing economy is one that delivers economic prosperity across social, economic, and environmental dimensions. This includes capitalising on Scotland's most advantageous economic opportunities such as the transition to a net zero economy and a green recovery from the COVID-19 pandemic. Additionally, it includes reducing the socio-economic inequalities that exist between parts of the country.

4.2.4 The ambition of the strategy is for 'Scotland to be successful' over the next decade. This includes creating an economy in which all people can have access to skilled, well-paid, jobs, and businesses and entrepreneurs have the conditions necessary to flourish.

4.2.5 To deliver its vision and address these challenges, five programmes of action have been identified (with a sixth priority of creating a culture of delivery), including:

- **entrepreneurial people and culture**: establishing Scotland as a world-class entrepreneurial nation;
- **new market opportunities**: strengthening Scotland's position in new markets and industries, generating new, well-paid jobs from a just transition to net zero;
- **productive businesses and regions**: making Scotland's businesses, industries, regions, communities and public services more productive and innovative;
- **skilled workforce**: ensuring that people have the skills they need to meet the demands of the economy, and that employers invest in their skilled employees;
- **a fairer and more equal society**: reorienting the economy towards wellbeing and fair work.

4.2.6 The Proposed Project will contribute in particular to the programmes of action related to new market opportunities and to productive businesses and regions, as well as indirectly contributing to all of the other programmes.

A Fairer, Greener Scotland – Programme for Government 2021-22

4.2.7 This strategy built on the Scottish Government's Programme for Government 2021-22 (Scottish Government, 2021), which set out the strategic aims and ambitions for a 'fairer, greener Scotland' over a parliamentary term, and highlighted the longer term priorities of the Scottish Government.

4.2.8 The space sector is specifically mentioned in the Programme for Government: "*One sector which offers significant potential is the space sector. We will support Scotland to become a leading European space nation by working with industry to deliver a full end to end solution for satellite design, manufacture and testing, launch and data exploitation, targeting a £4 billion share of the global space market. One step will be the development of a joint Scottish Government, industry and academia strategy for sector growth, to be launched in October 2021, and delivery of a dedicated launch capability by summer 2023, targeting a £4 billion share of the global space market, with 20,000 jobs in the sector by 2030.*"

4.2.9 In addition to its potential economic contribution, there are wider benefits from the operations of the sector. For example, the data collected from space support the tracking of climate variables, with 35 of the 45 essential climate variables that are set out by the UN relying on measurement from space. Satellite data have also either an important or supportive role in the monitoring of the UN's Sustainable Development Goals, which underpin its efforts to eradicate poverty and hunger across the world by 2030 (McKee, 2020).

Prosperity from Space

4.2.10 In 2018, the Space Growth Partnership, an industry group that brings together companies, academics, institutions and entrepreneurs involved in the space sector, published Prosperity from Space (Space Growth Partnership, 2018).

4.2.11 At the core of the strategy are four pillars:

- creating a National Space Programme to unlock increased private investment;
- creating the right environment for success by securing and building on existing strengths and market position;
- investing in people and places; and,
- continuing to drive growth from investment in ESA, Eumetsat and EU programmes.

4.2.12 The Proposed Project contributes towards addressing the need to maximise the value generated by UK spaceports and launch activities, one of four market priorities identified in the strategy, and to spread the benefits from the space sector across the UK.

Shetland Islands Council Economic Development Strategy, 2018-2022

4.2.13 In 2018, Shetland Islands Council published its economic development strategy to 2022 (Shetland Islands Council, 2018a). The document provides a baseline of the Shetland economy, highlighting its strengths as well as some of the challenges it faces, including a declining population, underemployment, pressure on public services and Brexit.

4.2.14 The mission underpinning the strategy is to: *"enable and promote the ideal conditions for growth and to support our businesses, residents and communities to take advantage of the opportunities this will create."* In order to fulfil this mission, the Economic Development Strategy sets outs six actions:

- to encourage private sector growth, diversification and development;
- to increase economic participation;
- to match economic development to skills and research and development;
- to ensure the representation of Shetland interests at national, regional and external level;
- to increase the attractiveness of Shetland as a place where to study, live and work; and,
- to increase the rate of innovation and adoption of new technologies.

Scotland's Outlook 2030

4.2.15 Following on from the Tourism Scotland 2020 strategy (Scottish Tourism Alliance, 2012), a collaborative network of industry experts created Scotland's Outlook 2030 (Scottish Tourism Alliance, 2020), which focuses on creating a world-leading tourism sector in Scotland that is sustainable in the long-term.

4.2.16 The strategy focuses on four key priorities: people, places, businesses and experiences. The strategy recognises the effects of climate change, technological advancements, Brexit and changing consumer behaviour on tourism and highlights the need for collaboration between government, communities and the public and private sectors.

Shetland Tourism Strategy, 2018-2023

4.2.17 The Shetland Tourism Strategy 2018-2023 (Shetland Tourism Association, 2018) was developed by a range of organisations with a stake in the development of the tourism sector in the Shetland Islands. These include Shetland Tourism Association, Shetland Islands Council, Visit Scotland, Highlands and Islands Enterprise, Lerwick Port Authority, Shetland Arts Development Agency and Shetland Amenity Trust.

4.2.18 The strategy is aligned with both the Tourism Scotland 2020 strategy (Scottish Tourism Alliance, 2012) and with three of the four priorities identified in the Shetland's Partnership Plan 2018-2028 (Various, 2018): participation, place and money.

4.2.19 The document identifies seasonality and constraints to capacity from air and boat services as two challenges for the tourism sector in the Shetland Islands. In particular, despite an increase in events throughout the year including Wool Week, tourism remains for the most part confined to the summer months.

4.2.20 The aim of the strategy is to: "*help make Shetland a year-round, sustainable tourism destination offering unique and outstanding visitor experiences*." To achieve this, three priority areas have been identified: leadership and collaboration, exploiting opportunities and enhancing visitor experience.

4.2.21 The Proposed Project could diversify the portfolio of visitor attractions that the Shetland Islands can offer. The fact that launches would take place throughout most of the year may also allow businesses in the tourism sector to benefit from visits outwith the summer months.

Local Development Plan

4.2.22 Socio-economic considerations feature prominently in the Shetland Local Development Plan. The foreword notes that: "*The Shetland Local Development Plan sets out the Council's vision and spatial strategy that recognises existing development and promotes sustainable growth. The strategy is supported by a framework for delivery that will: promote economic growth; result in sustainably located and planned housing; support appropriate transport and infrastructure planning; and conserve and protect biodiversity and the natural environment.*"

4.2.23 More specifically, GP1 Sustainable Development states that: "*Development will be planned to meet the economic and social needs of Shetland...*" and that is justified on the basis that: "*Enabling sustainable development requires coordinated action, combining economic competitiveness and social inclusion with environmental quality.*"

4.2.24 The Economic Development policies include ED1 Support for Business and Industry which states that: "*The Council encourages the creation of sustainable economic development opportunities and business developments in accordance with General Policies*".

Guidance

Guidance for the Assessment of Environmental Effects

4.2.25 The guidance document "*Guidance for the Assessment of Environmental Effects*" (Civil Aviation Authority et al., 2021) explains the process for completing an assessment of environmental effects as part of a licence application under the Space Industry Act and sets out the environmental topics likely to be affected by the proposed activities.

4.2.26 The guidance requires that potential direct and indirect significant effects of proposed spaceflight activities on environmental features, including population and human health, are considered. The guidance further requires that:

- Specific potential effects are identified and, where possible, quantified;
- The focus of the AEE should be on significant effects arising from the proposed activities;
- The AEE should explain what other environmental assessments have been conducted in relation to the proposed activities and whether they are being used in support of the AEE;
- Applicants for a launch operator licence set an environmental budget, comprising a maximum number of launches per launch vehicle type which can take place over the course of a year that can be carried out in an environmentally sustainable manner, taking into account the cumulative effect of all launches; and
- The AEE must address a range of environmental topics, including population and human health.

4.3 Human Health Effects: Summary

4.3.1 Effects on Human Health from the Proposed Project are considered to arise from operational effects on air quality and operational noise effects. These effects are assessed in detail in Chapters 7 and 8 respectively, and as such, a short summary of the findings presented here for information.

Air Quality

4.3.2 An assessment of the potential effects of emissions from the Proposed Project on local air quality has been undertaken.

4.3.3 Proposed Project-generated traffic is predicted to have an effect of negligible significance on air quality, therefore resulting in **no likely significant effect.**

4.3.4 Launch emissions are predicted to have no perceptible impact at any identified receptors under prevailing wind directions. The maximum predicted impact at a sensitive receptor is predicted to occur with north-easterly winds, which occur typically for less than 10 % of the year. The maximum predicted 8-hour concentration of CO is 71.1 % of the relevant air quality standard for human health. Emissions from launches are therefore considered to have an effect of negligible significance on air quality**,** therefore resulting in no **likely significant effect**.

Noise

4.3.5 Potential noise and vibration effects associated with the Proposed Project have been robustly assessed with regard to launches and associated non-launch activities.

4.3.6 Noise effects associated with road traffic and non-launch activities have been assessed as not significant, resulting in **no likely significant effect**.

4.3.7 Noise during engine tests (should they occur – not planned as part of normal operations) and launches will be audible at identified noise sensitive receptors and levels will exceed the criterion for community annoyance associated with aircraft noise. However, instantaneous noise levels will be below the threshold at which damage to hearing may occur.

4.3.8 As detailed in the SaxaVord Spaceport licence application, of the total 30 launches per year from the Spaceport it is anticipated that in any one month there may be up to four launches. Of these, it is anticipated that up to two will be launches of the Skyrora XL Launch Vehicle. The proposed infrequency of launches and the short duration of audible noise event will act to reduce associated levels of annoyance below that which may be associated with aircraft noise from conventional airports. Accordingly, adverse health effects are not anticipated. Noise at identified receptors associated with launches is below the level at which the potential for cosmetic damage to structures is likely. Noise effects associated with launches have therefore been assessed as not significant, resulting in **no likely significant effect**.

4.4 Population Effects: Assessment Methodology and Significance Criteria

Zone of Influence

4.4.1 The population and economic study areas considered in this assessment are:

- Unst;
- The Shetland Islands; and,
- Scotland.

Assessment of Socio-Economic Benefits

4.4.2 The assessment of socio-economic benefits from operation of the Proposed Project follows the guidance and methodology set out in the 'Draft Advice on Net Economic Benefit and Planning' (Scottish Government, 2016). As a result, all the economic impacts considered are net of those benefits that would occur if the project did not go ahead.

4.4.3 The methodology has been complemented by BiGGAR Economics' experience on estimating the economic impacts from other projects and by its understanding of the local economy.

4.4.4 The analysis of economic impacts relies on two commonly used measures:

- Gross Value Added (GVA), a measure of the value that an organisation, company or industry adds to the economy through its operations. The analysis uses the production approach to measure this contribution, where the GVA is equal to the value of production less the value of the inputs used; and,
- Employment, which is measured in terms of headcount jobs supported when considering operational impacts.

4.4.5 For this assessment, the likely sources of economic impact from operation of the Proposed Project have been identified as economic activities linked to the operation of the Proposed Project including:

- the employment supported by the contribution of the Proposed Project to the operations of SaxaVord Spaceport;
- temporary workers' spending on accommodation and subsistence; and,
- the spending of visitors viewing the launches.

4.4.6 The analysis relies on data from publicly available statistics and previous experience. Where assumptions have been made throughout the analysis, these have been set out clearly and justified.

4.4.7 To estimate the impacts associated with the Proposed Project, the value of contracts carried out or the employment supported by them has been estimated. The approach used to estimate the spending associated with tourism is slightly different, as the total number of visitors was estimated based on the maximum tourism capacity allowed by existing accommodation provision and links to the rest of the Shetland Islands. Turnover from tourism has been estimated by multiplying the total number of visitors by the average spending of visitors to the Shetland Islands.

4.4.8 Once total turnover or employment are estimated, economic activity is allocated to the economic sectors where it occurred based on the Office for National Statistics' (ONS) Standard Industrial Classification (SIC) codes (Office for National Statistics, 2009). In a similar way, spending and employment were allocated to the areas where they occurred.

4.4.9 The estimation of the direct GVA and employment supported by expenditure on project-related contracts and activities relied on applying sectoral level turnover per GVA, turnover per job or GVA per job ratios sourced from the Scottish Annual Business Statistics (SABS) (Scottish Government, 2019b).

4.4.10 Alongside direct GVA and employment impacts, the analysis considered indirect and induced economic impacts. Indirect impacts result from the spending taking place within the supply chains of those businesses that are awarded contracts related to the operation of the Proposed Project. Induced impacts refer to the benefits arising from the spending of salaries and wages by those employed in businesses carrying out contracts associated with the Proposed Project.

4.4.11 Indirect and induced impacts were estimated by applying the relevant Scottish GVA and employment Type 1 and Type 2 multipliers, as sourced from the Scottish Government 2016 Input-Output Tables (Scottish Government, 2019c).

4.4.12 In estimating net economic benefits, the analysis followed the guidance on additionality as set out in the Homes and Communities' Agency "Additionality Guide" (Homes & Communities Agency, 2014) and discounted impacts based on:

- leakage – any economic impacts benefitting those from outside the study area where a project takes place;
- displacement – any benefits to the area where the project takes place that are accounted for reduced activity in another geographical area; and,
- deadweight – any outcomes and benefits that are expected to arise if the project did not go ahead.

4.4.13 The assessment also includes consideration of wider economic benefits arising from the Proposed Project. These were not quantified but were described as part of the analysis.

Assessment of Potential Effect Significance

4.4.14 The assessment follows the evaluation methodology used in similar environmental impact assessments. This assesses the significance of a change in socio-economic conditions based on the sensitivity of the receptor and the magnitude of impact.

4.4.15 The following aspects were considered when appraising the sensitivity to changes in socio-economic conditions:

- the scale of the economy affected;
- its relative fragility; and,
- the diversification of its economic base.

4.4.16 For instance, an area with smaller economic activity is more sensitive to a change in employment than a relatively larger economic area. Equally, an economic area where activity is concentrated in one economic sector is more sensitive to the emergence of opportunities in another sector than an economy with a diversified economic base.

4.4.17 The magnitude of impacts is considered as follows:

- major if the project leads to a 4 % change in economic activity, which is more than double the average annual rate of growth for the Scottish economy;
- moderate if the project leads to a change in economic activity of 2 %, which is higher than the average annual rate of growth for the Scottish economy;

- minor if the project leads to a 1 % change in economic activity; and,
- negligible if the project leads to an increase in economic activity of less than 0.1 %.

4.4.18 The significance of changes is then assessed based on sensitivity and magnitude and professional judgement. The significance of effects is described below. In terms of assessment of environmental effect under the Space Industry Act 2018, major and moderate impacts are to be considered to result in significant effects.

Limitations to Assessment

4.4.19 Since there are no existing operational orbital spaceports located in the UK or across Europe from which launch operators are currently operating at the time of writing, it is not possible to rely on any evaluation carried out on the impacts from a similar project in an equivalent socio-economic environment.

4.5 Population Effects: Baseline Conditions

Economic Context

4.5.1 The population of Unst has declined significantly over the last century to an estimated level of around 700 people and is expected to decrease further. The population decline has been caused in part by the closures of Baltasound Airport in 1996 and RAF Saxa Vord in 2006. These closures have also depressed job opportunities in Unst, and incomes in Unst and the North Isles tend to be lower than in other parts of the Shetland Islands. When compounded with higher living costs, this results in the area around the Proposed Project being one of the least affluent areas in the Shetland Islands.

4.5.2 Much of the economic history of Unst over the last seventy years has been characterised by the presence at Saxa Vord of a Royal Airforce (RAF) base, RAF Saxa Vord. Originally established in 1957 during the Cold War, the base has been an important feature of the Unst economy and has had a relatively strong link with the local community. Through it, the Ministry of Defence (MOD) played an important role as a local employer, alongside supporting jobs across other sectors. Around sixty years after its opening, the base was closed in 2006.

4.5.3 More recently, following incursions on the UK airspace by Russian fighter jets, a radar-based point was re-established. However, no permanent staff are based in Unst since the radar system is operated remotely.

4.5.4 Since the RAF left the area, there has been an attempt to redirect the local economy. The Proposed Project represents a transformational and much needed economic development opportunity to diversify the local economy and bring investment to Unst.

Socio-Economic Characteristics

4.5.5 Baseline socio-economic characteristics have been determined for three study areas aiming up the EZI for this assessment: Unst, The Shetland Islands and Scotland.

4.5.6 Data reflect the most recent evidence available. However, it is recognised that depending on its impact, the COVID-19 pandemic may have temporary or more lasting effects on socio-economic characteristics. Indeed, the space industry is considered likely to play an important role in economic recovery through the high-value jobs it supports and the range of activities it enables. Where data for Unst were not available specifically, information has been reported for the North and East Isles.

Population

4.5.7 In 2019, the population of the Shetland Islands was 22,920, around 0.4 % of Scotland's total population (National Records of Scotland, 2020a). While the National Records of Scotland do not provide population estimates below local authority areas, Visit Unst estimates that the population of Unst is currently around 700 people (Visit Unst, 2020a).

4.5.8 As shown in Table 4.1 below, the Shetland Islands has a slightly larger proportion of the population aged 0-15 than the Scottish average, and the proportion of the population of working age is lower than the Scottish average.

Table 4.1 2019 Population Estimates

	Unst*	Shetland Islands	Scotland
Population	700	22,920	5,463,300
0-15	-	18.3 %	16.9 %
16-64	-	61.2 %	64.0 %
65+	-	20.4 %	19.1 %

Source: (National Records of Scotland, 2020b), (Visit Unst, 2020a)

4.5.9 As shown in Table 4.2, by 2043 the population of the Shetland Islands is expected to decline to 21,579, a decrease of around 6 % on the 2018 population. In comparison, the population of Scotland is expected to increase by 2.5 % over the same period.

4.5.10 The Shetland Islands are also expected to have a smaller proportion (57.1 %) of the population of working age than Scotland (60.3 %) by 2043. Both the populations of the Shetland Islands and Scotland are expected to age over the period to 2043, but the trend is more marked in the Shetland Islands with 27.9 % of the population aged 65 or over - three percentage points higher than for Scotland.

Table 4.2 Population Projections (2018-2043), Shetland Islands and Scotland

	Shetland Islands		Scotland	
	2018	2043	2018	2043
Population	22,990	21,579	5,438,100	5,574,819
0-15	18.3 %	15.1 %	16.9 %	14.8 %
16-64	61.9 %	57.1 %	64.2 %	60.3 %
65+	19.8 %	27.9 %	18.9 %	24.9 %

Source: (National Records of Scotland, 2020a) (National Records of Scotland, 2020b)

4.5.11 In summary, the Shetland Islands has a younger than average population, with a smaller proportion of people of working age than the Scottish average. In addition, the number of people aged 65 or over is projected to increase significantly by 2043.

Economic Activity and Employment

4.5.12 As shown in Table 4.3 below, the 2019 economic activity rate in the Shetland Islands was 3.3 % higher than for Scotland overall. Similarly, the 2019 unemployment rate for the Shetland Islands was 2 % lower than the average for Scotland and the median annual pay of full-time workers in the Shetland Islands was higher than across Scotland as a whole.

Table 4.3 Economic Activity and Earnings (2019)

	Shetland Islands	Scotland
Economic Activity Rate (16-64)	80.8 %	77.5 %
Unemployment Rate (16-64)	1.5 %	3.5 %
Median Annual Pay of Full-time Workers (£)	£31,339	£30,000
% of Full Time Workers	60.8 %	74.7 %
% of Part Time Workers	39.2 %	25.2 %

Source: (Office for National Statistics, 2020a) (Office for National Statistics, 2020b) (Highlands and Islands Enterprise, 2019)

4.5.13 In its publication Shetland in Statistics, Shetland Islands Council collects detailed statistics on a range of subjects including the economy, tourism and demographics. Based on the latest publication (Shetland Islands Council, 2018b), as presented in Table 4.4 below, in 2017 the mean income in the North Isles of Shetland was £31,364, the lowest among the other areas of the Shetland Islands considered. The mean income of the lower quartile was also smaller in the North Isles (£15,256) than across other areas in the Shetland Islands.

Table 4.4 Mean Income and Income of the Lower Quartile - Shetland Islands

	Mean Income	Lower Quartile
Central Mainland	£40,644	£20,430
Lerwick and Bressay	£34,834	£16,473
North Isles	£31,364	£15,256
North Mainland	£36,533	£18,087
South Mainland	£42,477	£21,573
West Mainland	£35,351	£17,765
Whalsay & Skerries	£42,477	£16,704

4.5.14 Source: (Shetland Islands Council, 2018b)

4.5.15 Table 4.5 below, in 2018 agriculture, forestry and fishing were the main employers in the Shetland Islands, accounting for 18.8 % of total employment. Health and social care (14.1 %) and wholesale and retail trade (10.2 %) were other relatively important sectors in terms of employment.

4.5.16 However, in the North and East Isles of the Shetland Islands (including Unst), manufacturing was a large source of employment, accounting for 18.2 %, compared to 5.9 % for the Shetland Islands as a whole and 6.9 % for Scotland. Employment in the accommodation and food service sector was lower in the North and East Isles (2.2 %) than for the Shetland Islands (6.2 %) and the Scottish average (7.9 %).

Table 4.5 Business Register and Employment Survey, 2018

	North and East Isles	Shetland Islands	Scotland
Agriculture, forestry and fishing*	0.0 %	18.8 %	3.2 %
Mining and quarrying	0.0 %	0.5 %	1.1 %
Manufacturing	18.2 %	5.9 %	6.9 %
Electricity, gas, steam and air conditioning supply	0.0 %	1.0 %	0.7 %

	North and East Isles	Shetland Islands	Scotland
Water supply, sewerage, waste	0.0 %	0.7 %	0.8 %
Construction	2.2 %	8.6 %	5.5 %
Wholesale and retail trade	0.0 %	10.2 %	13.6 %
Transportation and storage	4.4 %	6.2 %	4.2 %
Accommodation and food service activities	2.2 %	6.2 %	7.9 %
Information and communication	0.0 %	1.3 %	3.1 %
Finance and insurance activities	0.0 %	0.2 %	3.4 %
Real estate activities	0.0 %	0.6 %	1.5 %
Professional, scientific and technical activities	4.4 %	3.4 %	7.0 %
Administrative and support service activities	4.4 %	3.8 %	7.9 %
Public administration and defence	6.7 %	5.0 %	6.0 %
Education	20.0 %	7.0 %	7.4 %
Human health and social work activities	22.2 %	14.1 %	15.1 %
Arts, entertainment and recreation	8.8 %	5.6 %	4.8 %
Total Employment	220	16,000	2,611,500

Source: (Office for National Statistics, 2019a) *excludes farm agriculture and includes aquaculture.

4.5.17 In summary, economic activity is higher and unemployment is lower in the Shetland Islands when compared to Scotland as a whole. This is complemented by higher wages, though it is noted that part-time work is more prevalent in the Shetland Islands. Across the North Isles (including Unst) however, wages are lower than in other areas of the Shetland Islands.

Qualification Levels

4.5.18 Education qualification levels in the Shetland Islands are significantly lower than in Scotland as a whole as shown in Table 4.6 below. In Scotland, around 45 % of the population had an NVQ4 or equivalent in 2019, whereas in the Shetland Islands this figure was 27.5 %. Conversely, the proportion of the population with no qualifications is lower in the Shetland Islands at 2.6 % compared to 9.8 % for Scotland as a whole.

Table 4.6 Qualification Levels, % of population aged 16-64

	Shetland Islands	Scotland
% with NVQ4+	27.5 %	45.3 %
% with NVQ3+	49.7 %	60.8 %
% with NVQ2+	80.5 %	75.6 %
% with NVQ1+	93.7 %	83.5 %
% with other qualifications (NVQ)	3.7 %	6.7 %
% with no qualifications (NVQ)	2.6 %	9.8 %

Source: (Office for National Statistics, 2020a)

4.5.19 In summary, qualification levels are lower in the Shetland Islands than in Scotland as a whole with a lesser share of the population obtaining university and college level qualifications. The largest employer in the Shetland Islands is agriculture, forestry and fishing, whereas in the North and East Isles (including Unst), manufacturing, health and education are the largest sectors of employment.

Deprivation

4.5.20 According to the 2020 Scottish Index of Multiple Deprivation (Scottish Government, 2020a), which takes account of a wide range of measures of deprivation, none of the 15 % most deprived data zones in Scotland are located in the Shetland Islands. However, in the North and East Isles, geographical access to services scores low and the area is ranked in the most deprived 10 % under this specific indicator.

Tourism Context

4.5.21 Sustainable tourism is one of six sectors identified by the Scottish Government as comprising those industries where Scotland has a relative advantage. As detailed in Table 4.8 below, in 2017/2018, the sustainable tourism sector generated £39.7 million GVA in the Shetland Islands and £4.1 billion GVA in Scotland (Scottish Government, 2020b). In the same year, the sector employed 1,250 people in the Shetland Islands, compared to 218,000 people in Scotland as a whole. The sector has a similar weight in the economies of the Shetland Islands and Scotland supporting around 8 % of total employment.

Table 4.7 Employment and GVA in the Sustainable Tourism Sector

	Shetland Islands	Scotland
Employment	1,250	218,000
GVA (£m)	39.7	4,127.1

Source: (Scottish Government, 2020b)

4.5.22 The most recent evidence on tourism activity within the Shetland Islands comes from the Shetland Visitors Survey 2019 (Shetland Islands Council et al., 2020). In 2019 there were reportedly 80,128 visits to the Shetland Islands, which included visitors spending time in different locations of the Shetland Islands during a single visit.

4.5.23 For 69 % of visitors, the sceneries and landscapes were one of the reasons motivating a visit to the Shetland islands. History, culture and the ability to 'get away from it all' were mentioned by 49 % and 25 % of respondents respectively. Among visitor attractions, those related to history and heritage were the ones visited by tourists in Unst, with 27 % of leisure visitors to the Shetland Islands visiting Unst Heritage Centre & Unst Boat Haven and 21 % Viking Unst.

4.5.24 The survey also considered where visitors spent time while in the Shetland Islands. Visitors tended to spend most of their time in the Mainland of Shetland, with more than 50 % saying that they had visited Lerwick, South Mainland, Central Mainland and West Mainland. In 2019, around 34 % of visitors spent time in Unst, 1 % higher than was recorded in the previous 2017 visitors survey (Shetland Islands Council et al., 2018). Unst was also more popular among leisure visitors, 47 % of whom visited the island – than with those visiting friends and relatives and those coming to the island for business reasons

4.5.25 Whilst the preferred means of transportation for visitors once in the Shetland Islands is hiring a car, intra-island movements take place for the most part by ferry. To reach Unst from the Mainland of Shetland, it is necessary to use the ferry service from Toll (Shetland Mainland) to Ulsta (Yell) and from Gutcher (Yell) to Belmont (Unst). The journey between Lerwick and Unst may take between 90 and 120 minutes (Visit Unst, 2020b).

4.5.26 Over the period between May 2019 and March 2020, over 130,000 passengers used the ferry service serving Unst, Yell and Fetlar and a total 18,085 journeys were completed (Shetland Islands Council, 2020). The busiest months were those during the summer period and coincided with when the tourism season is at its peak.

4.5.27 There are a number of existing accommodation providers in Unst, ranging from hotels to self-catered cottages and hostels. Primarily these services are available during the summer season (April through to October) however, some smaller self-catered accommodation providers also operate on a restricted basis during the winter months. In total (in season), they can provide accommodation for approximately 230 visitors (Visit Unst, 2020a).

4.5.28 The Proposed Project, as part of the wider SaxaVord Spaceport initiative, provides an opportunity for Unst to diversify its offer to visitors by including space tourism to its attractions' portfolio. It may also result in visitors that would have already come to the island for other reasons, including its scenery or its heritage and history, to spend more time on Unst.

4.5.29 The Proposed Project is also expected to lead to an increase in business tourism, as the launches will require staff to be on-site for a minimum of four weeks per launch campaign.

4.5.30 The increase in activity will provide existing businesses with opportunities to fill their offer of rooms. This may also lead to an extension of the tourism season to take advantage from the opportunities associated with launches as well as to expand existing provision.

4.5.31 In summary, the contribution of the tourism sector in the Shetland Islands economy is proportionately similar to that of Scotland as a whole. Most of the visitors to the Shetland Islands visit the islands to enjoy its naturalistic offer, explore its history and heritage and to unwind.

4.5.32 Unst and the North Isles receive a lower share of tourism than other areas of Shetland. This is partly because of their location since it may take up to two hours and two ferry crossings to reach Unst from Lerwick. Accommodation providers in Unst can provide overnight accommodation for around 230 visitors and may benefit from the increase in demand associated from the Proposed Project.

4.6 Receptors Brought Forward for Assessment

4.6.1 The following receptors were brought forward for assessment:

- the economy of Unst;
- the economy of The Shetland Islands; and,
- the economy of Scotland.

4.7 Potential Effects

4.7.1 During operation of the Proposed Project, beneficial economic impacts are expected to arise from three main sources:

- employment associated with operation of the Proposed Project;
- accommodation for temporary workers during launches; and,
- space tourism activity.

Employment associated with operation of the Proposed Project

4.7.2 SaxaVord Spaceport will support 98 jobs; 63 are expected to be based in Unst and 35 elsewhere within the Shetland Islands. The Proposed Project accounts for just over half of the launch activity of the SaxaVord Spaceport and therefore it is reasonable to attribute just over half of the employment to the Proposed Project.

4.7.3 To estimate the GVA associated operation of the Proposed Project, anticipated job numbers have been multiplied by the relevant sectoral GVA per job, based on Scottish Annual Business Statistics and a study on the UK space sector, "Size and Health of the UK Space Industry 2018" (London Economics, 2019).

4.7.4 Supply chain impacts have been estimated by applying the relevant Scottish Type 1 GVA and employment multipliers from the Scottish Input-Output Tables (Scottish Government, 2019c) to the GVA and employment estimated above.

4.7.5 The impact from the spending of salaries and wages created by the operation of the Proposed Project has been estimated using data on the gross/net salary per job from the Scottish Annual Business Statistics the London Economics report. It has been assumed that residents in Unst spend 30 % of their salaries in Unst, 50 % in the Shetland Islands (including Unst) and 70 % in Scotland (including the Shetland Islands). Likewise, residents of the Shetland Islands were estimated to spend 5 % of their salaries in Unst, 50 % in the Shetland Islands and 70 % in Scotland[1]. Impacts from workers' expenditure was then estimated based on the ratios and multipliers of the household spending sector.

4.7.6 Summing these elements together, it is estimated employment associated with operation of the Proposed Project will generate £1.8 million GVA and support 37 jobs in Unst. For the Shetland Islands this increases to £2.9 million GVA and 64 jobs, and for Scotland, £3.4 million GVA and 74 jobs as shown in Table 4.8 below.

Table 4.8 Economic Impact – Employment associated with the Proposed Project

	Unst	Shetland Islands	Scotland
Employment	37	64	74
GVA (£m)	1.8	2.9	3.4

4.7.7 The effect associated with employment is therefore assessed as:

- major beneficial (**significant effect**) for Unst;
- minor beneficial for The Shetland Islands; and,
- negligible for Scotland.

Accommodation for temporary workers during launches

4.7.8 Launch staff will need to be accommodated locally during preparation and decommissioning works prior to each launch. It is envisaged that some staff may also be permanently located in Unst.

4.7.9 The Applicant will pay for the maintenance (accommodation and food) of their staff while in Unst. This spending in turn will benefit local accommodation providers supporting their turnover and employment.

4.7.10 The Applicant anticipates that approximately 50 launch staff will be stationed on Unst for around four weeks during any launch campaign. By multiplying staff days required by the number of launches it is estimated that launch staff workers will stay on Unst for over 22,000 days per year when the target of 16 launches per year is achieved.

[1] where the spending taking place in the Shetland Islands and Scotland were estimated based on BiGGAR Economics' analysis of households spending patterns, as reported in (Office for National Statistics, 2019).
To account for the fact that ratios from the Scottish Annual Business Statistics do not account for taxation, it was then necessary to discount workers' expenditure by 8 %, the share of UK household spending that is devoted to Value Added Taxation according to a 2013 study from the European Commission (European Commission, 2013).

4.7.11 Given the existing accommodation capacity in Unst and the available data on average occupancy rates for the Shetland Islands from the 2019 Scottish Accommodation Occupancy Survey (Moffat Centre et al., 2020), workers are unlikely to displace any other users of accommodation facilities in Unst. As a result, all of this impact is considered as additional.

4.7.12 Maintenance expenditure associated with these stays has been assumed to amount to an average of £50 per worker per day and, on this basis, spending on accommodation will amount to around £1.1 million, discounted by 8 % to account for spending on VAT.

4.7.13 By applying the turnover per GVA ratio from the Accommodation and Food Services activities from Scottish Annual Business Statistics, direct GVA and employment supported by this spending has been calculated. Supply chain impacts and income effects have been estimated by applying relevant Type 1 and Type 2 Scottish multipliers, as done in previous sections.

4.7.14 It is estimated that spending on food and accommodation from the temporary launch workers will generate £0.64 million GVA and support 29 jobs on Unst. For the Shetland Islands this increases to £0.72 million GVA and 32 jobs, and for Scotland £0.85 million GVA and 34 jobs as shown in Table 4.9.

Table 4.9 Economic Impact - Accommodation Spending

	Unst	Shetland Islands	Scotland
Employment	29	32	34
GVA (£m)	0.6	0.7	0.8

4.7.15 The effects associated with spending on accommodation is therefore assessed as:

- major beneficial (**significant effect**) for Unst; and,
- negligible for The Shetland Islands and Scotland.

Tourism Activity

4.7.16 Launches are anticipated to attract visitors to Unst and the Shetland Islands. Visitor spending will have economic benefits, supporting local businesses and increasing employment in the tourism sector.

4.7.17 The level of impact from tourism is based on the total number of visitors that are able to view any given launch. This will be constrained by the number of overnight stays available on Unst and by the capacity of the ferry links to carry visitors for day trips.

4.7.18 As set out previously, it is estimated that Unst has capacity for up to 230 overnight stays. However, 50 of these will be taken up by launch staff as described in the previous section. In addition, approximately 20 of the visitors are anticipated to be senior staff from the Applicant. Consequently, it has been assumed that there will be capacity to accommodate 160 visitors overnight per launch.

4.7.19 Ferry capacity for day trips has been estimated using data from Shetland Islands Council, which states that the monthly peak number of passengers on the ferry to Unst, Yell and Fetlar in 2019 was 20,381. (Shetland Islands Council, 2020). This equates to a daily maximum of around 657 people per day. As day visitors must also travel home following the launch, the maximum number of day visitors has been estimated as 329. In total, it is estimated that a maximum of 489 visitors will be able to view any given launch.

4.7.20 To determine the number of visitors over a year, it has been assumed that the number of visitors will decline by 5 % for subsequent launches, to account for possible saturation interest. When the target of 16 launches per year is achieved, it is estimated that 3,922 visitors will view the launches.

4.7.21 Not all tourism activity can be considered as additional. Given the constraints in accommodation and ferry capacity, some visitors may displace other tourists that would have otherwise visited Unst for other reasons. As a result, it has been assumed that around 90 % of tourism activity will be additional with respect to Unst, 80 % with respect to the Shetland Islands and 50 % with respect to Scotland.

4.7.22 It has been assumed that overnight visitors will spend on average £448 during their stay in the Shetland Islands (Shetland Islands Council, 2018). In terms of the Scottish economy, predicted spend is higher at £726 per visit and takes into account of travelling costs to reach the Shetland Islands. It has been assumed that day visitors to Unst will spend on average £36[2] on the island. These visitors are considered as overnight visitors from the perspective of their spending in the Shetland Islands and in Scotland. Tourism spending has been discounted by 8 % to account for VAT, which is not included in the ratios from the UK Input-Output tables and multipliers.

4.7.23 Direct GVA and employment have been estimated by applying the turnover per GVA and turnover per job ratios for the Tourism sector, constructed using a series of industrial sector codes linked to accommodation, food and beverage and leisure activities. Indirect and induced impacts were then estimated making use of Scottish GVA and employment Type 1 and Type 2 multipliers.

4.7.24 It is estimated that tourism due to the Proposed Project will generate £0.21 million GVA and support 10 jobs on Unst. For the Shetland Islands this increases to £0.43 million GVA and 16 jobs, and for Scotland £0.80 million GVA and 29 jobs as shown in Table 4.10 below.

Table 4.10 Tourism Impact

	Unst	Shetland Islands	Scotland
Employment	10	16	29
GVA (£m)	0.2	0.4	0.8

4.7.25 The effect from tourism activity related to the Proposed Project is assessed as being**:**

- major beneficial (**significant effect**) for Unst; and,
- negligible for The Shetland Islands and Scotland.

Summary

4.7.26 Summing the beneficial effects resulting from employment associated with the operation of the Proposed Project, accommodation for temporary workers during launches and space tourism activity, as detailed in Table 4.11 below, it is considered that the Proposed Project will generate:

- £2.6 million GVA and 74 jobs in Unst (representing a substantial increase in employment);
- £4.0 million GVA and 112 jobs across the Shetland Islands; and,
- £5.0 million GVA and 136 jobs across Scotland.

Table 4.11 Total Economic Impact from Operation of Proposed Project

	Unst	Shetland Islands	Scotland
Employment	74	112	136
GVA (£m)	2.6	4.0	5.0

[2] based on data from the Great Britain Day Visitor Survey for day visits to the Shetland Islands (Kantar, 2019)

The total effect from operation of the Proposed Project is therefore assessed as being:

- major beneficial (**significant effect**) for Unst;
- minor beneficial for The Shetland Islands; and,
- negligible for Scotland.

4.7.27 In addition, the Proposed Project, as part of the wider SaxaVord Spaceport initiative, will result in a series of wider, less quantifiable, benefits for the economies of Unst, the Shetland Islands and Scotland including:

- Making Scotland more competitive in the small satellite space sector. This would complement the activities already carried out in the sector in Scotland and would mean that Scotland could offer the whole supply-chain for the small satellite sector.
- Diversifying the economic base of Unst and the Shetland Islands towards the space sector and away from the oil and gas industry, on which it currently relies heavily and is noted to be in decline. This diversification of the economic base may lead to an increase of the local economy's resilience.
- Offering a wider range of employment opportunities and new career paths available to young people in Unst and in the Shetland Islands.
- Acting as a catalyst for further investment.
- Encouraging investment in the tourism sector, as launches extend the tourism season and provide additional visitors to Unst and to the Shetland Islands with another reason to spend time there.

4.8 Mitigation and Further Studies

4.8.1 No mitigation is applicable to this chapter as the effects were all assessed as beneficial.

4.9 Residual Effects

4.9.1 As no mitigation is required, the residual effects on socio-economic characteristics are assessed as being effectively the same as the potential effects set out in Section 4.7 above, as summarised below.

4.9.2 The residual effects from the operational phase of the Proposed Project are assessed as being:

- major beneficial (**significant effect**) for Unst,
- minor beneficial for The Shetland Islands; and,
- negligible for Scotland.

4.10 Cumulative Assessment

4.10.1 The SaxaVord Spaceport has a proposed capacity for 30 launches per annum. The Proposed Project will account for 16 of those launches.

4.10.2 Assuming operators are identified for the remaining capacity, the cumulative socio-economic benefits of all 30 launches would be expected to be approximately double the benefits identified in the assessment above, as documented in the SaxaVord Spaceport AEE:

"Full operation of the [SaxaVord Spaceport] will see a maximum of 30 launch events per year. During operation, beneficial economic impacts are expected to arise from three main sources:

- *employment associated with operation of the Proposed Project;*
- *accommodation for temporary workers during launches; and,*
- *space tourism activity.*

It is estimated that employment associated with this level of activity will generate:

- *£3.3 million GVA and support 68 jobs in Unst;*
- *£5.3 million GVA and support 119 jobs in The Shetland Islands; and,*
- *£6.2 million GVA and support 137 jobs across Scotland.*

Spending on accommodation for temporary workers during launches is estimated to generate:

- *£1.2 million GVA and support 55 jobs in Unst;*
- *£1.4 million GVA and support 59 jobs in The Shetland Islands; and,*
- *£1.6 million GVA and support 64 jobs across Scotland.*

Spending by visitors coming to Unst for space tourism is estimated to generate:

- *£0.4 million GVA and support 17 jobs in Unst;*
- *£0.8 million GVA and support 30 jobs in The Shetland Islands; and,*
- *£1.5 million GVA and support 54 jobs across Scotland.*

Summing all these impacts together, it is estimated that the total impact from operation of the Proposed Project will be:

- *£4.9 million GVA and 139 jobs in Unst;*
- *£7.5 million GVA and 209 jobs in The Shetland Islands; and,*
- *£9.3 million GVA and 255 jobs in Scotland.*

4.10.3 Additionally, if the Proposed Project, as part of the wider Spaceport development, were to stimulate investment (for example, to provide additional visitor accommodation for those working on or viewing launches) or new entrepreneurial activity to take advantage of the supply chain opportunities that are expected to arise, this would increase the economic impacts in the Unst and Shetland Islands economies.

4.11 Summary

4.11.1 This chapter provides the human health and population assessment of the Proposed Project. The analysis has considered impacts associated with operation of the Proposed Project and how this fits into the local and national economic context.

4.11.2 The population of Unst has declined significantly over the last century, reaching 632 people in the latest Census (2011), and is expected to decrease further. The population decline has been caused in part by the closures of Baltasound Airport in 1996 and RAF Saxa Vord in 2006. These closures have also depressed job opportunities in Unst, and incomes in Unst and the North Isles tend to be lower than in other parts of the Shetland Islands. When compounded with higher living costs, this results in the area around the Proposed Project being one of the least affluent areas in the Shetland Islands.

4.11.3 Within the context of the wider SaxaVord Spaceport, the Proposed Project represents a transformational and much needed economic development opportunity for Unst and for the Shetland Isles and will generate significant beneficial local effects through:

- employment associated with operation of the Proposed Project;
- demand for goods and services to support the operation of the Proposed Project;
- hosting temporary workers and staff from the Applicant who will then utilise local shops, hospitality and other amenities; and,
- attracting tourists who will visit to watch launches and/or explore the SaxaVord Spaceport (including outside the current summer tourism season).

4.11.4 The predicted economic effects are considered to be major beneficial (**significant**) locally.

4.11.5 Full operation of the Proposed Project will see a maximum of 16 launches of the Skyrora XL Launch Vehicle per year. During operation, beneficial economic impacts are expected to arise from three main sources:

- employment associated with operation of the Proposed Project;
- accommodation for temporary workers during launches; and,
- space tourism activity.

4.11.6 It is estimated that employment associated with this level of activity will generate:

- £1.8 million GVA and support 37 jobs in Unst;
- £2.9 million GVA and support 64 jobs in The Shetland Islands; and,
- £3.4 million GVA and support 74 jobs across Scotland.

4.11.7 Spending on accommodation for temporary workers during launches is estimated to generate:

- £0.6 million GVA and support 29 jobs in Unst;
- £0.7 million GVA and support 32 jobs in The Shetland Islands; and,
- £0.8 million GVA and support 34 jobs across Scotland.

4.11.8 Spending by visitors coming to Unst for space tourism is estimated to generate:

- £0.2 million GVA and support 10 jobs in Unst;
- £0.4 million GVA and support 16 jobs in The Shetland Islands; and,
- £0.8 million GVA and support 29 jobs across Scotland.

4.11.9 Summing all these impacts together, it is estimated that the total impact from operation of the Proposed Project will be:

- £2.6 million GVA and 74 jobs in Unst;
- £4.0 million GVA and 112 jobs in The Shetland Islands; and,
- £5.0 million GVA and 136 jobs in Scotland.

4.11.10 The total effect from operation of the Proposed Project is therefore assessed as being:

- major beneficial (**significant**) for Unst;
- minor beneficial for The Shetland Islands; and,
- negligible for Scotland.

4.11.11 In addition, the Proposed Project, as part of the wider SaxaVord Spaceport initiative, is also expected to result in a series of wider, less quantifiable, benefits for the economies of Unst, the Shetland Islands and Scotland including:

- Making Scotland more competitive in the small satellite space sector, by contributing to the development and success of the SaxaVord Spaceport.
- Diversifying the economic base of Unst and the Shetland Islands towards the space sector.
- Offering a wider range of employment opportunities and new career paths available to young people in Unst and in the Shetland Islands.
- Acting as a catalyst for further investment; and,
- Encouraging investment in the tourism sector, as launches extend the tourism season and provide additional visitors to Unst and to the Shetland Islands.

4.12 References

Department for Transport. (2021). *Guidance to the regulator on environmental objectives relating to the exercise of its functions under the Space Industry Act 2018*

Civil Aviation Authority et al. (2021). *Guidance for the Assessment of Environmental Effects*

European Commission. (2013). *A study on the economic effects of the current VAT rates structure.*

Highlands and Islands Enterprise. (2019). *Shetland Islands - Key Statistics.*

Homes & Communities Agency. (2014). *Additionality Guide, Fourth Edition 2014.*

Kantar. (2019). *The Great Britain Day Visitor 2018 Annual Report.*

London Economics. (2019). *Size & Health of the UK Space Industry 2018.*

McKee, I. (2020, October 24). *Scotland's space industry has incredible potential because of its unique selling point: tiny satellites and cleaner, greener rockets – Ivan McKee MSP*. Retrieved from The Scotsman: https://www.scotsman.com/news/opinion/columnists/scotlands-space-industry-has-incredible-potential-because-its-unique-selling-point-tiny-satellites-and-cleaner-greener-rockets-ivan-mckee-msp-3013036

Moffat Centre et al. (2020). *Scottish Accommodation Occupancy Survey 2019.* Moffat Centre and VisitScotland.

National Records of Scotland. (2020a). *Mid-2019 Population Estimates Scotland.*

National Records of Scotland. (2020b). *Population Projections for Scottish Areas (2018-based).*

Office for National Statistics. (2009). *UK Standard Industrial Classification of Economic Activities 2007.*

Office for National Statistics. (2019). *Family spending in the UK : April 2018 to March 2019.*

Office for National Statistics. (2019a). *Business Register and Employment Survey 2018.*

Office for National Statistics. (2020a). *Annual Population Survey 2019.*

Office for National Statistics. (2020b). *Annual Survey of Hours and earnings 2019.*

Scottish Government. (2016). *Draft Advice on Net Economic Benefit and planning.*

Scottish Government. (2019b). *Scottish Annual Business Statistics.*

Scottish Government. (2019c). *Supply, Use and Input-Output Tables, 1998-2016.*

Scottish Government. (2020a). *Scottish Index of Multiple Deprivation 2020.*

Scottish Government. (2020b). *Growth Sector Statistics.*

Scottish Government. (2021). *A fairer, greener Scotland – Programme for Government 2021-22.*

Scottish Government. (2022). *National Strategy for Economic Transformation.*

Scottish Tourism Alliance. (2012). *Tourism Scotland 2020.*

Scottish Tourism Alliance. (2020). *Scotland Outlook 2030, Responsible Tourism for a Sustainable Future.*

Shetland Islands Council. (2018a). *Economic Development Startegy 2018-2022.*

Shetland Islands Council. (2018b). *Shetland in Statistics 2017.*

Shetland Islands Council. (2020). *Shetland Islands Council Performance Explorer*. Retrieved from https://www.pentanarpm.uk/CovalentWebModule/Dashboard?c=412&i=5127626

Shetland Islands Council et al. (2018). *Shetland Islands Visitor Survey 2017.* Shetland Islands Council & Visit Scotland.

Shetland Islands Council et al. (2020). *Shetlands Islands Visitor Survey 2019.* Shetland Islands Council and Visit Scotland.

Shetland Tourism Association. (2018). *Shetland Tourism Strategy, 2018-2023.*

Space Growth Partnership. (2018). *Propserity from Space.*

Various. (2018). *Shetland's Partnership Plan 2018-28, Working together to improve the lives of everyone in Shetland.*

Visit Unst. (2020a). *About*. Retrieved from Visit Unst: http://www.visit-unst.com/about.html

Visit Unst. (2020b). *Getting to Unst*. Retrieved from Visit Unst: https://unst.org/web/location/location/

Chapter 5 Ornithology

5. Ornithology

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5. Ornithology

5.1 Introduction

5.1.1 This chapter considers the likely significant effects of the Proposed Project on birds, both on-site and in the surrounding ornithological study area. The assessment is based upon comprehensive baseline data, comprising specifically targeted ornithological surveys of potentially important and legally protected bird species identified during a desk study and consultation feedback. It draws on pre-existing information, where appropriate, from other studies, survey data sources and relevant Chartered Institute for Ecology and Environmental Management (CIEEM) and NatureScot (previously Scottish Natural Heritage, SNH) guidance. The scope of the ornithological assessment excludes potential impacts on habitats, flora and other fauna, which are considered separately in Chapter 6: Ecology.

5.1.2 Alba Ecology Limited led on all aspects of the ornithological fieldwork and assessment in association with the Proposed Project. Alba Ecology is a Scottish-based multi-disciplinary ecological consultancy that has worked in the north of Scotland, and Shetland specifically, for many years. Alba Ecology's staff have led on and contributed to all aspects of Ecological Impact Assessment (EcIA) on several large-scale development projects, including the management of Ecological Clerks of Work (ECoW) teams, principal ornithological/ecological surveyors and advisors on planning applications, expert witness advice at Public Local Inquiry and the production of Environmental Statements, Habitat Regulations Assessments and Habitat Management Plans.

5.1.3 The ornithological surveyors used between 2018 and 2020 were Mr David Cooper, Mr Brydon Thomason and Dr Peter Cosgrove. These surveyors have extensive ornithological field experience of Shetland and Unst specifically. Surveyors carried out bird surveys in a systematic and objective manner, following recognised standardised methods. Those surveyors working near breeding birds listed in Schedule 1 of the Wildlife and Countryside Act 1981 (and as amended) were covered by relevant SNH Schedule 1 Bird Licences.

5.1.4 This chapter is supported by ornithological drawings in Volume III and the following Appendices in Volume IV:

- Appendix 5.1: Shetland Space Centre Breeding Birds Survey Report, where further details of ornithological survey methodologies and data collected can be found.
- Appendix 5.2: Background literature review of noise impacts on birds for the Shetland Space Centre.
- Appendix 5.3 Habitat Management Plan.

5.1.5 Confidential bird species information, where information would have appeared in the relevant sections of this AEE Report chapter were it not for the fact that this information could endanger rare and legally protected species from wildlife crime, has been submitted to and assessed previously by the local planning authority, as part of the EIA process for the SaxaVord Spaceport facility. For confidentiality reasons, this information is not included in the AEE submission.

5.1.6 The assessment involved the following key stages:

- Reference to relevant legislation, policy and guidance.
- Identification of the likely environmental zone of influence of the Proposed Project.
- Identification of potentially important ornithological receptors likely to be affected (baseline conditions) by the Proposed Project.
- Evaluation of important ornithological receptors and features likely to be affected by the Proposed Project.

- Identification of likely impacts and magnitude of the Proposed Project on important ornithological receptors.
- Assessment of the likely significant effects of the Proposed Project, including any mitigation and enhancement measures and any residual significant effects.

5.1.7 The term '*receptor*' is used throughout the AEE process and is defined as the element in the environment affected by a development (e.g., a bird in the case of ornithology). The term '*impact*' is also used commonly throughout the AEE process and is defined as a change experienced by a receptor (this can be beneficial, neutral or adverse). The term '*effect*' is defined as the consequences for the receptor of an impact.

5.2 Legislation, Policy and Guidelines

Legislation

Space Industry Act

5.2.1 The Space Industry Act (2018) regulates all spaceflight activities carried out in the United Kingdom, and associated activities. The Act requires any person or organisation to obtain the relevant licence to:

- launch a launch vehicle from the UK;
- return a launch vehicle launched elsewhere than the UK to the UK landmass or the UK's territorial waters;
- operate a satellite from the UK;
- conduct sub-orbital activities from the UK;
- operate a spaceport in the UK; or
- provide range control services from the UK.

5.2.2 As the Applicant wishes to become a spaceflight operator and launch Skyrora XL Launch Vehicles from the UK, they are required to apply for a launch operator licence, and as part of this application, submit an AEE of the proposed project.

Space Industry Regulations 2021

5.2.3 The Space Industry Regulations 2021 (the Regulations) set out in more detail the requirements for each licence and the Regulators Licensing rules, which specify what information the UK Civil Aviation Authority (CAA) – the regulator - requires in support of an application.

Policy Context

5.2.4 Further relevant legislation and best practice guidance documents have been reviewed and taken into account as part of this ornithological assessment. The approach used to assess the significance of likely effects of the Proposed Project upon ornithological receptors is set in the context of:

- The Wildlife and Countryside Act 1981 (as amended);
- European Commission (EC) (2011) European Biodiversity Strategy;
- EC Directive 2009/147/EC on the conservation of wild birds (codified version). The so-called 'Birds Directive';
- EC Directive 1992/43/EEC on the conservation of natural habitats and of wild fauna and flora. The so-called 'Habitats Directive';
- The Conservation (Natural Habitats) Regulations 1994. The so-called 'Habitats Regulations';
- The Conservation of Habitats and Species Regulations 2010;

- The Nature Conservation (Scotland) Act 2004 (as amended);
- Scottish Government PAN 1/2013;
- Scottish Government Planning Circular 1 2017: The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017;
- Guidelines for Ecological Impact Assessment in the UK and Ireland (CIEEM, 2016; 2018; 2019 as amended);
- Regional Population Estimates of Selected Scottish Breeding Birds (SNH, now NatureScot);
- Natural Heritage Zones Bird Population Estimates. SWBSG (Scottish Windfarm Bird Steering Group) Commissioned Report: 150413;
- Scottish Government. The Scottish Biodiversity List (SBL);
- Scottish Government 2020. The Environment Strategy for Scotland: vision and outcomes;
- Biodiversity Net Gain: Good practice principles for development: A practical guide. (CIRIA, CIEEM and IEMA 2019);
- Biodiversity Net Gain in Scotland, CIEEM Scotland Policy Group, 2019;
- Strategic Plan for Biodiversity 2011-2020. Convention on Biological Diversity;
- 'Living Shetland' – the Shetland Local Biodiversity Action Plan (LBAP);
- The Shetland Local Development Plan (2014); and
- The Shetland Local Development Plan – Natural Heritage Supplementary Guidance (2012).

5.2.5 There is no Scottish or UK specific ornithological guidance on satellite launch operations.

5.2.6 Scottish Planning Policy (Scottish Government, 2014) sets out the Scottish Government's national planning policies for the protection of biodiversity through the planning system. This seeks to ensure that projects provide biodiversity benefits where possible, not simply to avoid significant adverse effects. These policies are incorporated into development plans and are a material consideration in the determination of development proposals.

5.2.7 The UK Biodiversity Action Plan (BAP) was the UK Government's 2004 response to the Convention on Biological Diversity, to which the UK was a signatory. Action plans for the most threatened species and habitats (called 'UK BAP species and habitats') were set out to aid recovery. Following the publication of the Convention on Biological Diversity's 'Strategic Plan for Biodiversity 2011–2020' (Convention on Biological Diversity, 2010), its commitment to 20 'Aichi targets', agreed at Nagoya Japan in October 2010, and the launch of the European Biodiversity Strategy in May 2011, the UK Government has changed its strategic thinking.

5.2.8 The Scottish Biodiversity List (SBL) is a list of animals, plants and habitats that Scottish Ministers consider to be of principal importance for biodiversity conservation in Scotland, under the Nature Conservation (Scotland) Act 2004. The SBL therefore supersedes the UK BAP list of species and habitats. Nevertheless, since most existing planning policy and guidance requires consideration of, and makes explicit reference to, UK BAP species and habitats, these are still referred to where necessary.

5.2.9 The Shetland Local Development Plan (2014) contains policies and objectives to conserve and enhance the habitats and species that contribute to the unique character and heritage of Shetland. It has links to Supplementary Guidance on Local Nature Conservation Sites in Shetland and Supplementary Guidance on Natural Heritage. This guidance is provided to aid planning applicants and their agents when considering development in relation to their biodiversity responsibilities.

5.2.10 It is recognised that the term '*Favourable Conservation Status*' (FCS) as articulated within the EC Habitats Directive is not used in the EC Birds Directive, but SNH (now NatureScot) advises on its use and context in relation to consideration of birds. Conservation status is considered favourable where:

- Population dynamics indicate that the species is maintaining itself on a long-term basis as a viable component of its habitat.
- The natural range of the species is not being reduced, nor is it likely to be reduced in the foreseeable future.
- There is (and will continue to be) a sufficiently large habitat area to maintain its populations on a long-term basis.

5.2.11 Whilst considering a range of potential outcomes that could arise from the Proposed Project, the assessment reports the effects that are considered likely to be significant on the basis of evidence, standard guidance and professional judgement. It is these *likely significant effects* that the applicant is obliged to report, and that the decision maker is obliged to consider.

Relevant Guidance

Guidance for the Assessment of Environmental Effects

5.2.12 The CAA, with the UK Space Agency, the Department for Business, Energy and Industrial Strategy and the Department for Transport, issued guidance note '*CAP 2215 Guidance for the Assessment of Environmental Effects*' in July 2021. The guidance sets out what is required by the regulator regarding assessment of environmental effects as part of a licence application under the Act.

5.2.13 The AEE Guidance requires that potential direct and indirect significant effects of proposed spaceflight activities on environmental features, including noise and vibration, are considered. The guidance further requires that:

- Specific potential effects are identified and, where possible, quantified;
- The focus of the AEE should be on significant effects arising from the proposed activities;
- Applicants set an environmental budget, comprising a maximum number of launches per launch vehicle type which can take place over the course of a year that can be carried out in an environmentally sustainable manner, taking into account the cumulative effect of all launches; and
- The AEE must address a range of environmental topics, including ecology and biodiversity.

Guidance to the regulator on environmental objectives relating to the exercise of its functions under the Space Industry Act 2018

5.2.14 The Department for Transport issued its document '*Guidance to the regulator on environmental objectives relating to the exercise of its function under the Space Industry Act 2018*' in 2021, clarifying the government's environmental objectives relating to spaceflight and associated activities in the UK:

The environmental objective for spaceflight are to:

- *Minimise emissions contributing to climate change resulting from spaceflight activities*
- *Protect human health and the environment from the impacts of emissions on local air quality arising from spaceflight activities*
- *Protect people and wildlife from the impacts of noise from spaceflight activities*
- *Protect the marine environment from the impact of spaceflight activities.*

5.2.15 The objectives presented in the guidance are noted to be consistent with the environmental topics that must be addressed in an AEE.

5.3 Consultation

5.3.1 Extensive statutory consultation on ornithological matters was carried out during preparation and determination of the planning application for the SaxaVord Spaceport, from where the Proposed Project will operate. Where directly relevant to this AEE, consultation responses received during the SaxaVord Spaceport planning application period have been summarised in Table 5.1.

Table 5.1 SaxaVord Spaceport Consultation Responses directly relevant to this AEE

Consultee	Summary ornithology response	Where and how addressed
SNH - Jonathan Swale 16/02/18	Following an approach on 06/02/20 by Alan Farningham of Farningham Planning Ltd into the scope and scale of ornithological surveys, Jonathan Swale of SNH responded on 16/02/18 as follows: "*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 whimbrel 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 final planning Application Boundary, therefore is not reported on. SNH also 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.	The nature and scale of the ornithological study area (environmental zone of influence) is discussed within this chapter and also Appendix 5.1. Breeding bird survey data collected by Alba Ecology is presented in Volume IV Appendix 5.1. Consideration of potential noise impacts on birds is presented in Volume IV Appendix 5.2. Consideration of sensitive Schedule 1 species breeding information has been submitted to and assessed previously by the local planning authority, as part of the EIA process and is therefore not included in this AEE for reasons of confidentiality.
SNH - Glenn Tyler 24/05/20	Agreement on the proposed seabird (boat-based) survey methods and personnel was sought 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	Seabird survey data collected by Alba Ecology is presented in Appendix 5.1.

Consultee	Summary ornithology response	Where and how addressed
	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.	
SNH – 28/05/20	Alba Ecology provided SNH with a draft version of Appendix 5.1.	Provided as part of a verbal agreement to share information/data ahead of the planning application submission.
SNH – 29/05/20 and 02/06/20	During data sharing with SNH it became apparent that SNH's existing bird data for the SPA (Special Protection Area) did not exist for the whole of the 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 was the only section SNH monitors. Consequently, a gap in nesting seabird data for the area between Virdik and Ura was identified. On 02/06/20 SNH provided what up-to- date breeding bird data they had for the relevant designated sites.	Boat-based seabird surveys were conducted for the relevant 'gap' 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.
SNH – 18/08/20	Alba Ecology provided SNH with a brief update on the 2020 survey results and a draft of Appendix 5.2.	Information provided as part of a verbal agreement to share information/data ahead of the planning application submission.
Royal Society for the Protection of Birds (RSPB) – 28/05/20	Alba Ecology provided RSPB with a draft version of Appendix 5.1.	Provided as part of a verbal agreement to share information/data ahead of the planning application submission.
RSPB – 18/08/20	Alba Ecology provided RSPB with a brief update on the 2020 surveys and a draft of Appendix 5.2.	Information provided as part of a verbal agreement to share information/data.

5.3.2 Following consultation with NatureScot subsequent to submission of the planning application SaxaVord Spaceport, it has been confirmed by planning condition that no satellite launches, or static tests will be carried out by SaxaVord Spaceport between mid-May and the end of June in order to avoid disturbance to breeding birds during the critical incubation and early brooding period. The Applicant is aware of this operational constraint and will not schedule launches within the defined mid-May to end of June window.

5.3.3 The following potential impacts have been assessed in full in relation to the operation of the Proposed Project:

- Loss of foraging or breeding habitat due to displacement or avoidance.
- Death or injury of birds (including eggs and dependent young) through noise impacts associated with launches.

5.3.4 Collision risk with birds striking the Skyrora XL Launch Vehicle during take-off is not considered likely. Given the noise generated at launch, it is not considered likely that many birds would remain in the vicinity of the launch pads. At some satellite launch facilities, very occasional bird strikes have occurred e.g., vultures at the Kennedy Space Centre in Florida (Appendix 5.2) which do not occur on Unst.

5.4 Assessment Methodology and Significance Criteria

Consultation

5.4.1 In accordance with CIEEM best practice guidance, consultation was undertaken throughout the planning process for SaxaVord Spaceport. As the Proposed Project environmental budget makes up approximately 50 % of that of the wider Spaceport; it was not considered necessary to undertake further consultation for this AEE.

Environmental Zone of Influence and Study Area

5.4.2 For the purposes of this AEE, the Environmental Zone of Influence (EZI) is based on and comprises the proposed launch flight corridor and all study areas required for the technical disciplines included in the AEE, as presented on drawing 3.6.

5.4.3 Within the EZI, the study area(s) required for each technical discipline assessed vary and as such the rationale for the ornithological study area has been included in this chapter. The ornithological study area is shown in the context of the AEE on Drawing 2.1 and reproduced with greater detail on Drawing 5.1.

Proposed Project

5.4.4 The main elements of the Proposed Project which have the potential to impact on ornithological receptors during operation are described in Chapter 3 and include:

- Preparation of Skyrora XL Launch Vehicle;
- Storage and Handling of Launch Vehicle Propellant;
- Operation of Ground Segment and Mobile Launch Complex; and
- Launch of Skyrora XL Launch Vehicle.

5.4.5 The Proposed Project comprises the preparation and launch of the limiting case Skyrora XL launch vehicle from any of three terrestrial vertical launch pads at the SaxaVord Spaceport situated at Lamba Ness on Unst, Shetland.

5.4.6 The Skyrora XL launch vehicle is approximately 24 m long, three-stage liquid fuelled orbital launch vehicle intended to place customer payloads into sun synchronous or polar orbits. Launches will take place in a northerly direction over the sea.

5.4.7 The Applicant is applying for a maximum environmental budget of 16 launches per year which, from 2029 when maximum launch cadence is reached, will make up just over one half of SaxaVord Spaceport's own environmental budget of 30 launches per year.

5.4.8 Assessing the potential effects of disturbance on bird species is a complex issue which will vary 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 ornithological study area over which potentially affected breeding bird species should be surveyed is challenging. Consequently, this was considered in a number of different ways, which are outlined below.

5.4.9 In Scotland, all wild birds are legally protected, but some species are considered more sensitive to human related 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, predation and starvation of chicks and ultimately the abandonment of a breeding territory. Therefore, the distance over which disturbance might potentially occur was considered particularly important when determining the ornithological study area.

5.4.10 Limited work has taken place on the impact of disturbance on most of the bird species potentially present within habitats on Unst. However, for two of the important species which breed on Unst, some guidance has been published on the distances at which they are likely to be affected by human-related disturbance. In Ruddock and Whitfield (2007), 80 % of experts canvased estimated static disturbance occurred at 500 m to 750 m for nesting and chick-rearing red-throated divers (*Gavia stellata*) and expert opinion suggested 'safe working distances' could exceed 500 m. 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 (e.g., up to 500 m). Evidence from Viking Wind Farm studies in Shetland indicated that some individual red-throated divers (perhaps habituated) appear to tolerate moderate levels of disturbance in some situations. The size of waterbodies also has an impact; breeding divers 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 and dive underwater without taking flight.

5.4.11 Similarly, breeding merlins (*Falco columbarius*) are considered sensitive to human activity, visual disturbance and sudden noise events over large distances (e.g., 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 merlin pairs 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 (mostly predictable) disturbance occurs.

5.4.12 Based on Ruddock and Whitfield (2007), there is some limited evidence and expert opinion that sudden noise events up to 500 m to 750 m away from the two potentially affected bird species could be detrimental. Based on this, it might have been possible to recommend a one-kilometre survey buffer around the launch pads. However, none of the potentially affected target species had been monitored in relation to short-duration loud noise events of the magnitude of a launch. Furthermore, at the time of Pre-application consultation with SNH (2018) and determination of the ornithological study area, there was no information on predicted noise levels available. Consequently, this nominal one-kilometre survey buffer was not considered an adequate basis on which to determine the size of the ornithological study area.

5.4.13 During initial survey planning, there was only an indicative boundary area for the SaxaVord Spaceport. As a result, an arbitrary, but very large precautionary initial study area, was selected for breeding bird surveys, based on bird species likely to be present from existing data sources e.g., Pennington *et al*. 2004 and the habitats present. 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 km - 2 km (for breeding golden eagle – which does not occur on Unst), and this was even considered by Ruddock and Whitfield to be overly precautious. Nevertheless, 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 Project, was a legitimate precautionary basis on which to proceed with breeding bird surveys to cover the potential zone of influence. Consequently, the size of the breeding bird study area (Drawing 5.1) was much larger than the final site boundary of the SaxaVord Spaceport, and much larger than that of the Proposed Project boundary as shown in Drawing 3.1.

Desk Study

5.4.14 An initial desk study was conducted in 2018 using the SNH's SiteLink website and Shetland Biological Records Centre data held for the study area. This was supplemented by existing knowledge of the breeding birds of Unst and consultation with SNH on the nature and scope of bird surveys. Given the time gap between 2018 and the current planning submission, the exercise was undertaken again from the same data providers, alongside up to date information from the National Biodiversity Network (NBN); a collaborative UK partnership created to exchange biodiversity information. This information was compiled into a report and is presented in Volume IV Technical Appendix 5.1.

5.4.15 The desk study identified several Annex 1, Schedule 1, UK BAP and SBL species previously recorded within the study area. Based on the results of the desk study, initial site-walkover, size/quality/importance of habitats present, EIA Scoping comments and feedback from the regulators, legal protection, the site and the exercise of professional judgement, the following potentially important ornithological receptors have been identified for further consideration:

- Nearby designated site species.
- Breeding red-throated diver.
- Breeding raptors, in particular merlin.
- Breeding waders, in particular whimbrel (*Numenius phaeopus*), curlew (*Numenius arquata*), ringed plover (*Charadrius hiaticula*), golden plover (*Pluvialis apricaria*) and dunlin (*Calidris alpina*).
- Breeding terns and skuas, in particular Arctic tern (*Sterna paradisaea*) and Arctic skua (*Stercorarius parasiticus*).
- Cliff nesting seabirds, in particular black guillemot (*Cepphus grylle*), common guillemot (*Uria aalge*), razorbill (*Alca torda*), puffin (*Fratercula arctica*), shag (*Phalacrocorax aristotelis*), fulmar (*Fulmarus glacialis*) and gulls.
- Potentially rare species, including confidential breeding Schedule 1 species.

5.4.16 There was no evidence from the desk study of the study area being especially important for non-breeding birds and SNH did not request non-breeding bird surveys. Consequently, surveys focussed on breeding birds.

Site Visit

5.4.17 A reconnaissance site visit by Dr Peter Cosgrove in late autumn 2017 determined that the Proposed Project area was predominantly open coastal/upland habitat characterised by peatland, grassland and sea cliffs. The principal land use was sheep grazing through crofting and common grazing. There was potential for several specially protected bird species to be present, so breeding bird surveys were conducted under a SNH Schedule 1 licence.

Breeding Bird Surveys

5.4.18 Breeding bird surveys were undertaken monthly between April and July 2018 and 2019 within the ornithological study area. In 2020, additional Schedule 1 surveys were undertaken within the Proposed Project site boundary, to inform other surveyors working there of the potential avian sensitivities present through the production of an up-to-date Breeding Birds Protection Plan (BBPP) and associated on-site Ecological Clerk of Works (ECoW) support. Repeat breeding bird surveys (moorland, raptor, diver, black guillemot and cliff nesting seabirds) are currently being conducted at the time of writing.

Moorland Breeding Bird Surveys

5.4.19 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 main habitat was open moorland/grassland and 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. Further details are provided in Appendix 5.1.

5.4.20 Population estimates of terrestrial 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 500 m 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 survey visits is used to identify a notional territory centre (the species 'dot' on the relevant drawing) where a nest was not discovered. Surveys were undertaken in 2018 and 2019 as per agreement with SNH across the study area and additionally in 2020 for Schedule 1 species within the SaxaVord Spaceport boundary.

Breeding Raptor Surveys

5.4.21 SNH provides clear guidance in relation to raptor sensitivities and survey effort (2005; and subsequent updates). Breeding raptor surveys were undertaken to determine the location of any breeding merlins within the study area using standardised merlin survey methods (e.g., 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 across the study area and additionally in 2020 for Schedule 1 species within the SaxaVord Spaceport boundary. Further details are provided in Appendix 5.1.

Breeding Red-throated Diver Surveys

5.4.22 Following SNH standard 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 across the study area and additionally in 2020 within the SaxaVord Spaceport boundary Further details are provided in Appendix 5.1.

Black Guillemot

5.4.23 Counts of individual adult black guillemots provide the most accurate survey method for this species (Gilbert *et al.*, 1998). Two survey visits, a week or more apart during the first three weeks of April were undertaken. The surveys were conducted from first light until particular defined potential black guillemot cliff reaches were surveyed, during suitable, calm and clear weather conditions (as per Gilbert *et al.*, 1998). 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. Surveys were undertaken in 2018 and 2019 as per agreement with SNH across the study area.

Cliff Nesting Seabirds

5.4.24 The standard method for surveying cliff nesting seabirds requires the number of individual adult birds per visit recorded or Apparently Occupied Nests (AON), which can either be summed and a mean produced over different survey visits undertaken or simply use the highest count to provide a maximum population estimate. The standard survey guidance recommends between two and 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 (south-east of Hill of Clibberswick), as per agreement with SNH. No climbing down cliffs to count breeding seabirds was undertaken.

5.4.25 The razorbill, common guillemot and shag standard survey methods recommend surveys in the first three weeks of June in the north of Scotland in 'normal years' (June or July for gannets (*Morus bassanus*), June for fulmar, early-mid June for kittiwake (*Rissa tridactyla*). Consequently, boat-based surveys were scheduled for and undertaken during the first three weeks of June given the main species likely to be present on the cliffs (and where possible due to weather constraints, 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).

5.4.26 Puffins are difficult to census due to their use of burrows, often in inaccessible locations. The most reliable way in which 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 much of the terrain (Mitchell *et al.,* 2004). 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 mostly taken place at the same time as the optimal count for other cliff nesting seabirds in June, when it is known that nonbreeding puffins also attend colonies and so can inflate numbers of presumed breeders present. This is a recognised limitation of the survey method in Shetland and needs to be recognised when comparing puffin data from other/previous surveys.

5.4.27 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; Table 5.1). Surveys were undertaken in 2018 as per agreement with SNH. Further details are provided in Appendix 5.1.

5.4.28 During data sharing with SNH in 2020 it became apparent that existing bird data for the SPA did not exist for the whole of the 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 (socially distanced) outdoor work. The same experienced surveyors who undertook the 2018 boat-based seabird surveys conducted the 2020 boat-based seabird surveys between Virdik and Ura, providing consistency of experienced observers.

Assessment of Potential Effect Significance

5.4.29 This section defines the criteria used to evaluate the likely significance of predicted effects on important ornithological receptors due to the Proposed Project. A level of confidence (whether the predicted effect is certain, likely, possible or unlikely) is attached to the predicted effect.

Evaluating Conservation Importance

5.4.30 The ornithological receptors identified in the baseline studies have been evaluated following best practice guidelines (e.g., CIEEM, 2018). Identifying the importance of potential ornithological receptors was the first step of the process, and those considered potentially important and present were then subject to detailed survey and assessment. Those considered sufficiently widespread, unthreatened and resilient to the project impacts have been scoped out of further assessment as per best practice EcIA guidance (e.g., CIEEM, 2018).

5.4.31 Ornithological receptors can be important for a variety of reasons and the rationale used to define their importance has been explained to demonstrate a robust selection and evaluation process. Importance may relate, for example, to a designated site, to species rarity, to the extent to which they are threatened throughout their range, or to their rate of decline. Various characteristics contribute to the potential importance of ornithological receptors within a study area. Examples include:

- Naturalness of a bird population.
- Species, sub-species or varieties that are rare or uncommon, either internationally, nationally or more locally, including those that may be seasonally transient.
- Ecosystems and their component parts, which provide the habitats required by important bird species, populations and/or assemblages.
- Endemic bird species or locally distinct sub-populations of a species.
- Size of a bird population.
- Bird species in decline.

- Large populations of bird species or concentrations of species considered uncommon or threatened in a wider context.
- Bird species on the edge of their range, particularly where their distribution is changing as a result of global trends and climate change.

5.4.32 Guidance on EcIA sets out categories of ornithological or nature conservation importance that relate to a geographical framework (e.g., international through to local) together with criteria and examples of how to place a site or study area (defined by its ornithological attributes) into these categories. It is generally straightforward to evaluate sites or species populations designated for their international or national importance (as criteria for defining these exist e.g., SPA and SSSI), but for sites or populations of regional or local importance, criteria may not be easily defined.

5.4.33 According to CIEEM EcIA guidance (2018) the importance of an ecological feature should be considered within a defined geographical context, and these should be adapted to suit local circumstances, as outlined in Table 5.2.

Table 5.2 Summary of Geographic Population Importance Criteria Used

Term	Use
International	For example, >1 % of European Community (EC) population, internationally designed site feature.
National	For example, >1 % of United Kingdom (UK) or Scottish population, nationally designated site feature.
Regional	For example, >1 % of the relevant Natural Heritage Zone (NHZ) population, regionally designed site feature.
Local	For example, within local area (<1 % of relevant NHZ population), local wildlife sites.

5.4.34 There is no fundamental biological reason to take 1 % of a population as the threshold level for establishing the level of geographic importance of a site. Nevertheless, this percentage is widely considered to be of value in developing measures that give an appropriate level of protection to populations and has gained acceptance on this basis throughout the world. The criterion was, for example, adopted by parties involved in the Ramsar Convention 1971. Thereafter, the 1 % level of national species totals has been taken as the basis of assessment in various countries, including Britain (Stroud *et al*. 1990).

5.4.35 For breeding bird species, SNH/NatureScot uses the NHZ (Natural Heritage Zone) as the appropriate regional biogeographical unit of assessment. Twenty-one zones covering Scotland have been drawn to reflect biogeographical differences between zones, with a high level of coherence within each zone. According to SNH guidance "*the question as to whether there is an impact on a [bird] species regionally therefore may be translated into the question as to whether there is an impact within the relevant NHZ*". The Proposed Project is wholly within the Shetland NHZ and so this biogeographical unit is used for the regional population assessment.

5.4.36 The Scottish Wind Farm Bird Steering Group published a systematic review of NHZ bird populations across Scotland, including Shetland (Wilson *et al*., 2015), which is helpful in the context of determining regional bird population estimates. The Viking Wind Farm Environmental Statement also examined existing data sources and estimated relevant Shetland bird populations (Viking Energy Partnership, 2009), and provides useful additional information on Shetland priority bird population estimates. The regional population metrics reported in this chapter are mostly derived from the Scottish Wind Farm Bird Steering Group report and those used in the Viking Wind Farm ES and have been updated where more up to date population data/information was available.

5.4.37 The importance attached to an ecological receptor can also be determined according to legislative status. Some ecological receptors are subject to a general level of legal protection through e.g., the Wildlife and Countryside Act 1981 (as amended), or The Nature Conservation (Scotland) Act 2004 (as amended) and others under the Birds Directive. There is no clear guidance for conservation importance of ecological receptors other than those of European Protected Species and designated sites. The importance of other species and habitats is based on professional judgement using the characteristics outlined above. The status of potentially important receptors, such as being on the SBL, is also taken into consideration.

5.4.38 Nevertheless, and for the avoidance of doubt, CIEEM EcIA guidance (2018) makes it clear that species which appear on national lists e.g., Schedule 1 of the Wildlife and Countryside Act (1981 as amended) and SBL are not necessarily evaluated as of national importance simply by appearing on such a 'national' list. Importance evaluation must consider the number of individuals of species or area of habitat within a geographical context/scale, i.e., how many of a particular species are likely to be affected by the Proposed Project and what proportion of the local/regional/national population does this constitute. Legal listing/protection is a separate but important consideration.

Extent

5.4.39 According to CIEEM (2018) EcIA guidance, extent is the spatial or geographical area over which the predicted impact/effect may occur under a suitably representative range of conditions.

Magnitude

5.4.40 According to CIEEM (2018) EcIA guidance, magnitude refers to size, amount, intensity and volume. It should be quantified if possible and expressed in absolute or relative terms e.g., the amount of habitat lost, number of pairs lost, percentage decline in a species population. For consistency across all the topics within the AEE, magnitude terms are required and are clearly defined (Table 5.3), along with metrics in absolute and relative terms. There are a number of approaches for determining the significance of effects on ecological features. This includes methods for scoring and ranking impacts on the basis of subjective criteria. Results are often presented in the form of a matrix in which ecological value/importance and magnitude of impact are combined into a significance score. A matrix approach is commonly used in EIA by disciplines other than ecology to assign significant residual effects to categories (e.g., major, moderate, minor). CIEEM (2018) guidance discourages use of the matrix approach and artificial significance scores. Spurious assessment should be avoided in which artificial numerical scores, or significance rankings/categories are used without a clear definition of the criteria and thresholds that underpin them. In this chapter the approach used for assessing significance is outlined in paragraphs 5.4.44-5.4.46.

Table 5.3 Summary of Magnitude Criteria Used

Term	Definition
Major	Total/near total loss of a population due to mortality or displacement. Total/near total loss of breeding productivity in a population due to disturbance. e.g., ≥50 % of population affected.
Moderate	Moderate reduction in the status or productivity of a population due to mortality or displacement or disturbance. e.g., 10-49 % of population affected.
Minor	Small but discernible reduction in the status or productivity of a population due to mortality or displacement or disturbance. e.g., 1-9 % of population affected.
Negligible	Very slight reduction in the status or productivity of a population due to mortality or displacement or disturbance. Reduction barely discernible, approximating to the 'no change' situation. e.g., <1 % population affected.

Duration

5.4.41 According to CIEEM (2018) EcIA guidance, duration should be defined in relation to ornithological characteristics (such as the life cycle of a species). The duration of an activity may differ from the duration of the resulting effect caused by the activity. Impacts and effects may be described as short, medium or long-term and permanent or temporary and should be defined. In this assessment three timeframes are used: short-term (up to two years), medium-term (two-five years) and long-term (between five years and the lifetime of the Proposed Project).

Frequency and Timing

5.4.42 According to CIEEM (2018) EcIA guidance, the number of times an activity occurs will influence the resulting effect. For example, a single person walking a dog will likely have very limited impact on nearby wader utilisation of a wetland, but numerous dog walkers will subject the waders to frequent disturbance and could affect feeding success, leading to displacement of the birds and knock-on effects on their ability to survive. The timing of an activity may result in an impact if it coincides with critical life-stages or seasons e.g., bird nesting season.

Reversibility

5.4.43 According to CIEEM (2018) EcIA guidance, an irreversible effect is one from which recovery is not possible within a reasonable timescale or there is no reasonable chance of action being taken to reverse it. A reversible effect is one from which spontaneous recovery is possible or which may be counteracted by mitigation. In some cases, the same activity can cause both reversible and irreversible effects.

Sensitivity

5.4.44 Another factor when assessing potential impacts is the sensitivity of the ornithological receptor under consideration (e.g., high, medium or low), which can vary in space and time. Different receptors respond differently to stimuli, making some particularly sensitive to development activities and others less so. Professional judgement is used when assigning a sensitivity value to an ornithological receptor and this is recorded in a clear and transparent way.

5.4.45 By way of example, sensitivity is determined according to species behaviour, using broad criteria set out in Table 5.4. Behavioural sensitivity can differ between species and between individuals of the same species. Therefore, sensitivity is likely to vary with both the nature and context of the disturbance activity as well as the experience and even personality of the individual bird. Sensitivity also depends on the activity the species is undertaking. For example, a species is likely to be less tolerant of disturbance close to its nest during the breeding season than at other times of year. Furthermore, breeding birds are widely considered to be more likely to abandon eggs rather than dependent young, which they may have developed familial ties to. Thus, sensitivity changes with both space and time.

Table 5.4 Summary of Sensitivity Criteria Used

Term	Definition
High	Species occupying remote areas away from human activities and exhibiting strong and long-lasting reactions to disturbance events.
Medium	Species that appear to be warily tolerant of human activities and exhibiting short-term reactions to disturbance events.
Low	Species occupying areas subject to frequent human activity and exhibiting mild and brief reaction to disturbance events.

Ecosystem Services

5.4.46 Ecosystem services are the benefits that people derive from the natural environment. The natural environment can be considered a stock of 'natural capital' from which many benefits flow e.g., social, health-related, cultural or economic (CIEEM, 2018).

Criteria for Evaluating Significance

5.4.47 Significance is a concept related to the weight that should be attached to predicted effects when decisions are made. A '*significant effect*' is an effect that either supports or undermines biodiversity conservation objectives for important receptors (CIEEM, 2018). There could be any number of possible impacts on important ornithological features arising from a development. However, it is only necessary to describe in detail the impacts that are considered likely to be significant. Impacts that are either unlikely to occur, or if they did occur are unlikely to be significant, can be scoped out.

5.4.48 In this assessment, a significant effect is defined as "*an impact on the integrity of a defined site or ecosystem and/or the conservation status of habitats or species within a defined geographical area*". Thus, the geographical terms of reference at which a predicted effect may be considered significant must also be defined (e.g., an effect on a species population evaluated to be of regional importance at a given site is likely to be either significant or not at the regional level). Effects can be considered significant at a wide range of scales from international to local.

5.4.49 There is sometimes confusion over geographical context, potentially important receptors and quantifying predicted effects and EcIA best practice guidance has struggled to articulate this clearly. For example, if a potentially important species appears on a conservation list e.g., the SBL and there is a predicted impact, the geographical context in which the receptor is found must be considered (CIEEM, 2018). Therefore, the simple presence of a species on the SBL within an area does not mean that likely effects are significant at the national (Scottish) level. For that to occur a Proposed Project must have likely significant effects on its national (Scottish) population.

Requirements for Mitigation

5.4.50 Best practice guidance e.g., CIEEM (2018) identifies a hierarchy of mitigation for potential impacts that seeks to:

- Avoid and prevent adverse ecological impacts, especially those that would likely be significant to important receptors.
- Minimise and reduce adverse impacts that cannot be avoided.
- Compensate and offset for any remaining likely significant residual impacts.

5.4.51 CIEEM EcIA guidance (2018) states that "*Avoiding and/or minimising negative impacts is best achieved through consideration of potential impacts of a project from the earliest stages of scheme design and throughout its development*". This approach to avoiding potential adverse impacts within a design layout is sometimes described as embedded mitigation or mitigation by design. "*Mitigation by design is particularly beneficial as there is greater certainty that it will be delivered*" (CIEEM 2018).

5.4.52 This AEE Report chapter considers mitigation in the context of CIEEM guidance and also in relation to local planning authority guidance for protected species. The embedded mitigation is considered in the design layout and because of this, it is guaranteed through planning conditions for the Proposed Project. Where likely significant effects are predicted regardless of design layout, further mitigation is separately identified as per CIEEM best practice guidance.

Assessment of Residual Effect Significance

5.4.53 After assessing the potential impacts of the Proposed Project (incorporating embedded mitigation), all feasible attempts have been made to further avoid and mitigate predicted adverse ornithological impacts. Once measures to avoid and mitigate predicted ornithological impacts had been incorporated, assessment of the residual impacts was undertaken to determine the likely significance of their effects on important ornithological features.

Limitations to Assessment

5.4.54 Where assumptions within the assessment are made, these are explicitly identified and explained. Similarly, limitations in methods and knowledge of species' ecology are also identified and discussed, particularly where this is likely to affect the outcome of the assessment. As with any environmental assessment there will be elements of uncertainty. Where there is uncertainty, this is identified and reported transparently, along, where possible, with the measures taken to reduce it, assumptions made, and an explanation as to the likely extent that any uncertainties are likely to affect the assessment conclusions. In circumstances where there is uncertainty; evidence, expert opinion, best practice guidance and professional judgement have been used to evaluate what is considered biologically likely to occur if the Proposed Project is operational.

5.4.55 The level of certainty of impact prediction varies depending upon a range of parameters discussed already. For some elements e.g., land-take it is relatively straightforward to assess and quantify the area of habitat that is likely to be lost to development infrastructure and therefore quantify potential impacts of land-take on the habitats and species present. The main limitations in this assessment are common to most ornithological assessments because:

- Baseline surveys undertaken are based on sampling techniques, not absolute censuses. Results give an indication of the numbers of ornithological receptors recorded at the particular times that surveys were carried out (e.g., 2018, 2019 and 2020 for breeding bird surveys). Species occurrence changes over time and therefore the results presented in this AEE Report are snapshots in time. 2022 breeding bird surveys are currently being conducted to provide an update.
- Putting ornithological survey results into a wider geographical context is sometimes challenging because some species have not been systematically surveyed beyond the study area. Thus, defining a receptor population as locally or regionally important is potentially difficult because local or regional population estimates do not exist for many taxa. Whenever such uncertainty exists, professional judgement and published evidence is used and populations in the study area or site have been assumed to be at their highest potential level of geographical/ornithological importance.

5.5 Baseline Conditions

Designated Sites

5.5.1 The 2020 desk study identified three designated sites (which overlap) where birds were a qualifying feature within the 4 km ornithological study area on Unst (Drawing 5.2). These are:

Hermaness, Saxa Vord and Valla Field SPA (6,833 ha)

5.5.2 According to SNH (https://sitelink.nature.scot/site/8512; Accessed July 2020) "*The Hermaness, Saxa Vord and Valla Field SPA lies in the north-west corner of the island of Unst, Shetland, at the northernmost tip of Britain. It consists of 100-200 m high sea cliffs and adjoining areas of grassland, heath and blanket bog. The boundary of the SPA is coincident with that of the Hermaness SSSI, Saxa Vord SSSI, and Valla Field SSSI. The seaward extension extends approximately 2 km into the marine environment to include the seabed, water column and surface.*

5.5.3 *Hermaness, Saxa Vord and Valla Field SPA qualifies under Article 4.1 by regularly supporting populations of European importance of the Annex I species red-throated diver (average of 26 proven breeding pairs for 1994 - 1999, 3 % of the British breeding population). It also qualifies under Article 4.2 by regularly supporting populations of European importance of the migratory species; gannet (16,400 pairs in 1999, 8 % of the British and 6 % of the world population), great skua (788 pairs in 1997, 9 % of the British and 6 % of the world population) and puffin (55,000 individuals in 1999, 6 % of the British and 3 % of the total population of the sub-species* F. a. grabae*).*

5.5.4 *The Hermaness, Saxa Vord and Valla Field SPA qualifies further under Article 4.2 by regularly supporting in excess of 20,000 individual seabirds. It regularly supports 157,500 seabirds including nationally important populations of the following species: fulmar (19,539 pairs in 1999; 4 % of the GB population), shag (450 pairs in censuses in 1995 and 1999; 1 % of the GB population), common guillemot (25,000 individuals over two surveys carried out in 1996 and 1999; 2 % of the GB population) and kittiwake (922 pairs in 1999; 0.2 % of the GB population)".*

Hermaness SSSI (978 ha)

5.5.5 According to SNH (https://sitelink.nature.scot/site/776; Accessed July 2020) "*The high cliffs and stacks of the west and north support large colonies of nesting seabirds. A range of species occur in various nesting habitats including kittiwake on bare cliff ledges, herring gull and great black-backed gull on the summits of stacks and on sloping coastal rocks, shag and razorbill among cliff-foot boulders and black guillemot in rock crevices.*

5.5.6 *Some species individually reach numbers of national importance. These include gannet at 6 % of the British population, puffin (4 %), fulmar (3 %) and guillemot (1 %). Inland from the cliffs, the bog and heath vegetation provide nesting habitat for one of the largest colonies of great skua in the world, representing over 3 % of the global population*". Hermaness SSSI is part of Hermaness, Saxa Vord and Valla Field SPA.

Saxa Vord SSSI (55.47 ha)

5.5.7 According to SNH (https://sitelink.nature.scot/site/475; Accessed July 2020) "*The site is located on the coastline to the east of Saxa Vord hill overlooking Burra Firth and extends from Grisa Lee in the south to The Noup in the north. At the Noup the site boundary includes both sides of the headland and extends down the east coast to Ura. The site also contains several skerries which along with the sea cliffs support a wide range of seabirds. The site is notified for its nationally and internationally important breeding fulmar and guillemot populations and for the seabird colony as a whole.*

5.5.8 *The site supports a breeding colony of fulmar and guillemot contributing to 1.2% and 0.4% of the British population respectively*".

5.5.9 Beyond the 4 km Ornithological Study Area (Volume III Drawing 5.2) there are other designated sites, some with ornithological features. Table 6.6 within AEE Report Chapter 6, Ecology, outlines biological designated sites within 10 km of the Proposed Project and includes the recently designated Fetlar to Haroldswick Marine Protection Area.

Ornithological Receptors

5.5.10 A summary of the principal findings from three years of targeted ornithological surveys (2018-2020) are provided below.

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

5.5.12 A total of 135 bird species were recorded in the study area during targeted breeding bird surveys. For full list of species recorded see Appendix 5.1. There is direct evidence from the study area surveys of potentially sensitive and specially protected bird species breeding within, and adjacent to, the Proposed Project and so these need to be considered further. These birds were considered '*wider countryside species*' for the purposes of evaluation and do not form part of any designated site feature.

5.5.13 The accompanying drawings provided for important ornithological receptors have been drawn showing distance bands away from the most westerly pad (Pad 1) with the following increments illustrated: 0-0.5 km; 0.5-1 km; 1-2 km; 2-3 km and 3-4 km.

Red-throated Diver

5.5.14 Evidence of breeding from three lochans within the study area (Confidential Drawing 1). Two breeding attempts in study area in 2018 – one failed and one presumed failed. Two breeding attempts in study area in 2019, both presumed successful as near-fledged juveniles seen at both sites.

Black Guillemot

5.5.15 The maximum count in 2018 was 84 black guillemots with 101 in 2019. The black guillemot surveys counted individual adult birds. The locations of breeding black guillemots are presented in Drawing 5.3.

Shag

5.5.16 The maximum boat-based count was 55 shag AON in 2018. The addition of a maximum 26 AON in the area between Virdik and Ura in 2020, provides an overall total of 81 shag AON within the four-kilometre study area (between Ura and The Nev). The locations of breeding shags are presented in Drawing 5.4.

Gannet

5.5.17 For clarity, no breeding gannets were recorded on boat-based surveys in 2018 and 2020.

Fulmar

5.5.18 The maximum boat-based count was 4,300 fulmar AON in 2018. The addition of 2,657 AON in the area between Virdik and Ura in 2020, provides an overall total of 6,987 fulmar AON within the four-kilometre study area (between Ura and The Nev). The locations of breeding fulmars are presented in Drawing 5.5.

Kittiwake

5.5.19 The maximum boat-based count was 55 kittiwake AON in 2018. The addition of no kittiwake AON in the area between Virdik and Ura in 2020, provides an overall total of 55 kittiwake AON within the four-kilometre study area (between Ura and The Nev). The locations of breeding kittiwake are presented in Drawing 5.6.

Black-headed Gull

5.5.20 A small black-headed gull (*Chroicocephalus ridibundus*) colony consisting of 11 pairs (2018) and 13 pairs (2019) was present at the Norwick Meadows (Drawing 5.6).

Common Gull

5.5.21 A moderate number of common gulls (*Larus canus*) bred, consisting of 22 pairs (2018) and 30 pairs (2019) at Braefield in a mixed gull colony (Drawing 5.6).

Lesser Black-backed Gull

5.5.22 A small number of lesser black-backed gulls (*Larus fuscus*) bred, consisting of 12 pairs (2018) and 10 pairs (2019) at Braefield in a mixed gull colony (Drawing 5.6).

Great Black-backed Gull

5.5.23 The maximum boat-based count was two great black-backed gull (*Larus marinus*) AON in 2018. The addition of a maximum six AON in the area between Virdik and Ura in 2020, provides an overall total of eight great black-backed gull AON within the 4 km study area (between Ura and The Nev). The locations of breeding great black-backed gulls are presented in Drawing 5.6.

Herring Gull

5.5.24 There was no herring gull (*Larus argentatus*) AON recorded in 2018. The addition of five AON in the area between Virdik and Ura in 2020, provides an overall total of five herring gull AON within the 4 km study area (between Ura and The Nev). Up to 16 pairs also bred in land at Braefield in a mixed gull colony, within the 3-4 km distance band. The locations of breeding herring gulls are presented in Drawing 5.6.

Common Guillemot

5.5.25 The maximum boat-based count was 80 individual common guillemots in 2018. The addition 20 individuals in the area between Virdik and Ura in 2020 provides an overall total of 100 individual common guillemots within the four kilometre study area (between Ura and The Nev). The locations of breeding common guillemots are presented in Drawing 5.7.

Razorbill

5.5.26 The maximum boat-based count was 11 individual razorbills in 2018. The addition of four individuals in the area between Virdik and Ura in 2020, provides an overall total of 15 individual razorbills within the 4 km study area (between Ura and The Nev). The locations of breeding razorbills are presented in Drawing 5.8.

Puffin

5.5.27 The maximum boat-based count was 49 individual puffins in 2018. The addition of 76 individuals in the area between Virdik and Ura in 2020, provides an overall total of 125 individual puffins. The locations of puffins recorded on potentially suitable nesting habitat during the breeding season are presented in Drawing 5.9.

Merlin

5.5.28 Evidence of successful breeding near to, but not within the study area. One nearby successful breeding attempt in 2018 - a brood of three fledged merlin 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 around between Skaw and Inner Skaw. Despite careful searching, no merlin nest was recorded within the study area and it is not known where the fledged brood came from. Whilst it is assumed, they came from close to the study area boundary, it is possible they may have come from further away.

Ringed Plover

5.5.29 Evidence of multiple pairs breeding in study area. Nine breeding pairs were recorded in 2018 and ten breeding pairs recorded in 2019 (Drawing 5.10). Most of the pairs were found at Skaw, Lamba Ness and Norwick, including pairs within the Proposed Project boundary (Drawing 5.11).

Golden Plover

5.5.30 Evidence of multiple pairs breeding in study area. Seven breeding pairs were recorded in 2018 and 13 pairs in 2019 in the study area (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, including one pair within the Proposed Project boundary (Drawing 5.13).

Whimbrel

5.5.31 Evidence of multiple pairs breeding in study area. There were five breeding territories in 2018 and four in 2019. Further details have been provided to the local planning authority for assessment during the planning application stage of the Proposed Project in accordance with SNH (2016) guidance.

Curlew

5.5.32 Evidence of multiple pairs breeding in study area. There were ca. 16 breeding territories in 2018 and ca. 13 in 2019 (Drawing 5.14). 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 curlew territories have been plotted close together e.g., Norwick Meadows, there was direct evidence of multiple pairs being present within a relatively small area, including pairs within the SaxaVord Spaceport Planning Application boundary (Drawing 5.15).

Dunlin

5.5.33 Evidence of multiple pairs breeding in study area (Drawing 5.16). Five breeding territories were recorded in 2018 and four breeding territories recorded in 2019. Breeding territories were located in areas including Saxa Vord hill, Southers Field, Skaw, Lamba Ness and Housi Field, including one pair within the Proposed Project boundary (Drawing 5.17).

Arctic Tern

5.5.34 Evidence of multiple pairs breeding in study area (Drawing 5.18). A few small breeding colonies were present within the study area, 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.

Arctic Skua

5.5.35 Evidence of multiple pairs breeding in study area. Five pairs of Arctic skua recorded breeding in the study area in 2018 and 2019 (Drawing 5.19). Pairs occupied territories both years in areas such as Hill of Clibberswick, Ward of Norwick and Inner Skaw, including territories very close to the Proposed Project boundary (Drawing 5.20).

Great Skua

5.5.36 Highly variable numbers of great skua (*Stercorarius skua*) were recorded during surveys, reflecting the social nature of this species. Large numbers of non-breeding great skuas 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 the numbers of breeding pairs within the study area likely to be in the low tens, with breeding birds mainly concentrated over three kilometres away from the nearest launch pad. 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 (Drawing 5.21).

Confidential Schedule 1 species

5.5.37 Confidential species information, where information would have appeared in the relevant sections of this AEE Report chapter were it not for the fact that this information could endanger rare and legally protected species from wildlife crime, has been submitted to and assessed previously by the local planning authority, as part of the EIA process for the SaxaVord Spaceport facility. For confidentiality reasons, this information is not included in the AEE submission.

Natural Capital

5.5.38 The most easterly headland on Lamba Ness, where the Proposed Project will be operated, is regularly used by local people and visitors for bird watching and whale watching.

5.6 Receptors Brought Forward for Assessment

5.6.1 Ornithological designated site interests on the Hermaness, Saxa Vord and Valla Field SPA (and overlapping Hermaness SSSI and Saxa Vord SSSI) and the following non-designated wider countryside ornithological receptors are taken forward for assessment: red-throated diver, merlin, black guillemot, common guillemot, puffin, razorbill, shag, kittiwake, fulmar, ringed plover, golden plover, whimbrel, curlew, dunlin, Arctic tern, Arctic skua and a confidential Schedule 1 species. The numbers of most gull species (with the exception of kittiwake) were considered small and trivial in relation to their overall regional population size and so have been scoped out of further consideration, as was gannet.

Potentially Important Ornithological Receptors

5.6.2 The conservation/legal importance of potentially important ornithological receptors was determined using criteria set out in Table 5.5. The importance of a species from a legal perspective in this listing does not equate to the importance of population at a site. The conservation importance of the birds using a site is evaluated by considering the number of individuals of species present in the context of geographical populations. A site can hold a protected species of importance, but the population present may not be regionally, nationally or internationally important. Thus, the occurrence of a legally protected species listed in Table 5.5 does not mean a site is necessarily important for that species.

Table 5.5 Conservation Listing of Potentially Important Ornithological Receptors

Species	Conservation listing of target species
Red-throated diver	S1, A1
Gannet	Amber L
Black guillemot	Amber L
Common guillemot	Amber L
Puffin	Red L
Razorbill	Amber L
Shag	Red L
Kittiwake	Red L
Fulmar	-
Merlin	A1, S1, Red L
Ringed plover	Red L
Golden plover	A1
Dunlin	A1 (*schinz*), Amber L
Whimbrel	S1, Red L
Curlew	Red L
Arctic tern	Amber L
Arctic skua	Red L
Great skua	Amber L

Key: A1 = EC Birds Directive Annex I species, S1 = UK Wildlife and Countryside Act Schedule 1 species, Amber L = UK Birds of Conservation Concern Amber List Species, Red L = UK Birds of Conservation Concern Red List species.

5.6.3 Geographical population estimates for potentially important bird species within the study area are provided in Table 5.6.

Table 5.6 Geographical Population Estimates for Potentially Important Study Area Bird Species (breeding pairs unless stated)

Species	Shetland (Regional) population	Scotland population	UK (National) population	Europe population (International status)
Red-throated diver	407*	935-1,500	1,250	42,100-93,000 (Least Concern)
Gannet	42,183 AOS**	243,505 AOS**	295,000	683,000 (Least Concern)
Black guillemot	15,739 individuals***	18,750	19,500	304,000-742,000 individuals (Least Concern)
Common guillemot	172,681 individuals***	780,000	950,000	2,350,000-3,060,000 individuals (Least Concern)
Puffin	107,676 AOBs*	493,000	580,000	4,770,000-5,780,000 (Vulnerable)
Razorbill	9,492 individuals***	93,300	165,000	979,000-1,020,000 individuals (Near Threatened)
Shag	6,147 AON***	21,500-30,000	17,500	76,300-78,500 (Least Concern)
Kittiwake	16,732 AON***	282,200	205,000	1,730,000-2,200,000 (Vulnerable)
Fulmar	188,544 AOS***	486,000 AOS	350,000	3,380,000-3,500,000 (Least Concern)
Merlin	30*	800	1,150	32,000-51,600 (Least Concern)
Ringed plover	800-1,000*	4,900-6,700	5,300	140,000-213,000 (Least Concern)
Golden plover	5,665*	15,000	32,500-50,500	630,000-860,000 (Least Concern)
Dunlin	2,054*	8,000-10,000	8,600-10,500	426,000-562,000 (Least Concern)
Whimbrel	290*	400-500	310	343,000-402,000 (Least Concern)
Curlew	4,227*	58,800	58,500	212,000-292,000 (Near Threatened)
Arctic tern	24,716 AON***	47,300 AON	53,500	564,000-906,000 (Least Concern)
Arctic skua	516*	2,100	785	39,900-56,200 (Least Concern)
Great skua	6,846	9,650	9,650	16,300-17,200 (Least Concern)

Species	Shetland (Regional) population	Scotland population	UK (National) population	Europe population (International status)
Population estimate reference	*Wilson *et al*. 2015 **Murray *et al.* 2015 ***Mitchell *et al.* 2004	Wilson *et al*. 2015	Woodward *et al*. 2020	Birdlife International, 2015

AOB = Apparently Occupied Burrow, AOS = Apparently Occupied Site, AON = Apparently Occupied Nest. Quoting the most recent published estimate for geographical populations sometimes results anomalies, such as the apparently larger Scottish than UK population estimate for whimbrel. The UK population estimate of 310 pairs is more up to date than the older Scottish population estimate of 400-500 pairs. For whimbrel the 290 Shetland metric comes from work Dr Digger Jackson conducted in 2009 on the Viking Wind Farm and he reported that subsequent monitoring across west and central Shetland shows the population has not substantially changed since then. Furthermore, the 290 pairs metric originally quoted was based on a single survey visit and subsequent detailed whimbrel population monitoring work has shown that if two-three site visits are undertaken, then surveyors record ca. 10 % more pairs. Consequently, the actual Shetland whimbrel population size is probably around ca. 320 pairs (D. Jackson, *pers com.*).

5.6.4 The behavioural sensitivity of the potentially important ornithological receptors is described using criteria set out in Table 5.7. When available, the assumed distance thresholds and hence sensitivity for disturbance in Table 5.7 was predominantly based on expert opinion examined by Ruddock and Whitfield (2007), Gilbert *et al*., (1998), Scottish Government (2012) and field experience. The assessment of behavioural sensitivity is primarily based on disturbance to breeding birds at the nest, not general disturbance of birds undertaking other activities. However, note that the Scottish Government (2012) assessment of sensitivity was largely based around disturbance at sea foraging and not at the nest and each species was given a 'Disturbance Score' out of 5, where scoring categories were: 1 (hardly any escape behaviour and a very short flight distance when approached), to 5 (strong escape behaviour, at a large response distance).

5.6.5 A potentially useful and recognised method used to describe potential disturbance to birds involves two basic measures of receptor response (Ruddock and Whitfield, 2007):

- 'Alert Distance' (AD) – the distance between the disturbance source and the bird; at the point where the bird changes its behaviour in response to the approaching disturbance event.
- 'Flight Initiation Distance' (FID) – the point at which the bird flushes or flies away from the approaching disturbance event.

5.6.6 Where known, the difference between AD and FID in potentially important ornithological receptors is described based on published and unpublished research sources. However, few studies have looked in enough detail at AD and FID to differentiate these with any degree of rigour or confidence and often simply describe a 'flushed at' distance instead (equivalent to FID).

5.6.7 To understand potential impacts of short duration loud noise events, a background literature review of noise impacts on birds for the Proposed Project (Appendix 5.2) was undertaken. This literature review looked 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 launches. To do this, the review focussed on identifying impulsive noise studies for the species of interest on Unst and specifically within the ornithological study area. A variety of freely available databases have been searched including ResearchGate and Google Scholar. References considered included both peer-reviewed published scientific papers and grey literature reports. However, relevant literature was limited and so a wider literature search was conducted looking at other species including where possible analogous birds to those present in the ornithological study area.

5.6.8 Taking into account evidence from the literature review (Appendix 5.2), it is apparent that loud infrequent noise associated with Skyrora XL Launch Vehicle launches could be expected to impact on birds in close proximity to operational launch pads. Less clear, are the ecological effects and consequences of the short duration loud disturbance impacts on these birds. Most studies consider potential impacts (e.g., startled response, increased vigilance etc.) and do not show or demonstrate long-term population level consequences or effects. Nevertheless, 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 Florida, USA, is home to large breeding populations of wading birds (Smith and Breininger, 1995), despite being exposed to irregular loud impulsive noise events.

Table 5.7 Behavioural Sensitivity of Potentially Important Species in the Study Area

Species	Nature of sensitivity	Sensitivity level
Red-throated diver	Breeding birds are sensitive to human activity, visual disturbance and sudden noise events over large distances (up to 500 m). However, evidence from the Shetland Viking Wind Farm studies indicates that some individuals (perhaps habituated) appear to tolerate moderate levels of disturbance in some situations. The size of waterbodies also has an impact on FID; breeding birds are more easily disturbed and fly from small nesting lochans than large lochs, where they have the ability to swim away and/or dive without taking flight.	High at nest.
Gannet	Scottish Government advice (2012) on disturbance by wind farm structures, ship and helicopter traffic conducted a literature search focused on disturbance sensitivity of seabirds, and allocated scores by experts on sensitivity (1 = hardly any escape behaviour and a very short flight distance when approached, to 5 = strong escape behaviour, at a large response distance). Gannet scored 2. Gannets are highly traditional in where they breed (Mitchell *et al.,* 2004) and have increased at locations such as Sula Sgeir, where they are regularly disturbed and still exploited for food, with ca. 2,000 well-grown chicks harvested every year (Murray *et al.,* 2015).	Low at sea and nest.
Black guillemot	Scottish Government advice (2012) on disturbance by wind farm structures, ship and helicopter traffic conducted a literature search focused on disturbance sensitivity of seabirds, and allocated scores by experts on sensitivity. Black guillemot scored 3, sometimes flying from approaching boats hundreds of metres away (FID). Elsewhere, e.g., Lerwick Harbour, the species nests in harbour wall holes in very close proximity to regular, but also unexpected human disturbance (both visual and noise) on water and land.	Moderate at sea. Low at nest.
Common guillemot	Scottish Government advice (2012) on disturbance by wind farm structures, ship and helicopter traffic conducted a literature search focused on disturbance sensitivity of seabirds, and allocated scores by experts on sensitivity. Common guillemot scored 3, sometimes flying from approaching boats hundreds of metres away. Nest sensitivity considered to be moderate, with for example guillemots sometimes being flushed from ledges if boats get too close.	Moderate at sea and nest.

Species	Nature of sensitivity	Sensitivity level
Puffin	Scottish Government advice (2012) on disturbance by wind farm structures, ship and helicopter traffic conducted a literature search focused on disturbance sensitivity of seabirds, and allocated scores by experts on sensitivity. Puffin scored 2. Nest sensitivity considered low, with puffins able to tolerate large numbers of humans within a few metres of nesting burrows e.g., Sumburgh Head RSPB Reserve.	Low at sea and nest.
Razorbill	Scottish Government advice (2012) on disturbance by wind farm structures, ship and helicopter traffic conducted a literature search focused on disturbance sensitivity of seabirds, and allocated scores by experts on sensitivity. Razorbill scored 3, sometimes flying from approaching boats hundreds of metres away. Nest sensitivity considered moderate.	Moderate at sea and nest.
Shag	Scottish Government advice (2012) on disturbance by wind farm structures, ship and helicopter traffic conducted a literature search focused on disturbance sensitivity of seabirds, and allocated scores by experts on sensitivity. Shag scored 3. Nest sensitivity considered to be moderate, with for example shag sometimes being flushed from ledges if boats get too close.	Moderate at sea and nest.
Kittiwake	Scottish Government advice (2012) on disturbance by wind farm structures, ship and helicopter traffic conducted a literature search focused on disturbance sensitivity of seabirds, and allocated scores by experts on sensitivity. Kittiwake scored 2. Nest sensitivity considered to be low.	Low at sea and nest.
Fulmar	Scottish Government advice (2012) on disturbance by wind farm structures, ship and helicopter traffic conducted a literature search focused on disturbance sensitivity of seabirds, and allocated scores by experts on sensitivity. Fulmar scored 1. Nest sensitivity also considered to be low.	Low at sea and nest
Merlin	Breeding merlin are particularly sensitive to human activity, visual disturbance and sudden noise events over large distances (up to 500 m). However, some individual merlins appear to tolerate moderate levels of disturbance in some situations. For example, some merlins appear to be able to nest relatively close to public roads, where regular disturbance occurs, including on Shetland.	High at nest
Ringed plover	Breeding ringed plovers have relatively small territories and regularly select to nest on man-made habitats in Shetland, such as road verges and quarries and so is not considered particularly susceptible or sensitive to human disturbance.	Low at nest
Golden plover	Breeding golden plovers have relatively small territories are sensitive to human activity, visual disturbance and sudden noise events over moderate distances (~250 m).	Moderate at nest
Dunlin	Breeding dunlin have very small territories, are sensitive to human activity, visual disturbance and sudden noise events over moderate distances (~250 m).	Moderate at nest

Species	Nature of sensitivity	Sensitivity level
Whimbrel	Breeding birds are usually considered sensitive to human activity, visual disturbance and sudden noise events. However, in Shetland whimbrel nest in short, grazed vegetation, periodically visited by crofters. Adult whimbrel on their breeding territories shows disturbance responses to the presence of a moving or static person up to 250 m away (Massey *et al.,* 2016).	Moderate at nest
Curlew	Breeding birds are usually considered sensitive to human activity, visual disturbance and sudden noise events over moderate distances (~250 m). However, in Shetland curlews often nest and feed close to or on in-bye fields, which are regularly used by crofters, often on a daily basis.	Moderate at nest
Arctic tern	Scottish Government advice (2012) on disturbance by wind farm structures, ship and helicopter traffic conducted a literature search focused on disturbance sensitivity of seabirds, and allocated scores by experts on sensitivity. Arctic tern scored 2. Tern colonies are considered moderately sensitive; with total colony abandonment possible under some (poorly understood) circumstances.	Low at sea, moderate at nest
Arctic skua	Arctic skuas have relatively small nesting territories (sometimes within discrete colonies). Although birds aggressively defend territories, care needs to be taken around nests, especially not to flush young skuas which are vulnerable to predation by neighbouring adult Arctic and great skuas. Scottish Government advice (2012) on disturbance by wind farm structures, ship and helicopter traffic conducted a literature search focused on disturbance sensitivity of seabirds, and allocated scores by experts on sensitivity. Arctic skua scored 1.	Low at sea, low-moderate at nest
Great skua	Great skua colonies are relatively robust to human disturbance e.g., consider the 9,000 people who walk through the great skua colony at Hermaness annually [1]. Scottish Government advice (2012) on disturbance by wind farm structures, ship and helicopter traffic conducted a literature search focused on disturbance sensitivity of seabirds, and allocated scores by experts on sensitivity. Great skua scored 1.	Low at sea, low-at nest

5.6.9 The typical breeding calendar of the potentially important ornithological receptors within the study area is provided in Table 5.8. There is obviously overlap between the main egg laying/incubation period and the main period dependent young present. However, for simplicity, these main periods are separated out in Table 5.8.

Table 5.8 Typical Breeding Calendar of Potentially Important Species in the study area

Species	April		May		June		July		August		Sept		Reference
Red-throated diver													Incubation 27 days; Fledging 43 days[1,2,3]
Gannet													Incubation 43 days; Fledging 90 days[1,2,3]

[1] Jonathan Swale (SNH) reported in the press that visitor numbers to Hermaness had gone up by 50 % over the previous four years to 9,000 in 2019. https://www.shetnews.co.uk/2019/06/06/hermaness-path-to-be-upgraded-to-cope-with-rising-visitor-numbers/

Species	April		May		June		July		August		Sept		Reference
Black guillemot													Incubation 23-40 days; Fledging 40 days[1,2,3]
Common guillemot													Incubation 34 days; Fledging 20 days[1,2,3]
Puffin													Incubation 42 days; Fledging 50 days[1,2,3]
Razorbill													Incubation 34 days; Fledging 20 days[1,2,3]
Shag													Incubation 31 days; Fledging 53 days[1,2,3]
Kittiwake													Incubation 29 days; Fledging 43 days[1,2,3]
Fulmar													Incubation 51 days; Fledging 49 days[3]
Merlin													Incubation 30 days; Fledging 30 days[4]
Ringed plover													Incubation 24 days; Fledging 24 days[1,2,3]
Golden plover													Incubation 29 days; Fledging 30 days[1,2,3]
Dunlin													Incubation 22 days; Fledging 20 days[1,2,3]
Whimbrel													Incubation 28 days; Fledging 30 days[1,2,3]
Curlew													Incubation 28 days; Fledging 34 days[1,2,3]
Arctic tern													Incubation 22 days; Fledging 23 days[1,2,3]
Arctic skua													Incubation 27 days; Fledging 28 days[1,2,3]
Great skua													Incubation 29 days; Fledging 44 days[1,2,3]

Red = typical main egg laying/incubation period, Yellow = typical main period dependent young present. Note, table does not include relay or 2nd brood dates. 1 = Gilbert *et al.,* 1998 (reprinted 2011); 2 = Forrester and Andrews, 2007; 3 = Snow and Perrins, 1998; 4 = Hardey *et al.,* 2013.

5.6.10 A summary of the population size and percentage of geographical population estimates for potentially important bird species is provided in Table 5.9.

5.6.11 Whilst considering the potential consequences of loud impulsive noise events on important and sensitive bird species, consideration has also been given to SNH's ornithological comments and advice on the recent 2020 Sutherland Space Hub planning application. The Caithness and Sutherland Peatlands SPA and the Ben Hutig and A'Mhoine SSSI are 31 m away from the nearest access road and 109 m away from the launch pad of that Project. Thus, that Project is very close to the designated sites and their breeding birds, which include dunlin, greenshank, golden plover and red-throated diver; three of which breed within the Proposed Project study area on Unst.

5.6.12 In SNH's consultation response on the Sutherland Space Hub of 12/03/20 it stated that "*Disturbance through noise from launches has been evaluated in the EIAR and although the noise events are extremely loud they will be very short-lived. From our own experience of blasting for construction and from military jets, it appears that sudden, loud noise events have short-term effects and do not appear to result in the permanent displacement of breeding birds. Therefore, our advice is that there is no basis for concluding adverse impact from the launches themselves*".

Table 5.9 Summary Population Size and Percentage of Geographical Population Estimates for Potentially Important Bird Species in the study area (breeding pairs unless stated). **Species in bold match or exceed nominal 1 % threshold of either the Regional or National population levels.**

Species	Shetland (Regional) population	Scotland population	UK (National) population	Europe population	Population and % of Regional (and where relevant National) population within 4 km of launch pads (max est.)	Population and % of Regional population (and where relevant National) within 2 km of launch pads (max est.)	Population and % of Regional population within 1 km of launch pads (max est.)
Red-throated diver	407	935-1,500	1,250	42,100-93,000	2 (0.5 % of Regional pop)	0 (0 %)	0 (0 %)
Gannet	42,183 AOS	243,505 AOS	295,000	683,000	0 (0 %)	0 (0 %)	0 (0 %)
Black guillemot	15,739 individuals	18,750	19,500	304,000-742,000 individuals	101 ind (0.64 % of Regional pop)	50 ind (0.32 % of Regional pop)	25 ind (0.16 % of Regional pop)
Common guillemot	172,681 individuals	780,000	950,000	2,350,000-3,060,000 individuals	100 ind (0.0 6% of Regional pop)	27 ind (0.02 % of Regional pop)	0 ind (0 %)
Puffin	107,676 AOB	493,000	580,000	4,770,000-5,780,000	125 ind (0.06 % of Regional pop*)	35 (0.02 % of Regional pop*)	8 (0.004 % of Regional pop*)
Razorbill	9,492 individuals	93,300	165,000	979,000-1,020,000 individuals	15 (0.16 % of Regional pop)	0 (0 %)	0 (0 %)
Shag	6,147 AON	21,500-30,000	17,500	76,300-78,500	81 (1.32 % of Regional pop)	6 (0.1 % of Regional pop)	1 (0.02 % of Regional pop)
Kittiwake	16,732 AON	282,200	205,000	1,730,000-2,200,000	55 (0.32 % of Regional pop)	50 (0.3 % of Regional pop)	0 (0 %)
Fulmar	188,544 AOS	486,000 AOS	350,000	3,380,000-3,500,000	6,987 (3.7 % of Regional and 1.99 % of National pop)	2,635 (1.4 % of Regional pop)	1,170 (0.62 %)

Species	Shetland (Regional) population	Scotland population	UK (National) population	Europe population	Population and % of Regional (and where relevant National) population within 4 km of launch pads (max est.)	Population and % of Regional population (and where relevant National) within 2 km of launch pads (max est.)	Population and % of Regional population within 1 km of launch pads (max est.)
Merlin	30	800	1,150	32,000-51,600 (Least Concern)	0 (0 %), although one fledged brood recorded within study area	0 (0 %)	0 (0 %)
Ringed plover	800-1,000	4,900-6,700	5,300	140,000-213,000	10 (1.0-1.25 % of Regional pop)	8 (0.8-1.0 % of Regional pop)	3 (0.3-0.38 % of Regional pop)
Golden plover	5,665	15,000	32,500-50,500	630,000-860,000	13 (0.23 % of Regional pop)	4 (0.07 % of Regional pop)	1 (0.02 % of Regional pop)
Dunlin	2,054	8,000-10,000	8,600-10,500	426,000-562,000	5 (0.24 % of Regional pop)	3 (0.15 % of Regional pop)	1 (0.05 % of Regional pop)
Whimbrel	[290] D. Jackson pop est. ca. 320	400-500	310	343,000-402,000	5 (1.7 % of Regional and 1.6 % of National pop)] 1.6 % of Regional pop using D. Jackson pop est	[3 (1.04 % of Regional pop)] 0.9 % of Regional pop using D. Jackson pop est	[2 (0.69 % of Regional pop)] 0.63 % of Regional pop using D. Jackson pop est
Curlew	4,227	58,800	58,500	212,000-292,000	16 (0.4 % of Regional pop)	3 (0.07 % of Regional pop)	1 (0.02 % of Regional pop)
Arctic tern	24,716 AON	47,300 AON	53,500	564,000-906,000	13(0.05 % of Regional pop)	13 (0.05 % of Regional pop)	0 (0 %)
Arctic skua	516	2,100	785	39,900-56,200	5 (0.97 % of Regional pop)	3 (0.58 % of Regional pop)	1 (0.19 % of Regional pop)
Great skua	6,846	9,650	9,650	16,300-17,200	Low tens (<1 % of Regional pop)	0 (0 %)	0 (0 %)

AOB = Apparently Occupied Burrow, AOS = Apparently Occupied Site, AON = Apparently Occupied Nest. *metric assumes all individuals counted were breeding birds and AOB converted from number of individuals for comparative purposes.

5.7 Standard Mitigation

5.7.1 Following CIEEM (2018) guidance, the assessment process assumes the application of standard mitigation measures. A range of mitigation measures have already been in-built as part of the iterative design process for the SaxaVord Spaceport, to avoid the higher value species and their habitats. As a Launch Operator working within the boundary of the SaxaVord Spaceport, the Applicant is committed to adhering to the following standard mitigation measures:

- A detailed Breeding Birds Protection Plan, required as a planning condition for the SaxaVord Spaceport, has been produced and will be updated regularly.
- Following the NatureScot consultation response dated 11 March 2021, SaxaVord Spaceport committed to a no-launch window whereby no satellite launches, or static tests will be carried out between mid-May and the end of June (subject to ongoing monitoring and appraisal). The Applicant is aware of this operational constraint and will not schedule launches within the defined mid-May to end of June window.
- Species licensing, where planned activities may result in potential disturbance which would likely be considered unlawful under the 1981 Wildlife and Countryside Act and the 2004 Nature Conservation (Scotland) Act unless they were licensed, will be undertaken by the Applicant as required.
- Adherence to any and all Launch Operator requirements within the Habitat Management Plan, required as a planning condition for the SaxaVord Spaceport (Appendix 5.3).

5.8 Potential Effects

Designated Sites

5.8.1 Internationally important populations of birds are present within the Hermaness, Saxa Vord and Valla Field SPA, including red-throated diver (3 % of British population), gannet (8 % of British and 6 % of world population), great skua (9 % of British and 6 % of world population) and puffin (6 % of British population). The SPA also regularly supports over 150,000 breeding seabirds which include 4 % of the British fulmar population, 1 % of the British shag population, 2 % of the British common guillemot population and 2 % of the British kittiwake population (https://sitelink.nature.scot/site/8512; Accessed July 2020).

5.8.2 SNH provided Alba Ecology with the designated sites' breeding bird data on 02/06/20 (Table 5.10).

Table 5.10 Designed Site Breeding Bird Data (courtesy of SNH)

Species	Saxa Vord SSSI	Hermaness SSSI/NNR	Valla Field
Red-throated diver		5 pairs (2015-2016), 6 pairs (2018-2019)	12 pairs (2012-2013), average 18 pairs in past
Common guillemot	1,948 ind. (2017)	5,808 ind. (2016)	
Puffin	217 ind. (2017)	11,455 AOB (2017)*	82 ind. (2016)
Razorbill	42 ind. (2017)	139 ind. (2016)	
Shag	32 AON (2017)		
Kittiwake	95 AON (2017)	171 AON (2016)	
Fulmar	8,057 AOS (2016)	11,786 AOS (2016)	1,146 AOS (2016)
Gannet		25,580 AON (2014)*	

Species	Saxa Vord SSSI	Hermaness SSSI/NNR	Valla Field
Merlin		1 pair (2018)	
Arctic skua		2 AON (2016, 2018, 2019), 1 AON (2017)	
Great skua		955 AON (2018)	198 AOT (2013)

*Puffin estimate calculated from counts of loafing birds and so has a wide margin of error (Jonathan Swale, *pers comm.*).
**Gannets were due to be counted in 2020 but surveys were postponed due to COVID-19. The colony is growing at around 3% p.a. so likely to be about 30,000 AON by now (Jonathan Swale, *pers comm.*)

5.8.3 The distance between the nearest land part of the Hermaness, Saxa Vord and Valla Field SPA (at the Noup) and the most westerly launch pad (Pad 1) is 3.79 km. This lies within the predicted maximum 90-100 dB level for Launch LAmax (A-weighted, maximum sound level). NatureScot holds the breeding bird data for all the SPA qualifying species (summarised in Table 5.10) and these species occur within the 90-100 dB level for Launch LAmax or lower predicted noise levels the further away from the launch site the birds are. Based on the likely launch schedule, up to nine launches could take place annually between April and June, the main incubation period for the SPA birds.

5.8.4 In the context of the Sutherland Space Hub, the launch pad of which was 109 m from the nearest part of the Caithness and Sutherland Peatlands SPA, SNH considers *"loud noise events have short-term effects and do not appear to result in the permanent displacement of breeding birds. Therefore, our advice is that there is no basis for concluding adverse impact from the launches themselves"* and so it seems unlikely that Hermaness, Saxa Vord and Valla Field SPA birds, the nearest of which are approximate 3.79 km away from Pad 1, would be adversely affected by the predicted maximum noise levels at launch.

5.8.5 Under this scenario, the potential magnitude of adverse impacts of operational (noise) disturbance on designated site bird species would likely be **negligible**, with **no likely significant effects** predicted.

Red-throated Diver

5.8.6 Red-throated diver is an Annex 1 and Schedule 1 species and therefore of high conservation importance (Table 5.5). The behavioural sensitivity of the species is considered to be high (Table 5.7). The regional, national and international population estimates of this species are known (Table 5.6). The Shetland NHZ red-throated diver population estimate is 407 pairs and without evidence to the contrary the species is likely to be in FCS within Shetland.

5.8.7 The species nests on the edge of freshwater lochs and lochans, often within blanket bog/peatland. The adults usually forage away from the breeding lochs, feeding in the sea, or occasionally large freshwater lochs and carry fish back to the chicks (Forrester and Andrews, 2007). Consequently, the breeding sites are a relatively predictable 'fixed constraint' insofar as they always nest within 1 m of a loch/lochan shore, can only use certain types of waterbody (whose characteristics are well known) and regularly use the same lochs and lochans over time.

5.8.8 Details of potential operational impacts on red-throated diver have been provided in a confidential appendix previously to the local planning authority in accordance with SNH (2016) guidance.

5.8.9 The potential magnitude of adverse impacts of operational disturbance combined on red-throated diver would likely be **negligible**, with **no likely significant effects** predicted. Although red-throated diver is a species of high conservation importance, the likely effects are judged to be not significant, i.e. there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates, that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Red-throated diver is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.

- The natural range of red-throated diver in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the red-throated diver population on a long-term basis should the Proposed Project operate.

Black Guillemot

5.8.10 Black guillemot is an Amber listed species and therefore of moderate conservation importance (Table 5.5). The behavioural sensitivity of the species is considered to be low at the nest (Table 5.7). The regional, national and international population estimates of this species are known (Table 5.6). The Shetland NHZ black guillemot population estimate is 15,739 individuals and without evidence to the contrary the species is likely to be in FCS within Shetland.

5.8.11 The species typically nests on predator-free islands with suitable boulder beaches in loose colonies, or at lower densities on cliffs inaccessible to mammalian predators (Forrester and Andrews, 2007). The adults feed at sea and carry fish back to the chicks. Consequently, the breeding sites are a relatively predictable 'fixed constraint' insofar as they nest within the same boulder beach and cliff habitats over time.

5.8.12 With a maximum of 101 black guillemots breeding within the study area, all will be within the range of elevated noise levels associated with Proposed Project. Table 5.12 outlines the maximum predicted dB levels on nesting black guillemot. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.12 Maximum Predicted Decibel Levels at Black Guillemot Nesting Locations

Individuals	Launch LAmax		
Black guillemot	Pad 1	Pad 2	Pad 3
13-14 ind, 0-0.5km	120-130dB	120-130dB	120-130dB
8-12 ind, 0.5-1km	110-120dB	110-120dB	100-110dB
25-27 ind, 1-2km	100-110dB	100-110dB	90-110dB
25-26 ind, 2-3km	90-100dB	90-100dB	90-100dB
10-25 ind, 3-4km	90-100dB	90-100dB	90-100dB

5.8.13 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, breeding black guillemot within the study area and there is also no threshold noise metric against which to compare potential effects on black guillemot. However, pigeon guillemot (*Cepphus columba*), a similar analogous Pacific species has shown adverse responses to fireworks near nesting sites in California (Appendix 5.2).

5.8.14 Breeding black guillemot are not considered particularly sensitive to human activity, visual disturbance and sudden noise events at the nest, as evidenced by the range of nesting sites provided by Forrester and Andrews (2007). Nevertheless, whether the pre-launch warning siren, followed by the low frequency rumble of the Skyrora XL Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds (in the underground nest) to cope with the noise is currently speculative. Based on the likely launch schedule, two to four launches would take place during the typical 23-40 day incubation period for black guillemot (Table 5.8). It should be noted that following the NatureScot consultation response (11 March 2021), commitment to a no-launch window whereby no satellite launches will be carried out between mid-May and the end of June has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.15 If a worst-case (*not likely*) scenario is assumed (a failure for all breeding black guillemot directly related to a launch) then this would constitute an adverse impact on 101 individuals out of Shetland's 15,739 individual black guillemots, i.e., 0.64 % of the regional population (Table 5.9). If no such adverse response took place, then 0 % of the regional population would be adversely affected. Under both of these scenarios, a significant operational impact on the regional black guillemot population in Shetland is considered unlikely.

5.8.16 Under either of these scenarios, the potential magnitude of adverse impacts of operational disturbance on black guillemot would likely be **negligible**, with **no likely significant effects** predicted. Although black guillemot is a species of moderate conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operated, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Black guillemot is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of black guillemot in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the black guillemot population on a long-term basis should the Proposed Project be operated.

Common Guillemot

5.8.17 Common guillemot is an abundant Amber listed species and therefore of moderate conservation importance (Table 5.5). The behavioural sensitivity of the species is considered to be moderate at the nest (Table 5.7). The regional, national and international population estimates of this species are known (Table 5.6). The Shetland NHZ common guillemot population estimate is 172,681 individuals and without evidence to the contrary the species is likely to be in FCS within Shetland.

5.8.18 The species typically nests in colonies, often containing many thousands of pairs, in locations inaccessible to mammalian predators e.g., ledges on sheer cliffs, tops of stacks and among boulders and flat ground on offshore islands (Forrester and Andrews, 2007). The adults feed at sea and carry fish back to the chicks. Consequently, the breeding sites are a relatively predictable 'fixed constraint' insofar as they nest within the same sheer cliff habitats over time.

5.8.19 With a maximum of 100 common guillemots breeding within the study area, all will be within the range of elevated noise levels associated with the operation of the Proposed Project. Table 5.13 outlines the maximum predicted dB levels on nesting common guillemot. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.13 Maximum Predicted Decibel Levels at Common Guillemot Nesting Locations

Individuals	Launch LAmax		
Common guillemot	Pad 1	Pad 2	Pad 3
27 ind, 1-2km	100-110dB	100-110dB	90-110dB
20 ind, 2-3km	90-100dB	90-100dB	90-100dB
53 ind, 3-4km	90-100dB	90-100dB	90-100dB

5.8.20 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, breeding common guillemot within the study area and there is also no threshold noise metric against which compare potential effects on common guillemot.

5.8.21 A study (Dunnet, 1977) to explore the possibility that an increase in air traffic associated with oilfields off the north-east of Scotland was impacting on breeding seabirds recorded the reactions of a mixed seabird colony, including common guillemots, on the Buchan cliffs in relation to aircraft flying within 100 m. Virtually no behavioural reaction was reported as a result of the flyovers to within 100 m of the colony which was conducted during early egg laying and early nestling periods (Appendix 5.2).

5.8.22 Breeding common guillemots are considered moderately sensitive to human activity, visual disturbance and sudden noise events at the nest. Based on the literature available (Appendix 5.2) on common guillemot (called common murre in the USA publications) on disturbance from planes/helicopters suggests that this species is most sensitive to flushing in the pre-egg laying/early egg laying period. Flushing in this species occasionally causes eggs/chicks to be dislodged. However, it is not known if such dislodging of eggs/chicks is additive in terms of overall mortality, as sub-optimal nest locations regularly lose eggs/chicks naturally in the breeding season regardless. Whether the pre-launch warning siren, followed by the low frequency rumble of the Skyrora XL Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Such activity would likely to be most severe during pre-egg laying and early incubation period. Based on the likely launch schedule, up to three launches would take place during the typical 34-day incubation period for common guillemot (Table 5.8). It should be noted that following the NatureScot consultation response (11 March 2021), commitment to a no-launch window whereby no satellite launches will be carried out between mid-May and the end of June has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.23 If a worst-case (*not likely*) scenario is assumed (a failure for all breeding common guillemots directly related to a launch) then this would constitute an adverse impact on 100 individuals out of Shetland's 172,681 individual common guillemots, i.e., 0.06 % of the regional population (Table 5.9). If no such adverse response took place, then 0 % of the regional population would be adversely affected. Under both of these scenarios, a significant operational impact on the regional common guillemot population in Shetland is considered unlikely.

5.8.24 Under either of these scenarios, the potential magnitude of adverse impacts of operational disturbance on common guillemot would likely be **negligible**, with **no likely significant effects** predicted. Although common guillemot is a species of moderate conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Common guillemot is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of common guillemot in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the common guillemot population on a long-term basis should the Proposed Project be operated.

Puffin

5.8.25 Puffin is a common Red listed species and therefore of high conservation importance (Table 5.5). The behavioural sensitivity of the species is considered to be low at the nest (Table 5.7). The regional, national and international population estimates of this species are known (Table 5.6). The Shetland NHZ puffin population estimate is 107,676 AOB and with recent evidence of an apparent decline the species in Shetland (e.g., Owen *et al.,* 2018), puffin is not likely to be in FCS within Shetland.

5.8.26 The species typically nests within burrows (dug in soil and less commonly among boulders) in colonies, in locations inaccessible to mammalian predators (Forrester and Andrews, 2007). The adults feed at sea and carry fish back to the chicks. Consequently, the breeding sites are a relatively predictable 'fixed constraint' insofar as they nest within the same burrow habitats over time.

5.8.27 With a maximum of 125 individuals breeding within the study area, all will be within the range of elevated noise levels associated with the operation of the Proposed Project. Table 5.14 outlines the maximum predicted dB levels on apparently nesting puffin. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.14 Maximum Predicted Decibel Levels at Puffin Nesting Locations

Individuals	Launch LAmax		
Puffin	Pad 1	Pad 2	Pad 3
2 ind, 0-0.5 km	120-130dB	120-130dB	120-130dB
6 ind, 0.5-1 km	110-120dB	110-120dB	100-110dB
27 ind, 1-2 km	100-110dB	100-110dB	90-110dB
23 ind, 2-3 km	90-100dB	90-100dB	90-100dB
67 ind, 3-4 km	90-100dB	90-100dB	90-100dB

5.8.28 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, breeding puffin within the study area and there is also no threshold noise metric against which compare potential effects on puffin.

5.8.29 A study (Dunnet, 1977) to explore the possibility that an increase in air traffic associated with oilfields off the north-east of Scotland was impacting breeding seabirds recorded the reactions of a mixed seabird colony, including puffins, on the Buchan cliffs in relation to aircraft flying within 100 m. Virtually no behavioural reaction was reported as a result of the flyovers to within 100 m of the colony which was conducted during early egg laying and early nestling periods (Appendix 5.2).

5.8.30 Breeding puffins are considered tolerant of human activity, visual disturbance and sudden noise events at the nest. Based on the literature available, puffins hearing range is between 500h hz to 6,000 hz (Appendix 5.2) so they would certainly hear the noise at launch. The presence of puffin nests in underground burrows will substantially reduce the potential noise at nests. Whether the pre-launch warning siren, followed by the low frequency rumble of the Skyrora XL Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Such activity would probably be most severe during pre-egg laying and the incubation period (early April to the end of May). Based on the likely launch schedule, up to four launches would take place during the typical 42 day incubation period for puffin (Table 5.8). It should be noted that following the NatureScot consultation response (11 March 2021), commitment to a no-launch window whereby no satellite launches will be carried out between mid-May and the end of June has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.31 If a worst-case (*not likely*) scenario is assumed (a failure for all breeding puffins directly related to a launch) then this would constitute an adverse impact on 125 individuals (assuming they were all breeders, which is unlikely) out of Shetland's 107,676 AOB (215,352 individuals), i.e., 0.06 % of the regional population (Table 5.9). If no such adverse response took place, then 0 % of the regional population would be adversely affected. Under both of these scenarios, a significant operational impact on the regional puffin population in Shetland is considered unlikely.

5.8.32 Under either of these scenarios, the potential magnitude of adverse impacts of operational disturbance on puffin would likely be **negligible**, with **no likely significant effects** predicted. Although puffin is a species of high conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Puffin is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of puffin in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the puffin population on a long-term basis should the Proposed Project be operated.

Razorbill

5.8.33 Razorbill is an Amber listed species and therefore of moderate conservation importance (Table 5.5). The behavioural sensitivity of the species is considered to be moderate at the nest (Table 5.7). The regional, national and international population estimates of this species are known (Table 5.6). The Shetland NHZ razorbill population estimate is 9,492 individuals and without evidence to the contrary the species is likely to be in FCS within Shetland.

5.8.34 The species typically nests on open rocky coastlines, low cliffs and boulder scree slopes, particularly on offshore islands to high precipitous cliffs. Razorbills can nest individually or within loose groups (Forrester and Andrews, 2007). The adults feed at sea and carry fish back to the chicks. Consequently, the breeding sites are a relatively predictable 'fixed constraint' insofar as they nest within the same cliff habitats over time.

5.8.35 With a maximum of 15 razorbills breeding within the study area, all will be within the range of elevated noise levels associated with the operation of the Proposed Project. Table 5.15 outlines the maximum predicted dB levels on nesting razorbill. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.15 Maximum Predicted Decibel Levels at Razorbill Nesting Locations

Individual	Launch LAmax		
Razorbill	Pad 1	Pad 2	Pad 3
2 ind, 2-3 km	90-100dB	90-100dB	90-100dB
13 ind, 3-4 km	90-100dB	90-100dB	90-100dB

5.8.36 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, breeding razorbill within the study area and there is also no threshold noise metric against which compare potential effects on razorbill.

5.8.37 A study (Dunnet, 1977) to explore the possibility that an increase in air traffic associated with oilfields off the north-east of Scotland was impacting breeding seabirds recorded the reactions of a mixed seabird colony, including razorbills, on the Buchan cliffs in relation to aircraft flying within 100 m. Virtually no behavioural reaction was reported as a result of the flyovers to within 100 m of the colony which was conducted during early egg laying and early nestling periods (Appendix 5.2).

5.8.38 Breeding razorbills are considered low-moderately sensitive to human activity, visual disturbance and sudden noise events at the nest. Whether the pre-launch warning siren, followed by the low frequency rumble of the Skyrora XL Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Such activity would probably be most severe during pre-egg laying and early incubation period (early April to the end of May). Based on the likely launch schedule, up to three launches would take place during the typical 34-day incubation period for razorbill (Table 5.8). It should be noted that following the NatureScot consultation response (11 March 2021), commitment to a no-launch window whereby no satellite launches will be carried out between mid-May and the end of June has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant .

5.8.39 If a worst-case (*not likely*) scenario is assumed (a failure for all breeding razorbill directly related to a launch) then this would constitute an adverse impact on 15 individuals out of Shetland's 9,492 individual razorbills, i.e., 0.16 % of the regional population (Table 5.9). If no such adverse response took place, then 0 % of the regional population would be adversely affected. Under both of these scenarios, a significant operational impact on the regional razorbill population in Shetland is considered unlikely.

5.8.40 Under both of these scenarios, the potential magnitude of adverse impacts of operational disturbance on razorbill would likely be **negligible**, with **no likely significant effects** predicted. Although razorbill is a species of moderate conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Razorbill is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of razorbill in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the razorbill population on a long-term basis should the Proposed Project be operational.

Shag

5.8.41 Despite being a common and widespread resident breeding species throughout Scotland (Forrester and Andrews, 2007), shag is a Red listed species and therefore of high conservation importance (Table 5.5). Relatively recent surveys of shags have revealed mixed fortunes across colonies from severe decline e.g., Foula (Heubeck *et al.,* 2014), relatively stable populations in the Outer Hebrides (Taylor *et al.,* 2018) to increases elsewhere such as Argyll and north-east Scotland (Forrester and Andrews, 2007). Nevertheless, whilst still numerous, when assessed in 1998-2002, the Britain and Ireland shag population revealed a widespread decline since the mid-1980s, for poorly understood reasons (Mitchell *et al.,* 2004).

5.8.42 The behavioural sensitivity of the species is considered to be low at the nest (Table 5.7). A study (Dunnet, 1977) to explore the possibility that an increase in air traffic associated with oilfields off the north-east of Scotland was impacting breeding seabirds recorded the reactions of a mixed seabird colony, including shags, on the Buchan cliffs in relation to aircraft flying within 100 m. Virtually no behavioural reaction was reported as a result of the flyovers to within 100 m of the colony which was conducted during early egg laying and early nestling periods (Appendix 5.2).

5.8.43 The regional, national and international population estimates of this species are known (Table 5.6). The Shetland NHZ shag population estimate is 6,147 individuals and without evidence to the contrary the species is likely to be in FCS within Shetland, Foula notwithstanding.

5.8.44 The species typically nests among boulders on small islands and at the bases of cliffs, in caves, crevices and less commonly on flat open ledges and high sea cliffs (Forrester and Andrews, 2007). The adults feed at sea and carry fish back to the chicks. Consequently, the breeding sites are a relatively predictable 'fixed constraint' insofar as they nest within the same boulder and cliff habitats over time.

5.8.45 With a maximum of 81 shag AON within the study area, all will be within the range of elevated noise levels associated with the operation of the Proposed Project. Table 5.16 outlines the maximum predicted decibel dB levels on nesting shag. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.16 Maximum Predicted Decibel Levels at Shag Nesting Locations

AON	Launch LAmax		
Shag	Pad 1	Pad 2	Pad 3
1 AON, 0-0.5 km	120-130dB	120-130dB	120-130dB
5 AON, 1-2 km	100-110dB	100-110dB	90-110dB
24 AON, 2-3 km	90-100dB	90-100dB	90-100dB
51 AON, 3-4 km	90-100dB	90-100dB	90-100dB

5.8.46 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, breeding shag within the study area and there is also no threshold noise metric against which compare potential effects on shag. Dunnet's (1977) research suggests that shag may have a tolerance for unexpected loud noises. However, the volume of a launch will exceed that of an aircraft flying within 100 m of nesting shags.

5.8.47 Breeding shags are considered to have low sensitive to human activity, visual disturbance and sudden noise events at the nest. Whether the pre-launch warning siren, followed by the low frequency rumble of the Skyrora XL Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Based on the likely launch schedule, up to three launches would take place during the typical 31 day incubation period for shag (Table 5.8). It should be noted that following the NatureScot consultation response (11 March 2021), commitment to a no-launch window whereby no satellite launches will be carried out between mid-May and the end of June has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.48 If a worst-case (*not likely*) scenario is assumed (a failure for all breeding shag directly related to a launch) then this would constitute an adverse impact on 81 AON out of Shetland's 6,147 AON, i.e., 1.32 % of the regional shag population (Table 5.9). If no such adverse response took place, then 0 % of the regional population would be adversely affected. The former worst-case scenario would constitute a **minor** impact on the regional shag population in Shetland. The question therefore follows, how likely is this worst-case complete breeding failure to occur? Based on Dunnet's (1977) work, it is apparent that shags can tolerate unexpected loud noises and with the vast majority of shag AON in the study area (75 out of the 81) greater than two kilometres away from launch sites, it seems highly unlikely that such a worst-case scenario would occur. Therefore, were any adverse effect to occur (and there is no direct evidence that it would) it would most likely occur on the six AON within two kilometres of the launch pad sites (ca. 0.1% of the regional population).

5.8.49 Consequently, the potential magnitude of adverse impacts of operational disturbance on shag would likely be **negligible**, with **no likely significant effects** predicted. Although shag is a species of high conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely

affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Shag is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of shag in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the shag population on a long-term basis should the Proposed Project be operated.

Kittiwake

5.8.50 Despite being a common and widespread breeding species throughout coastal Scotland (Forrester and Andrews, 2007) and the most numerous gull species in the world (Mitchell *et al.,* 2004), kittiwake is a Red listed species in the UK and therefore of high conservation importance (Table56.5). The national censuses suggested that the Scottish population increased by 4 % between 1969-70 and 1985-88, but then declined by 21 % by 1998-2002, with the greatest declines in Shetland (Mitchell *et al.,* 2004; Forrester and Andrews, 2007). Although this decline occurred throughout most of the British Isles, there was substantial regional variation in trends. Oceanographic changes (resulting in reduction of their food) and predation of kittiwakes by an expanding great skua population in Shetland are believed to have contributed significantly to the overall decline in kittiwakes in Shetland (Mitchell *et al.,* 2004).

5.8.51 The behavioural sensitivity of the species is considered to be low at the nest (Table 5.7). A study (Dunnet, 1977) to explore the possibility that an increase in air traffic associated with oilfields off the north-east of Scotland was impacting breeding seabirds recorded the reactions of a mixed seabird colony, including kittiwakes, on the Buchan cliffs in relation to aircraft flying within 100 m. Virtually no behavioural reaction was reported as a result of the flyovers to within 100 m of the colony which was conducted during early egg laying and early nestling periods (Appendix 5.2).

5.8.52 The regional, national and international population estimates of this species are known (Table 5.6). The Shetland NHZ kittiwake population estimate is 16,732 AON and based on successive seabird surveys the species is unlikely to be in FCS within Shetland.

5.8.53 The species typically nests colonially on vertical rock cliffs, offshore stacks and, occasionally, on man-made structures (Forrester and Andrews, 2007). The adults feed at sea and carry fish back to the chicks. Consequently, the breeding sites are a relatively predictable 'fixed constraint' insofar as they nest within the same cliff habitats over time.

5.8.54 With a maximum of 55 kittiwake AON within the study area, all will be within the range of elevated noise levels associated with the operation of the Proposed Project. Table 5.17 outlines the maximum predicted dB levels on nesting kittiwake. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.17 Maximum Predicted Decibel Levels at Kittiwake Nesting Locations

AON	Launch LAmax		
Kittiwake	Pad 1	Pad 2	Pad 3
50 AON 1-2 km	100-110dB	100-110dB	90-110dB
5 AON 3-4 km	90-100dB	90-100dB	90-100dB

5.8.55 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, breeding kittiwake within the and there is also no threshold noise metric against which compare potential effects on kittiwake. Dunnet's (1977) research suggests that kittiwake may have a tolerance for unexpected loud noises. However, the volume of a launch will exceed that of an aircraft flying within 100 m of nesting kittiwake.

5.8.56 Breeding kittiwakes are considered to have low sensitive to human activity (for example, they have bred on buildings and structures along the quayside at the busy Newcastle-Gateshead Quayside on the River Tyne in Northeast England since the 1960s), visual disturbance and sudden noise events at the nest. Whether the pre-launch warning siren, followed by the low frequency rumble of the Skyrora XL Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Based on the likely launch schedule, up to three launches would take place during the typical 29-day incubation period for kittiwake (Table 5.8). It should be noted that following the NatureScot consultation response (11 March 2021), commitment to a no-launch window whereby no satellite launches will be carried out between mid-May and the end of June has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.57 If a worst-case (*not likely*) scenario is assumed (a failure for all breeding kittiwake directly related to a launch) then this would constitute an adverse impact on 55 AON out of Shetland's 16,732 AON, i.e., 0.32 % of the regional kittiwake population (Table 5.9). If no such adverse response took place, then 0 % of the regional kittiwake population would be adversely affected. How likely is this worst-case complete breeding failure to occur? Based on Dunnet's (1977) work, it is apparent that kittiwakes can tolerate unexpected loud noises and with none within one kilometre of the launch site and 50 AON within two kilometres, it seems unlikely that such a worst-case scenario would occur. Therefore, were any adverse effect to occur (and there is no direct evidence that it would) it would most likely occur on the 50 AON within two kilometres of the launch sites (ca. 0.3 % of the regional population).

5.8.58 Consequently, the potential magnitude of adverse impacts of operational disturbance on kittiwake would likely be **negligible**, with **no likely significant effects** predicted. Although kittiwake a species of high conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Kittiwake is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of kittiwake in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the kittiwake population on a long-term basis should the Proposed Project be operated.

Fulmar

5.8.59 Fulmar is one of the commonest seabirds around Britain (Mitchell *et al.,* 2004) particularly in the Northern Isles and Outer Hebrides, but also breeding in coastal areas throughout Scotland (Forrester and Andrews, 2007). The spectacular growth in fulmar numbers across Britain in the 20th Century is one of the best documented for any bird species (Mitchell *et al.,* 2004). It is the only bird species taken forward for assessment within this AEE chapter that is not conservation listed or specially protected, i.e., it is not Amber, or Red listed and does not appear on Schedule 1 of the 1981 Wildlife and Countryside Act or Annex 1 of the Birds Directive (Table 5.5) and is therefore of low conservation importance. It was taken forward in this assessment based on the relatively large number of AOS recorded within the study area and because SNH specifically mentioned the species during EIA Scoping (Table 5.1).

5.8.60 The behavioural sensitivity of the species is considered to be low at the nest (Table 5.7). A study (Dunnet, 1977) to explore the possibility that an increase in air traffic associated with oilfields off the north-east of Scotland was impacting breeding seabirds recorded the reactions of a mixed seabird colony, including fulmars, on the Buchan cliffs in relation to aircraft flying within 100 m. Virtually no behavioural reaction was reported as a result of the flyovers to within 100 m of the colony which was conducted during early egg laying and early nestling periods (Appendix 5.2).

5.8.61 The regional, national and international population estimates of this species are known (Table 5.6). The Shetland NHZ fulmar population estimate is 188,544 AOS and the species is likely to be in FCS within Shetland.

5.8.62 The species typically nests on cliffs on islands and open coasts, both on vegetated and bare ledges. It can also nest in dunes and on shorelines on low, mammalian predator free, islands. Occasionally it nests on man-made structures such as bridges and quarries (Forrester and Andrews, 2007). The adults feed at sea and bring food back to the chicks. Consequently, the breeding sites are a relatively predictable 'fixed constraint' insofar as they nest within the same cliff and open coast habitats over time.

5.8.63 With a maximum of 6,987 fulmar AOS within the study area, all will be within the range of elevated noise levels associated with the operation of the launch facility. Table 5.18 outlines the maximum predicted dB level on nesting fulmar. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.18 Maximum Predicted Decibel Levels at Fulmar Nesting Locations

AON	Launch LAmax		
Fulmar	Pad 1	Pad 2	Pad 3
430 AON 0-0.5 km	120-130dB	120-130dB	120-130dB
740 AON 0.5-1 km	110-120dB	110-120dB	100-110dB
1,465 AON 1-2 km	100-110dB	100-110dB	90-110dB
2,645 AON 2-3 km	90-100dB	90-100dB	90-100dB
1,707 AON 3-4 km	90-100dB	90-100dB	90-100dB

5.8.64 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, breeding fulmar within the study area and there is also no threshold noise metric against which compare potential effects on fulmar. Dunnet's (1977) research suggests that fulmar may have a tolerance for unexpected loud noises. However, the volume of a launch will exceed that of an aircraft flying within 100 m of nesting fulmar.

5.8.65 Breeding fulmars are considered to have low sensitivity (high tolerance) to human activity, visual disturbance and sudden noise events at the nest. Whether the pre-launch warning siren, followed by the low frequency rumble of the Skyrora XL Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Based on the likely launch schedule, up to five launches would take place during the typical 51-day incubation period for fulmar (Table 5.8). It should be noted that following the NatureScot consultation response (11 March 2021), commitment to a no-launch window whereby no satellite launches will be carried out between mid-May and the end of June has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.66 If a worst-case (*not likely*) scenario is assumed (a failure for all breeding fulmar directly related to a launch) then this would constitute an adverse impact on 6,987 AOS out of Shetland's 188,544 AOS, i.e., 3.7 % of the regional fulmar population (Table 5.9). Based on Dunnet's (1977) work, it is apparent that fulmars can tolerate unexpected loud noises and so it seems highly unlikely that such a worst-case scenario would occur. If no such adverse response took place, then 0 % of the regional fulmar population would be adversely affected. However, this is also considered unlikely given the large number of AOS widely spread throughout the study area, and with 1,170 AOS within one kilometre of launch facilities (ca. 0.6% of regional population), it is considered likely that some of these fulmars will be adverse affected and some breeding attempts may fail, but it is not known how many, but possibly some of the 430 AON within 0.5 km of the launch pads.

5.8.67 Consequently, the potential magnitude of adverse impacts of operational disturbance on fulmar would likely be **negligible** on the regional population, with **no likely significant effects** predicted. Fulmar is not a species of conservation importance, and the likely effects are judged to be not significant, i.e., there would be little/no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Fulmar is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of fulmar in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the fulmar population on a long-term basis should the Proposed Project be operated.

Merlin

5.8.68 Merlin is scarce upland breeding raptor that predominantly nests in heather moorland, usually on sloping ground on hillsides (Forrester and Andrews, 2007). Merlin is an Annex 1, Schedule 1 and Red listed species and therefore is considered to be of High conservation importance (Table 5.5). The behavioural sensitivity of the species is considered High (Table 5.7). The national and international population estimates of this species are known (Table 5.6). The Shetland NHZ merlin population estimate is ca. 30 pairs and without evidence to the contrary the species is likely to be in FCS within Shetland.

5.8.69 The favoured merlin breeding territories tend to be used year after year. Consequently, the breeding sites are relatively predictable, but new sites can and are used in different years. Nesting sites are relatively difficult to find and consequently the species is somewhat under-recorded.

5.8.70 As no merlins nest within the study area, the species is unlikely to be susceptible to disturbance from operational launch activities and **no** likely significant effects are predicted.

5.8.71 Consequently, the potential magnitude of adverse impacts of operational disturbance on merlin would equate to **no effect** on the regional population, with **no likely significant effects** predicted. Although merlin is a species of high conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Merlin is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of merlin in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.

- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the merlin population on a long-term basis should the Proposed Project be operated.

Ringed Plover

5.8.72 Ringed plover is a largely coastal wader species, nesting on or above the strandline on open sand and shingle beaches, but can also use sand dunes, grass hinterlands, rocky headlands, maritime heath, small storm beaches and artificial habitats (Forrester and Andrews, 2007). Ringed plover is a Red listed species and therefore of high conservation importance (Table 5.5). The behavioural sensitivity of the species is considered low (Table 5.7). The national and international population estimates of this species are known (Table 5.6). The Shetland NHZ ringed plover population estimate is 800-1,000 pairs and without evidence to the contrary the species is likely to be in FCS within Shetland.

5.8.73 The favoured breeding sites tend to be used year after year and evidence from 2018 and 2019 surveys shows a high degree of overlap in terms of ringed plover territories. Consequently, the breeding sites are a relatively predictable 'fixed constraint', but new sites can and are used in different years.

5.8.74 With a maximum of ten pairs of ringed plover within the study area, all will be within the range of elevated noise levels associated with the operation of the Proposed Project. Table 5.19 outlines the maximum predicted dB levels on nesting ringed plover. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.19 Maximum Predicted Decibel Levels at Ringed Plover Nesting Locations

Pairs	Launch LAmax		
Ringed plover	Pad 1	Pad 2	Pad 3
3 pairs, 0-0.5 km	120-130dB	120-130dB	120-130dB
4-5 pairs, 1-2 km	100-110dB	100-110dB	90-110dB
1-2 pairs, 2-3 km	90-100dB	90-100dB	90-100dB
0-1 pair, 3-4 km	90-100dB	90-100dB	90-100dB

5.8.75 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, all the breeding ringed plover within the study area and there is also no threshold noise metric against which compare potential effects on ringed plover. The literature review (Appendix 5.3) identified studies on two potentially analogous coastal wader species: Wilson's plover (*Charadrius wilsonia*) and snowy plover (*Charadrius nivosus*). The Wilson's plover study reported military flights increased bird's 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. The snowy plover study was focused on Titan IV rocket launches (130 dBA) and the birds did not exhibit any adverse reactions to a 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.

5.8.76 The lack of an adverse response of the analogous snowy plover to rocket launches up to 130 dBA suggests that *Charadrius* plovers maybe relatively robust/tolerant of sudden, very loud noise events and so worst-case scenarios (where all ten breeding pairs fail) within the study area are considered unlikely to occur. Nevertheless, one-two pairs are particularly close (<250 m) to the launch pads and so are potentially most likely to be adversely affected by operational disturbance. Whether the pre-launch warning siren, followed by the low frequency rumble of the Skyrora XL Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the

birds to cope with the noise is currently speculative. Based on the likely launch schedule, up to two-three launches would take place during the typical 24-day incubation period for ringed plover (Table 5.8). It should be noted that following the NatureScot consultation response (11 March 2021), commitment to a no-launch window whereby no satellite launches will be carried out between mid-May and the end of June has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.77 If a worst-case (*not likely*) scenario is assumed (a failure for all breeding ringed plover directly related to a launch) then this would constitute an adverse impact on 10 pairs out of Shetland's 800-1,000 pairs, i.e., approximately 1 % of the regional ringed plover population (Table 5.9). However, based on the responses of analogous *Charadrius* plovers to rocket launches in the USA, this seems an unlikely scenario. If no such adverse response took place, then 0 % of the regional ringed plover population would be adversely affected. However, this is also considered unlikely given that the territories of one-two pairs in 2018-2019 were located close enough to launch pads (<250 m) to assume that they would likely be adversely affected and possibly fail.

5.8.78 Consequently, the potential magnitude of adverse impacts from operational disturbance on ringed plover would likely be **negligible** on the regional population, with **no likely significant effects** predicted. Although ringed plover is a species of high conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Ringed plover is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of ringed plover in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the ringed plover population on a long-term basis should the Proposed Project be operated.

Golden Plover

5.8.79 Golden plover breeds in semi-natural moorland, dwarf shrub, peatland and arctic alpine heath (Forrester and Andrews, 2007). Golden plover is an Annex 1 wader species and therefore of high conservation importance (Table 5.5), although it is still a quarry species that can legally be shot in season in the UK. The behavioural sensitivity of the species is considered moderate (Table 5.7). The national and international population estimates of this species are known (Table 5.6). The Shetland NHZ golden plover population estimate is 5,665 pairs and without evidence to the contrary the species is likely to be in FCS within Shetland.

5.8.80 There is high annual variation in terms of site occupancy (e.g., with seven breeding pairs recorded in the study area in 2018 and 13 pairs in 2019) and is a feature of many upland golden plover populations Alba Ecology has worked on. Consequently, the breeding sites are considered relatively unpredictable in terms of annual occupancy, although some favoured territories appear to be regularly used.

5.8.81 With a maximum of 13 pairs of golden plover within the study area, all will be within the range of elevated noise levels associated with the operation of the Proposed Project. Table 5.20 outlines the maximum predicted dB level on nesting golden plover. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.20 Maximum Predicted Decibel Levels at Golden Plover Nesting Locations

Pairs	Launch LAmax		
Golden plover	Pad 1	Pad 2	Pad 3
0-1 pair, 0-0.5 km	120-130dB	120-130dB	120-130dB
2-3 pairs, 1-2 km	100-110dB	100-110dB	90-110dB
1-5 pairs, 2-3 km	90-100dB	90-100dB	90-100dB
4 pairs, 3-4 km	90-100dB	90-100dB	90-100dB

5.8.82 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, all the breeding golden plover within the study area and there is also no threshold noise metric against which compare potential effects on golden plover. The literature review (Appendix 5.2) identified studies on two potentially analogous *Charadrius* species: Wilson's plover and snowy plover. The Wilson's plover study 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. The snowy plover study was focused on Titan IV rocket launches (130 dBA) and the birds did not exhibit any adverse reactions to a 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. Furthermore, studies of golden plover breeding on the Otterburn firing range in northern England showed an apparent population increase from 25 pairs in 1994 to 34 pairs in 1998 despite regular loud noise disturbance from live firing and explosions (Appendix 5.2).

5.8.83 The lack of an adverse response of the analogous snowy plover to rocket launches up to 130 dBA and population increases of golden plover in an English live fire range despite explosive noise disturbance suggests that *Charadrius* plovers are relatively robust/tolerant of sudden, very loud noise events and so worst-case scenarios (where all 13 breeding pairs fail) within the study area are considered unlikely to occur. Nevertheless, one pair in 2019 was particularly close <250 m) to the launch pads and so would potentially be most likely to be adversely affected by operational disturbance. Whether the pre-launch warning siren, followed by the low frequency rumble of the Skyrora XL Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Based on the likely launch schedule, up to three launches would take place during the typical 29-day incubation period for golden plover (Table 5.8). It should be noted that following the NatureScot consultation response (11 March 2021), commitment to a no-launch window whereby no satellite launches will be carried out between mid-May and the end of June has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.84 If a worst-case scenario (*not likely*) is assumed (a failure for all breeding golden plover directly related to a launch) then this would constitute an adverse impact on a maximum of 13 pairs out of Shetland's 5,665 pairs, i.e., 0.23 % of the regional golden plover population (Table 5.9). However, based on the responses of analogous *Charadrius* plovers to rocket launches in the USA and golden plover breeding success at an English live firing range, this seems an unlikely scenario. If no such adverse response took place, then 0 % of the regional golden plover population would be adversely affected. However, this is also considered unlikely given that one territory (if subsequently used) is located close enough to launch pads to assume that they would likely be adversely affected and possibly fail.

5.8.85 Consequently, the potential magnitude of adverse impacts of operational disturbance on golden plover would likely be **negligible** on the regional population, with **no likely significant effects** predicted. Although golden plover is a species of high conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was

operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH use to consider FCS):

- Golden plover is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of golden plover in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the golden plover population on a long-term basis should the Proposed Project be operated.

Dunlin

5.8.86 Dunlin breeds on wet upland and montane heath, especially where bog pool systems occur, but also on machair and rarely on salt marsh (Forrester and Andrews, 2007). Dunlin (sub-species *schinzii*, which breeds in Shetland) is an Annex 1 wader species and therefore of high conservation importance (Table 5.5). The behavioural sensitivity of the species is considered moderate (Table 5.7). The national and international population estimates of this species are known (Table 5.6). The Shetland NHZ dunlin population estimate is 2,054 pairs and without evidence to the contrary the species is likely to be in FCS within Shetland.

5.8.87 There is high annual variation in terms of site occupancy (e.g., with five breeding pairs recorded in the study area in 2018 and four pairs in 2019, mostly in different locations). Consequently, the breeding sites are considered relatively unpredictable in terms of annual occupancy, although some favoured territories appear to be regularly used.

5.8.88 With a maximum of five pairs of dunlin within the study area, all will be within the range of elevated noise levels associated with the operation of the Proposed Project. Table 5.21 outlines the maximum predicted dB levels on nesting dunlin. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.21 Maximum Predicted Decibel Levels at Dunlin Nesting Locations

Pairs	Launch LAmax		
Dunlin	Pad 1	Pad 2	Pad 3
0-1 pair, 0-0.5 km	120-130dB	120-130dB	120-130dB
2 pairs, 1-2 km	100-110dB	100-110dB	90-110dB
0-1 pair, 2-3 km	90-100dB	90-100dB	90-100dB
1-2 pairs, 3-4 km	90-100dB	90-100dB	90-100dB

5.8.89 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, all the breeding dunlin within the study area and there is also no threshold noise metric against which compare potential effects on dunlin. The literature review (Appendix 5.2) did not identify any directly relevant studies on dunlin or potentially analogous wader species. Based on current information it is not possible to predict likely responses of all breeding dunlin to the noise caused by the launches, but it is considered that one territory occupied in 2019 would likely be adversely affected (were it to be subsequently occupied) by operational noise during launches. Whether the pre-launch warning siren, followed by the low frequency rumble of the Skyrora XL Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Based on the likely launch schedule, up to two launches would take place during the typical 22-day incubation period for dunlin (Table 5.8). It should be noted that following the NatureScot consultation response (11

March 2021), commitment to a no-launch window whereby no satellite launches will be carried out between mid-May and the end of June has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.90 If a worst-case scenario (*not likely*) is assumed (a failure for all breeding dunlin directly related to a launch) then this would constitute an adverse impact on a maximum of five pairs out of Shetland's 2,054 pairs, i.e., 0.24 % of the regional dunlin population (Table 5.9). However, based on the predicted responses of other waders, this worst-case scenario seems an unlikely scenario. If no such adverse response took place, then 0 % of the regional dunlin population would be adversely affected. However, this is also considered unlikely given that one territory (in 2019) was located close enough to launch pads to assume that they would likely be adversely affected were it to be subsequently occupied.

5.8.91 Consequently, the potential magnitude of adverse impacts of operational disturbance combined on dunlin would likely be **negligible** on the regional population, with **no likely significant effects predicted**. Although dunlin is a species of high conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Dunlin is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of dunlin in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the dunlin population on a long-term basis should the Proposed Project be operated.

Whimbrel

5.8.92 Within Shetland, whimbrel breed in short vegetation on wet heath, blanket bog and serpentine heath (Grant 1991; Massey *et al.,* 2016). Whimbrel is a Schedule 1 and Red listed wader species and therefore of high conservation importance (Table 5.5). The behavioural sensitivity of the species is considered to be moderate (Table 5.7). The national and international population estimates of this species are known (Table 5.6). The published Shetland NHZ whimbrel population estimate is 290 pairs, but should be increased by 10 % (Digger Jackson, *pers comm.*) to ca. 320 pairs. The current status of the Shetland population is unknown, but detailed monitoring across west and central Shetland suggests it has not substantially changed over the last decade and consequently the species is probably in FCS within Shetland, especially with great skua, believed to be the main culprit in the species' decline (at least in the Northern Isles), now apparently in decline itself. It should be noted that the RSPB quote that the Shetland and Orkney breeding population has been slowly increasing and the UK population estimate to be 400-500 pairs (https://www.rspb.org.uk/birds-and-wildlife/wildlife-guides/bird-a-z/whimbrel/ - accessed August 2020). It is not clear on what the much higher RSPB population data is based, but it is considered misleading and so has not been used within this assessment.

5.8.93 There is a relatively low variation in terms of site occupancy (with five breeding pairs recorded in the study area in 2018 and four pairs in 2019, mostly in similar locations). Consequently, the breeding sites are considered relatively predictable in terms of annual occupancy.

5.8.94 Details of potential impacts on whimbrel have been provided previously in a confidential appendix to the local planning authority in accordance with SNH (2016) guidance.

5.8.95 The potential magnitude of adverse impacts of operational disturbance on whimbrel would likely be **negligible** on the regional (which also is almost all the national) population, with **no likely significant effects** predicted, as discussed below. Although whimbrel is a species of high

conservation importance and probably in FCS, the likely effects are judged to be not significant, i.e. there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Whimbrel is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of whimbrel in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the whimbrel population on a long-term basis should the Proposed Project operate.

Curlew

5.8.96 Curlew is a widespread but declining Scottish breeding bird on farmland and uplands (Forrester and Andrews, 2007). Curlew is a Red listed wader species and therefore of high conservation importance (Table 5.5). The behavioural sensitivity of the species is considered to be moderate (Table 5.7). The national and international population estimates of this species are known (Table 5.6). The Shetland NHZ curlew population estimate is 4,227 pairs and without evidence to the contrary, the species is likely to be in FCS within Shetland.

5.8.97 There is relatively low variation in terms of site occupancy, with many territories occupied in both years of survey (e.g., there were ca. 16 breeding territories in 2018 and ca. 13 in 2019). Consequently, the breeding sites are considered relatively predictable in terms of annual occupancy.

5.8.98 With a maximum of 16 pairs of curlew within the study area, all will be within the range of elevated noise levels associated with the operation of the launch facility. Table 5.23 outlines the maximum predicted dB levels on nesting curlew. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.23 Maximum Predicted Decibel Levels at Curlew Nesting Locations

Pairs	Launch LAmax		
Curlew	Pad 1	Pad 2	Pad 3
0-1 pair, 0-0.5 km	120-130dB	120-130dB	120-130dB
2-3 pairs, 1-2 km	100-110dB	100-110dB	90-110dB
5 pairs, 2-3 km	90-100dB	90-100dB	90-100dB
5-8 pairs, 3-4 km	90-100dB	90-100dB	90-100dB

5.8.99 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, all the breeding curlew within the study area and there is also no threshold noise metric against which compare potential effects on curlew. The literature review (Appendix 5.2) did not identify any directly relevant noise studies on breeding curlew or potentially analogous wader species (although it did note some evidence of noise disturbance impacts on wintering curlew). Based on current information it is not possible to predict likely responses of all breeding curlew to the noise caused by the launches, but it is considered that one-two regularly occupied territories would likely be adversely affected by operational noise during launches. Whether the pre-launch warning siren, followed by the low frequency rumble of the Skyrora XL Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Based on the likely launch schedule, up to three launches would take place during the typical 28-day incubation period for curlew (Table 5.8). It should be noted that following the NatureScot consultation response (11 March 2021),

commitment to a no-launch window whereby no satellite launches will be carried out between mid-May and the end of June has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.100 If a worst-case scenario (*not likely*) is assumed (a failure for all breeding curlew directly related to a launch) then this would constitute an adverse impact on a maximum of 16 pairs out of Shetland's 4,227 pairs, i.e.,0.4 % of the regional curlew population (Table 5.9). However, based on the distribution of curlew territories and predicted responses of other waders, this worst-case scenario seems an unlikely scenario. If no such adverse response took place, then 0 % of the regional curlew population would be adversely affected. However, this is also considered unlikely given that one-two territories are located close enough to launch pads to assume that they would likely be adversely affected. Were that scenario to take place, this would constitute an adverse effect (loss) of 0.02-0.05 % of the regional curlew population.

5.8.101 Consequently, the potential magnitude of adverse impacts of operational disturbance on curlew would likely be **negligible** on the regional population, with **no likely significant effects** predicted. Although curlew is a species of high conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Curlew is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of curlew in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the curlew population on a long-term basis should the Proposed Project be operated.

Arctic Tern

5.8.102 Arctic tern is a widespread coastal breeding summer visitor, with strongholds in Orkney and Shetland (Forrester and Andrews, 2007). Arctic tern is an Amber listed species and therefore of moderate conservation importance (Table 5.5). The behavioural sensitivity of the species at the nest is considered to be moderate (Table 5.7). The national and international population estimates of this species are known (Table 5.6). The Shetland NHZ population estimate is 24,716 AON and without evidence to the contrary, the species is likely to be in FCS within Shetland.

5.8.103 There is some variation in terms of site occupancy, with a few small breeding colonies present within the study area, which fluctuate annually in terms of occupancy.

5.8.104 With a maximum of 13 Arctic tern AON within the study area, all will be within the range of elevated noise levels associated with the operation of the Proposed Project. Table 5.24 outlines the maximum predicted dB levels on nesting Arctic tern. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.24 Maximum Predicted Decibel Levels at Arctic Tern Nesting Locations

Pairs	Launch LAmax		
Arctic tern	Pad 1	Pad 2	Pad 3
8-13 pairs, 1-2 km	100-110dB	100-110dB	90-110dB
0-1 pair, 2-3 km	90-100dB	90-100dB	90-100dB

5.8.105 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, all the breeding Arctic tern within the study area and there is also no threshold noise metric against which compare potential adverse effects on Arctic tern. The literature review (Appendix 5.2) found that Arctic tern 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. Based on current information it is not possible to predict likely responses of all breeding Arctic tern to the noise caused by the launches. Whether the pre-launch warning siren, followed by the low frequency rumble of the Skyrora XL Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Based on the likely launch schedule, up to two launches would take place during the typical 22-day incubation period for Arctic tern (Table 5.8). It should be noted that following the NatureScot consultation response (11 March 2021), commitment to a no-launch window whereby no satellite launches will be carried out between mid-May and the end of June has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.106 If a worst-case scenario (*not likely*) is assumed (a failure for all breeding Arctic tern directly related to a launch) then this would constitute an adverse impact on a maximum of 13 AON out of Shetland's 24,716 AON, i.e., 0.05 % of the regional Arctic tern population (Table 5.9). However, given the distance between the small Arctic tern colonies and the launch sites, this worst-case scenario seems an unlikely scenario. If no such adverse response took place, then 0 % of the regional Arctic tern population would be adversely affected and this seems most likely.

5.8.107 Consequently, the potential magnitude of adverse impacts of operational disturbance on Arctic tern would likely be **negligible** on the regional populations, with **no likely significant effects** predicted. Although Arctic tern is a species of moderate conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Arctic tern is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of Arctic tern in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the Arctic tern population on a long-term basis should the Proposed Project be operated.

Arctic Skua

5.8.108 Arctic skua is a localised and apparently declining breeding species in Scotland (Forrester and Andrews, 2007). Arctic skua is a Red list species and therefore of high conservation importance (Table 5.5). The behavioural sensitivity of the species is considered to be moderate at the nest (Table 5.7). The national and international population estimates of this species are known (Table 5.6). The Shetland NHZ population estimate is 516 pairs and without evidence to the contrary, the species is unlikely to be in FCS within Shetland.

5.8.109 There is annual variation in terms of site occupancy, but some territories were occupied in both years of survey (there were five breeding territories in 2018 and 2019). Consequently, some of the breeding sites are relatively predictable in terms of annual occupancy.

5.8.110 With a maximum of five pairs of Arctic skua within the study area, all will be within the range of elevated noise levels associated with the operation of the Proposed Project. Table 5.25 outlines the maximum predicted dB levels on nesting Arctic skuas.

Table 5.25 Maximum Predicted Decibel Levels at Arctic Skua Nesting Locations

Pairs	Launch LAmax		
Arctic skua	Pad 1	Pad 2	Pad 3
1 pair, 0.5-1 km	110-120dB	110-120dB	100-110dB
1-2 pairs, 1-2 km	100-110dB	100-110dB	90-110dB
2-3 pairs, 2-3 km	90-100dB	90-100dB	90-100dB

5.8.111 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, all the breeding Arctic skua within the study area and there is also no threshold noise metric against which compare potential effects on Arctic skua. The literature review (Appendix 5.2) did not identify any directly relevant noise studies on breeding Arctic skua or potentially analogous species. Based on current information it is not possible to predict likely responses of all breeding Arctic skua to the noise caused by the launches, but it is considered that one regularly occupied territory (approximately 600 m away from the most westerly launch pad) would likely be adversely affected by operational noise during launches. Whether the pre-launch warning siren, followed by the low frequency rumble of the Skyrora XL Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Based on the likely launch schedule, up to three launches would take place during the typical 27-day incubation period for Arctic skua (Table 5.8). It should be noted that following the NatureScot consultation response (11 March 2021), commitment to a no-launch window whereby no satellite launches will be carried out between mid-May and the end of June has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.112 If a worst-case scenario (*not likely*) is assumed (a failure for all breeding Arctic skua directly related to a launch) then this would constitute an adverse impact on a maximum of five pairs out of Shetland's 516 pairs, i.e., 0.97 % of the regional Arctic skua population (Table 5.9). However, given the distance away of some territories, this worst-case scenario seems an unlikely scenario. If no such adverse response took place, then 0 % of the regional Arctic skua population would be adversely affected. However, this is also considered unlikely given that one territory is located close enough to launch pads to assume that they would likely be adversely affected. Were that scenario to take place, this one pair would constitute an adverse effect (loss) on 0.19 % of the regional Arctic skua population.

5.8.113 Consequently, the potential magnitude of adverse impacts of operational disturbance on Arctic skua would likely be **negligible** on the regional population, with **no likely significant effects** predicted. Although Arctic skua is a species of high conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates, that the conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Arctic skua is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of Arctic skua in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the Arctic skua population on a long-term basis should the Proposed Project be operated.

Great Skua

5.8.114 Great skua is a localised breeding species in Scotland (Forrester and Andrews, 2007). Great skua is an Amber listed species and therefore of moderate conservation importance (Table 5.5). The behavioural sensitivity of the species is considered to be low at the nest (Table 5.7). The national and international population estimates of this species are known (Table 5.6). The Shetland NHZ population estimate is 6,846 pairs and without evidence to the contrary, the species is likely (in the long-term) to be in FCS within Shetland. A study of abundance data in Scotland from 1992 to 2015 indicated that great skuas increased at most sites, with some very large increases at smaller colonies. However, declines at the two largest colonies (Foula and Hoy) resulted in little overall change in AOTs across all colonies combined (https://jncc.gov.uk/our-work/great-skua-stercorarius-skua/#conservation-status: Accessed August 2020).

5.8.115 The difficulties in distinguishing between non-breeding and breeding pairs holding territory, makes estimates of annual site occupancy challenging (unless undertaken as part of detailed single species monitoring). Consequently, the surveys do not provide sufficient information to comment on annual site occupancy in any detail. At best, the surveys provide evidence of breeding pairs in the low tens, with breeding mainly concentrated over three kilometres away from the Proposed Project around Saxa Vord hill.

5.8.116 With tens of pairs of great skua within the study area, all will be within the range of elevated noise levels associated with the operation of the Proposed Project (Drawing 5.21). Table 5.26 outlines the maximum predicted dB levels on nesting great skuas. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.26 Maximum Predicted Decibel Levels at Great Skua Nesting Locations

Pairs	Launch LAmax		
Great skua	Pad 1	Pad 2	Pad3
Low tens of pairs, 3-4 km	90-100dB	90-100dB	90-100dB

5.8.117 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, all the breeding great skua within the study area and there is also no threshold noise metric against which compare potential effects on great skua. The literature review (Appendix 5.2) did not identify any directly relevant noise studies on great skua or potentially analogous species. Based on current information it is not possible to predict likely responses of all breeding great skua to the noise caused by the launches. Nevertheless, with most of the tens of pairs 3-4 km away from the launch site, few if any breeding pairs would likely be adversely affected by operational noise during launches. Whether the pre-launch warning siren, followed by the low frequency rumble of the Skyrora XL Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Based on the likely launch schedule, up to three launches would take place during the typical 29-day incubation period for great skua (Table 5.8). It should be noted that following the NatureScot consultation response (11 March 2021), commitment to a no-launch window whereby no satellite launches will be carried out between mid-May and the end of June has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.118 If a worst-case scenario (*not likely*) is assumed (a failure for all breeding great skua directly related to a launch) then this would constitute an adverse impact on a maximum of low tens of pairs out of Shetland's 6,846 pairs, i.e., <1 % of the regional great skua population (Table 5.9). However, given the large distance away of most breeding territories, this worst-case scenario seems an unlikely scenario. If no such adverse response took place, then 0 % of the regional great skua population would be adversely affected and this seems most likely.

5.8.119 Consequently, the potential magnitude of adverse impacts of operational disturbance on great skua would likely be **negligible** on the regional population, with **no likely significant effects** predicted. Although great skua is a species of moderate conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH use to consider FCS):

- Great skua is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of great skua in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the great skua population on a long-term basis should the Proposed Project be operated.

Natural Capital

5.8.120 Informal discussions with local birdwatchers and whale watchers raised a concern that access to the favoured tip of Lamba Ness might be curtailed by the Proposed Project. As a consequence of this, a new dedicated wildlife watching hide and path too it will be built. Details of the wildlife watching hide are provided in Appendix 5.3 Habitat Management Plan.

5.9 Additional Mitigation

5.9.1 The Habitat Management Plan for the SaxaVord Spaceport identifies seven objectives, three of which are focussed on breeding Schedule 1 bird species and therefore relevant to this chapter.

5.9.2 Two of the objectives, creation of breeding pools and protection/restoration of existing pools, target mitigation for species likely to be adversely affected by the Spaceport and hence the Proposed Project. The third objective, habitat creation, is better described as enhancement as the objective is for a receptor where no adverse or likely significant effects are predicted. All objectives are the responsibility of SaxaVord Spaceport but will be adhered to by the Applicant as applicable.

5.9.3 After mitigation, all residual effects are predicted likely to be not significant.

5.10 Residual Effects

5.10.1 No likely significant residual effects are predicted.

5.11 Cumulative Assessment

5.11.1 Cumulative effects can result from individually insignificant but collectively significant actions taking place over a period of time or concentrated in a location (CIEEM, 2018). This guidance goes on to say that "*developments to be included in the cumulative impact assessment should be in accordance with national guidance*".

5.11.2 SNH provides no advice or guidance in relation to the cumulative impacts of a spaceport. CIEEM (2018) state in relation to cumulative assessment that "*Information about developments within the zone(s) of influence may be available in other EcIAs, Local Plan documents, Marine Spatial Plans, Strategic Environmental Assessments (SEAs), Sustainability Appraisals (SAs), Water Framework Directive Assessments (WFDAs), and Habitats Regulations Assessments/Appraisals (HRAs), including 'Natura Impact Statements' (NISs) / 'Natura Impact Reports' (NIRs), 'Information / 'Reports to Inform an Appropriate Assessment', 'Shadow Habitats Regulations Assessments' and, for Nationally Significant Infrastructure Projects, 'Reports on the Implications for European Sites' (RIES)*".

5.11.3 Shetland Islands Council confirmed during the planning application for SaxaVord Spaceport that there were no other committed development or infrastructure projects which needed to be considered in that assessment and there has been no change subsequent to planning consent. As such, as far as the Applicant is aware, there are no like for like or similar projects within the ecological study area and therefore, no significant issues are likely to arise from developments other than the SaxaVord Spaceport.

5.11.4 The SaxaVord Spaceport has a proposed capacity for 30 launches per annum. Once maximum launch cadence is achieved, the Proposed Project will account for 16 of those launches. A comparison of the Skyrora XL Launch Vehicle against the RepLV used as the basis of assessment in the SaxaVord Spaceport AEE has been undertaken; the composition and fuelling specifics of the two launch vehicles has been assessed by all technical leads working on the AEE and a review of environmental effect significance from the two vehicles carried out. It has been confirmed that for all topics, the Skyrora XL Launch Vehicle is within the limiting case envelope assessed for the SaxaVord Spaceport - sub-orbital and orbital launches of small satellites into either polar or sun-synchronous, low-earth orbits. As such the assessment of cumulative ornithological effects completed for the SaxaVord Spaceport AEE is considered appropriate to this AEE.

5.11.5 Assuming operators are identified for the remaining capacity, the cumulative ornithological effects of all 30 launches would therefore be expected to be as documented in the SaxaVord Spaceport AEE:

"The ornithological study area (out to four kilometres from the Proposed Project) is an equivalent to the potential 'zone of influence' and as there are no existing or proposed developments within that area, no significant issues are considered likely to arise from inter-project additive or cumulative effects.

Intra-project cumulative effects are those where an environmental topic/receptor is affected by more than one impact from the same Proposed Project and the impacts act together. The interactions between noise and ornithology have been identified and assessed within this chapter, and no other environmental topic are considered likely to give rise to potential intra-project cumulative effects."

5.12 Summary

5.12.1 Targeted and licensed breeding bird surveys were undertaken following agreed standardised survey methods between 2018 and 2020 within the ornithological study area. A total of 135 bird species were recorded during breeding bird surveys. There was direct evidence of potentially sensitive and specially protected bird species breeding within, and adjacent to, the Proposed Project boundary.

5.12.2 Ornithological designated site interests on the Hermaness, Saxa Vord and Valla Field SPA (and overlapping Hermaness SSSI and Saxa Vord SSSI) and the following non-designated wider countryside ornithological birds are taken forward for assessment: red-throated diver, merlin, black guillemot, common guillemot, puffin, razorbill, shag, kittiwake, fulmar, ringed plover, golden plover, whimbrel, curlew, dunlin, Arctic tern, Arctic skua, great skua and a confidential Schedule 1 species.

5.12.3 To understand potential impacts of loud, short duration noise events, a background literature review of noise impacts on relevant bird species was undertaken. This literature review looked at how impulsive noise (from various sources including aircraft, fireworks, military ranges and rocket launches) impacted on birds in order to help assess the potential noise impacts of the launches.

5.12.4 Potential impacts from the Proposed Project (preparation and launch of the Skyrora XL Launch Vehicle) have been assessed. The magnitude of predicted operational effects is either 'no effect' or 'negligible' for all bird species considered except one. Minor operational impacts are predicted for a confidential Schedule 1 breeding species.

5.12.5 Confidential bird species information has been submitted to and assessed previously by the local planning authority, as part of the planning process for the Proposed Project.

5.12.6 A summary of the magnitude of predicted residual effects on target study area wider countryside bird species is provided in Table 5.27.

Table 5.27 Significance of Residual Effects on Target Species

Species	Significance of Residual Effect
Red-throated diver	No likely significant effect
Black guillemot	No likely significant effect
Common guillemot	No likely significant effect
Puffin	No likely significant effect
Razorbill	No likely significant effect
Shag	No likely significant effect
Kittiwake	No likely significant effect
Fulmar	No likely significant effect
Merlin	No likely significant effect
Ringed plover	No likely significant effect
Golden plover	No likely significant effect
Dunlin	No likely significant effect
Whimbrel	No likely significant effect
Curlew	No likely significant effect
Confidential Schedule 1 species*	No likely significant effect
Arctic tern	No likely significant effect
Arctic skua	No likely significant effect
Great skua	No likely significant effect

*Minor magnitude operational effects were considered likely to be significant before mitigation. After mitigation applied, effects are predicted likely to be not significant.

5.12.7 After mitigation, all residual effects are predicted likely to be not significant.

5.13 References

BirdLife International. (2004; updated on-line 2015). *Birds in Europe: population estimates, trends and conservation status*. BirdLife Conservation Series No. 12, Cambridge, UK; On-line update accessed July 2020.

Brown, A.F and Shepherd, K.B. (1993). *A method for censusing upland breeding waders*. Bird Study 40: 189-195.

CIEEM. (2016). *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal*, 2nd edition Chartered Institute of Ecology and Environmental Management, Winchester.

CIEEM. (2018). *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine version 1.1*. Chartered Institute of Ecology and Environmental Management, Winchester.

CIEEM, CIRIA and IEMA, (2019). *Biodiversity Net Gain: Good practice principles for development. A Practical Guid*e. CIRIA C776a.

CIEEM. *Biodiversity Net Gain in Scotland*. (2020). CIEEM Scotland Policy Group.

Dunnet, G. M. (1977). *Observation on the effects of low-flying aircraft at seabird colonies on the coast of Aberdeenshire, Scotland*. Biological Conservation 12, 55-63.

Eaton, M., Aebischer, N., Brown, A., Hearn, R., Lock, L., Musgrove, A., Noble, D., Shroud, D. and Gregory, R.D. (2015). *Birds of Conservation Concern 4: the population status of birds in the United Kingdom, Channel Islands and the Isle of Man.* British Birds 108: 708-746.

Gilbert, G., Gibbons, D.W. and Evans, J. (1998). *Bird Monitoring Methods: a manual of techniques for key UK species*. RSPB, Sandy.

Forrester, R. and Andrews, I. (eds). (2007). *The Birds of Scotland.* The Scottish Ornithologists' Club, Aberlady.

Grant, M.C. (1991). *Nesting densities, productivity and survival of breeding Whimbrel Numenius phaeopus in Shetland*. Bird Study 38: 160–169.

Grant, M.C., Chambers, R. and Evans, P.R. (1992). *The effects of re-seeding heathland on breeding Whimbrel Numenius phaeopus in Shetland. III. Habitat use by broods*. J. Appl. Ecol. 29: 516–523.

Hardey, J., Crick, H., Wernham, C., Riley, H., Etheridge, B. and Thompson, D. (2013). (3rd Edition). *Raptors, a field guide to survey and monitoring*. The Stationery Office, Edinburgh.

Heubeck, M., Gear, S. and Harris, M. (2014). *A photographic survey of seabird colonies on Foula, Shetland*. Scottish Birds 34: 291-302.

Joint Nature Conservation Committee. (2012). *The UK Biodiversity Action Plan* http://jncc.defra.gov.uk/page-5155

Massey, K., Cosgrove, P., Massey, F., Jackson, D. and Chapman, M. (2016). *Habitat characteristics of breeding Eurasian Whimbrel Numenius phaeopus on Mainland Shetland, Scotland, UK*. Bird Study 63: 500-508.

Mitchell, I.P., Newton, S.F., Ratcliffe, N. and Dunn, T.E. (2004). *Seabird populations of Britain and Ireland*. Poyser.

Murray, S., Harris, M.P., and Wanless, S. (2015). *The status of the Gannet in Scotland in 2013-2014*. Scottish Birds 35: 3-18

Owen, E., Prince, O., Cachia-Zammit, C., Cartwright, R., Coledale, T., Elliot, S., Haddon, S., Longmore, G., Swale, J., West, F. and Hughes, R., (2018). *Counts of Puffins in Shetland suggest an apparent decline in numbers*. Scottish Birds 38: 223-231.

Pearce-Higgins, J.W. and Grant, M.C. (2006). *Relationships between bird abundance and the composition and structure of moorland vegetation*. Bird Study 53: 112-125.

Pearce-Higgins, J.W., Stephen, L., Douse, A. and Langston, R.H.W. (2012). *Greater impacts of wind farms on bird populations during construction than subsequent operation: results of a multi-site and multi-species analysis*. Journal of Applied Ecology 49: 386-394.

Pennington, M., Osborn, K., Harvey, P., Riddington, R., Okill, D., Ellis, P and Heubeck, M. (2004). *The Birds of Shetland.* Helm, London.

Ruddock, M. and Whitfield, D.P. (2007). *A review of disturbance distances in selected bird species.* A report from Natural Research (Projects) Ltd to SNH.

Scottish Government. (2012). *Vulnerability of Scottish seabirds to offshore wind turbines*.

Birds of the Western Palearctic. (eds Snow and Perrins). 1998. Oxford.

Smith, R. B. & Breininger, D. R. 1995. *Wading Bird Populations of the Kennedy Space Center*. Bulletin of Marine Science, 57, 230-236.

Stroud, D.A., Mudge G.P. and Pienkowski, M.W. (1990). *Protecting Internationally Important Bird Sites: A Review of EEC Special Protected Area Network in Great Britain*. Nature Conservancy Council, Peterborough, UK.

SNH. (2006). *Assessing Significance of Impacts from Onshore Windfarms on Birds Outwith Designated Areas*. SNH guidance.

SNH. (2016) Environmental Statements and Annexes of Environmentally Sensitive Bird Information Guidance for Developers, Consultants and Consultees.

Taylor, P., MacMinn, R., Marsh, S., de L. Brooke, M., Macdonald, M., Hughes, P., Donald, F., Docherty, H., Over, A., Beaton. J., Scridel., D., Robertson, L. and Currie, N. (2018). *Seabird population trends on the Shiant Isles, Outer Hebrides, 2000-15*. Scottish Birds 38: 3-14.

Civil Aviation Authority et al. (2021). *CAP2215 Guidance for the Assessment of Environmental Effects.*

Viking Energy Partnership. (2009). *The Viking Wind Farm Environmental Statement*.

Walsh, P.M., Halley, D.J., Harris, M.P., del Nevo, A., Sim, I.M.W. and Tasker, M.L. 1995 (reprinted 2011). *Seabird monitoring handbook for Britain and Ireland*. Published by JNCC/RSPB/ITE/Seabird Group, Peterborough.

Whittingham, M.J., Percival, S.M. and Brown, A.F. (2000). *Time budgets and foraging of breeding golden plover*. Journal of Applied Ecology 37: 632-646.

Wilson, M.W., Austin, G.E., Gillings, S. and Wernham, C.V. (2015). *Natural Heritage Zone Bird Population Estimates*. SWBSG Commissioned Report: 1504

Woodward, I., Aebischer, N., Burnell, D., Eaton, M., Frost, T., Hall, C., Stroud, D. and Noble, D. (2020). *Population estimates of birds in Great Britain and the United Kingdom*. British Birds 113: 69-104.

Chapter 6 Ecology

6. Ecology and Biodiversity

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6. Ecology and Biodiversity

6.1 Introduction

6.1.1 This chapter considers the likely effects of the Proposed Project on ecological receptors on-site and in the relevant ecological study area. This assessment is based upon comprehensive baseline data, comprising specifically targeted ecological surveys of potentially important and legally protected ecological receptors identified during the desk study and consultation feedback. It draws on pre-existing information, where appropriate, survey data and Chartered Institute for Ecology and Environmental Management (CIEEM) best practice guidance. The scope of the ecological assessment excludes potential impacts on birds, which are considered separately in Chapter 5.

6.1.2 Alba Ecology Limited led on all aspects of the ecological fieldwork and assessment of the Proposed Project. Alba Ecology is a Scottish-based multi-disciplinary ecological consultancy that has worked in the north of Scotland, and Shetland specifically, for many years. Alba Ecology's staff have led on and contributed to all aspects of Ecological Impact Assessment (EcIA) on many large-scale development projects, including the management of Ecological Clerks of Work teams, principal ornithological/ecological surveyors and advisors on planning applications, expert witness advice at Public Local Inquiry and production of EcIA Reports, Habitat Regulations Assessments and Habitat Management Plans.

6.1.3 The ecological surveyors used between 2018 and 2020 were Dr Peter Cosgrove, Mr Brydon Thomason, Dr Fergus Massey and Dr Kate Massey.

6.1.4 The aforementioned surveyors have extensive ecological field experience of Shetland, and Unst specifically, and have attended regular training events led by experts, covering areas such as species identification, recording data concisely and accurately, navigation techniques and health and safety. Surveyors were trained to carry out surveying and mapping work in a systematic manner, following recognised standardised survey methods. When ecological surveys required working near birds listed in Schedule 1 of the Wildlife and Countryside Act 1981 (and as amended) in the breeding season they were covered by relevant Scottish Natural Heritage (now NatureScot) Schedule 1 Bird Licences.

6.1.5 This Chapter is supported by the following documents:

- Appendix 6.1: Natural Heritage Desk Study.
- Appendix 6.2: Phase 1 Habitat, National Vegetation Classification (NVC) and Potential Groundwater dependent Terrestrial Ecosystem (GWDTE) Survey Report.
- Appendix 6.3a: Otter Survey Report and Otter Protection Plan March 2022.
- Appendix 6.3b: SaxaVord Spaceport pre-construction Otter Survey Report 2022.
- Appendix 6.4: Freshwater Pearl Mussel Survey Report.
- Appendix 6.5: SaxaVord Spaceport AEE Chapter 9: Water.
- Appendix 5.3: Habitat Management Plan.

6.1.6 This Chapter should be read alongside other chapters within the AEE Report, in particular Chapters 2, 3, 5, and 10.

6.1.7 The assessment involved the following key stages:

- Reference to relevant legislation, policy and guidance.
- Identification of likely environmental zone of influence (study area) and within that, relevant ecological study area, for the Proposed Project.

- Identification of potentially important ecological receptors likely to be affected (baseline conditions) by the Proposed Project.
- Evaluation of important ecological receptors and features likely to be affected by the Proposed Project.
- Identification of likely impacts and magnitude of the Proposed Project works on important ecological receptors.
- Assessment of the likely significant effects of the Proposed Project, including any mitigation and enhancement measures and definition of any residual significant effects.

6.1.8 The term '*receptor*' is used throughout this AEE and is defined as the element in the environment affected by a Project (e.g., a species or habitat in the case of ecology). The term '*impact*' is also used commonly throughout the AEE and is defined as a change experienced by a receptor (this can be beneficial, neutral or adverse). The term '*effect*' is defined as the consequences for the receptor of an impact.

6.2 Legislation, Policy and Guidelines

Legislation

Space Industry Act

6.2.1 The Space Industry Act (2018) regulates all spaceflight activities carried out in the United Kingdom, and associated activities. The Act requires any person or organisation to obtain the relevant licence to:

- launch a launch vehicle from the UK;
- return a launch vehicle launched elsewhere than the UK to the UK landmass or the UK's territorial waters;
- operate a satellite from the UK;
- conduct sub-orbital activities from the UK;
- operate a spaceport in the UK; or
- provide range control services from the UK.

6.2.2 As the Applicant wishes to become a spaceflight operator and launch launch vehicles from the UK, it is required to apply for a launch operator licence, and as part of this application, submit an AEE of the proposed project.

Space Industry Regulations 2021

6.2.3 The Space Industry Regulations 2021 (the Regulations) set out in more detail the requirements for each licence the Regulators Licensing rules, which specify what information the UK Civil Aviation Authority (CAA), the regulator, requires in support of an application.

Policy Context

6.2.4 Further relevant legislation and best practice guidance documents have been reviewed and taken into account as part of this ecological assessment. The approach used to assess the significance of likely effects of the Proposed Project upon ecological receptors is set in the context of:

- The Wildlife and Countryside Act 1981 (as amended);
- European Commission (EC) (2011) European Biodiversity Strategy;
- European Commission (EC) (2020). European Biodiversity Strategy;

- EC Directive 1992/43/EEC on the conservation of natural habitats and of wild fauna and flora. The so-called 'Habitats Directive';
- The Conservation (Natural Habitats) Regulations 1994. The so-called Habitats Regulations;
- The Conservation of Habitats and Species Regulations 2010;
- The Nature Conservation (Scotland) Act 2004 (as amended);
- Scottish Government PAN 1/2013;
- Guidelines for Ecological Impact Assessment in the UK and Ireland (CIEEM, 2016; 2018);
- Scottish Government. The Scottish Biodiversity List (SBL);
- Scottish Government 2014. Scottish Planning Policy;
- Scottish Government 2020. The Environment Strategy for Scotland: vision and outcomes;
- Biodiversity Net Gain: Good practice principles for development: A practical guide. (CIRIA, CIEEM and IEMA 2019);
- Biodiversity New Gain in Scotland, CIEEM Scotland Policy Group, 2019;
- Strategic Plan for Biodiversity 2011-2020. Convention on Biological Diversity;
- Land-use planning system Scottish Environment Protection Agency (SEPA) Guidance Note 31: Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems. LUPG-GU31 Version 3 (SEPA, 2017); and
- Living Shetland Local Biodiversity Action Plan (LBAP) documents.

6.2.5 Scottish Planning Policy (Scottish Government, 2014) sets out the Scottish Government's national planning policies for the protection of biodiversity through the planning system. This seeks to ensure that projects provide biodiversity benefits where possible, not simply to avoid significant adverse effects. These policies are incorporated into development plans and are a material consideration in the determination of development proposals.

6.2.6 The UK Biodiversity Action Plan (BAP) was the UK Government's 2004 response to the Convention on Biological Diversity, to which the UK was a signatory. Action plans for the most threatened species and habitats (called 'UK BAP species and habitats') were set out to aid recovery. Following the publication of the Convention on Biological Diversity's 'Strategic Plan for Biodiversity 2011–2020' (Convention on Biological Diversity, 2010), its commitment to 20 'Aichi targets', agreed at Nagoya Japan in October 2010, and the launch of the European Biodiversity Strategy in May 2011 the UK Government has changed its strategic thinking.

6.2.7 The Scottish Biodiversity List (SBL) is a list of animals, plants and habitats that Scottish Ministers consider to be of principal importance for biodiversity conservation in Scotland, under the Nature Conservation (Scotland) Act 2004. The SBL therefore supersedes the UK BAP list of species and habitats (CIEEM, 2017). Nevertheless, since most current planning policy and SNH guidance requires consideration of, and makes explicit reference to, UK BAP species and habitats and the definitions of SBL habitats are largely based on UK BAP definitions, these are still referred to where necessary.

6.2.8 The Shetland Local Development Plan (2014) contains policies and objectives to conserve and enhance the habitats and species that contribute to the unique character and heritage of Shetland. It has links to Supplementary Guidance on Local Nature Conservation Sites in Shetland and Supplementary Guidance on Natural Heritage. This guidance is provided to aid planning applicants and their agents when considering development in relation to their biodiversity responsibilities.

6.2.9 Whilst considering a range of potential outcomes that could arise from the Proposed Project, the assessment reports the effects that are considered likely to be significant on the basis of evidence, standard guidance and professional judgement. It is these *likely significant effects* that the Applicant is obliged to report, and that the decision maker is obliged to consider.

Relevant Guidance

Guidance for the Assessment of Environmental Effects

6.2.10 The CAA, with the UK Space Agency, the Department for Business, Energy and Industrial Strategy and the Department for Transport, issued guidance note '*CAP2215 Guidance for the Assessment of Environmental Effects*' in July 2021. The guidance sets out what is required by the regulator regarding assessment of environmental effects as part of a licence application under the Act.

6.2.11 The AEE Guidance requires that potential direct and indirect significant effects of proposed spaceflight activities on environmental features, including noise and vibration, are considered. The guidance further requires that:

- Specific potential effects are identified and, where possible, quantified;
- The focus of the AEE should be on significant effects arising from the proposed activities;
- Applicants set an environmental budget, comprising a maximum number of launches per launch vehicle type which can take place over the course of a year that can be carried out in an environmentally sustainable manner, taking into account the cumulative effect of all launches; and
- The AEE must address a range of environmental topics, including ecology and biodiversity.

Guidance to the regulator on environmental objectives relating to the exercise of its functions under the Space Industry Act 2018

6.2.12 The Department for Transport issued its document '*Guidance to the regulator on environmental objectives relating to the exercise of its function under the Space Industry Act 2018*' in 2021, clarifying the government's environmental objectives relating to spaceflight and associated activities in the UK:

The environmental objective for spaceflight are to:

- *Minimise emissions contributing to climate change resulting from spaceflight activities;*
- *Protect human health and the environment from the impacts of emissions on local air quality arising from spaceflight activities;*
- *Protect people and wildlife from the impacts of noise from spaceflight activities; and*
- *Protect the marine environment from the impact of spaceflight activities.*

6.2.13 The objectives presented in the guidance are noted to be consistent with the environmental topics that must be addressed in an AEE.

6.3 Consultation

6.3.1 Extensive statutory consultation on ecological matters was carried out during preparation and determination of the planning application for the SaxaVord Spaceport, where the Proposed Project will be operated. Where directly relevant to this AEE, consultation responses received during the SaxaVord Spaceport planning application period have been summarised in Table 6.1. In addition, notes on relevant planning conditions received from Shetland Islands Council are also included for information.

Table 6.1 Record of Consultation and relevant Planning Conditions

Consultee	Summary Ecological Response	Where and How Addressed
Scottish Natural Heritage (SNH; now NatureScot) 16/02/18	Otters "*Otters are protected by law, making it an offence to disturb one in a holt or whilst it is caring for its young, or to destroy, damage or obstruct access to a holt*" SNH provided a link to SNH's standing advice on otters (in May 2020 this was superseded by NatureScot standing advice on otters, which is essentially the same as the previous SNH standing advice). SNH provided standing advice for planning consultation with regard to otter. It states that "*this is standing advice to help planning applicants seeking permission for development that could affect otters, and to assist planning officers and other regulators in their assessment of these applications. It avoids the need for us to advise on individual planning consultations in relation to otters. We will only provide further advice in exceptional circumstances that are not covered by this standing advice*". SNH went on to say that "*in Shetland, otters are predominantly coastal animals, however natal holts (places of shelter where cubs are born and reared) are usually hidden inland and away from watercourses...If a holt is found it may be necessary to submit a species protection plan with your planning application and consider whether a licence might be required for the development*".	Otter surveys are reported in Appendix 6.3 and are considered throughout this Chapter.
SNH (NatureScot) 16/02/18	Plants "*The key plant species, referred to in the Alba Ecology report, are the Shetland endemic Edmondston's chickweed (Cerastium nigrescens) and serpentine dandelion (Taraxacum serpenticola), nationally rare Norwegian sandwort (Arenaria norvegica) and nationally scarce northern rock-cress (Arabis petraea), all of which have very limited distributions in areas with ultrabasic "serpentine" bedrock with natural or semi-natural vegetation. Only the former RAF camp and Baltasound airport are in serpentine areas, and on the first of these the vegetation has been highly modified so none of these species is likely to be present. Consequently, the proposed rare plant survey can be restricted to the airport*".	The airport is not included in the Planning Application; therefore, no specific rare plant surveys were reported in the EIA Report. A detailed Phase 1 Habitat and NVC survey was conducted during the standard field season. Although this does not constitute a formal floristic survey, or rare plants survey, plant species were recorded where they were encountered. Plants species records are listed in Appendix 7.1 and are considered in Sections 7.4, 7.5 and 7.7. Habitats and,

Consultee	Summary Ecological Response	Where and How Addressed
		associated plant species are reported in Appendix 7.2 and considered in Sections 7.3, 7.4, 7.5 and 7.7.
SNH (NatureScot) 16/02/18	Marine mammals "*Noise and vibration from onshore activity close to the coast, such as drilling and blasting (and potentially rocket launching) can affect cetaceans so should not be scoped out at this stage, however there is no need for a survey of marine mammals as the assessment of potential impacts and any necessary mitigation can be generic in nature*."	Marine mammals are considered in Chapter 10.
Shetland Islands Council Conditions document (1/4/2022).	NatureScot: *Scottish Natural Heritage (SNH) – SNH are content that the proposal can be progressed with appropriate mitigation... They also identified that mitigation measures identified in the EIAR will reduce to some extent the impact on otters, a European Protected Species, and any licence required from them would be granted.*	Otter surveys are reported in Appendix 6.3 and are considered throughout this Chapter.
Shetland Islands Council Conditions document (1/4/2022).	Condition 17 Otter Protection Plan *No development shall commence unless and until:* *(a) i) a pre-construction otter survey is conducted and a report produced;* *ii) based on the results from the pre-construction otter survey apply for an otter licence, if necessary, from NatureScot; and* *iii) until such otter licence (if necessary) is issued, not carry out any works on any otter holts.; and* *(b) an Otter Protection Plan (OPP) has been submitted to and approved in writing by the Planning Authority following consultation with NatureScot, which shall provide for a programme of future monitoring for otters on the site to allow the adaptation of management under the approved OPP as may be agreed to in writing by the Planning Authority.*	Otter surveys, including the pre-construction otter survey are reported in Appendix 6.3. The Otter protection Plan is also provided as part of Appendix 6.3 (note that this is a 'live document'). Otters are considered throughout this Chapter.

6.3.2 Given the geographical location and habitats present, and in consultation with SNH (now NatureScot), the protected mammal survey focussed on determining the potential presence of otter (*Lutra lutra*). All terrestrial mammal species in Shetland are non-native having been introduced by humans over time (Johnston, 1999). Neither NatureScot nor CIEEM provides guidance on determining the value of non-native species, so professional judgement and general guidance from the Invasive Non-native Species Framework Strategy for Great Britain has been used (DEFRA, 2015). This suggests that non-native species should not be considered as valuable or important ecological receptors. This approach was also used at the Viking Wind Farm, Beaw Field Wind Farm and Mossy Hill Wind Farm. SNH and Shetland Islands Council agreed with the intention to scope out non–native terrestrial mammal species within a Shetland context, with the exception of otter, which is a European Protected Species (EPS).

6.3.3 Marine mammals are considered separately in Chapter 10.

6.3.4 Consultation and best practice guidance identified key ecological surveys required to consider the potential impacts of the Proposed Project on ecology. These studies included:

- a natural heritage desk study;
- a Phase 1 Habitat survey;
- a National Vegetation Classification (NVC) survey;
- a Groundwater Dependent Terrestrial Ecosystem (GWDTE) survey;
- an otter survey; and,
- a freshwater pearl mussel survey.

6.3.5 Full details of ecological survey methodologies and results can be found in Appendices 6.1 to 6.4 inclusive.

6.4 Assessment Methodology and Significance Criteria

Consultation

6.4.1 In accordance with CIEEM best practice guidance, consultation was undertaken with SNH on the nature and scale of surveys as part of the preparation for environmental impact assessment of the SaxaVord Spaceport in February 2018. These surveys remain pertinent to the Proposed Project and have therefore been included in the AEE.

Environmental Zone of Influence and Study Area

6.4.2 For the purposes of this AEE, the Environmental Zone of Influence (EZI) is based on and comprises the proposed launch flight corridor and all study areas required for the technical disciplines included in the AEE, as presented on drawing 3.6.

6.4.3 Within the EZI, the study area(s) required for each technical discipline assessed vary and as such the rationale for the ornithological study area has been included in this chapter. The ecological study area is shown in the context of the AEE on Drawing 2.1 and reproduced with greater detail on Drawing 6.1.

6.4.4 The following geographic definitions are used in this Chapter and associated Appendices (Drawings 6.1 and 6.2 and Table 6.2). These geographic areas combined are considered to be the ecological study area for the Proposed Project.

Table 6.2 Site and Study Area Definitions

Term	Definition
The site	This refers to all of the land within the Proposed Project boundary.
The Development Footprint	This refers to the footprint of the infrastructure within the SaxaVord Spaceport boundary.
The Study Area	The study area equates to the land within the Proposed Project footprint, plus an appropriate survey buffer. This can be variable depending on the ecological receptor and is described in the relevant appendices. As surveys were conducted as part of the SaxaVord Spaceport planning application works, the habitats study area equates to the SaxaVord Spaceport site plus a ca. 100 meters (m) or 250 m buffer, excluding private properties and gardens. For otters the study area was the site plus a 500 m buffer. In this Chapter two study areas are referred to: ➢ The Habitats study area, which is the SaxaVord Spaceport site at Lamba Ness plus a 250 m buffer, for habitats and vegetation communities. ➢ The Otter study area, which is the SaxaVord Spaceport site at Lamba Ness plus a 500 m buffer, for otters. These are shown in Drawing 6.1.

6.4.5 The Proposed Project comprises the preparation and launch of the limiting case Skyrora XL Launch Vehicle from any of three terrestrial vertical launch pads at the SaxaVord Spaceport situated at Lamba Ness on Unst, Shetland.

6.4.6 The Skyrora XL Launch Vehicle is approximately 24 m long, three-stage liquid fuelled orbital launch vehicle intended to place customer payloads into sun synchronous or polar orbits. Launches will take place in a northerly direction over the sea.

6.4.7 The Applicant is applying for a maximum environmental budget of 16 launches per year which, from 2029 when maximum launch cadence is reached, will make up just over one half of SaxaVord Spaceport's own environmental budget of 30 launches per year.

6.4.8 The main elements of the Proposed Project which have the potential to impact on ecological receptors during operation are described in Chapter 3 and comprise:

- Preparation of Skyrora XL Launch Vehicle;
- Storage and Handling of launch vehicle propellant;
- Operation of Ground Segment and Mobile Launch Complex; and
- Launch of Skyrora XL Launch Vehicle.

6.4.9 The relevant ecological study area for a project is the area over which ecological receptors may be affected by biophysical changes as a result of the Proposed Project. The study area will vary for different ecological receptors depending on their sensitivity to, and nature of, an environmental change. The study area can extend beyond the site and the study areas, particularly in the context of hydrological connectivity and potential pollution events. However, the study area for each receptor is considered an appropriate zone of influence for the vast majority of ecological receptors.

6.4.9 For habitats, the study area is considered to be straight forward and is defined as the Proposed Project site plus a buffer, which equates to the study area. The Proposed Project Site Habitats study area has a 250 m buffer in accordance with SEPA's guidance for GWDTE assessments (SEPA, 2017).

6.4.10 Assessing the potential effects of disturbance on other ecological receptors, such as otters, is a more complex issue which will vary depending on the type of disturbance (e.g., routine/predictable verses unusual/unexpected), topography, vegetation and the behaviour/tolerance of the receptor species and even different individuals within species.

6.4.11 For the previous SaxaVord Spaceport planning application, SNH's standing guidance on otter surveying (no date) stated that "*otters could be affected by a development proposal anywhere in Scotland close to a water course, wetland, coastline or estuary. An otter survey should be carried out for any proposal within 200 m of these habitats*". The updated NatureScot standing guidance issued subsequently (no date) provides the same advice. Whilst this is in accordance with best practice guidance e.g., Chanin (2003), the potential noise and vibration from the satellite launches could be considerable. Consequently, this 200 m survey buffer was not necessarily considered an adequate basis on which to determine the size of the Otter study area.

6.4.12 There is no standard guidance on potential disturbance (and so survey) distances for satellite launches and so in the planning application, and followed through into this AEE, a precautionary approach to determining the size of the study area has been adopted in line with CIEEM (2018) best practice guidance.

6.4.13 Given the lack of any empirical evidence or guidance on the potential impact of satellite launches on otters, it was decided that at least doubling the standing guidance for determining survey area, from a 200 m to a 500 m buffer was a legitimate precautionary basis on which to proceed with otter surveys. Consequently, the size of the Otter study area (Drawing 6.1) is considerably larger than the Proposed Project boundary area and is centred on indicative launch site locations provided by the Applicant during SaxaVord Spaceport planning pre-application consultation discussions in 2018.

6.4.14 Surveys have continued where, in the professional judgement of the surveyor, otter signs may have occurred just outwith the survey buffer in potentially suitable and contiguous habitats e.g., along watercourses.

Survey Approach

6.4.15 A reconnaissance site visit by Dr Peter Cosgrove in late autumn 2017 determined that the Proposed Project area was predominantly open coastal/upland habitat characterised by peatland, grassland and sea cliffs (plus some buildings and associated hard standings). The principal land use was sheep grazing through crofting and common grazing.

6.4.16 The ecological surveys included a desk study of historical information sources and a series of targeted field surveys of potentially important and/or legally protected ecological receptors. All the ecology field surveys were undertaken by experienced ecological surveyors using recognised survey methods, during suitable times of year and under suitable weather conditions for the habitats and species concerned. Any departures from standard guidance are explicitly stated and reasons for the departure given.

Desk Study

6.4.17 An initial desk study was conducted in 2017 using the SNH's SiteLink website and Shetland Biological Records Centre data held for the Search Area. This was supplemented by existing knowledge of Unst. Given the time gap between 2017 and the current planning submission, the exercise was repeated from the same data providers, alongside up to date information from the National Biodiversity Network (NBN) Atlas; a collaborative partnership created to exchange biodiversity information. This information was then compiled into a technical report in August 2020 (Appendix 6.1).

6.4.18 All known records of potentially important ecological receptors within at least a one kilometre (km) radius of the Proposed Project were identified. All designated sites with ecological qualifying features within a 10 km radius of the Proposed Project were also identified.

Field Surveys

Phase 1 Habitat Survey

6.4.19 A Phase 1 Habitat survey was conducted in July 2018 and updated in July 2020. The vegetation was described and mapped following the methods described in the Joint Nature Conservation Committee (JNCC) Handbook for Phase 1 Habitat surveys (JNCC, 2010), the revised field manual (JNCC, 2012). Details of the survey methodology and results are provided in Appendix 6.2.

National Vegetation Classification (NVC) Survey

6.4.20 A NVC survey was conducted in July 2018 and updated in July 2020. The vegetation was classified and mapped following the methods described in the JNCC National Vegetation Classification User's Handbook (Rodwell, 2006). Details of the survey methodology and results are provided in Appendix 6.2.

Potential Groundwater Dependent Terrestrial Ecosystem (GWDTE) Survey

6.4.21 Wetland habitats were identified in July 2018 and updated in July 2020 as part of the Phase 1 Habitats and NVC vegetation surveys, in accordance with the Functional Wetland Typology (SNIFFER, 2009a, 2009b). Where wetlands were identified, an assessment was made as to whether they were likely to be potential GWDTEs as defined by SEPA (SEPA, 2017). Details of the survey methodology and results are provided in Appendix 6.2.

Peatland Condition Assessment (PCA)

6.4.22 A PCA was undertaken in July 2018 and updated in July 2020 as part of the Phase 1 Habitats and NVC vegetation surveys, in accordance with the Peatland Action Guidance (Peatland Action, 2016). Details of the assessment methodology and results are provided in Appendix 6.2.

Otter Survey

6.4.23 The Otter study area was surveyed under SNH licence for otters in 2018 and 2020 by Brydon Thomason, a highly experienced and locally based otter surveyor, with unparalleled practical experience of working on otters on Unst.

6.4.24 A typical/standard otter survey often involves a single survey visit. However, otters are known to be seasonal in their use of certain habitats and so single visits can underestimate occupancy or seasonal use of an area. To ensure that a robust assessment of otter activity was undertaken and the use by otters understood, the Otter study area was surveyed during June and October 2018 and again in July 2020. A pre-construction otter survey was undertaken in March 2022 by Donald Shields MCIEEM, a highly experienced mammal surveyor and ecologist. Surveys were undertaken around the Development Footprint and in suitable habitat within a 200m buffer.

6.4.25 The survey methods involve a systematic survey of terrestrial, aquatic and riparian habitats within the study areas looking for place's otters use for shelter, resting and protection (such as couches, lying-up sites and holts), or for signs of activity (such as spraints, feeding remains or footprints). The otter surveys took place during suitable weather conditions, so that otter field signs (spraints, slides, sheltering or resting places etc.) would have had time to build up, be relatively visible and would not have been degraded/washed away e.g., after heavy rain. Details of the survey methodology and results are provided in Appendix 6.3.

Freshwater Pearl Mussel Survey

6.4.26 The Burn of Norwick was surveyed by Dr Peter Cosgrove, an experienced and licensed freshwater pearl mussel surveyor in September 2018. Details of the survey methodology and results are provided in Appendix 6.4.

Assessment of Potential Effect Significance

6.4.27 This section defines the criteria that were used to evaluate the significance of predicted likely effects on important ecological receptors due to the Proposed Project. A level of confidence or likelihood (whether the predicted effect is certain, likely, possible or unlikely) is attached to the predicted effect.

Evaluating Conservation Importance

6.4.28 The ecological receptors identified in the baseline studies were evaluated following best practice guidelines (e.g., CIEEM, 2018). Identifying the importance of potential ecological receptors was the first step of the process, and those considered potentially important and present were then subject to detailed survey and assessment. Those considered sufficiently widespread, unthreatened and resilient to the project impacts were scoped out of further assessment as per best practice EcIA guidance (e.g., CIEEM, 2018).

6.4.29 Ecological receptors can be important for a variety of reasons and the rationale used to define their importance has been explained to demonstrate a robust selection and evaluation process. Importance may relate, for example, to a designated site, to species rarity, to the extent to which they are threatened throughout their range, or to their rate of decline. Various characteristics contribute to the potential importance of ornithological receptors within an area. Examples include:

- naturalness;
- animal or plant species, sub-species or varieties that are rare or uncommon, either internationally, nationally or more locally, including those that may be seasonally transient;
- ecosystems and their component parts, which provide the habitats required by important species, populations and/or assemblages;
- endemic species or locally distinct sub-populations of a species;
- habitats that are rare or uncommon;
- habitats that are effectively irreplaceable;
- habitat diversity;
- size of habitat or species population;
- habitat connectivity and/or synergistic associations;
- habitats and species in decline;
- rich assemblages of plants and animals;
- large populations of species or concentrations of species considered uncommon or threatened in a wider context;
- plant communities (and their associated animals) that are considered to be typical of valued natural/semi-natural vegetation types, including examples of naturally species-poor communities; and,
- species or habitats on the edge of their range, particularly where their distribution is changing as a result of global trends and climate change.

6.4.30 Guidance on EcIA also sets out categories of ecological or nature conservation importance that relate to a geographical framework (e.g., international through to local) together with criteria and examples of how to place a site or study area (defined by its ecological attributes) into these categories. It is generally straightforward to evaluate sites or species populations designated for their international or national importance (as criteria for defining these exist e.g., SAC and SSSI), but for sites or populations of regional or local importance, criteria may not be easily defined. Where possible, the potential importance of an ecological receptor in the site/study area has been determined within a defined geographical context using criteria outlined in Table 6.3.

Table 6.3 Summary of Geographic Population Importance Criteria Used

Term	Definition
International	For example, >1 % of European Community (EC) population/area of habitat
National	For example, >1 % of United Kingdom (UK/Scotland) population/area of habitat
Regional	For example, <1 % of United Kingdom (UK/Scotland) population/area of habitat, but >1 % of regional resource (Shetland) population/area of habitat
Local	For example, within local area

6.4.31 It should be noted that there is no fundamental biological reason to take 1 % of a population as the threshold level for establishing the level of geographical importance of a site. Nevertheless, this percentage is widely considered to be of value in developing measures that give an appropriate level of protection to populations and has gained acceptance on this basis throughout the world. The criterion was, for example, adopted by parties involved in the Ramsar Convention 1971. Thereafter, the 1 % level of national species totals has been taken as the basis of assessment in various countries, including Britain (Stroud *et al*., 1990).

6.4.32 To be clear, the ecological importance afforded to a habitat or species within a site or study area is determined by both the geographical context, as well as the range of ecological characteristics of the habitat or species exhibit (listed above). For example, a habitat in any condition, which is >1 % of the national total could be considered nationally important, whereas a habitat smaller than this, but considered to be of particular high quality (for example, meeting SSSI selection criteria) and/or are connected to/are a stepping-stone between designated sites may also be considered nationally important.

6.4.33 The importance attached to an ecological receptor can also be determined according to legislative status. Some ecological receptors are subject to a general level of legal protection through e.g., the Wildlife and Countryside Act 1981 (as amended), or The Nature Conservation (Scotland) Act 2004 (as amended) and others under Council Directive 1992/43/EEC of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora (the so-called Habitats Directive). There is no clear guidance for conservation importance of ecological receptors other than those of European Protected Species and nationally designated site species and habitats. The importance of other species and habitats is based on professional judgement using the characteristics outlined above. The status of potentially important receptors, such as being on the SBL, is also taken into consideration.

6.4.34 Nevertheless, for the avoidance of doubt, CIEEM EcIA guidance (2018) makes it clear that species which appear on national lists e.g., Schedule 1 of the Wildlife and Countryside Act (1981 as amended) and SBL are not necessarily evaluated as of national importance simply by appearing on such a 'national' list. Importance evaluation must consider the number of individuals of species or area of habitat within a geographical context/scale, i.e., how many of a particular species are likely to be affected by the Proposed Project and what proportion of the local/regional/national population does this constitute. Legal listing/protection is a separate but important consideration.

6.4.35 Once the importance of an ecological receptor has been determined, the potential impacts on that receptor are considered in terms of magnitude, extent, duration, frequency and timing, reversibility, sensitivity and whether the impact would likely be beneficial, adverse or neutral.

Beneficial or Adverse

6.4.36 According to CIEEM (2018) beneficial (positive) and adverse (negative) impacts and effects should be determined according to whether the change is in accordance with nature conservation objectives and policy. In the CIEEM Guidance, the terms positive and negative are used, but in this AEE Report Chapter the equivalent terms beneficial and adverse are used, as synonyms, for consistency between Chapters. These terms are defined as:

- Beneficial – a change that improves the quality of the environment e.g., by increasing species diversity, extending habitat or improving water quality. This may also include halting or slowing an existing decline in the quality of the environment.
- Adverse – a change which reduces the quality of the environment e.g., destruction of habitat, habitat fragmentation, pollution.
- Impacts and effects can also be assessed as neutral.

Extent

6.4.37 According to CIEEM EcIA guidance (2018), extent is the spatial or geographical area over which the predicted impact/effect may occur under a suitably representative range of conditions.

Magnitude

6.4.38 According to CIEEM EcIA guidance (2018), magnitude refers to size, amount, intensity and volume. It should be quantified if possible and expressed in absolute or relative terms e.g., the amount of habitat lost, percentage change to habitat area, percentage decline in a species population. In this assessment there are considered to be four levels of magnitude of impact (Table 6.4) and it is assumed these are adverse, unless otherwise stated.

Table 6.4 Summary of Magnitude Criteria Used

Term	Definition
Major	Total/near total loss of a population/habitat due to mortality or displacement. Total/near total loss of breeding productivity in a population due to disturbance. e.g., ≥50 % of population/habitat affected.
Moderate	Moderate reduction in the status or productivity of a population/habitat due to mortality or displacement or disturbance. e.g., 10 % to 49 % of population/habitat affected.
Minor	Small but discernible reduction in the status or productivity of a population/habitat due to mortality or displacement or disturbance. e.g., 1 % to 9 % of population/habitat affected.
Negligible	Very slight reduction in the status or productivity of a population/habitat due to mortality or displacement or disturbance. Reduction barely discernible, approximating to the 'no change' situation. e.g., <1 % population/habitat affected.

Duration

6.4.39 According to CIEEM EcIA guidance (2018), duration should be defined in relation to ecological characteristics (such as the life cycle of a species). The duration of an activity may differ from the duration of the resulting effect caused by the activity. Impacts and effects may be described as short, medium or long-term and permanent or temporary and should be defined. In this assessment three timeframes are used: short-term (up to two years), medium-term (two-five years) and long-term (between five years and the lifetime of the Proposed Project).

Frequency and Timing

6.4.40 According to CIEEM EcIA guidance (2018), the number of times an activity occurs may influence the resulting effect. For example, a single person walking a dog will have very limited impact on nearby otters using wetland habitat, but numerous dog walkers will subject the otters to frequent disturbance and could affect breeding/feeding success, leading to displacement and knock-on effects on their ability to survive. The timing of an activity or change may result in an impact if it coincides with critical life-stages or seasons.

Reversibility

6.4.41 According to CIEEM EcIA guidance (2018), an irreversible effect is one from which recovery is not possible within a reasonable timescale or there is no reasonable chance of action being taken to reverse it. A reversible effect is one from which spontaneous recovery is possible or which may be counteracted by mitigation. In some cases, the same activity can cause both reversible and irreversible effects.

Sensitivity

6.4.42 Another factor when assessing potential impacts is the behavioural sensitivity of the ecological receptor under consideration (e.g., high, medium or low) and the zone of influence. Different receptors respond differently to stimuli, making some particularly sensitive to development activities and others less so. Professional judgement is used when assigning sensitivity to an ecological receptor and this is recorded here in a clear and transparent way. Sensitivity criteria vary across the wide range of taxonomic groups considered in an ecological impact assessment and are therefore provided in the receptor descriptions of this Chapter.

6.4.43 By way of example, sensitivity is determined according to species' behaviour, using broad criteria set out in Table 6.5. Behavioural sensitivity can differ between species and between individuals of the same species. Therefore, sensitivity is likely to vary with both the nature and context of the disturbance activity as well as the experience and even 'personality' of the species, in the case of mammals. Sensitivity also depends on the activity the species is undertaking and when it is doing it. For example, a species is likely to be less tolerant of disturbance during the breeding season than at other times of year. Thus, sensitivity changes with both space and time.

Table 6.5 Summary of Sensitivity Criteria Used

Term	Definition
High	Species occupying remote areas away from human activities or exhibiting strong and long-lasting reactions to disturbance events. Habitats that are considered to have a slow recovery time to disturbance.
Medium	Species that appear to be warily tolerant of human activities or exhibiting short-term reactions to disturbance events. Habitats that are considered to have a moderate recovery time to disturbance.
Low	Species occupying areas subject to frequent human activity and exhibiting mild and brief reaction to disturbance events. Habitats that are considered to have a quick recovery time from disturbance.

Likelihood

6.4.44 Finally, a level of confidence (whether the predicted impact is certain, likely, possible or unlikely) can be attached to a predicted effect.

Criteria for Evaluating Significance

6.4.45 Significance is a concept related to the weight that should be attached to predicted effects when decisions are made. A "*significant effect*" is an effect that either supports or undermines biodiversity conservation objectives for important receptors (CIEEM, 2018). There could be any number of possible impacts on important ecological features arising from a development. However, it is only necessary to describe in detail the impacts that are likely to be significant. Impacts that are either unlikely to occur, or if they did occur are unlikely to be significant, can be scoped out.

6.4.46 In the context of AEE, each likely effect is evaluated and classified as either significant or not significant, using professional judgement, evidence and best practice guidance. In this assessment, a significant effect is defined as "*an impact on the integrity of a defined site or ecosystem and/or the conservation status of habitats or species within a defined geographical area*". Thus, the geographical terms of reference at which a predicted effect may be considered significant must also be defined (e.g., an effect on a species population evaluated to be of regional importance at a given site is likely to be either significant or not at the regional level). Effects can be considered significant at a wide range of scales from international to local.

6.4.47 There is sometimes confusion over geographical context, potentially important receptors and quantifying predicted effects and EcIA best practice guidance has often struggled to articulate this clearly. For example, if a potentially important species appears on a conservation list e.g., the SBL and there is a predicted impact, the geographical context in which the receptor is found must be considered. Therefore, the simple presence of a species on the SBL within an area does not mean that likely effects are significant at the national (Scottish) level. For that to occur, the Proposed Project must have significant effects on its national (Scottish) population.

Requirements for Mitigation

6.4.48 Best practice guidance e.g., CIEEM (2018) identifies a hierarchy of mitigation for potential impacts that seeks to:

- Avoid adverse ecological impacts, especially those that could be significant to important receptors.
- Minimise adverse impacts that could not be avoided.
- Compensate for any remaining significant residual impacts.

6.4.49 CIEEM EcIA guidance (2018) states that "*Avoiding and/or minimising negative impacts is best achieved through consideration of potential impacts of a project from the earliest stages of scheme design and throughout its development*". This approach to avoiding potential adverse impacts within a design layout is sometimes described as embedded mitigation or mitigation by design. "*Mitigation by design is particularly beneficial as there is greater certainty that it will be delivered*" (CIEEM 2018).

6.4.50 This Chapter considers mitigation in the context of CIEEM guidance and also in relation to local planning authority guidance for protected species. The embedded mitigation has been considered in the design layout of the SaxaVord Spaceport and because of this, has been guaranteed through planning conditions for the same. Where likely significant effects are predicted regardless of design layout, further mitigation is separately identified as per CIEEM best practice guidance.

Assessment of Residual Effect Significance

6.4.51 After assessing the potential impacts of the Proposed Project (incorporating embedded mitigation), all attempts were made to further avoid and mitigate predicted adverse ecological impacts. Once measures to avoid and mitigate predicted ecological impacts had been incorporated, assessment of the residual impacts was undertaken to determine the likely significance of their effects on important ecological features.

Limitations to Assessment

6.4.52 Where assumptions within the assessment are made, these are explicitly identified and explained. Similarly, limitations in methods and knowledge of species' ecology are also identified and discussed, particularly where this is likely to affect the outcome of the assessment. As with any environmental assessment there will be elements of uncertainty. Where there is uncertainty, this is identified and reported transparently, along with the measures taken to reduce it, assumptions made, and an explanation as to the likely extent that any uncertainties are likely to affect the conclusions. In circumstances where there is uncertainty; evidence, expert opinion, best practice guidance and professional judgement have been used to evaluate what is biologically likely to occur if the Proposed Project is constructed.

6.4.53 The level of certainty of impact prediction varies depending upon a range of parameters discussed already. For some elements e.g., land-take it is relatively straightforward to assess and quantify the area of habitat that is likely to be lost to development infrastructure and therefore quantify potential impacts of land-take on the habitats present. However, other impacts are less certain because there can be a range of possible scenarios. The main limitations in this assessment are common to most ecological assessments because:

- Baseline surveys undertaken are based on sampling techniques, not absolute censuses. Results give an indication of the numbers of ecological receptors recorded at the particular times that surveys were carried out e.g., summer 2018. Species occurrence changes over time and therefore the results presented in this AEE Report are snapshots in time. Importantly, no information gaps were identified in the baseline survey data that would prevent assessments in line with the requirements of the AEE to be undertaken.
- Putting ecology survey results into a wider geographical context is sometimes challenging because most species and habitats have not been systematically surveyed beyond the study area. Thus, defining a receptor population as locally or regionally important is potentially difficult because local or regional population estimates do not exist for most taxa and habitats. Whenever such uncertainty exists, professional judgement and published evidence is used and populations in the study area or site have been assumed to be at their highest potential level of geographical/ecological importance.

6.5 Baseline Conditions

Desk Study – Designated Sites

6.5.1 A total of 10 designated sites with ecological qualifying features within a 10 km radius of the Proposed Project have been identified (Table 6.6; Drawing 6.2). There are a number of Local Nature Conservation Sites on Unst and these are listed in Table 6.7.

Table 6.6 Biological Designated Sites within 10 km of the Proposed Project.

Designated Site	Designation Type	Area (ha)	Distance (km) and Direction from Proposed Project	Biological Qualifying Features
Hermaness, Saxa Vord and Valla Field	SPA	6,832 ha	1.5 km, northwest	Breeding birds: • Fulmar (*Fulmarus glacialis*) • Gannet (*Morus bassanus*) • Great skua (*Stercorarius skua*) • Guillemot (*Uria aalge*) • Kittiwake (*Rissa tridactyla*)

Designated Site	Designation Type	Area (ha)	Distance (km) and Direction from Proposed Project	Biological Qualifying Features
				• Puffin (*Fratercula arctica*) • Red-throated diver (*Gavia stellata*) • Shag (*Phalacrocorax aristotelis*) Breeding bird assemblages
Keen of Hamar	SAC	40 ha	4.9 km, south	Upland habitats: • Base rich scree • Dry heath Grasslands on soils rich in heavy metals
Keen of Hamar	SSSI	50 ha	4.7 km, south	Calaminarian grassland and serpentine heath Vascular plant assemblages
Hill of Colvadale and Sobul	SSSI	809 ha	7.9 km, south	Arctic sandwort (*Arenaria norvegica*) Breeding birds: • Arctic skua (*Stercorarius parasiticus*) • Whimbrel (*Numenius phaeopus*) Breeding bird assemblages Calaminarian grassland and serpentine heath
Valla Field	SSSI	629 ha	6.0 km, southwest	Breeding birds: • Great skua Red-throated diver
Crussa Field and Heogs	SSSI	469 ha	4.5 km, south	Breeding birds: • Arctic skua • Whimbrel Breeding bird assemblages Vascular plant assemblages Calaminarian grassland and serpentine heath
Hermaness	SSSI	978 ha	3.9 km, west	Breeding birds: • Fulmar • Gannet • Great skua • Guillemot • Puffin Breeding seabird colony

Designated Site	Designation Type	Area (ha)	Distance (km) and Direction from Proposed Project	Biological Qualifying Features
Saxa Vord	SSSI	56 ha	3.0 km, west	Breeding birds: • Fulmar • Guillemot Breeding seabird colony
Norwick Meadows	SSSI	25 ha	0.75 km, southwest	Sand dune habitats Valley fen wetlands
Fetlar to Haroldswick	MPA	216,000 ha	3.0 km, south	Aggregation of breeding birds: • Black guillemot (*Cepphus grylle*) Horse mussel beds Circalittoral sand and coarse sediment communities Kelp and seaweed communities on sublittoral sediment

Table 6.7 Local Nature Conservation Sites on Unst (Shetland Islands Council, 2015).

Local Conservation Sites on Unst	Primary Interest	Justification for Local Conservation Site
Baltasound	Species	Glasswort (*Salicornia europea*) and annual sea-blite (*Suaeda maritima*).
Burn of Mailand	Species	Rare plants. Lesser tussock sedge (*Carex diandra*) and small bur-reed (*Sparganium natans*) are found nowhere else in Shetland. Rich bryophyte flora.
Haroldswick mires	Species	Schedule 1 bird species. The pool at Haroldswick is attractive to migrant birds. The base-rich mire vegetation is unusual in Shetland.
Lochs of Bordastubble and Stourhoull	Species	These water bodies are on the Unst serpentine; they are nutrient rich and support a variety of aquatic species. Breeding Schedule 1 bird species.
Skeo Taing	Species	The herb-rich turf with base-rich shell sand provides habitat for a diverse range of plants. The nationally rare autumn gentian (*Gentianella amarelle septentrionalis*) is found on site and it is one of only a few sites in Shetland where harebell (*Campanula rotundifolia*) has been recorded.
Wick of Skaw	Geology	Easily identifiable exposure of a granite intrusion contact zone.
Belmont Quarry	Geology	Rock exposures across a major shear zone/ophiolite thrust. Part of the Shetland Ophiolite Suite.
Clibberswick Cross Geo	Geology	Part of the Shetland Ophiolite suite.

Local Conservation Sites on Unst	Primary Interest	Justification for Local Conservation Site
Hill of Clibberswick	Species	Two nationally scarce plant species are present on-site, Norwegian sandwort (*Arenaria norvegica*) and northern rock cress (*Arabis petraea*)

Desk Study – Species

6.5.2 Full details of the of the desk study are provided in Appendix 6.1. The desk study demonstrated that there are a large number of records of species of potential interest within vicinity of the site, including legally protected species, SBL species and locally important/rare species. Table 6.8 summaries the results of the desk study for species with potential ecological importance for the site.

Table 6.8 Species Identified as EPS, SBL Species or having Local Importance in the Desk Study

Species name	Common name	Taxa	Listing	Closest Record to the Proposed Project	Year of Record
Lutra	Otter	Mammal	EPS, SBL	>700 m, Norwick	2002-2011
Celaena haworthii	Haworth's minor	Lepidoptera	SBL	One in Saxa Vord, one 150 m away, Houlanbrindy	2017
Eugnorisma glareosa	Autumnal rustic	Lepidoptera	SBL	Within Saxa Vord	2017
Hepialus humuli	Ghost moth	Lepidoptera	SBL	Near Northdale Road	2017
Xanthorhoe decoloraria	Red carpet	Lepidoptera	SBL	Within Saxa Vord	2017
Caloplaca britannica	A lichen	Lichen	SBL	Lamba Ness	2015
Leptogium britannicum	A lichen	Lichen	SBL	Lamba Ness	2015
Opegrapha areniseda	A lichen	Lichen	SBL	Lamba Ness	2015
Thelenella muscorum var. octospora	A lichen	Lichen	SBL	Lamba Ness	2015
Spergula arvensis	Corn spurry	Vascular plant	Nationally vulnerable	Northdale and near Saxa Vord	2012-2015
Mertensia maritima	Oyster plant	Vascular plant	LBAP. Near Threatened and Nationally Scarce and scarce in Shetland	Inner Skaw	2019

Field Surveys

Habitat Surveys

6.5.3 Full details of the methods and results of the Phase 1 Habitat and NVC surveys can be found in Appendix 6.2 and Drawings 6.3 and 6.4. The results are summarised here. It should be noted that the results of these surveys are based on the habitats study area prior to construction of SaxaVord Spaceport, and whilst the survey data are relevant beyond the Development Footprint, the habitats within the Development Footprint, as described in these surveys, has subsequently been stripped of all vegetation during pre-construction works for the SaxaVord Spaceport (Photo 1).



Photo 1: Vegetation stripping at Lamba Ness, March 2022

6.5.4 The habitats study area included distinctive maritime grasslands in the east, on Lamba Ness, which had a range of pools. This transitioned into an area of wet modified bog dominated by purple moor-grass (*Molinia caerulea*). More westerly in the habitats study area the habitats were made up of wet modified bog/wet heath, which was dominated by heather (*Calluna vulgaris*) and common cottongrass (*Eriophorum angustifolium*), and acid grasslands. To the north-west side of the Habitats study area transitioned into blanket bog habitats.

6.5.5 There were small areas of other habitats, including standing water, marginal vegetation at the edge of pools and saltmarsh perched within the coastal vegetation. The old military buildings and roads and other infrastructure were also mapped across the Habitats study area and often had distinct vegetation around them, enriched from the sheep that sheltered in them.

6.5.6 All the habitats within the habitats study area had clearly been subject to modification through current and historic management practices including sheep grazing and drainage. Sheep were evident across the habitats study area and the impacts of fertilisation, grazing and sheep lay-down areas were recorded. Drainage ditches, both very recently cut, and older, were also recorded in wet modified bog and wet modified bog/wet heath habitats. There were areas of naturally occurring haggs, within the blanket bog, which were likely to be exacerbated by sheep and subsequently wind erosion.

6.5.7 The list of Phase 1 habitats mapped and described in the Proposed Project site habitats study area along with the total area and the percentage of the study area are displayed in Table 6.9.

Table 6.9 Phase 1 Habitats Described in the Habitats Study Area

Phase 1 Habitats	Area (ha)	% of Habitats Study Area
Wet modified bog/wet heath	30.5	26.1
Wet modified bog	28.2	24.2
Coastal grassland	19.7	16.8
Semi-improved acid grassland	16.3	14.0
Unimproved acid grassland	7.3	6.2
Wet modified bog/wet heath/dry heath	6.5	5.6
Buildings and roads	1.8	1.5
Fen	1.5	1.3
Blanket bog/bare peat	1.5	1.3
Blanket bog	1.1	1.0
Dry dwarf shrub heath	0.7	0.6
Saltmarsh	0.4	0.3
Wet modified bog/wet heath/bare peat	0.3	0.2
Sand dunes	0.3	0.2
Marginal and inundation	0.2	0.2
Wet modified bog/wet heath/acid flush	0.2	0.2
Bare ground	0.1	<0.1
Acid flush	0.1	<0.1
Bare peat	0.1	<0.1
Neutral grassland	0.1	<0.1
Standing water	<0.1	<0.1
Open vegetation	Too small to map separately	N/A
Water courses and drains	Mapped as lines	N/A

6.5.8 The NVC communities found within the habitats study area were:

- Coastal grasslands
  - MC8d *Festuca rubra – Holcus lanatus* maritime grassland, *Holcus lanatus* sub-community
  - MC10a *Festuca rubra - Plantago spp.* maritime grassland, *Armeria maritima* sub-community
  - MC10b *Festuca rubra - Plantago spp.* maritime grassland, *Carex panacea* sub-community
  - MG11 *Festuca rubra – Agrostis stolonifera – Potentilla anserine* grassland community;

- Saltmarsh
  - SM16b *Festuca rubra* salt-marsh community, *Juncus gerardii* dominant sub-community;
- Sand dunes
  - SD4 *Elytrigia juncea* fore-dune community
  - SD8d *Festuca rubra – Galium verum* fixed dune grassland *Bellis perennis - Ranunculus acris* sub-community;
- Wet modified bog
  - M25b *Molinia caerulea – Potentilla erecta* mire, *Anthoxanthum odoratum* sub-community
  - Mxd *Carex nigra* provisional fen, *Molinia caerulea* sub-community
  - M3x *Eriophorum angustifolium* community;
- Fen
  - Mxd *Carex nigra* provisional fen, *Molinia caerulea* sub-community;
- Semi-improved acid grassland
  - U4b *Festuca ovina – Agrostis capillaris – Galium saxatile* grassland, *Holcus lanatus – Trifolium repens* sub-community;
- Unimproved acid grassland
  - U5a *Nardus stricta – Galium saxatile* grassland, species poor sub-community
  - U5b *Nardus stricta – Galium saxatile* grassland, *Agrostis canina – Polytrichum commune* sub-community
  - U6 *Juncus squarrosus – Festuca ovina* grassland community;
- Neutral grassland
  - MG10a *Holcus lanatus – Juncus effusus* rush-pasture, typical sub-community;
- Wet dwarf shrub heath
  - M15d *Trichophorum cespitosum – Erica tetralix* wet heath, *Vaccinium myrtillus* sub-community
  - M15 *Trichophorum cespitosum – Erica tetralix* wet heath community;
- Blanket bog
  - M2b *Sphagnum cuspidatum/fallax* bog pool, *Sphagnum fallax* sub-community
  - M19 *Calluna vulgaris – Eriophorum vaginatum* blanket mire community;

- Bare peat
  - M3 *Eriophorum angustifolium* bog pool community;
- Dry dwarf shrub heath
  - H10b *Calluna vulgaris – Erica cinerea* heath, *Racomitrium lanuginosum* sub-community;
- Acid flush
  - M6b *Carex echinata – Sphagnum fallax* mire, *Carex nigra – Nardus stricta* sub-community;

- Open vegetation
  - OV25 *Urtica dioica – Cirsium arvense* community; and
- Standing water, water margins and inundation vegetation
  - S19a *Eleocharis palustris swamp, Eleocharis palustris* sub-community;
  - A22a *Littorella uniflora - Lobelia dortmanna* community, *Littorella uniflora* sub-community
  - A24 *Juncus bulbosus* community
  - OV28 *Agrostis stolonifera – Ranunculus repens* community.

GWDTE

6.5.9 Full details of the GWDTE survey and assessment can be found in Appendix 6.2 and Drawing 6.5. NVC communities recorded in the study areas that are considered in the guidance (SEPA, 2017) to be potentially groundwater dependent include:

- M6 *Carex echinata – Sphagnum fallax* mire;
- M15 *Trichophorum cespitosum – Erica tetralix* wet dwarf shrub heath;
- M25 *Molinia caerulea – Potentilla erecta* mire;
- MG9 *Holcus lanatus – Deschampsia cespitosa* grassland;
- MG10 *Holcus lanatus – Juncus effusus* rush-pasture;
- MG11 *Festuca rubra – Agrostis stolonifera – Potentilla anserine* grassland community; and
- U6 *Juncus squarrosus – Festuca ovina* grassland.

6.5.10 Those not in the guidance, that are considered potentially GWDTE (due to their association with similar/related communities that are listed as potentially GWDTE), are:

- Mxd *Carex nigra* provisional fen, *Molinia caerulea* sub-community; and
- M3x *Eriophorum angustifolium* community.

6.5.11 Of these, only M6 is considered to be potentially highly groundwater dependent, depending on the hydrological setting (SEPA, 2017). All the other communities are considered potentially moderately groundwater dependent, depending on the hydrological setting (SEPA, 2017). All mosaics of habitat were allocated their GWDTE category according to the NVC community with the highest potential GWDTE.

6.5.12 The bedrock for the majority of the habitats study area was the Skaw Intrusion which was describe as a "*Low productivity aquifer*" with "*small amounts of groundwater in near surface weathered zone and secondary fractures; rare springs*" (BGS, 2020). To the far west of the habitats study area the bedrock is Hevda Phyllite Formation which was also described a "*Low productivity aquifer*" with "*small amounts of groundwater in near surface weathered zone and secondary fractures*" (BGS, 2020). Therefore, the majority of the potentially GWDTE are considered most likely to be present due to waterlogged conditions sustained by high rainfall in the region, rather than groundwater for their maintenance.

6.5.13 The M6 community was located at the transition between the two bedrock types in the habitats study area. This can be a source location for GWDTE, where groundwater is released at a spring or seepage line (McMullen, 2020). It is therefore considered that the M6 community may be an actual GWDTE.

6.5.14 Detailed geological and hydrological analysis of the SaxaVord Spaceport site determined that the potential GWDTE were either assessed as not being actual GWDTE or were >250 m from the Proposed Project (Appendix 6.5).

Peatland Condition

6.5.14 Full details of the PCA can be found in Appendix 6.2. The PCA bases the condition of blanket bog on indicators such as bog-moss cover, extent of bare peat and evidence of grazing and burning (Peatland Action, 2016). Given that the small area of bog habitat within the habitats study area was clearly grazed and drained and there were patches of bare peat, using PCA terminology, the blanket bog was considered to be modified and some areas drained. Using the PCA Support Tool, the blanket bog would be considered of intermediate condition.

Vascular Plants

6.5.15 Oyster plant, which was recorded in the fore-dune community within the habitats study area, is an LBAP species and considered Near Threatened and Nationally Scarce and scarce in Shetland.

6.5.16 No other species recorded during field surveys in 2018 were identified as being on the SBL, an LBAP species or in the lists of rare and scarce species for Shetland (Scott *et al.*, 2002).

6.5.17 There was no evidence of any notifiable non-native invasive species within the habitats study area during walkover surveys.

Lower Plants

6.5.18 No lower plant surveys were requested by SNH or conducted as part of this EcIA. Lichen and bryophyte records identified as part of the desk study have been considered. Full details of the desk study are provided in Appendix 6.1. Table 6.8 summaries the results of the desk study and includes four lichen species which are on the SBL and are within the Proposed Project boundary.

Otters

6.5.19 Numerous otter field signs were recorded during targeted surveys in June and October 2018. Based on 2018 survey data, there were eight-ten otter holts within the Otter study area, with six-seven of these within the site (Drawing 6.6).

6.5.20 In 2020, additional otter surveys were undertaken at the Proposed Project Site. Numerous otter signs were recorded (Drawing 6.7). This included eight holts, located in boulder scree and on the boulder beaches, above the high tide mark. The holts were in inaccessible locations, between boulder or going into caves/crevices and were viewed from the cliff tops with binoculars. Scats and regularly used runs were recorded at the holt sites, and otters occasionally seen/heard. One particular holt on Lamba Ness, which had a large build-up of scats, was clearly being used by a female and her young in July 2020. Three otter holts were recorded in the 2022 pre-construction surveys.

6.5.21 Scats and footprints, including those of adults and young, were also recorded in the abandoned buildings across Lamba Ness. It was considered likely that some of the buildings were used as lay-ups during poor weather conditions and the predated remains of several fulmars (*Fulmarus glacialis*) were also noted within the buildings. Similar evidence of otter use was recorded in the 2022 pre-construction surveys.

6.5.22 Otter use of an underpass at HP 671 154 was particularly noticeable. It was considered likely that otters use this underpass as a regular route to cross from the north to south side of Lamba Ness. The route was well delineated on the grassland and rocks showing a well-established run, and so was functionally important to otter use of the Lamba Ness area.

6.5.23 The data from 2020 indicated that there was one female with young using Lamba Ness as their home territory. Regular sightings of a male indicated that Lamba Ness also formed part of at least one, if not two, dog otter territories.

Freshwater Pearl Mussels

6.5.24 The Burn of Norwick was surveyed, under licence, for freshwater pearl mussels in September 2018. No evidence of freshwater pearl mussels was found in the Burn of Norwick survey reach. No patches of suitable or potentially suitable substrate habitat were recorded in the Burn of Norwick survey reach. There was no evidence of freshwater pearl mussel presence within the Burn of Norwick survey reach. Consequently, the survey evidence suggests that there are no special freshwater pearl mussel sensitivities that need to be considered.

6.6 Receptors Brought Forward for Assessment

Potentially Important Ecological Receptors

6.6.1 Ecological features/receptors can be important for a variety of reasons and the rationale used in evaluation should be explained to demonstrate a robust and transparent selection process (CIEEM, 2018). Based on the results of the desk study, initial site walkover, field surveys, consultation and feedback from the regulators, legal protection and professional judgement, the following potentially important receptors were identified for further consideration:

- designated sites;
- semi-natural habitats; and
- otter.

6.6.2 No other potentially important ecological receptors on which potentially significant effects were likely to occur were identified for further consideration. Other species (such as those identified in the desk study, cited as part of nearby designated areas with similar habitats to the study area or present in the LBAP), were mainly scoped out of further consideration on the basis of:

- recent survey results;
- habitats within the study area (e.g., coastal grassland) compared to the species' preferred habitat; and
- the population size of the potentially important species on a geographical basis.

6.6.3 Table 6.10 summarises the evaluation of potentially important receptor population/feature within the Proposed Project study area.

Table 6.10 Summary Evaluation of Potentially Important Ecological Receptors

Potentially Important Receptor	Evaluation of Potentially Important Receptor Population/Feature within Study Area
Designated sites	Nationally important designated sites <750 m from the study area. Norwick Meadows, is taken forward for assessment.
Otter	Legally protected species. Evidence of regular and frequent use of the study area, with numerus field signs and multiple holts around the Otter study area. Otter's use is likely to include at least one male and one female, sometimes with young, around the Otter study area.

Potentially Important Receptor	Evaluation of Potentially Important Receptor Population/Feature within Study Area
	Otters are considered to have moderate sensitivity to human activities, with resting places and holts considered highly sensitive. However, in Shetland, otters tolerate and utilise a wide variety of human built features, such as buildings, ferry terminals and fish farms. Status: Stable in Scotland. GB population estimate unknown (Mammal Society, 2020). Scottish population considered to be flourishing, with an estimate of ca. 8,000 individuals (JNCC, 2019; SNH, 2020). Shetland population estimate 700-900 (Kruuk *et al.,* 1989) – but note the age of this population estimate data and subsequent national population increase (30 years +). The study area is estimated to hold ca. 0.5 % of the Shetland population. The site population is therefore considered locally important. The ecological receptor, otter, is taken forward for assessment.
Semi-natural habitats	Local, regionally, nationally and internationally important habitats present in Shetland. Some of the habitats described within the study area are similar to, or approaching descriptions for, Annex 1 habitats and/or SBL habitats. These include: ➢ coastal grasslands; ➢ saltmarsh; ➢ sand dunes; ➢ wet modified bog; ➢ wet modified bog/blanket bog; ➢ blanket bog; ➢ dry dwarf shrub heath; ➢ acid flush; and ➢ water margin vegetation. Within the study area, the quantity/quality of semi-natural habitats evaluated as locally important, except for some of the water margin vegetation and the sand dune vegetation. For full details of these evaluation refer to Appendix 6.2. These habitats are taken forward for assessment.
GWDTE	Potentially important GWDTE habitats present in the vicinity of the study area. All the potential GWDTE were assessed as not being actual GWDTE and/or were >250 m from the Proposed Project (Appendix 6.5). Therefore, GWDTE have been scoped out of further consideration.
Freshwater pearl mussels	Legally protected species. Status: Listed as Critically Endangered in Europe by IUCN. Scotland population declining; extinct in 73 rivers, not recruiting in 44 rivers and recruiting in 71 rivers (Cosgrove *et al.,* 2016). Although present in Shetland (Cosgrove and Harvey, 2005), there was no evidence of freshwater pearl mussels, or potentially suitable habitat, in the Burn of Norwick during targeted surveys in 2018. Furthermore, all extant pearl mussel

Potentially Important Receptor	Evaluation of Potentially Important Receptor Population/Feature within Study Area
	populations in Scotland have headwater lochs/lochan, Burn of Norwick does not have a headwater loch/lochan. Therefore, freshwater pearl mussels have been scoped out of further assessment.
Plants	Oysterplant LBAP species. Considered Near Threatened and Nationally Scarce and scarce in Shetland. Distributed around the coast of northern Britain. Population increased in north, but declined in south (Preston *et al.,* 2002). Only found on gravelly beaches and shingle, and sometimes sand. This species was located on the fore-shore community at Inner Skaw. The dunes and fore-shore community at Inner Skaw are being avoided by the design layout. Therefore, this species has been scoped out of further assessment.
Lichens	The desk study identified four species of lichen, which have been recorded within close vicinity of the Proposed Project, that are SBL species ("*watching brief only*" category). *Caloplaca britannica* is considered rare in the UK (SBL, 2013). It is distributed widely around the coast of the UK and is of Least Concern according to the GB Red List (NBN Atlas, 2020) This species "*is found on coastal rocks, in the spray zone and is undoubtedly under-recorded*" (Images of British Lichens, 2013). In Shetland it is known to be located in "*sheltered crevices in landward-facing rock face*"(Dalby and Dalby, 2005). *Leptogium britannicum* is found on coastal rocks (Images of British Lichens, 2013). It is distributed widely on the west coast of the UK and on Shetland and Orkney and is of Least Concern according to the GB Red List (NBN Atlas, 2020). In Shetland it is known to be located within amongst mosses in salt marshes and on cliffs (Dalby and Dalby, 2005). *Opegrapha areniseda* is considered rare in the UK. It is found on "*slightly acid or neutral soft rocks near the seashore (schists) and mainly on old walls, notably of chapels*" (Maritime Lichens, 2020). It is distributed widely around the coast of the UK and is of Least Concern according to the GB Red List (NBN Atlas, 2020). This lichen species was not included in the Lichens of Shetland reference (Dalby and Dalby, 2005). *Thelenella muscorum var. octospora* is considered rare in the UK (SBL, 2013). No information was found on the UK habitat requirements for this lichen and it has limited records in the UK with only 20 records on the NBN Atlas, although these are spread across England, Wales, Ireland and Scotland. This species is considered circumboreal, and is found across western United States, western Canada, UK, Ireland, Scandinavia, Europe and Russia (Christy *et al.,* 2010). The habitat requirements that are reported in the United States are not consistent with the habitats found on Lamba Ness. It is considered that it is an obscure, under recorded and under researched species. The record on Lamba Ness describes the habitat it was found in as "*Coastal rocks, mainly granite, turf edge on cliff top*". This species is not legally protected and is has not been evaluated by the GB Red List (NBN Atlas, 2020). The closely related lichen species

Potentially Important Receptor	Evaluation of Potentially Important Receptor Population/Feature within Study Area
	Thelenella muscorum is distributed widely across the UK. This lichen species was not included in the Lichens of Shetland reference (Dalby and Dalby, 2005). It is considered unlikely that the three common species, which are of Least Concern, are widely distributed in the UK and were not mentioned by SNH in consultation, would be significantly impacted though the Proposed Project because: ➢ the relatively small number of records compared to the wide distribution of their under-recorded UK population; ➢ the study area is not designated or specially protected for these species, or habitats which support these species; ➢ they are located in habitat(s) which appear to be largely or wholly avoided by the design layout (e.g., namely coastal cliffs); and, ➢ ambient sulphur dioxide levels (the air pollutant which lichens are generally sensitive to) will not be impacted by the operation of the Proposed Project (Chapter 7). Therefore, these species have been scoped out of further assessment. These assessments are likely to also be relevant to the more obscure species *Thelenella muscorum var. octospora*. Additionally, the edge of the cliff, where this species was reported as being situated, is avoided by design. Therefore, it has also been scoped out of further assessment. Nevertheless, it is recognised that the ecological requirements of these poorly known species are not well understood. It should also be recognised that the distribution of some species can be poorly understood, particularly those in less widely known taxonomic groups, such as lichens. Where systematic surveys have not been widely undertaken know distributions may not fully reflect actual distribution and may be associated to where these species have been visited by specialist observers. This is a well know limitation of species distribution data.
Lepidoptera	Four species of Lepidoptera identified as part of the Desk Study which are all SBL species ("*watching brief only*" category). The four species were recorded within the vicinity of the Proposed Project. Haworth's minor (*Celaena haworthii*) is "*mainly a moorland species, occurring most commonly in northern England, Wales and Scotland… Cotton-grass* (Eriphorium spp.) *is the main foodplant, the larvae feeding internally on the stems*" (UK Moths, 2020). Distributed widely across the UK, more common in the north (Hill *et al.,* 2010; Butterfly Conservation, 2020). Considered local (only found in some areas) (Butterfly Conservation, 2020). Resident in Shetland (Nature in Shetland, 2020). Autumnal rustic (*Eugnorisma glareosa*) inhabits "*woodland fringes, moorland and sandy or chalky soils, it is widely distributed, though not always common, throughout Britain. The adults fly in August and September, and the caterpillars are polyphagous, living on a wide variety of plants and grasses*" (UK Moths, 2020). Distributed widely across the UK (Hill *et al.,* 2010). Considered common (NatureSpot, 2020). Resident in Shetland (Nature in Shetland, 2020).

Potentially Important Receptor	Evaluation of Potentially Important Receptor Population/Feature within Study Area
	Ghost moth (*Hepialus humuli*) is considered a "*common species over much of Britain… The adults fly during June and July. The larvae feed underground on the roots of grasses and small plants"* (UK Moths, 2020) including nettles (*Urtica dioica*) and dock (*Rumex* spp) (Butterfly conservation, 2020). Distributed widely across the UK (Hill *et al.,* 2010; Butterfly conservation, 2020). Considered common (Butterfly Conservation, 2020). Resident in Shetland (Nature in Shetland, 2020). Red carpet (*Xanthorhoe decoloraria*) "*A locally common species in northern Britain, occurring from Shropshire and Staffordshire northwards, into Scotland, where a local subspecies hethlandica occurs on the Shetland Isles… The favoured habitat is rocky moorland, where the larvae feed on lady's mantle Alchemilla spp., possibly also on other low plants"* (UK Moths, 2020). Distributed across northern Britain (Hill *et al.,* 2010). Considered common (Butterfly Conservation, 2020). Resident in Shetland (Nature in Shetland, 2020). It is considered unlikely that these, generally common and widespread species, which were not mentioned by SNH in consultation, would be significantly adversely impacted though the Proposed Project because: ➢ the relatively small number of records compared to the wide distribution of their under-recorded UK population; ➢ the study area is not specially designated for these species, or habitats which support these species; and ➢ other than a potentially small (negligible) land-take of possible habitat, no significant impacts are considered likely from the Proposed Project on these species. Therefore, these species have been scoped out of further assessment.

6.7 Standard Mitigation

6.7.1 In line with best practice guidance (CIEEM, 2018), an iterative design approach has been taken and the design of the SaxaVord Spaceport, and within that context the Proposed Project, has been amended to avoid or minimise impacts on ecological receptors as far as possible. As such, mitigation has been embedded within the design and layout of the infrastructure needed to carry out operation of the Proposed Project since Alba Ecology's first involvement in the project in 2017.

6.7.2 The three key mitigation hierarchy principles of EcIA (CIEEM, 2018; CAA et. al., 2021), namely avoidance first, followed by minimisation and finally by compensation, along with enhancement have all been considered.

Avoidance

6.7.3 According to CIEEM best practice guidance, adverse effects should be avoided or minimised through mitigation measures, either through the design of the project or subsequent measures that can be guaranteed. For example, through a planning condition. The baseline habitat surveys influenced the project design, avoiding, wherever possible areas of higher ecological sensitivities.

6.7.4 Avoidance of ecological receptors has been achieved by the Proposed Project because there will be no direct impact on any habitat type from the Proposed Project as all works will take place within the existing design footprint of the SaxaVord Spaceport.

Minimisation

6.7.5 There will be no direct impact on any habitat type from the Proposed Project as all works will take place within the existing design footprint of the SaxaVord Spaceport, and as such no minimisation of effects is required.

Compensation and Enhancement

6.7.7 Where there are significant residual adverse ecological effects despite the mitigation proposed, these should, under EcIA guidelines, be offset by appropriate compensatory measures and enhancement measures considered. This is not the case for the Proposed Project, and so no compensatory measures are proposed.

6.8 Potential Effects

Impacts to be Assessed

6.8.1 The main elements of the Proposed Project which have the potential to impact on ecological receptors are assessed within this section. For full details of the Proposed Project refer to Chapter 3.

6.8.2 The potential impacts of the Proposed Project are outlined in Table 6.11. It should be noted that potential impacts in this table do not imply that they would occur, or that any resultant effects would be significant.

Table 6.11 Summary of Potential Impacts on Ecology

Activity	Potential Ecological Impact
Launch pad operation	Noise and vibrations resulting in disturbance.
Tracks and road	Pollution and/or sediment release into watercourses. Mortality/disturbance from vehicles.

Effects on Designated Sites

6.8.3 There are 10 designated ecological sites within 10 kilometres of the Proposed Project, as identified in Table 6.6. This is reduced to six when ornithological designations, which are addressed separately in Chapter 5, are excluded. It is further reduced to five designated sites if Marine Protected Areas, addressed in Chapter 10, are excluded.

6.8.4 The closest designated ecological site is Norwick Meadows SSSI supporting important sand dune and valley fen habitats. The flora in this designated site is considered "floristically rich" with several rare and scares species (NatureScot, 2020). The valley fen is "one of the best and most extensive examples of mesotrophic (moderately nutrient-rich) marsh in Shetland" (NatureScot, 2020). Norwick Meadows SSSI is considered nationally important with high sensitivity. No land-take would take place within this designated site, so no direct habitat loss of the designated site would occur.

6.8.5 When assessing impacts on designated sites it is important to consider whether the Proposed Project is likely to undermine the conservation objectives of the site, the condition of the site, or the conservation status of the species or habitats for which the site is designated (CIEEM, 2018). Consideration should also be given to whether any process or key characteristic will be removed or changed, whether there will be an effect on the nature, extent, structure and function of component habitats and if there is an effect on the average population size and viability of species (CIEEM, 2018).

6.8.6 The conservation objectives for the Norwick Meadows SSSI (taken from Norwick Meadows SSSI Site Management Statement, 2011) are:

- To maintain and enhance the extent and condition of fen and swamp communities.
- To maintain and enhance the extent and condition of open dune and dune grassland habitats.
- To ensure populations of nationally scarce and locally rare species are protected.

6.8.7 As there will be no land-take from the Norwick Meadows designated site, there will be no direct loss to the fen and swamp communities, open dune, or dune grassland and the nationally scarce and locally rare species will not be directly impacted. Therefore, no likely significant direct effects are predicted for Norwick Meadows SSSI.

6.8.8 All the other terrestrial designated sites are >1.5 km away from the Proposed Project. Therefore, no land-take or changes to hydrology would take place within these designated sites, so no direct or indirect habitat loss would occur. No other route to impact on designated sites or their features are predicted. Consequently, **no significant effects** on designated sites are predicted.

Effects on Otters

6.8.9 This section describes the predicted effects on otters that could arise from the Proposed Project. Embedded mitigation, including avoidance and minimisation to reduce potential effects are described.

6.8.10 The Proposed Project has the potential to adversely affect otter directly or indirectly in a number of ways:

- damage to watercourses by runoff, pollution and blocking of streams;
- mortality caused by vehicle traffic during launch activities; and
- disturbance/damage to hearing caused by noise during launch activities.

6.8.11 Otters are legally protected species, considered to have moderate sensitivity to human activities, with resting places and holts considered highly sensitive. The population of otters using the Proposed Project site is considered of local importance.

6.8.12 Baseline otter surveys were completed on multiple occasions during the planning preparation stage for SaxaVord Spaceport, in different seasons and years, and were conducted in a larger study area than is usual for surveys of this nature. Consequently, otter use of the Proposed Project site is relatively well understood.

6.8.13 Numerous otter field signs were recorded including scats, holts, footprints and lay-ups. In the most recent 2022 pre-construction surveys, three holts were located in inaccessible boulder scree areas, caves and on the boulder beaches around Lamba Ness. Scats and footprints were also recorded in the abandoned military buildings across the Proposed Project site.

6.8.14 The survey data collected indicated that there was one female with young regularly using Lamba Ness as their (main) home territory. Regular sightings of a male indicated that Lamba Ness also formed part of at least one dog otter territory. This constitutes ca. 0.5 % of the Shetland otter population.

6.8.15 The Proposed Project will not result in any land-take and so there will be no mechanism for physical damage or loss of holts, feeding and resting places. Likewise, there will be no mechanism for severance or loss of connectivity as a result of the Proposed Project as there will be no land-take or construction of any kind (see Chapter 3 for details). Therefore, the physical damage or loss of holts, feeding and resting places, severance and loss of connectivity have been scoped out of the assessment.

Damage to watercourses by runoff, pollution and blocking of streams

6.8.30 In the unlikely event that a serious pollution incident occurred, leading to a sudden pulse of pollutant that was not readily contained, it might enter the aquatic environment and could affect otters directly e.g., by coating fur with oil or indirectly through damage to their prey species. However, taking into account the implementation of best practice pollution prevention measures required by all launch vehicle operators at SaxaVord Spaceport (Appendix 6.5), it is considered highly unlikely that a serious pollution incident would occur. Therefore, it is considered highly unlikely that pollution would substantially affect otter foraging. The magnitude of potential impact caused by a pollution event for otter is assessed as negligible. With the embedded mitigation designed into the SaxaVord Spaceport, the impact caused by a pollution event from the Proposed Project is considered to be unlikely, intermittent, reversible and short-term (event), with a medium-term recovery and **no likely significant effects** are predicted (Table 6.13).

Mortality caused by vehicle traffic

6.8.31 Vehicular traffic across the SaxaVord Spaceport site will be regular during the Proposed Project, meaning that individual otters would have a possibility (albeit very small) of being injured or killed. However, the existence of inbuilt mitigation measures such as the enforced low vehicle speed limits (10 mph) would greatly reduce the likelihood of injury or death occurring during operation. Otter crossing road signs will be located at the entrance to the SaxaVord Spaceport site and at the frequently used otter run to further help prevent vehicle traffic mortality during operation. Consequently, the magnitude of impact of direct mortality from operation of the Proposed Project is assessed as negligible. With the embedded mitigation, impact of direct mortality from operation of the Proposed Project is considered to be unlikely, intermittent, irreversible and short-term and **no likely significant effects** are predicted (Table 6.13).

Disturbance caused by noise

6.8.32 There is at least one dog otter and one female otter (sometimes with young), within the range of elevated noise levels associated with the Proposed Project. Table 6.12 outlines the maximum predicted dB levels on otter for launch vehicles assessed within the AEE for the SaxaVord Spaceport. The holts on Lamba Ness are in the 0 km to 0.5 km range, the holts located at Saxa's Kettle and Vadna Taing are in the 0.5 km to 1 km range. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 6.12 Maximum Predicted Decibel (dB) Levels at Otter Holts

Individuals	Pad 1	Pad 2	Pad 3
Distance from holt	Launch LAmax	Launch LAmax	Launch LAmax
0-0.5 km	120-130 dB	120-130 dB	120-130 dB
0.5-1 km	110-120 dB	110-120 dB	100-110 dB

6.8.33 Otters are considered moderately sensitive to human disturbance. Otters use acoustic communication in both antagonistic (blows, mewing and cries) and social (murmurs and two types of whistles) situations, with new-borns using "*twitters*" to demand care (Gnoli and Prigioni, 1995). Therefore, it can be concluded that hearing is an important sense for otters. A study of otter hearing range demonstrated that at 80 dB, in air hearing ranged from 200 hertz (Hz) to 32 kilohertz (kHz) (Voigt *et al.*, 2019). As the Skyrora XL Launch vehicle noise will be concentrated in the low frequencies, the frequencies will be audible to otters in the vicinity to the Proposed Project.

Exposure to loud sounds can result in hearing impairment or loss. Mammals are unable to regenerate damaged auditory (cochlear) hair cells following damage from high levels of noise. Therefore, any potential damage to hearing as a result of the Proposed Project would be considered permanent and non-reversible.

6.8.34 A literature search conducted using freely available sources (e.g., google scholar, researchgate), returned few relevant results regarding the impact of loud noise on otter. Areas of high human disturbance (i.e., not loud noise) has been shown to adversely impact on otter populations (e.g., Cortés *et al*., 1998). This does not necessarily translate to infrequent very loud noises, and otters in Shetland are known to deliberately inhabit areas around ferry terminals and fish farms which have moderate-high levels of human disturbance and noise.

6.8.35 Anecdotal accounts described in the literature suggest loud noise can impact on otter behaviour. Sharp and sudden noises have been reported to cause instant flight to the nearest water. These effects on behaviour may continue after the noise that caused the reaction has ceased (e.g., Jeffries 1985).

6.8.36 There is no direct evidence to suggest that the short-lived noise caused by the launch of the Skyrora XL Launch Vehicle would impact on, and adversely affect the success of, otters within the study area and there is also no threshold noise metric against which to compare potential effects on otters. The literature search did not identify any directly relevant noise studies on otters or potentially analogous species. Whether the pre-launch warning siren, followed by the low frequency rumble of the Skyrora XL Launch Vehicle followed by a rapid decrease back to baseline will be sufficient to allow otters to cope with the noise is currently speculative. Nevertheless, it is considered likely that this warning would give otters warning to swim underwater or find refuge in a holt or shelter where noise levels experienced are likely to be reduced.

6.8.37 As part of the SaxaVord Spaceport mitigation commitments a total of 10 artificial otter holts/shelters will have been provided to supply many suitable refuge locations for otters.

6.8.38 If a worst-case scenario is assumed, i.e., mortality of all the otters in the study area, this would constitute an adverse impact on a maximum of two to three otters out of the Shetland population of ca. 700 to 900 individuals, i.e., 0.3 % to 0.4 % of the regional population and 0.04 % of the Scottish population. However, based on the likelihood that the pre-launch warning siren would allow otters to find refuge, with a reduction in noise in holts or shelters, this worst-case scenario seems an unlikely scenario. If no such adverse response took place, then 0 % of the regional and Scottish otter population would be adversely affected.

6.8.39 The magnitude of potential impact, in the worst-case scenario, caused by mortality/loss of territory from noise disturbance, is negligible. In the worst-case scenario, the potential impact to otters caused by mortality/loss of territory from noise disturbance is considered to be possible, intermittent, irreversible and short-term and **no likely significant effects** are predicted (Table 6.13).

Table 6.13. Summary of Likely Predicted Impacts on Otter

Parameter	Pollution	Mortality from Traffic/Activities	Operational Disturbance
Beneficial/adverse/neutral	Adverse	Adverse	Adverse
Extent	Watercourse and coastal region around Lamba Ness	Site-wide	Site-wide

Parameter	Pollution	Mortality from Traffic/Activities	Operational Disturbance
Duration	Event = short-term Recovery = medium-term	N/A	Short-term noise level, potential for long term hearing damage
Reversibility	Reversible – pollution prevention measures and incident kits will be used.	Irreversible	Irreversible
Frequency	Intermittent	Intermittent	Intermittent
Probability	Unlikely	Unlikely	Possible
Magnitude	Negligible	Negligible	Negligible

6.8.40 In summary, with the implementation of the embedded mitigation measures, no likely significant effects are predicted for otters in relation to the Proposed Project (Table 6.13). To ensure up-to-date information with regard to otters on and around the wider SaxaVord Spaceport site, an Otter Protection Plan will be ongoing during the license period of the Proposed Project.

Effects on Semi-natural Habitats

6.8.41 The Proposed Project has the potential to adversely impact indirectly through pollution.

6.8.42 Direct impacts from land-take of habitats severance and indirect impacts through changes in hydrology are scoped out as there will be no change in the SaxaVord Spaceport design footprint and no additional land-take associated with the Proposed Project.

6.8.43 Potential indirect impacts on the habitats could arise from pollution events. Pollution prevention measures required by all launch operators using the SaxaVord Spaceport are outlined in Appendix 6.5 which takes into account standard mitigation, in particular implementation of a suitable OEMP and appropriate storage and management of fuels and chemicals. Therefore, with the embedded mitigation inherent to the SaxaVord Spaceport accounted for, the magnitude of change on habitats as a consequence of pollution form the Proposed Project is assessed as negligible. With the embedded mitigation, the indirect impact on habitats as a consequence of pollution is considered to be unlikely, intermittent, temporary and short-term (event) to medium term (recovery) and **no likely significant effects** are predicted (Table 6.17).

Table 6.17. Summary of Predicted Impacts on Habitats for the Proposed Project

Parameter	Pollution
Adverse/ beneficial/ neutral	Adverse
Extent	Around the Design Footprint on Lamba Ness and into watercourses and the sea.
Duration	Short-term (event) – medium-term (recovery).
Reversibility	Temporary.
Frequency	Intermittent.
Probability	Unlikely.
Magnitude	Negligible.

6.8.44 The Habitat Management Plan (Appendix 5.3) identifies eight main objectives, six of which will have direct ecological benefits to the Proposed Project site and surrounding area. These include peatland restoration, creation of riparian broadleaf tree/scrub cover, coastal grassland management, wetland creation including creating new pools and the creation of artificial otter holts. Whilst the pools and wetland areas are under the auspices of ornithology mitigation, they will none the less have ecological benefits increasing the biodiversity and providing additional habitat for non-avian species e.g., invertebrates.

6.9 Residual Effects

6.9.1 No likely significant effects are predicted on habitats or otters in relation to the Proposed Project and therefore no mitigation is proposed. As a result of this the residual effects are identical to the pre-mitigation effects predicted.

6.10 Cumulative Assessment

6.10.1 Cumulative effects can result from individually insignificant but collectively significant actions taking place over a period of time or concentrated in a location (CIEEM, 2018). This guidance goes on to say that "*developments to be included in the cumulative impact assessment should be in accordance with national guidance*". SNH/NatureScot provide no advice or guidance in relation to the cumulative impacts of a spaceport.

6.10.2 CIEEM (2018) also states in relation to cumulative assessment that "*Information about developments within the zone(s) of influence may be available in other EcIAs, Local Plan documents, Marine Spatial Plans, Strategic Environmental Assessments (SEAs), Sustainability Appraisals (SAs), Water Framework Directive Assessments (WFDAs), and Habitats Regulations Assessments/Appraisals (HRAs), including 'Natura Impact Statements' (NISs) / 'Natura Impact Reports' (NIRs), 'Information / 'Reports to Inform an Appropriate Assessment', 'Shadow Habitats Regulations Assessments' and, for Nationally Significant Infrastructure Projects, 'Reports on the Implications for European Sites' (RIES)*".

6.10.3 Shetland Islands Council confirmed during the planning application for SaxaVord Spaceport that there were no other committed development or infrastructure projects which needed to be considered in that assessment and there has been no change subsequent to planning consent. As such, as far as the Applicant is aware, there are no like for like or similar projects within the ecological study area and therefore, no significant issues are likely to arise from developments other than the SaxaVord Spaceport.

6.10.4 The SaxaVord Spaceport has a proposed capacity for 30 launches per annum. Once maximum launch cadence is achieved, the Proposed Project will account for 16 of those launches. A comparison of the Skyrora XL Launch Vehicle against the RepLV used as the basis of assessment in the SaxaVord Spaceport AEE has been undertaken; the composition and fuelling specifics of the two launch vehicles has been assessed by all technical leads working on the AEE and a review of environmental effect significance from the two vehicles carried out. It has been confirmed that for all topics, the Skyrora XL Launch Vehicle is within the limiting case envelope assessed for the SaxaVord Spaceport - sub-orbital and orbital launches of small satellites into either polar or sun-synchronous, low-earth orbits. As such the assessment of cumulative ecological effects completed for the SaxaVord Spaceport AEE is considered appropriate to this AEE.

6.10.5 Assuming operators are identified for the remaining capacity, the cumulative ecological effects of all 30 launches would therefore be expected to be as documented in the SaxaVord Spaceport AEE:

"Cumulative effects can result from individually insignificant but collectively significant actions taking place over a period of time or concentrated in a location (CIEEM, 2018). This guidance goes on to say that "developments to be included in the cumulative impact assessment should be in accordance with national guidance". SNH/NatureScot provide no advice or guidance in relation to the cumulative impacts of a spaceport.

CIEEM (2018) also states in relation to cumulative assessment that "Information about developments within the zone(s) of influence may be available in other EcIAs, Local Plan documents, Marine Spatial Plans, Strategic Environmental Assessments (SEAs), Sustainability Appraisals (SAs), Water Framework Directive Assessments (WFDAs), and Habitats Regulations Assessments/Appraisals (HRAs), including 'Natura Impact Statements' (NISs) / 'Natura Impact Reports' (NIRs), 'Information / 'Reports to Inform an Appropriate Assessment', 'Shadow Habitats Regulations Assessments' and, for Nationally Significant Infrastructure Projects, 'Reports on the Implications for European Sites' (RIES)".

The ecological study area is an equivalent to the potential 'environmental zone of influence' and as there are no existing or proposed developments within that area, no significant issues are considered likely to arise from inter-project additive or cumulative effects.

Intra-project cumulative effects are those where an environmental topic/receptor is affected by more than one impact from the same Proposed Project and the impacts act together. The interactions between noise and ecology have been identified and assessed within this chapter, and no other environmental topic are considered likely to give rise to potential intra-project cumulative effects."

6.11 Summary

6.11.1 This Ecology Chapter has:

- Established the baseline ecological conditions of the site using a desk-study and targeted ecological surveys (Phase 1 Habitat survey, NVC survey, GWDTE survey, otter survey and freshwater pearl mussel survey).
- Identified the potentially important ecological receptors likely to be affected by the Proposed Project namely designated sites, otters and semi-natural habitats.
- Assessed the ecological importance and sensitivity of designated sites, otters and semi-natural habitats.
- Evaluated the likely magnitude of predicted impact on these ecological receptors from the operation of the Proposed Project.
- Identified mitigation, including avoidance and minimisation of impacts on sensitive ecological receptors.

6.11.2 The assessment does not predict any likely significant ecological effects associated with the Proposed Project.

6.12 References

British Geological Society (BGS) (2020). GeoIndex Onshore. http://mapapps2.bgs.ac.uk/geoindex/home.html?layer=BGSHydroMap. Accessed April and May 2020.

Civil Aviation Authority et.al (2021). *CAP2215 Guidance for the Assessment of Environmental Effects*.

Carrs, D. N. (1995). *Foraging behaviour and feeding ecology of the otter* lutra*: a selective review*. Hystrix: the Italian Journal of Mammalogy, 7, pp 179 – 194.

Chartered Institute of Ecology and Environmental Management (CIEEM) (2016). *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal, 2nd Edition.*

CIEEM (2017) *Guidelines for Preliminary Ecological Appraisal*. CIEEM. Available at: https://cieem.net/resource/guidance-on-preliminary-ecological-appraisal-gpea/.

CIEEM (2018). *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine. Version 1.1. (Updated 2019).* Available at: https://cieem.net/resource/guidelines-for-ecological-impact-assessment-ecia/.

CIEEM (2019). *Biodiversity Net Gain. Good practice principals for development*. Available at: https://cieem.net/resource/biodiversity-net-gain-good-practice-principles-for-development/.

Cortés, Y., Fernández-Salvador, R., García, F.J., Virgós, E. and Llorente, M. (1998). *Changes in otter* Lutra *distribution in Central Spain in the 1964–1995 period*. Biological Conservation, 86 pp 179-183.

Cosgrove, P.J. and Harvey, P.V. (2005). *The rediscovery of freshwater pearl* mussels Margaritifera *(L.) in Shetland*. Shetland Naturalist 2:2 pp 57-64.

Cotanche, D. A. (2008). *Genetic and pharmacological intervention for treatment/prevention of hearing loss*. Journal of Communication Disorders, 41, pp 421–433.

Dalby, K. and Dalby, C. (2005). *Shetland Lichens*. Shetland Amenity Trust.

European Commission (EC) (2011). European Biodiversity Strategy https://ec.europa.eu/environment/nature/biodiversity/strategy_2020/index_en.htm.

EC Directive 1992/43/EEC on the conservation of natural habitats and of wild fauna and flora. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A31992L0043.

EC (2020). European Biodiversity Strategy. https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1590574123338&uri=CELEX:52020DC0380.

Gnoli, C. and Prigioni, C. (1995). *Preliminary study on the acoustic communication of captive otters* (Lutra lutra). Hystrix: the Italian Journal of Mammalogy, 7, pp 289 – 296.

Hill, L., Randie, Z., Fox, R. and Parsons, M. (2010). *Provisional Atlas of the UK's Larger Moths. Butterfly Conservation*, Wareham, Dorset.

Jefferies, D. J. (1985). *The effects of angling interests on otters, with particular reference to disturbance. From Proceedings* of "Angling and wildlife in fresh waters ITE symposium no. 19".

Joint Nature Conservation Committee (JNCC). 2010. *Handbook for Phase 1 Habitat surveys (revised 2016)*. JNCC, Peterborough. Available at: https://hub.jncc.gov.uk/assets/9578d07b-e018-4c66-9c1b-47110f14df2a.

JNCC (2019). *European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018. Supporting documentation for the conservation status assessment for the species: S1355 - Otter (Lutra lutra) SCOTLAND*. Available at: https://jncc.gov.uk/jncc-assets/Art17/S1355-SC-Habitats-Directive-Art17-2019.pdf.

JNCC (2012). *Handbook for Phase 1 Habitat Survey, a technique for environmental audit Field Manual*. Revised Reprint.

Kruuk, H., Moorhouse, A., Conroy, J.W.H., Durbin, L. and Frears, S. (1989). *An estimate of numbers and habitat preferences of otters* Lutra *in Shetland, UK.* Biological Conservation. 49:4, pp 241-254.

Lubert, C. P. (2017). *Sixty years of launch vehicle acoustic*. Conference proceedings of 174th Meeting of the Acoustical Society of America.

McMullen, A. (2020). GWDTE: Go With the Flow on Surveys. https://botanaeco.co.uk/botan%C3%A6co-blog/f/gwdte-i-go-with-the-flow-on-survey?blogcategory=GWDTE. Accessed June 2020.

National Biodiversity Network (NBN) Atlas, Scotland. (2020). https://scotland-species.nbnatlas.org/species/NHMSYS0000459024. Accessed 16th November 2020.

Nature in Shetland (2020). *Checklist of the Lepidoptera of Shetland. Compiled by Pennington, M. and Harvey, P. for Shetland Biological Records Centre*. V 2.032 4th July 2020. Available at: https://www.nature-shetland.co.uk/lepidoptera.

NatureScot (2020). Standing advice for planning consultations - Otters. Available at: https://www.nature.scot/doc/standing-advice-planning-consultations-otters . Accessed April 2022.

NatureScot (2020). Otters. Available at: https://www.nature.scot/plants-animals-and-fungi/mammals/land-mammals/otter. Accessed August 2020.

NatureSpot (2020). *Autumnal-rustic* Eugnorisma glareosa. Available at: https://www.naturespot.org.uk/species/autumnal-rustic. Accessed August 2020.

Peatland Action (2016). *Peatland Condition Assessment Guide*. Available at: https://www.nature.scot/sites/default/files/2017-10/Guidance-Peatland-Action-Peatland-Condition-Assessment-Guide-A1916874.pdf.

Preston, C.D., Pearman, D.A., and Dines, T.D. (2002). *New Atlas of the British and Irish Flora*. Oxford University Press.

Rodwell, J.S. (2006). *NVC Users' Handbook*, JNCC, Peterborough. Available at: https://hub.jncc.gov.uk/assets/a407ebfc-2859-49cf-9710-1bde9c8e28c7.

Scott, W., Harvey, P., Riddington, R. and Fisher, M (2002). *Rare Plants of Shetland*. Shetland Amenity Trust.

Scottish Environment Protection Agency (SEPA) (2017). *Land-Use Planning System SEPA Guidance Note 31: Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems. Version 3*. Available at https://www.sepa.org.uk/media/144266/lups-gu31-guidance-on-assessing-the-impacts-of-

development-proposals-on-groundwater-abstractions-and-groundwater-dependent-terrestrial-ecosystems.pdf.

Scottish Government (2013) PAN 1/2013 (revised 2017). Available at: https://www.gov.scot/publications/planning-advice-note-1-2013-environmental-impact-assessment/.

Scottish Government (2013). *The Scottish Biodiversity List*. Available at: https://www.webarchive.org.uk/wayback/archive/20160402063428/http://www.gov.scot/Topics/Environment/Wildlife-Habitats/16118/Biodiversitylist/SBL.

Scottish Government (2014). Scottish Planning Policy. Available at: https://www.gov.scot/publications/scottish-planning-policy/.

Scottish Government (2017). Planning Circular 1 2017: The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017. Available at: https://www.gov.scot/publications/planning-circular-1-2017-environmental-impact-assessment-regulations-2017/.

Scottish Government (2013) PAN 1/2013 (revised 2017). Available at: https://www.gov.scot/publications/planning-advice-note-1-2013-environmental-impact-assessment/.

Scottish Government (2021) Scotland 2045: Our Fourth National Planning Framework - Draft. Available at: Supporting documents - Scotland 2045 - fourth National Planning Framework - draft: consultation - gov.scot (www.gov.scot).Shetland Amenity Trust (2020). What to Look for this week – Gentian Heaven. https://www.shetlandamenity.org/what-to-look-for-this-week-gentian-heaven. Accessed 16th November 2020.

SNIFFER (2009a). *WFD95: A Functional Wetland Typology for Scotland – Project Report*. Available at: https://www.sniffer.org.uk/wfd95-a-functional-wetland-typology-for-scotland.

SNIFFER (2009b). WFD95: A Functional Wetland Typology for Scotland – Field Survey Manual. Version 1. Available at: https://www.sniffer.org.uk/wfd95-a-functional-wetland-typology-for-scotland.

The Convention on Biological Diversity (2010). *Strategic Plan for Biodiversity 2011-2020*. Available at: https://www.cbd.int/kb/record/decision/12268.

United Kingdom (UK) Government (2004). The UK Biodiversity Action Plan (BAP). Available at: https://www.gov.uk/government/publications/biodiversity-the-uk-action-plan.

UK Government (1981). The Wildlife and Countryside Act 1981 (as amended). Available at: https://www.legislation.gov.uk/ukpga/1981/69.

UK Government (1994). The Conservation (Natural Habitats) Regulations. Available at: https://www.legislation.gov.uk/uksi/1994/2716/contents/made.

UK Government (2004). The Nature Conservation (Scotland) Act 2004 (as amended). Available at: https://www.legislation.gov.uk/asp/2004/6/contents.

UK Government (2010). The Conservation of Habitats and Species Regulations. Available at: https://www.legislation.gov.uk/uksi/2010/490/contents/made.

Voigt, M. B., Hackenbroich, C., Krüger, H., Liebau, A. and Esser, K. (2019). *The in-air auditory thresholds of the eurasian otter (*Lutra*, L. 1758) as determined by auditory brainstem responses*. Hearing Research, 381, pp 107774.

Chapter 7 Air Quality

7. Air Quality

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7. Air Quality

7.1 Introduction

7.1.1 This chapter considers the potential effects of the Proposed Project on local air quality. The Proposed Project is described in full detail in Chapter 3; however, the elements with the potential to affect local air quality can be summarised as follows:

- Preparation of limiting case Skyrora XL Launch Vehicle;
- Storage and Handling of launch vehicle propellant;
- Operation of Ground Segment and Launch Complex; and
- Launch of limiting case Skyrora XL Launch Vehicle.

7.1.2 This chapter examines the potential effects of the following:

- potential for emissions from traffic associated with operation of each Skyrora XL launch to cause significant effects at ecological sites and receptors relevant for human health; and
- potential for emissions from each Skyrora XL Launch Vehicle to cause significant effects at receptors relevant for human health. There are no airborne pollutants associated with ancillary launch activities considered likely to have any significant adverse effects on important local ecology.

7.1.3 The pollutants considered in this assessment are:

- Vehicle exhaust emissions of oxides of nitrogen (NO_x) and particulate matter (PM_{10} and $PM_{2.5}$); and,
- Carbon monoxide (CO) emissions from launches.

7.1.4 This chapter has been prepared by ITPEnergised and should be read in conjunction with Drawings 7.1 to 7.9 and Technical Appendices 7.1-7.2 in Volumes III and IV respectively.

7.2 Legislation, Policy and Guidelines

Space Industry Act

7.2.1 The Space Industry Act (2018) regulates all spaceflight activities carried out in the United Kingdom, and associated activities. The Act requires any person or organisation to obtain the relevant licence to:

- launch a launch vehicle from the UK;
- return a launch vehicle launched elsewhere than the UK to the UK landmass or the UK's territorial waters;
- operate a satellite from the UK;
- conduct suborbital activities from the UK;
- operate a spaceport in the UK; or
- provide range control services from the UK.

7.2.2 As the applicant wishes to become a spaceflight operator and launch Skyrora XL Launch Vehicles from the UK, they are required to apply for a launch operator licence, and as part of this application, submit an AEE of the proposed project.

Space Industry Regulations 2021

7.2.3 The Space Industry Regulations 2021 (the Regulations) set out in more detail the requirements for each licence the Regulators Licensing rules, which specify what information the UK Civil Aviation Authority (CAA), the regulator, requires in support of an application.

Air Quality Legislation

7.2.4 The UK's legislation and regulatory regime, along with national, regional and local planning policy play a key role in the prevention, control and minimisation of atmospheric emissions that are potentially harmful to human health and the environment. Air Quality Objectives (AQOs) are quality standards for clean air that are used as assessment criteria for determining the significance of any potential changes in local air quality resulting from development proposals. Relevant legislation and guidance documents have been reviewed and taken into account as part of this AQIA.

European Legislation

7.2.5 The EU has published a Directive on Ambient Air Quality Assessment and Management which came into force in September 1996 (Directive 96/62/EC). This Directive is intended as a strategic framework for tackling air quality consistently, through setting European wide air quality limit values in a series of daughter directives, superseding and extending existing European legislation. The first four daughter directives were placed into national legislation. A new EU air quality directive (Directive 2008/50/EC) came into force in June 2008 and was transposed into The Air Quality Standards Regulations in England, Wales, Scotland and Northern Ireland in June 2010 (H.M Government, 2010). The Directive merged the four daughter directives and one Council decision into a single national directive on air quality.

National Legislation

7.2.6 The Environment Act 1995 (H.M. Government, 1995) required the preparation of a National Air Quality Strategy (NAQS) setting air quality standards and objectives for specified pollutants and outlining measures to be taken by local authorities through the system of Local Air Quality Management (LAQM) and by others to work in pursuit of the achievement of these objectives. The NAQS was published in 1997 and subsequently reviewed and revised in 2000, and an addendum to the Strategy published in 2002. The current Strategy was published in July 2007; (Defra, 2007).

7.2.7 The objectives which are relevant to local air quality management have been set into Regulations namely Air Quality (Scotland) Regulations 2000, Air Quality (Scotland) Amendment Regulations 2002 and Air Quality (Scotland) Amendment Regulations 2016 (Scottish Government, 2016), the latter of which introduces an additional statutory obligation for Scottish Local Authorities to comply with an annual mean objective for $PM_{2.5}$ to align with the World Health Organisation Guideline Value (WHO).

7.2.8 The air quality standards (AQSs) are set for the purpose of protecting human health, vegetation and ecosystems from certain harmful atmospheric pollutants. The Scottish AQSs take account of the EU limit values and are either effectively identical, or more stringent. The AQSs applicable to the pollutants considered in this assessment are shown in Table 7.1.

Table 7.1 Air Quality Standards

Pollutant	Air Quality Standard	
	Concentration (µg/m³)	Averaging Period
For the Protection of Human Health (Scotland)		
NO_2	200	1-hour mean; not to be exceeded more than 18 times a year
	40	Annual mean

Pollutant	Air Quality Standard	
	Concentration (µg/m³)	Averaging Period
PM_{10}	50	24-hour mean; not to be exceeded more than seven times a year
	18	Annual mean
$PM_{2.5}$	10	Annual mean
CO	10 mg/m³	Running 8-hour mean
For the Protection of Vegetation and Ecosystems (UK)		
NO_x	30	Annual mean

Local Air Quality Management

7.2.9 Under Section 82 of the Environment Act (1995) (Part IV) Local Authorities (LAs) are required to periodically review and assess air quality within their area of administration under the system LAQM. This review and assessment of air quality involves considering present and likely future air quality against the objectives and reporting to the Scottish Government by means of an Annual Progress Report (Shetland Islands Council, 2020). If it is predicted that levels at sensitive locations where members of the public are regularly present for the relevant averaging period are likely to be exceeded, the LA is required to declare an Air Quality Management Area (AQMA). For each AQMA the LA is required to produce an Air Quality Action Plan (AQAP), the objective of which is to reduce pollutant concentrations in pursuit of the objectives.

7.2.10 There are currently no AQMAs within the Shetland Islands.

Guidance

Guidance to the regulator on environmental objectives relating to the exercise of its functions under the Space Industry Act 2018

7.2.11 The Department for Transport issued its document '*Guidance to the regulator on environmental objectives relating to the exercise of its function under the Space Industry Act 2018*' in 2021, clarifying the government's environmental objectives relating to spaceflight and associated activities in the UK:

The environmental objective for spaceflight are to:

- *Minimise emissions contributing to climate change resulting from spaceflight activities*
- *Protect human health and the environment from the impacts of emissions on local air quality arising from spaceflight activities*
- *Protect people and wildlife from the impacts of noise from spaceflight activities*
- *Protect the marine environment from the impact of spaceflight activities.*

Guidance for the Assessment of Environmental Effects

7.2.12 The CAA, with the UK Space Agency, the Department for Business, Energy and Industrial Strategy and the Department for Transport, issued guidance note '*CAP2215 Guidance for the Assessment of Environmental Effects*' in July 2021. The guidance sets out what is required by the regulator regarding assessment of environmental effects as part of a licence application under the Act.

7.2.13 The guidance requires that potential direct and indirect significant effects of proposed spaceflight activities on environmental features, including population and human health, are considered. The guidance further requires that:

- Specific potential effects are identified and, where possible, quantified;
- The focus of the AEE should be on significant effects arising from the proposed activities;
- The AEE should explain what other environmental assessments have been conducted in relation to the proposed activities and whether they are being used in support of the AEE;
- Applicants for a launch operator licence set an environmental budget, comprising a maximum number of launches per launch vehicle type which can take place over the course of a year that can be carried out in an environmentally sustainable manner, taking into account the cumulative effect of all launches; and
- The AEE must address a range of environmental topics, including air quality.

Air Quality Guidance

7.2.14 The assessment also uses the guidance documents listed below:

- The Technical Guidance LAQM.TG(16) for Local Air Quality Management, (Defra 2021);
- The Environmental Protection UK (EPUK) and Institute of Air Quality Management (IAQM), Land-Use and Development Control: Planning for Air Quality (Moorcroft and Barrowcliffe et al, 2017);
- IAQM, A Guide to the Assessment of Air Quality Impacts on Designated Nature Conservation Sites, (Holman et al, 2017);
- The Environmental Protection Scotland (EPS) and Royal Town Planning Institute (RTPI) Scotland Delivering Cleaner Air for Scotland guidance (EPS and RTPI, 2017); and,
- CAA Airspace Change guidance CAP 1616 (CAA, 2000).

7.3 Consultation

7.3.1 Extensive statutory consultation on air quality was carried out during preparation and determination of the planning application for the SaxaVord Spaceport, where the Proposed Project will be operated. Where directly relevant to this AEE, consultation responses received during the SaxaVord Spaceport planning application period have been summarised in Table 7.2.

Table 7.2 Consultation

Consultee	Summary of Response	Where addressed
Air Quality / Ian Taylor assistant EHO, Shetland Islands Council / 26/06/2020	Agreement with the parameters and methodology of the AQIA however reservations about scoping out the potential impacts from vehicular movements during the operational phase together.	Appendix 7.1
Air Quality / Ian Taylor assistant EHO, Shetland Islands Council / 14/07/2020	Agreement on method to assess impacts of Skyrora XL Launch Vehicle emissions from launch pad 1, closest to a residential receptors. Agreement on screening approach for transport emissions.	Section 7.4 and Appendix 7.2

Consultee	Summary of Response	Where addressed
Air Quality/Peter Cosgrove/Director/Alba Ecology 12/06/2020	Confirmation that there are no airborne pollutants associated with launch emissions considered likely to have any significant adverse effects on important local ecology.	Appendix 7.2

7.4 Assessment Methodology and Significance Criteria

Scope of the Assessment

7.4.1 The scope of the assessment has included the following:

- Application of the method of assessment agreed in consultation with Shetland Islands Council during preparation and determination of the planning application for the SaxaVord Spaceport, where the Proposed Project will be operated;
- Identification of study area and air quality sensitive receptors;
- Collection of baseline CO concentrations at the Proposed Project;
- Collection of emissions data from Skyrora for the launch emissions from an approximately 24 m long Skyrora XL Launch Vehicle;
- Development of representative modelled scenario from launch pad 1 (closest to receptors);
- Development of a time-dependant puff model (duration up to 18s) of a jet release using ADMS 5 in a range of meteorological conditions and wind directions in typical UK and Shetland-specific wind speeds;
- Development of a time-integrated dose model to predict total dose at the closest residential receptor during the lifetime of the puff release (calculated at 1-minute intervals) using ADMS 5 in a range of meteorological conditions and wind directions;
- Conversion of total dose to 8-hour running mean concentrations and comparison with the relevant air quality standard (AQS) for CO for the protection of human health, presented in tables;
- Contour maps demonstrating the puff concentration at 5-minute intervals after release for the worst case meteorological condition; and
- Mitigation measures required where necessary; and,
- Residual summary of effects.

Effects Scoped Out of the Assessment

7.4.2 There are no airborne pollutants associated with launches considered likely to have any significant adverse effects on ecological receptors. Therefore, the effect of emissions from launches on ecological sites has not been considered further in the assessment.

Environmental Zone of Influence

7.4.3 For the purposes of this AEE, the Environmental Zone of Influence (EZI) is based on and comprises the proposed launch flight corridor and all study areas required for the technical disciplines included in the AEE, as presented on drawing 3.6.

7.4.4 Within the EZI, the study area(s) required for each technical discipline assessed vary and as such the rationale for the air quality study area has been included in this chapter. The air quality study area is shown in the context of the AEE on Drawing 2.1.

7.4.5 Maps and aerial images of the Proposed Project and the surrounding area have informed the selection of an appropriate air quality study area for the assessment.

7.4.6 For the potential effects of operational phase vehicle exhaust emissions, a study area of 50 m from affected roads was considered. This is in accordance with IAQM Guidance (Holman et al, 2014) and EPUK & IAQM guidance (Moorcroft and Barrowcliffe et al, 2017). The affected road links considered in the assessment and study area are shown in Drawing 7.1.

7.4.7 The closest air quality sensitive receptors in each direction from launch pad 1 were identified, and a study area up to 5 km was defined to track the concentration of the puff release from launch until concentrations returned to normal ambient background levels under a range of meteorological conditions. The closest occupied sensitive receptor is Banks Cottage at Norwick which is 1840 m from launch pad 1. This is shown as R1 on Drawing 7.2 in Volume III.

Method of Assessment

7.4.8 Due to the remote location of the Proposed Project, the low baseline traffic movements and a lack of industrial activity in the surrounding area, it was agreed with Shetland Islands Council that no ambient baseline air quality monitoring was required to support the SaxaVord Spaceport planning application. Instead, background air quality concentrations from published Government data were used and have subsequently been used in the SaxaVord Spaceport AEE and are considered fit for purpose for this assessment.

7.4.9 The potential impacts of emissions to atmosphere from the Proposed Project have been calculated using screening tools and modelling which inherently include a number of robust assumptions.

7.4.10 The emission rate of exhaust gases from Skyrora XL Launch Vehicle will vary with height during the launch. However, they have been modelled as short-term puff releases from ground level for the duration it takes the Skyrora XL Launch Vehicle to reach an altitude of 1000 ft as required by the Civil Aviation Authority. This is considered to represent the maximum potential impact of emissions for identified receptors.

Vehicle Emissions

7.4.11 There is the potential for changes to long-term and short-term mean concentrations of fine particulates (PM_{10}, $PM_{2.5}$) and NO_2 to occur because of predicted changes in road traffic movements on the local road network as a result of the Proposed Project.

7.4.12 The maximum daily values during a launch are predicted to be 70 light goods vehicles and 11 heavy goods vehicles; significantly below the EPUK and IAQM screening thresholds for detailed assessment. However, in order to satisfy the request from Shetland Islands Council, the potential magnitude of change in air quality due to operational traffic per launch has been assessed.

7.4.13 The magnitude of change at a sensitive roadside receptor has been calculated using the atmospheric dispersion model software ADMS Roads Version 5.0.0.1 (CERC, 2022) with built-in emissions factors, equivalent to those within the Defra emissions factors toolkit EfT 10.0 (2VC) (Defra, 2020).

7.4.14 The potential magnitude of change in air quality has been assessed by defining an affected road link which all of the maximum daily operational phase traffic is assumed to travel through. This assessment has used a section of the B9087 through Saxa Vord and Norwick where it is considered that maximum exposure to operational phase vehicle emissions is likely due to the number of residential settlements and a SSSI (Norwick Meadows) adjacent to the roadside as shown in Drawing 7.1.

7.4.15 A summary of the modelled road links, traffic speeds and development-generated traffic is shown in Tables 1 and 2 in Volume IV Technical Appendix 7.1.

7.4.16 Pollutant concentrations of NO_x, NO_2, PM_{10} and $PM_{2.5}$ have been predicted at selected receptors using development-generated traffic combined with existing baseline background concentrations in order to compare the total predicted concentration with the relevant AQSs.

7.4.17 The assessment has been undertaken using hourly meteorological data from 2019 for Baltasound Airport on Unst.

7.4.18 Details of general model conditions used in the dispersion model are provided in Table 7.3 below.

Table 7.3- General ADMS Roads Model Conditions

Variables	ADMS Roads Model Input
Surface roughness at source/meteorological site	0.02 m / 0.02 m (Open Grassland)
Minimum Monin-Obukhov length for stable conditions at source/meteorological site	Model-calculated per hourly meteorological condition
Terrain types	Flat Terrain
Receptor location	x, y coordinates determined by Geographic Information System (GIS) z = 1.5 m for ground floor human receptors z=0 m for ecological receptor
Pollutants	NO_x, PM_{10}, $PM_{2.5}$
Traffic Emissions Factors	Defra EfT10.0 (2 VC) emission factor dataset for 2022
Meteorological data	One year (2019) hourly sequential data from Baltasound Airport meteorological station.
Emission profiles traffic	None
Receptors	Selected existing receptors (residential) and SSSI
Model output	Long-term annual mean NO_x concentrations Long-term annual mean PM_{10} concentrations Long-term annual mean $PM_{2.5}$ concentrations

Launch Emissions

7.4.19 The Proposed Project comprises the preparation and launch of the Skyrora XL Launch Vehicle from any of three terrestrial vertical launch pads at the SaxaVord Spaceport situated at Lamba Ness on Unst, Shetland. The Applicant is applying for a maximum environmental budget of 16 launches per year which, from 2029 when maximum launch cadence is reached, will make up just over one half of SaxaVord Spaceport's own environmental budget of 30 launches per year.

7.4.20 The Skyrora XL Launch Vehicle is approximately 24 m long, a three-stage liquid fuelled orbital launch vehicle intended to place customer payloads into sun synchronous or polar orbits. Launches will take place in a northerly direction over the sea and launches will not occur simultaneously from more than one launch pad.

7.4.21 The Skyrora XL Launch Vehicles will use a propellent mixture of High Test Peroxide (HTP) (90%) and a Jet A-1 kerosene. The majority of emissions from burning this propellent are water vapour (H20) alongside much smaller quantities of carbon dioxide (CO_2) and CO. Emissions are via nine identical nozzles directed towards a flame deflector.

7.4.22 Launch greenhouse gas emissions (including CO_2) are quantified in Chapter 9.

7.4.23 The only pollutant that requires assessment with respect to air quality for potential effects on human health is CO.

7.4.24 There are no airborne pollutants considered likely to have any significant adverse effects on important local ecology.

7.4.25 In order to determine the maximum potential effects of emission from a launch at a sensitive receptor, the assessment considers the effects of emissions from launch pad 1 at receptor R1, Banks Cottage, the closest emission-receptor relationship.

7.4.26 CAA guidance document CAP1616 "Airspace Change – Guidance on the regulatory process for changing the notified airspace design and planned and permanent redistribution of air traffic, and on providing airspace information", states that assessment of emissions on local air quality is required for any airspace change less than 1000 feet in altitude. It is therefore only necessary for the AQIA to consider emissions from the Skyrora XL Launch Vehicles during Stage 1 as subsequent stages occur at significantly higher altitudes. This has been estimated to take a maximum of 18 seconds for the Skyrora XL Launch Vehicle.

7.4.27 The "Puff" model in ADMS 5 (CERC, 2022) enables releases of up to one-hour duration to be modelled and concentrations at chosen downwind distances to be predicted at different timesteps (time in seconds after the start of the emission). It is therefore possible to track the concentration at any point during the whole lifetime of that puff release, for any given meteorological condition, and calculate the total "dose" at each location i.e., the total concentration that a person would be exposed to if they stayed at the same location for the whole time the puff passed overhead. When considering the potential exposure for a human receptor during a launch, the total dose concentration is the most appropriate.

7.4.28 The assessment is provided in detail in Volume IV Technical Appendix 7.2.

Vehicle Exhaust Emissions and Launch Emissions

7.4.29 The change in pollutant concentrations with respect to future baseline concentrations has been described at identified sensitive receptors. The absolute magnitude of pollutant concentrations in the "future with Proposed Project" scenario is described, and this is used to consider the risk of the AQSs being exceeded.

7.4.30 The IAQM has published recommendations for describing the magnitude of impacts and determining the significance of such impacts at individual receptors (Moorcroft & Barrowcliffe et al., 2017). The impact descriptors are summarised in Table 7.4 below**.** A change of less than 0.5 % of the Air Quality Assessment Level (AQAL) is described as Negligible.

Table 7.4 – Impact Magnitude Descriptors for Individual Receptors

Long Term Average Concentration at Receptor	% Change in concentration relative to Air Quality Assessment Level (AQAL)			
	1 %	2-5 %	6-10 %	>10 %
75 % or less of AQAL	negligible	negligible	slight	moderate

Long Term Average Concentration at Receptor	% Change in concentration relative to Air Quality Assessment Level (AQAL)			
	1 %	2-5 %	6-10 %	>10 %
76-94 % of AQAL	negligible	slight	moderate	moderate
95-102 % of AQAL	slight	moderate	moderate	substantial
103-109 % of AQAL	moderate	moderate	substantial	substantial
110 % or more of AQAL	moderate	substantial	substantial	substantial

Overall Assessment of Significance

7.4.31 The reported magnitude impacts for each receptor have been considered for the Proposed Project in overall terms. In addition, the potential for the Proposed Project to contribute to or hinder the successful implementation of policies and strategies for the management of local air quality has been considered. The descriptors used to characterise the overall significance of effects at sensitive receptors are summarised in Table 7.5.

Table 7.5 - Descriptors used for the Overall Assessment of Significance at Sensitive Receptors

Effect Descriptor	Significance
Major	A significant effect that is likely to be a material consideration in its own right.
Moderate	A significant effect that may be a material consideration in combination with other significant effects but is unlikely to be a material consideration in its own right.
Minor	An effect that is not significant but that may be of local concern.
Negligible	An effect that is not significant change.

Requirements for Mitigation

7.4.32 Proposed mitigation measures are presented in Section 7.7.

Assessment of Residual Effect

7.4.33 An assessment of predicted significant residual effects, taking account of committed mitigation measures, is presented in Section 7.9.

7.5 Baseline Conditions

7.5.1 Background concentrations for NO_x, NO_2, PM_{10} and $PM_{2.5}$ have been taken from the 2018-based Scottish Air Quality Database (Air Quality in Scotland, 2022) and Defra LAQM background maps (Defra, 2022). The maximum 2022 annual background concentrations in the study area are predicted to be 2.1 µg/m^3 1.7 µg/m^3, 5.8 µg/m^3, 3.8 µg/m^3 and 0.05 mg/m^3 for NO_x, NO_2, PM_{10}, $PM_{2.5}$ and CO respectively. These are all significantly below the relevant AQSs outlined in Table 7.1.

7.6 Receptors Brought Forward for Assessment

7.6.1 The receptors brought forward for assessment are:

- Two residential properties closest to the roadside along the B9087 road (Saxa Vord Residential and Norwick Residential on Drawing 7.1);
- The closest residential receptor to launch pad 1 (R1 on Drawing 7.2); and,
- Norwick Meadows SSSI adjacent to the B9087 (shown on Drawing 7.1).

7.7 Standard Mitigation

Vehicle Emissions

7.7.1 Improvements to the existing public road network and the construction of the New Section of Access Road at Northdale required by the planning conditions for the SaxaVord Spaceport will act to mitigate against congestion pinch points that could lead to an increase in vehicle emissions due to reduced speed and stop-start behaviour during operation of the Proposed Project.

7.7.2 The SaxaVord Spaceport will use electric vehicles to collect and transport launch operator staff and visitors and as such this will mitigate emissions from the Proposed Project.

7.7.3 A Spectator Traffic Management Plan has been developed for the SaxaVord Spaceport to avoid congestion and encourage sustainable transport choices. The Applicant is aware of, and will adhere to, the requirements of this Plan and other Operational Environmental Management Plans at the Spaceport.

7.8 Potential Effects

Operational Traffic

7.8.1 The assessment of traffic emissions in Volume IV Technical Appendix 7.1 concludes that:

- The magnitude of change in concentration of each pollutant is significantly below 0.5 % of the relevant annual mean AQS at all receptors.
- The maximum predicted total concentration of NO_2 at a sensitive receptor is less than 4.5 % of the annual mean AQS.
- The maximum predicted concentration of PM_{10} at a sensitive receptor is less than 28.5 % of the annual mean AQS.
- The maximum predicted concentration of $PM_{2.5}$ at a sensitive receptor is less than 30 % of the annual mean AQS.
- There is no predicted risk of exceedance of the annual mean or short-term AQSs at any residential receptor due to the emissions from the forecast peak number of operational vehicles during a launch.
- The magnitude of change in concentration of each NO_x is significantly below 1 % of the relevant annual mean AQS for the protection of vegetation and ecosystems.
- The maximum predicted annual mean NO_x concentration at the Norwick Meadows SSSI is 7.2 % of the annual mean AQS (or critical level).
- There is no predicted risk of exceedance of the critical level threshold at a roadside ecological receptor.

7.8.2 The effect of operational phase vehicle emissions at all identified receptors is therefore predicted to be of negligible significance**,** therefore resulting in **no likely significant effect**.

Launch Emissions

7.8.3 The assessment of the potential effects of emissions from launches in Volume IV Appendix 7.3 predicted ambient concentrations at short term (1-minute) intervals after release. Modelling identified that the downwind concentration was detectible above background levels following launch for a period of up to 37 minutes in UK average wind speed conditions, after which time, concentrations reverted to background levels. The maximum predicted dose at R1 was 91.04 mg/m^3 CO over 19 minutes. This is equivalent to a dose over the lifetime of the jet release of 79.5 parts per million (ppm). There are no health effects of this level of exposure to CO over periods of 19 minutes. A person would have to be exposed to this dose for six to eight hours of constant exposure to experience headache or dizziness (Goldstein, 2008). For a health effect to arise from around 20 minutes of exposure, the dose would need to be around 1600 ppm.

7.8.4 The maximum predicted 8-hour concentration at R1 was 0.55 mg/m^3, 0.55 % of the AQS, when modelled using UK average convective (Stability A) meteorological conditions with wind from the north east (45°). This reduced to 0.53% of the AQS when average Unst wind speed conditions were modelled for this direction.

7.8.5 On analysis of the meteorological data, a north east (45°) wind only occurs for approximately 9 % of the year on Unst. There is therefore a high probability that launches will take place under the local prevailing wind condition which, over the period 2015-2019, was southerly to westerly. Under prevailing conditions, there is no detectible impact at the closest receptor R1.

7.8.6 The assessment has demonstrated that there is no risk of exceedance of the 8-hour AQS for CO at any sensitive receptor in the vicinity of the Proposed Project irrespective of the prevailing weather conditions during a launch and there are no health effects associated with the maximum predicted exposure over 19 minutes.

7.8.7 The effect of launch emissions on all identified receptors is concluded to be of negligible significance**,** therefore resulting in **no likely significant effect**.

7.9 Cumulative Assessment

7.9.1 There are no intra-project cumulative effects that have the potential to result in significant effects and so no intra-project cumulative assessment is required.

7.9.2 Shetland Islands Council confirmed during the planning application for SaxaVord Spaceport that there were no other committed development or infrastructure projects which needed to be considered in that assessment and there has been no change subsequent to planning consent. As such, as far as the Applicant is aware, there are no like for like or similar projects within the air quality study area and therefore, no significant issues are likely to arise from developments other than the SaxaVord Spaceport.

7.9.3 The SaxaVord Spaceport has a proposed capacity for 30 launches per annum. Once maximum launch cadence is achieved, the Proposed Project will account for 16 of those launches. A comparison of the Skyrora XL Launch Vehicle against the RepLV used as the basis of assessment in the SaxaVord Spaceport AEE has been undertaken; the composition and fuelling specifics of the two launch vehicles has been assessed by all technical leads working on the AEE and a review of environmental effect significance from the two vehicles carried out. It has been confirmed that for all topics, the Skyrora XL Launch Vehicle is within the limiting case envelope assessed for the SaxaVord Spaceport - suborbital and orbital launches of small satellites into either polar or sun-synchronous, low-earth orbits. As such the assessment of cumulative air quality effects completed for the SaxaVord Spaceport AEE is considered appropriate to this AEE.

7.9.4 Assuming operators are identified for the remaining capacity, the cumulative air quality effects of all 30 launches would therefore be expected to be as documented in the SaxaVord Spaceport AEE:

"Inter-project cumulative effects are those where an environmental topic/receptor is affected by impacts from more than one project at the same time and the impacts act together. Due to the location of the Proposed Project on the north coast of Unst, the most northerly of the Shetland Islands, it is considered that there are no potential inter-project cumulative effects as there are no other existing or proposed developments in the EZIs for air quality.

Shetland Islands Council was contacted during the planning application stage of the Proposed Project and confirmed that there are no committed development or infrastructure projects on the Island which should be considered in the assessment.

Intra-project cumulative effects are those where an environmental topic/receptor is affected by more than one impact from the same Proposed Project and the impacts act together. Given that none of the other environmental topics considered impact directly on air quality, and the fact that only one launch will occur at any given time and launches will be phased with time enough for the EZI to return fully to its baseline state between launches, it is considered that there is no potential for additive or intra-project cumulative effects."

7.10 Residual Effects

7.10.1 The residual effects on air quality from the Proposed Project are concluded to be of negligible significance, therefore resulting in **no likely significant effect**.

7.11 Summary

7.11.1 An assessment of the potential effects of emissions from the Proposed Project on local air quality has been undertaken. The assessment has considered the operational phase of the Proposed Project.

7.11.2 Proposed project-generated traffic is predicted to have an effect of negligible significance on air quality, therefore resulting in **no likely significant effect**.

7.11.3 Launch emissions are predicted to have no perceptible impact at any identified receptors under prevailing wind directions. The maximum predicted impact at a sensitive receptor is predicted to occur with north-easterly winds which occur typically for less than 10 % of the year. The maximum predicted 8-hour concentration of CO is 0.55% of the AQS. Emissions from launches are therefore considered to negligible effect on air quality**,** therefore resulting in **no likely significant effect**.

7.12 References

CAA, 2020, *Airspace Change – Guidance on the regulatory process for changing the notified airspace design and planned and permanent redistribuition of air traffic, and on providing airspace information, CAP1616*.

CAA et. al. (2021) *CAP2215 Guidance for the Assessment of Environmental Effects*.

CERC, 2022, Cambridge Environmental Research Consultants. Link to series of validation documents available at https://www.cerc.co.uk/environmental-software/model-validation.html

Defra (2009). *Local Air Quality Management - Technical Guidance (TG09).* Available at: https://laqm.defra.gov.uk

Defra (2021). *Local Air Quality Management - Technical Guidance (TG16).* Available at: https://laqm.defra.gov.uk

Defra (2020). *Emissions Factors Toolkit v10 - User Guide.* Available at https://laqm.defra.gov.uk/documents/EFTv10.1-user-guide-v1.0.pdf

Defra (2020b) *NO_x to NO_2 Converter version 8.1.* Available at: https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html

EPS & RTPI Scotland (2017). *Delivering Cleaner Air for Scotland - Development Planning & Development Mangement,* EP Scotland. Available at: www.ep-scotland.org.uk

Goldstein (2008), *Carbon monoxide poisoning*, Journal of Emergency Nursing 34 (6) 538-542, PMID 19022078

Holman et al (2019). *A guide to the assessment of air quality impacts on designated nature conservation sites – version 1.0*, Institute of Air Quality Management, London. Available from: www.iaqm.co.uk/text/guidance/airquality-impacts-on-nature-sites-2019.pdf

Laxen and Marner. (2003). *Analysis of the Relationship Between 1-Hour and Annual Mean Nitrogen Dioxide at UK Roadside and Kerbisde Monitoring Sites.* Available at https://uk-air.defra.gov.uk/assets/documents/reports/cat06/1hr_NO2_rpt_Final_b.pdf

Moorcroft and Barrowcliffe. et al. (2017) *Land-use Planning & Development Control: Planning for Air Quality. v1.2,* Institute of Air Quality Management, London

Scottish Government (2015), *Cleaner Air for Scotland – The Road to a Healthier Future,* Scottish Government. Available at: https://www.gov.scot/news/cleaner-air-for-scotland-1/

Scottish Government (2014), *Scottish Planning Policy*, Scottish Government ISBN: 978-1-78412-567-7. Available at: https://www.gov.scot/publications/scottish-planning-policy/

Shetland Islands Council (2020), *2020 Air Quality Annual Progress Report (APR) for Shetland Islands Council, In fulfilment of Part IV of the Environment Act 1995, Local Air Quality Management, June 2020.*

WHO (2005), *World Health Organisation Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulphur Dioxide, Global Update 2005. WHO/SDE/PHE/OEH/06.02* Available at:
http://apps.who.int/iris/bitstream/10665/69477/1/WHO_SDE_PHE_OEH_06.02_eng.pdfWebsites

Websites

AEA (2008), *Unit Conversion and Screening Tool.* Available at: https://IAQM.co.uk. Accessed 01 May 2022.

Defra, (2022), *UK Air-Air Information Resource.* Available at: https://uk-air.defra.gov.uk/data/laqm-background-home. Accessed 05 May 2022

Legislation

Council of European Communities (1996), *Framework Directive on ambient air quality assessment and management, European Council, 96/62/EC*.

Council of European Communities (2008), *2008/50/EC on Ambient Air Quality and Cleaner Air for Europe.*

Defra (2007), *The Air Quality Strategy for England, Scotland, Wales and Northern Ireland: Volume I and II.* Department of Environment, Farming and Rural Affairs in partnership with the Scottish Executive, Welsh Assembly Government and Department of the Environment Northern Ireland. July 2007.

H.M. Government (1995), *The Environment Act 1995.*

H.M Government (2010), *Air Quality Standards Regulations.*

Scottish Executive (2000), *The Air Quality (Scotland) Regulations 2000, Scottish Statutory Instrument 2000 No.97, 31st March 2000.* Available at http://www.legislation.gov.uk/ssi/2000/97/made

Scottish Executive (2002), *The Air Quality (Scotland) Amendment Regulations 2002, Scottish Statutory Instrument 2002 No.297,11th June 2002.* Available at http://www.legislation.gov.uk/ssi/2002/297/introduction/made

Scottish Government (2016), *The Air Quality (Scotland) Amendment Regulations 2016, Scottish Statutory Instrument 2016 No., 1st April 2016.* Available at https://www.legislation.gov.uk/sdsi/2016/9780111030837/introduction

Chapter 8 Noise and Vibration

8. Noise and Vibration

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8. Noise and Vibration

8.1 Introduction

8.1.1 This chapter considers the potential noise and vibration effects associated with the Proposed Project.

8.1.2 The Proposed Project comprises the preparation and launch of suborbital (Skyrora Skylark L) and orbital (Skyrora XL) Launch Vehicles from any one of three terrestrial vertical launch pads at the SaxaVord Spaceport situated at Lamba Ness on Unst, Shetland.

8.1.3 The Skyrora Skylark L suborbital Launch Vehicle is approximately 11.6 m long and comprises a guided suborbital Launch Vehicle powered by a single pressure fed, bi-liquid propellant engine. Launches will take place in a northerly direction over the sea and will be located on any of the three launch pads within the SaxaVord Spaceport.

8.1.4 The Skyrora XL orbital Launch Vehicle is approximately 24 m long, three-stage liquid fuelled orbital launch vehicle intended to place customer payloads into sun synchronous or polar orbits. Launches will take place in a northerly direction over the sea and will be located on any of the three launch pads within the SaxaVord Spaceport.

8.1.5 For the purposes of this AEE, the Skyrora XL orbital Launch Vehicle has been determined to be, and assessed as, the limiting case Launch Vehicle. Commentary on the justification for this is provided in AEE Report Volume II, Chapter 2.

8.1.6 The applicant is applying for an assumed maximum environmental budget of 16 launches per year; which will make up just over one half of SaxaVord Spaceport's environmental budget of 30 launches per year.

8.1.7 For the purposes of this AEE the effects of the applicant's environmental budget, within the envelope of the SaxaVord Spaceport budget in terms of cumulative effects, has been assessed so as to give the predicted effects over any one year. The Applicant has not determined a specific timeframe for the Launch Operator Licence and as such the effect over any given year period is considered to be the most appropriate for the AEE.

8.1.8 The characteristics of the Skyrora XL Launch Vehicle are within the range assessed previously as part of the planning application EIA works for the SaxaVord Spaceport. As such, and due to the fact that in terms of noise impact it is best practice to assess cumulative impact, that same assessment has been used in this AEE.

8.1.9 The Applicant provided input data for the SaxaVord Spaceport AEE noise assessment, which then considered a 'worst-case' launch schedule of 30 launches of the Skyrora XL Launch Vehicle. As such this AEE reports on the same noise modelling and assessment undertaken for the SaxaVord Spaceport AEE but frames the findings in the context of the Proposed Project.

Scope of Assessment

8.1.10 The scope of the noise impact assessment comprised the following:

- Baseline noise survey at the SaxaVord Spaceport site (2018);
- Evaluation of predicted road traffic noise for the SaxaVord Spaceport operation;
- Modelling of engine testing and launch noise from 30 orbital launches per year from the SaxaVord Spaceport (undertaken by BRRC);
- Evaluation and interpretation of modelling results; and,
- Specification of appropriate mitigation.

8.1.11 Ground-borne vibration effects associated with launches and engine testing will be highly localised and are considered to be negligible at human receptor locations. The evaluation of ground-borne vibration effects has therefore been scoped out of this assessment.

8.1.12 Prediction of noise associated with launch vehicles, including static engine tests and launches, has been undertaken by Blue Ridge Research and Consulting LLC (BRRC). BRRC is an acoustical engineering consultancy focused on critical noise and vibration challenges for aerospace, aviation, and US Department of Defense projects. With experience from more than 250 civilian and military noise studies, BRRC's team of acoustical engineers is recognised as a trusted advisor to public, private, and academic clients in the space industry around the world.

8.1.13 BRRC's modelling evaluates the potential impacts of launch vehicle noise and sonic booms on a cumulative basis in terms of human annoyance. In addition, potential impacts are evaluated on a single-event basis in relation to hearing conservation, sleep disturbance, speech interference, and structural damage. As applicable, model results have then been incorporated into this AEE Report chapter by ITPEnergised.

8.1.14 The BRRC modelling assessment is provided in Volume IV Appendix 8.1. It is recommended that the reader reviews the BRRC report prior to proceeding with this chapter.

8.1.15 With reference to Volume IV Appendix 8.1 Figure 40, the sonic boom from launches of the Skyrora XL Launch Vehicle will occur 60 km out to sea, away from populated areas, therefore further consideration of air overpressure effects on structures and human receptors has been scoped out of this assessment.

8.1.16 Sonic booms associated with the Skyrora Skylark L are not expected to differ significantly in their reception locations at sea level to those to the Skyrora XL and will occur far out to sea, however, the smaller size of the vehicle will result in a marginally lesser sonic boom level. The Skyrora XL Launch Vehicle is therefore considered to be a robust limiting case for this assessment.

Glossary of Acoustics Terms

8.1.17 Acoustics and vibration are necessarily highly technical disciplines, and as such there are numerous specific terms which are used within this assessment. The terms are defined here to aid the lay reader.

- **Noise** – unwanted sound.
- **A-weighting** – an electronic filter applied to measured sound levels to approximate the hearing response of humans to different frequencies, denoted 'A' in noise indices.
- **Ambient level, $L_{eq,T}$** – the equivalent continuous sound pressure level (L_{eq}) of the totally encompassing sound in a given situation at a given time at the assessment location over a given time interval, T. Denoted $L_{Aeq,T}$ when A-weighted.
- **Background level, $L_{A90,T}$** - the A-weighted sound pressure level that is exceeded for 90 percent of a given time interval, T.
- **Maximum level, L_{Amax}** – the A-weighted maximum instantaneous sound level during a measurement period or noise 'event', recorded during a time interval, T.
- **Day-night noise level, L_{den}** - the A-weighted ambient level over a 24-hour period, with a +10 dB penalty for night-time noise (23:00 – 07:00) and a +5 dB penalty for evening noise (19:00 – 23:00). The L_{den} index is a cumulative yearly average, taking into account all noise 'events' associated with a particular source throughout the year.
- **Sound Exposure Level, SEL** – the SEL (alternatively the Single Event Noise Exposure Level, SENEL) is the one-second long steady level that contains as much sound energy as the varying level over the full event. The SEL is similar to the L_{eq}, however, the SEL uses a reference period of one second, whereas the L_{eq} can be expressed for any time interval.

8.2 Legislation, Policy and Guidelines

8.2.1 A short summary of relevant legislation, policy and guidelines that have been taken into consideration in this assessment is provided below. Where appropriate, detailed summaries of these documents for the lay reader are provided in Volume IV Appendix 8.2.

Legislation

Space Industry Act

8.2.2 The Space Industry Act (2018) regulates all spaceflight activities carried out in the United Kingdom, and associated activities. The Act requires any person or organisation to obtain the relevant licence to:

- launch a launch vehicle from the UK;
- return a launch vehicle launched elsewhere than the UK to the UK landmass or the UK's territorial waters;
- operate a satellite from the UK;
- conduct suborbital activities from the UK;
- operate a spaceport in the UK; or
- provide range control services from the UK.

8.2.3 As the applicant wishes to become a spaceflight operator and launch the Skyrora XL Launch Vehicle from the UK, they are required to apply for a launch operator licence, and as part of this application, submit an AEE of the proposed project.

Space Industry Regulations 2021

8.2.4 The Space Industry Regulations 2021 (the Regulations) set out in more detail the requirements for each licence the Regulators Licensing rules, which specify what information the UK Civil Aviation Authority (CAA), the regulator, requires in support of an application.

Control of Noise at Work Regulations, 2005

8.2.5 The Control of Noise at Work Regulations (CoNaW Regs.) seek to protect against hearing damage by controlling the exposure of employees to noise during the course of their working day by providing threshold noise exposure values which trigger particular requirements of employers and employees.

8.2.6 The threshold noise exposure values relate to either daily or weekly personal exposure; the individual 'noise dose' received by an employee during work hours is calculated over the appropriate time period. Where an employee is exposed to noise levels above the thresholds, certain requirements on behalf of the employer and employee are triggered, such that their risk of noise-induced hearing damage is minimised.

8.2.7 The threshold values are as follows:

- **Lower Exposure Action Value (LEAV);**
  - Daily or weekly personal noise exposure of 80 dB(A) and,
  - Peak sound pressure of 135 dB(C);
- **Upper Exposure Action Value (UEAV);**
  - Daily or weekly personal noise exposure of 85 dB(A) and,
- Peak sound pressure of 137 dB(C);**Exposure Limit Value (ELV);**
  - Daily or weekly personal noise exposure of 87 dB(A) and,
  - Peak sound pressure of 140 dB(C);

8.2.8 A weekly value may be used where the exposure of an employee varies markedly from day to day.

8.2.9 The daily exposure is calculated using the following formula:

$$L_{EP,d} = L_{Aeq,Te} + 10\log_{10}(T_e/T_0)$$

8.2.10 Where:

- T_e is the duration of the person's working day in seconds;
- T_0 is 28,800 seconds (8 hours); and,
- $L_{Aeq,T}$ is the equivalent continuous A-weighted sound pressure level that represents the sound the person is exposed to during the working day.

Policy

Planning Advice Note PAN1/2011

8.2.11 PAN1/2011 (Scottish Government, 2011), sets out a series of noise issues for planning authorities to consider when making decisions on planning applications. A Technical Advice Note (TAN) on Assessment of Noise (Scottish Government, 2011) has been published to accompany PAN 1/2011. The TAN sets out appropriate technical guidance for evaluating different sources of noise and provides an example framework for determining impact magnitude and effect significance.

Consultation Response on UK Airspace Policy: A Framework for balanced decisions on the design and use of airspace

8.2.12 In February 2017 the UK Government put forward proposals to address the noise impact of aviation as part of a consultation on how changes to airspace could be implemented to allow airports to keep up with demand.

8.2.13 The consultation response noted that the UK Government believes that the 54 $dBL_{Aeq,16hr}$ metric remains appropriate, on the basis of a Survey of Noise Attitudes Study (SoNA, 2014) commissioned by the Department for Transport (DfT) which indicated that the degree of annoyance based on percentage of respondents 'highly annoyed' previously occurring at 57 $dBL_{Aeq,16hr}$ now occurs at 54 $dBL_{Aeq,16hr}$.

Shetland Local Development Plan 2014

8.2.14 The Local Development Plan notes that:

- Development should not have a significant adverse effect on existing uses;
- Development should not compromise acceptable health and safety standards or levels; and
- Development should be consistent with National Planning Policy, other Local Development Plan policies and Supplementary Guidance.

Guidance

Guidance for the Assessment of Environmental Effects

8.2.15 The Guidance for the Assessment of Environmental Effects (AEE) explains the process for completing an assessment of environmental effects as part of a licence application under the Space Industry Act.

8.2.16 The AEE Guidance requires that potential direct and indirect significant effects of proposed spaceflight activities on environmental features, including noise and vibration, are considered. The guidance further requires that:

- The launch operator AEE must cover all operations and activities that could have an environmental effect from the proposed launch(es);

- The applicant must provide a detailed assessment of the environmental effects of the specific launch(es) they are intending to apply for. The regulator will expect more detailed data for a launch operator AEE than for a spaceport AEE as the launch vehicle(s) will be known. The AEE must be based on the actual details of the class, type and detailed requirements of the launch vehicle and must not be based on assumptions;
- If more than one launch is being applied for, under the same launch operator licence application, then a cumulative assessment of those launches must be conducted. The launch operator AEE must also include any test launch(es) that will be authorised by the launch operator licence;
- The AEE must cover the entire launch operation, including:
  - from ground processing to the injection of the payload on orbit;
  - reusable or/and refurbishable elements, for example, the return flight of a reusable spaceplane;
  - objects jettisoned during the course of a nominal launch operation, for example, spent stages and fairings; and
  - for a suborbital operation, until the vehicle returns to earth
- The AEE must address a range of environmental topics, including noise.

Guidance to the Regulator on Environmental Objectives Relating to the Exercise of its Functions Under the Space Industry Act 2018

8.2.17 The Department for Transport issued its document '*Guidance to the regulator on environmental objectives relating to the exercise of its function under the Space Industry Act 2018*' in 2021, clarifying the government's environmental objectives relating to spaceflight and associated activities in the UK:

The environmental objectives for spaceflight are to:

- *Minimise emissions contributing to climate change resulting from spaceflight activities*
- *Protect human health and the environment from the impacts of emissions on local air quality arising from spaceflight activities*
- *Protect people and wildlife from the impacts of noise from spaceflight activities*
- *Protect the marine environment from the impact of spaceflight activities.*

8.2.18 The guidance identifies that noise from spaceflight activities is anticipated to be one of the greatest environmental concerns for impacts to humans and wildlife.

8.2.19 It is further noted that noise generated by spaceflight activities is not covered by WHO guidelines, ISO or BSI assessment methods, however, fixed spaceport activities should be assessed in accordance with BS 4142, as for any other type of industrial noise.

8.2.20 With regard to appropriate indices for the evaluation of rocket noise, the guidance notes the following:

"When assessing distinct and infrequent noise, such as rocket noise, measures of single events such as the maximum noise level (L_{Amax}) and the sound exposure level (SEL or LAE) are most appropriate. Unweighted maximum noise level (L_{max}) may also be appropriate for assessing risk of structural damage to the surrounding buildings and properties. To avoid acute damage to the human inner ear resulting from impulsive sounds, WHO noise guidelines suggest the maximum sound level (L_{Amax}) should never exceed 110 dBL_{ASmax}. To avoid and minimise the risk of structural damage the maximum unweighted noise level (L_{ASmax}) should not exceed 120 dB (unweighted)."

8.2.21 The guidance notes that the regulator must ensure:

- That where the rocket launch noise footprint could result in exposures in excess of 80, 85, 90, 95 and 100 dBL_{ASmax}, that these areas are published on suitable maps and used to communicate with local stakeholders.
- Where a night-time launch has been proposed by an applicant, the regulator should ensure that the applicant has assessed the risks to sleep disturbance in the vicinity around the launch using the following probability of awakening (equation provided in guidance).
- That any noise assessment provided takes into account an assessment of noise under predominant meteorological conditions and favourable weather conditions for launch where they differ.
- That any noise assessment provided clearly identifies the sources of noise and establishes what levels of noise have no observed effect, which have low observed adverse effects, and which have significant observed adverse effects.
- That a range of noise metrics have been assessed in addition to A-weighted measurements when considering a sonic boom. Where sonic booms over land cannot be avoided, the maximum overpressure should not exceed 47.88 pascals (Pa).
- All reasonable steps have been taken by operators to mitigate and minimise the adverse effects of noise events on human health and sensitive wildlife receptors.

8.2.22 The guidance notes that the noise assessment should include noise arising from ground operations and ancillary services, such as increased vehicle movement, generators and on-site equipment, assembly of launch vehicles, propellant loading and static fire testing.

8.2.23 Example mitigation measures are provided, including site selection away from sensitive receptors, applying operational procedures, e.g., restrictions during the night-time, seasonal restrictions, and implementing launch caps.

British Standard BS4142:2014+A1:2019

8.2.24 BS4142 describes methods for rating and assessing sound from industrial or commercial premises at residential receptors by comparison of the rating level due to the noise source with the background level in the absence of noise from the source.

8.2.25 The following evaluation impact significance identifiers are provided in the Standard, in which the difference between the rating level and measured background level are considered:

- The greater the difference, the greater the magnitude of impact;
- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact;
- A difference of around +5 dB is likely to be an indication of an adverse impact;
- The lower the rating level, relative to the measured background level, the less likely that the specific sound source will have an adverse (or significant adverse) impact; and,
- Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact.

Calculation of Road Traffic Noise (CRTN)

8.2.26 CRTN (Department of Transport, 1988) provides a method for the prediction of noise levels due to road traffic based on traffic flows, average speed, road type and geometry.

Converting the UK traffic noise index $L_{A10,18hr}$ to EU noise indices for noise mapping

8.2.27 This report by TRL Ltd. may be used to convert CRTN 10th percentile ($L_{A10,18hr}$) noise index values to equivalent continuous ($L_{Aeq,T}$) index values, including $L_{Aeq,16hr}$, L_{day} and L_{night}.

Design Manual for Roads and Bridges (DMRB)

8.2.28 DMRB provides standards and advice regarding the assessment, design and operation of roads in the UK and provides significance criteria by which the percentage of people adversely affected by traffic noise can be related to the total noise level due to road traffic, or the increase over existing levels.

ISO 9613: Attenuation of sound during propagation outdoors, Part 1 and Part 2

8.2.29 ISO 9613 provides a calculation method for determining the attenuation of sound during propagation outdoors to predict the levels of environmental noise from a variety of sources.

The Environmental Noise (Scotland) Regulations 2006

8.2.30 The Regulations enact European Union Directive 2002/49/EC relating to the assessment and management of environmental noise in Scotland. The Regulations require that noise strategic noise maps are made showing the contribution of road, rail, aircraft and industrial activities. The strategic maps are to be used to develop noise action plans for areas close to major airports and other infrastructure. The Regulations use the noise indices L_{den} and L_{night}.

World Health Organization – Environmental Noise Guidelines for the European Region (WHO ENG)

8.2.31 The World Health Organization (WHO) was requested by the Member States in the European Region to produce noise guidelines that included not only transportation noise sources but also personal electronic devices, toys and wind turbines, which had not yet been considered in existing guidelines. Furthermore, European Union Directive 2002/49/EC relating to the assessment and management of environmental noise (END) and related technical guidance from the European Environment Agency both elaborated on the issue of environmental noise and the importance of up-to-date noise guidelines.

8.2.32 The WHO Regional Office for Europe has therefore developed environmental noise guidelines for the European Region, proposing an updated set of public health recommendations on exposure to environmental noise.

8.2.33 A strong recommendation can be adopted as policy in most situations. The guideline is based on the confidence that the desirable effects of adherence to the recommendation outweigh the undesirable consequences. The quality of evidence for a net benefit – combined with information about the values, preferences and resources – inform this recommendation, which should be implemented in most circumstances.

8.2.34 With regard to aircraft noise, the Guidelines provide the following recommendations:

"For average noise exposure, the Guideline Development Group (GDG) strongly recommends reducing noise levels produced by aircraft below 45 dB Lden, as aircraft noise above this level is associated with adverse health effects. For night noise exposure, the GDG strongly recommends reducing noise levels produced by aircraft during night-time below 40 dB Lnight, as night-time aircraft noise above this level is associated with adverse effects on sleep.

To reduce health effects, the GDG strongly recommends that policy-makers implement suitable measures to reduce noise exposure from aircraft in the population exposed to levels above the guideline values for average and night noise exposure. For specific interventions the GDG recommends implementing suitable changes in infrastructure."

8.2.35 The WHO ENG relies on meta-analysis of studies of the effects of aircraft noise on populations and determined that there was an absolute risk of 10% of a population would be 'highly annoyed' at an aircraft noise exposure level of 45.4 dB L_{den}. The quality of the supporting evidence was reported to be 'moderate'.

8.2.36 The International Civil Aviation Organization (ICAO) 2019 Environmental Report (ICAO. 2019) considers whether aircraft noise annoyance has increased over the last 50 years considered the case presented in the WHO ENG, given that the 45 dB L_{den} recommendation is 10 dB (i.e., an order of magnitude) below the previous recommendation of 55 dB L_{den}. The study concluded that there has been no change in people's response to aircraft noise over the past 50 years, however, there is a substantial spread in the annoyance response, which is attributed to non-acoustic factors, with examples such as noise sensitivity, fear of accidents, mistrust towards airport authorities, maximum noise levels, changes in exposure patterns and the duration of silent periods between noise events listed. On the basis of the ICAO report, this assessment considers the WHO ENG 45 dB L_{den} recommendation to be a highly conservative method for determining potential community annoyance.

World Health Organization –Guidelines for Community Noise (GCN)

8.2.37 The GCN notes the following with regard to sleep disturbance:

If the noise is not continuous, LAmax or SEL are used to indicate the probability of noise induced awakenings. Effects have been observed at individual LAmax exposures of 45 dB or less. Consequently, it is important to limit the number of noise events with a LAmax exceeding 45 dB.

Aircraft noise effect on sleep: application of the results of a large polysomnographic field

8.2.38 With regard to potential sleep disturbance, Basner et al. (2006) noted that a healthy adult briefly awakens around 20 times during an 8-hour night period in environments without external stressors, and there should be less than one additional awakening induced by aircraft noise per night for the avoidance of adverse health effects.

8.3 Consultation

8.3.1 Extensive statutory consultation on noise matters was carried out during preparation and determination of the planning application for the SaxaVord Spaceport, where the Proposed Project will be operated. Where directly relevant to this AEE, consultation responses received during the SaxaVord Spaceport planning application period and subsequent consultation with the CAA pertaining to this application has been summarised in Table 8.1.

Table 8.1 SaxaVord Spaceport Consultation Responses directly relevant to this AEE

Consultee	Consultation sent/response	Action taken
Shetland Islands Council	Email sent 11th July 2018 seeking agreement of representative study area and noise sensitive receptors, representative baseline survey locations (based on SaxaVord Spaceport project footprint at the time).	Shetlands Islands Council confirmed they could not respond prior to survey being undertaken. Robust survey undertaken with reference to appropriate UK guidance.

Consultee	Consultation sent/response	Action taken
Shetland Islands Council & SEPA	Email sent 9th June 2020 Outlining ITPEnergised's role in the noise and vibration assessment and seeking agreement on method of evaluation of construction, operational non-launch and launch noise for the SaxaVord Spaceport planning application EIA Report.	-
SEPA	15th June 2020 SEPA email received confirming it is unlikely that a licence under the Pollution Prevention and Control (PPC) regulations was required, therefore the Proposed Project is not within SEPA's remit	No action required
Shetland Islands Council	26th June 2020 email received confirming proposed approach and suggested threshold values are appropriate.	No action required
Shetland Islands Council	26th June 2020 sent further email confirming that ground-borne vibration associated with launches will be negligible, therefore requesting confirmation it may be scoped out of assessment of operational phase.	Ground-borne vibration during launches scoped out of study
Civil Aviation Authority (CAA)	ITPEnergised provided interpretation of the CAA guidance and described our proposed approach to the assessment. The CAA responded to confirm that it was unable to comment until an application was formally submitted, however, the interpretation of the guidance should be "*proportional and appropriate to the operation*."	Context regarding ITPEnergised's interpretation of the guidance is included within this report

8.4 Assessment Methodology and Significance Criteria

Consultation

8.4.1 Details of communications with regulatory bodies are provided in Section 8.3. Consultation was undertaken prior to the baseline survey in 2018 and at the time of the detailed assessment for the SaxaVord Spaceport planning application in 2020.

Environmental Zone of Influence

8.4.2 For the purposes of this AEE, the Environmental Zone of Influence (EZI) is based on and comprises the proposed launch flight corridor and all study areas required for the technical disciplines included in the AEE, as presented on Drawing 3.6.

8.4.3 Within the EZI, the study area(s) required for each technical discipline assessed vary and as such the rationale for the noise study area has been included in this chapter. The noise study area is shown in the context of the AEE on Drawing 2.1.

8.4.4 For a new development a noise impact study area is chosen based on the number of receptors at which the development may be audible or has the potential to exceed a particular noise threshold. A sample of the closest or most-affected noise-sensitive receptors (NSRs) would then be selected for the detailed evaluation of impacts, with impacts at more distant receptors considered to be lesser. Determining an acceptable level of impact at the closest NSRs is assumed to entail an acceptable level of impact at all receptors within the wider noise study area.

8.4.5 The Proposed Project comprises the preparation and launch of suborbital Skyrora Skylark L and orbital Skyrora XL Launch Vehicles from any one of three terrestrial vertical launch pads at the SaxaVord. While some of the launches will use the Skyrora Skylark L Launch Vehicle, the Skyrora XL Launch Vehicle has greater thrust and is therefore noisier. As such, for the purposes of this AEE, the Skyrora XL Launch Vehicle has been determined to be, and assessed as, the limiting case Launch Vehicle. The applicant is applying for an assumed maximum environmental budget of 16 launches per year, which will make up just over one half of SaxaVord Spaceport's own environmental budget of 30 launches per year. .

8.4.6 This assessment considers up to 16 launches per year. The actual split between daytime, evening and night-time periods is currently unknown. The L_{den} metric requires evening and night-time weightings to be added, therefore requires an assumed split of the 16 launches across these periods. The assumed split considered within this assessment is therefore: eight during the daytime, four during the evening and four during the night-time period.

8.4.7 Ancillary operations within scope of the Proposed Project include transport of personnel and equipment (including the Skyrora XL Launch Vehicle), assembly and fuelling.

8.4.8 The study area for this assessment has been informed by maps and aerial images of the Proposed Project areas and its surroundings, as well as site visits undertaken during the baseline noise survey. A buffer of five km from the boundary of the Proposed Project has been chosen for the consideration of noise effects. Noise effects may occur beyond this buffer; however, potential effects will be most significant within.

8.4.9 While the AEE guidance notes that the assessment should consider potential effects along the trajectory of launch vehicles, the SaxaVord Spaceport lies at the northernmost tip of the UK and launches will all have a northerly bearing. As such, there will be no permanent human Noise Sensitive Receptors (NSRs) along the trajectory of the launch vehicles, and a circular study area is sufficient to consider the worst-case noise impacts. There will be no on-land ecological receptors north of launch site and noise impacts will diminish rapidly as the launch vehicle gains altitude, such that consideration of worst-case noise impacts to ecological receptors can be achieved within the five km circular study area buffer.

8.4.10 A sample of the closest, and therefore potentially worst-affected, Noise Sensitive Receptors (NSRs) to the Proposed Project have been identified and adopted for the evaluation of noise impacts. These are listed in Section 8.6. While vibration impacts have been scoped out of this assessment on the basis that vibration effects will be negligible, we note that the NSRs identified will also be the closest Vibration Sensitive Receptors (VSRs).

8.4.11 NSRs are typically considered to include residential buildings, such as private dwellings, as well as institutional and cultural buildings, such as schools, hospitals, churches and museums. Of these types of potential NSR, only residential buildings have been identified within the adopted study area.

Site Visit and Baseline Noise Survey

8.4.12 ITPEnergised undertook a baseline noise survey in the vicinity of the Proposed Project on 19th and 20th July 2018. Approximately four years have elapsed since the baseline data was collected, however, given the rural and remote nature of the site setting, this assessment considers that no significant changes will have occurred to the baseline noise environment since the survey was completed. Monitoring was undertaken in accordance with the methods outlined in BS7445 and BS4142.

8.4.13 Measurements were undertaken using a Rion NL-52 Class I sound level meter (SLM). The SLM and calibrator were within their laboratory calibration period, and field calibration checks were performed before and after every measurement. No significant drifts in calibration were noted. A 5-minute averaging period was used for measurements, and the SLM was set to A-weighting and fast averaging. A hand-held anemometer was used to determine the wind speed at each monitoring position.

8.4.14 A single measurement of approximately 30 hours was undertaken at Saxa Vord, and supplementary spot measurements of shorter durations were undertaken at locations representative of residential properties close to proposed infrastructure associated with the Proposed Project, both during the daytime period (07:00 - 23:00) and the night-time period (23:00 – 07:00), as defined in PAN1/2011 TAN. The noise monitoring positions (NMPs) used are shown in Drawing 8.1.

8.4.15 Measurements were undertaken in accordance with the requirements of BS4142, with low wind speeds (<5 m/s) and no rain. Records of the baseline survey are provided in Volume IV Appendix 8.3.

Assessment of Potential Effect Significance

Overall Approach to Launch Operator AEE, Reliance on Previous Studies

8.4.16 ITPEnergised undertook the AEE for the SaxaVord Spaceport Operator Licence application. The Applicant provided input data for the SaxaVord Spaceport AEE noise assessment, which then considered a 'worst-case' launch schedule of 30 launches of the Skyrora XL Launch Vehicle. Given that the Applicants environmental budget is now set at 16 launches per year, this is considered to be a suitable precautionary approach to assessment of environmental effects and so has not been revised.

8.4.17 Specific road traffic movement numbers associated with the applicant's launches fall within the envelope considered for the SaxaVord Spaceport AEE.

8.4.18 As such this AEE reports on the same noise modelling and assessment undertaken for the SaxaVord Spaceport AEE but frames the findings in the context of the Proposed Project in isolation.

Receptor Sensitivity

8.4.19 The guidance contained within the Technical Advice Note to PAN 1/2011 has been drawn upon in the generation of an appropriate set of significance criteria. The receptor sensitivity criteria are presented within Table 8.2.

Table 8.2 NSR and VSR sensitivity criteria

Receptor Sensitivity	Description	Examples
High	Receptors where people or operations are particularly susceptible to noise and/or vibration.	Residential, quiet outdoor recreational areas, schools and hospitals.
Medium	Receptors moderately sensitive to noise and/or vibration, where it may cause some distraction or disturbance.	Offices and restaurants.
Low	Receptors where distraction or disturbance from noise and/or vibration is minimal.	Buildings not occupied, factories and working environments with existing levels of noise.

Impact Magnitude Criteria

8.4.20 Threshold noise levels have been defined for the Proposed Project. The derivation of threshold levels is described in subsequent sections, however, the general approach to deriving the magnitude of noise impacts for different aspects of the project is provided below.

Road traffic

8.4.21 A previous version to the current iteration of DMRB provided the following general relationship between changes in traffic flow and the resultant change in the traffic noise: *"In the period following a change in traffic flow, people may find benefits or disadvantages when the noise changes are as*

small as 1 dB(A) – equivalent to an increase in traffic flow of 25% or a decrease in flow of 20%. These effects last for a number of years". By contrast, PAN1/2011 advises that a change of 3 dB(A) is the minimum perceptible change in noise outside of laboratory conditions.

8.4.22 CRTN provides a procedure for calculating road traffic noise for links with low flows, defined as between 50 and 200 vehicle movements per hour, or 1,000 to 4,000 vehicle movements per day, and notes that calculations of noise level for traffic flows below these ranges are unreliable, recommending that measurements be undertaken when evaluating such cases.

8.4.23 Using these principles, the noise impact magnitude has been determined according to the criteria provided in Table 8.3.

Table 8.3 Road traffic noise impact magnitude criteria

Increase (i) over existing road traffic noise level due to project-generated traffic flows, dB	Impact magnitude
i ≥+5	High
+3 ≤ i < +5	Medium
+1 ≤ i < +3	Low
0 ≤ i < +1	Negligible

Noise from engine testing and launches

8.4.24 No standard UK or Scottish guidance exists upon which the magnitude of noise impacts associated with launches is available. This assessment has therefore considered as a robust basis of assessment, the potential for adverse health effects on the local population by reference to guidelines for aircraft noise provided by the WHO and the EU with regard to potential annoyance, and to the CoNaW Regs with regard to the potential for hearing damage.

8.4.25 Guidance relating to aircraft noise is a useful point of reference with regard to potential annoyance and sleep disturbance, however, it is noted that the character, duration and level of noise associated with launch vehicle launches will differ from that associated with conventional civilian or military airfields.

8.4.26 Given the nature of noise from launches, with high levels of noise occurring over a relatively short duration, two metrics have been considered for the determination of noise impact magnitude as follows:

- Firstly, the L_{den} noise level has been used to determine the potential for community annoyance; and,
- Secondly, instantaneous L_{Amax} noise levels have been considered with regard to potential adverse health/discomfort impacts.

8.4.27 This two-tier approach seeks to set in context the L_{den} levels generated by short-duration noisy events averaged over a year.

8.4.28 With reference to para. 8.4.16 this AEE relies on L_{den} calculations undertaken in support of the SaxaVord Spaceport AEE which consider the cumulative effect of thirty launches of the Skyrora XL Launch Vehicle (or similar equivalent) per annum across three launch pads, including daytime, evening and night-time launches. The L_{den} is a cumulative metric considering annual exposure, including weightings for evening and night-time events. While the Proposed Project will account for approximately half of the total number of launches and their respective impacts, the impact of these 16 launches cannot be meaningfully considered in isolation. This assessment therefore considers noise impacts from the Proposed Project in combination with those of other launch operators who will use the SaxaVord Spaceport for the L_{den} index.

8.4.29 The threshold criteria for the L_{Amax} index adopt the CoNaW Regs thresholds, and robustly assume that the highest predicted $L_{Amax,1sec}$ level occurs at each NSR for the full duration of the noise 'event'. By way of context, sustained noise levels above 110 dB may cause discomfort and levels of 120 dB and above are considered the threshold of pain, therefore the CoNaW Regs thresholds are substantially below noise levels which may cause instantaneous discomfort to nearby residents. The impact magnitude criteria are presented in Table 8.4.

Table 8.4 Operational noise impact magnitude criteria matrix – launches – likelihood of annoyance (L_{den}) and noise exposure ($L_{EP,d}$)

Likelihood of annoyance threshold, dB L_{den}	Noise exposure, $dBL_{EP,d}$	Rationale	Impact magnitude
>45	≥85	Above threshold of community annoyance and above UEAV	High
	≥80, <85	Above threshold of community annoyance and below UEAV	Medium
	<80	Above threshold of community annoyance and below LEAV	Low
<45	<80	Below threshold of community annoyance and below LEAV	Negligible

8.4.30 At all NSRs where the predicted L_{den} is below the threshold for community annoyance *and* the $L_{EP,d}$ derived from predicted $L_{Amax,1sec}$ values is below the daily LEAV, the impact magnitude will be 'negligible'.

8.4.31 At all NSRs where the 45 dBL_{den} threshold for community annoyance is exceeded, the impact magnitude will be greater than 'negligible', and the impact magnitude will be determined by the $L_{EP,d}$ relative to the CoNaW threshold values.

8.4.32 Further consideration has been given to the number of additional potential awakening events, with regard to the findings of the aircraft noise effect on sleep study (Basner, 2006), with potential for night-time sleep disturbance determined by SEL values above 90 dB (BRRC) and L_{Amax} values above 45 dB.

Noise from non-launch activities and plant

8.4.33 For noise from fixed plant and non-launch activities such as assembly, maintenance and control buildings and activities, significance criteria have been derived based on the guidance contained within BS4142, i.e., by consideration of the difference between the rating level from the plant noise and the prevailing background sound levels, but also with respect to context and the resulting sound levels in absolute terms.

8.4.34 The impact magnitude scale for noise associated with fixed plant and non-launch activities has been derived based on the PAN1/2011 and BS4142 guidance and is presented in Table 8.5.

Table 8.5 Non-launch plant and activity noise impact magnitude criteria

Difference (d) between predicted operational noise level and applicable noise limit, dB	Impact magnitude
d ≥+5	High
0 ≤ d < +5	Medium
-10 ≤ d < 0	Low
<-10	Negligible

Vibration from engine tests and launches

8.4.35 Airborne vibration (air overpressure) associated with launches is considered with reference to predicted noise levels in the BRRC report, which notes that "*one damage claim in 100 households exposed is expected at an average continuous sound level of 120 dB (unweighted), and one in 1,000 households at 111 dB (unweighted)*". These levels match the criterion in the CAA guidance whereby "*…the maximum unweighted noise level (L_{ASmax})[1] should not exceed 120 dB (unweighted)*". Vibration criteria are provided for the determination of effect significance in Table 8.6.

Table 8.6 Operational vibration (air overpressure) impact magnitude criteria matrix – launches – likelihood of structural damage

Likelihood of structural damage threshold, dBL_{max}	Rationale	Impact magnitude
≥120	Likelihood of damage complaints greater than 1 in 100 households	Medium / High
≤111, <120	Likelihood of damage complaints lesser than 1 in 100 households, greater than 1 in 1,000 households	Low
<111	Likelihood of damage complaints lesser than 1 in 1,000 households	Negligible

Effect significance

8.4.36 This assessment determines the significance of effects drawing on the example criteria provided in PAN1/2011 (refer to Table 1 in Appendix 8.2). The adopted criteria are provided for a range of NSR sensitivities in Table 8.7.

Table 8.7 Effect significance criteria

Impact magnitude	Effect significance		
	Low	Medium	High
High	Slight / Moderate	Moderate / Large	Large
Medium	Slight	Slight / Moderate	Moderate
Low	Neutral / Slight	Slight	Slight
Negligible	Neutral	Neutral	Neutral

[1] We note that the CAA guidance refers to "L_{ASmax}" values, however, we assume that the L_{max} (i.e. unweighted) value is intended here.

8.4.37 This assessment considers effects with a significance of 'moderate' and above are significant and effects with a significance of 'slight' or below are considered not significant.

8.4.38 All noise sensitive receptors (NSRs) considered in this assessment are considered to have a high sensitivity to noise and vibration.

Limitations to Assessment

8.4.39 This assessment relies on information provided by BRRC. Launch data has been provided by the applicant to BRRC, who undertook verification and predictions of launches using proprietary methods as described in their report, *Noise Study for Launch Vehicle Operations at Shetland Space Centre* included in Volume IV as Appendix 8.1.

8.4.40 This assessment considers the methods and models developed by BRRC to be appropriate and notes their routine use in the United States of America to evaluate noise from similar launch facilities, including for NASA and SpaceX. Further details of BRRC's capability and experience are given in the document *BRRC Shetland Space Centre Data Call* included for reference in Volume IV as Appendix 1.1.

8.5 Baseline Conditions

8.5.1 During the baseline survey, the baseline noise environment was determined to be consistent between all monitoring locations. There was little anthropogenic noise, and natural sources such as bird calls, wind and wind-induced rustling of vegetation were the primary contributors to overall noise levels. Very infrequent vehicle movements were a lesser contributor, with traffic typically slow-moving and fewer than five movements per hour. A summary of the measured noise levels is provided in Table 8.8. Full details of the survey are provided in Volume IV Appendix 8.3.

Table 8.8 Summary of measured baseline noise levels

Monitoring position / period	Monitoring duration, T	Measured level, dB(A)			
		Ambient, $L_{Aeq,T}$	Background, $L_{A90,T}$	Maximum, $L_{Amax,T}$	10th percentile, $L_{A10,T}$
NMP1 (day)	1 hr	38	27	57	39
NMP1 (night)	35 min	38	19	53	32
NMP2 (day)	1.5 hr	40	33	53	42
NMP2 (night)	40 min	27	18	45	25
NMP3	30 hrs	45	22	51	34
NMP3 (day)	5 hrs	42	21	55	36
NMP4 (day)	15 min	41	31	61	39
NMP5 (day)	1.5 hr	39	28	57	39

8.5.2 With reference to the measured levels presented in Table 8.8 above, time-event plots provided for each NMP in Volume IV Appendix 8.3 and field notes, the following observations may be drawn regarding the baseline noise environment:

- Noise levels across the study area are very low, representative of a remote, rural area with little or no influence from anthropogenic noise sources such as road traffic, air traffic, industry or power generation.
- The primary contributors to the noise environment are natural sources, such as bird calls and the wind, and agricultural sources, such as livestock.

- There is very little temporal variation in noise levels between the daytime and the night-time periods. This is particularly evident in the background (L_{A90}) trace for the 30-hour measurement at Saxa Vord, which ranges from <20 dB up to a maximum of 34 dB at 05:00, attributed to dawn chorus.
- There is very little spatial variation in noise levels between monitoring positions, with the main control on noise levels being the level of wildlife activity and atmospheric conditions.
- Throughout the daytime and the night-time period noise levels lower than the 'noise floor' of the SLM (the threshold below which accurate measurements cannot be obtained due to electrical 'noise' within the circuitry) were recorded at most of the NMPs.

8.5.3 Note that the higher noise levels recorded at NMP4 preceded a squall which required the measurement to be abandoned, therefore this measurement is not considered suitably representative of the noise environment and is provided for information only.

8.6 Receptors Brought Forward for Assessment

8.6.1 NSRs considered in this assessment comprise a representative sample of the closest inhabited dwellings to the Proposed Project falling within the study area extending in a 5 km radius from the SaxaVord Spaceport. The NSRs are shown in Drawing 8.1 and listed in Table 8.9.

Table 8.9 NSRs considered in assessment

NSR ID	NSR Name	Rationale for selection
NSR1	Booths	Representative of closest dwellings to the Proposed Project
NSR2	Valie	Representative of dwellings to the north-west of Norwick
NSR3	Norwick	Representative of dwellings within Norwick
NSR4	Millfield	Representative of slightly elevated dwellings to the east of Norwick
NSR5	Virse	Representative of dwellings to the south of Norwick
NSR6	Northdale	Representative of dwellings in Northdale
NSR7	Haroldswick	Representative of dwellings in Haroldswick

8.7 Standard Mitigation

8.7.1 The design and operation of the Proposed Project will incorporate the following standard mitigation:

- Assembly of the Skyrora XL Launch Vehicles and integration of Payload to be undertaken at appropriate facilities within the SaxaVord Spaceport and measures will be in place to minimise generation of unnecessary noise; and

8.7.2 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 the applicant's launches will be advertised by SaxaVord Spaceport well in advance, in local media and online, such that local residents can avoid launch noise if they choose. Predicted noise levels inside the closest dwellings will be substantially below the level at which discomfort or hearing damage would occur and residents wanting to minimise their noise exposure may choose to remain indoors when a launch is scheduled;

- SaxaVord Spaceport plans to engage with the local community to support local jobs and increase employment, increase tourism to the area and connect with local schools and colleges to aid teaching of science and technology subjects. Further details of proposed community engagement and expected local benefits are provided in Chapter 4. Such measures are expected to make the local community feel engaged with the Proposed Project and reduce the likelihood of non-acoustic factors contributing to annoyance associated with noise from launches (refer to para. 8.2.36 above). The Applicant will support these community engagement initiatives.
- Suggestions for appropriate community liaison activities to which the applicant may contribute to are provided below:
  - Establish Liaison Group Forum;
  - Produce project update newsletter;
  - Media, website update, social media;
  - Briefings with site neighbours, landowners, community representatives, interest groups and other key stakeholders;
  - 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 community council meetings quarterly; and,
  - Manage complaints procedure.

8.8 Potential Effects

Noise from engine testing and launches

8.8.1 As noted above, this assessment relies on predicted noise levels associated with static engine tests and launches provided by BRRC. Full details of the modelling undertaken are provided in Volume IV Appendix 8.1, which should be read in conjunction with this AEE chapter. Skyrora does not propose to undertake static engine tests prior to launches, however, the modelling undertaken to determine the L_{den} includes noise from static tests. Including noise from tests within the assessment is a robust approach and L_{den} values will therefore be lower than reported and impacts lesser than assessed.

8.8.2 The BRRC report notes that the predicted noise levels consider the most likely scenario with regard to meteorological conditions, rather than those specifically likely to be favourable for launches or favourable to propagation.

8.8.3 The predicted L_{den} values from all launch-related activities at the SaxaVord Spaceport, including launches from all three launch pads and static engine tests, of which the Proposed Project comprises up to 16 launches, are provided in Table 8.10. The predicted L_{den} values are shown as contours at five dB intervals in Drawing 8.2. Where NSRs lie between contours an interval of values has been reported.

Table 8.10 Predicted L_{den} values at NSRs

NSR ID	Predicted level, dBL_{den}
NSR1	<60, >55
NSR2	<60, >55

NSR ID	Predicted level, dBL_{den}
NSR3	<60, >55
NSR4	<60, >55
NSR5	≥55
NSR6	<55, >45
NSR7	<50, >45

8.8.4 To provide context to the lay reader, it is noted that normal conversation may register a typical noise level of 60 dB, while ambient noise levels within a quiet office may range from 40 – 50 dB.

8.8.5 Predicted L_{den} values at all of the representative NSRs considered are greater than 45 dB, therefore the impact magnitude exceeds 'negligible' at all NSRs. As discussed above, this assumes that noise from a space centre will generate similar levels of annoyance to noise from airports. This assessment considers that the very short duration and infrequent occurrence of noise from launches is likely to generate lower levels of annoyance than aircraft noise, which is far more frequent and regular and varies little from day to day. Launches will offer substantially greater periods of respite for nearby residents than an equivalent airport, and residents will be given warning in advance of each launch, such that they can plan accordingly to avoid the noise if they choose.

8.8.6 The predicted $L_{Amax,1sec}$ values for launches are provided in Drawing 8.3a-c. These figures cover thirty launches spread across the three SaxaVord Spaceport launch pads; the pad(s) that the applicant will use for the Proposed Project have yet to be confirmed.

8.8.7 The predicted duration for which specific noise levels will be exceeded at NSR1 (the closest receptor to the Proposed Project) are provided in Table 8.11.

Table 8.11 Time above durations at 2 km

Level / rationale for use of level	Launch – time above level (seconds)
22 dB – representative 24-hour background level in Norwick.	340
45 dB – representative 24-hour ambient level in Norwick and also the external level which corresponds to the internal level of 30 dB via open-window transmission, above which sleep disturbance may occur.	190
66 dB – level above which speech intelligibility reduces; used to evaluate potential adverse effects of rocket noise within national parks in the USA.	70
89 dB – representative of maximum level during overflight by an oil rig shuttle helicopter, as occurs occasionally within the study area.	45

8.8.8 A time-history chart, showing how the predicted noise level changes at the closest NSR throughout a launch is provided in Figure 8.1.



Figure 8.1 Time-history chart of launch noise

8.8.9 The noise levels at the closest NSR show a short-duration (approx. 50 seconds) peak where noise levels are in the range 80 – 100 dB(A), followed by a rapid decline to approx. 55 dB by 100 seconds. Figure 8.1 shows that the noise level drops to 45 dB, representative of the baseline ambient level, within 200 seconds. Table 8.11 above shows that the noise level drops below 22 dB, representative of the baseline background level and below which noise from the launch will trend towards being inaudible, within 340 seconds. The maximum duration of launches in terms of noise will therefore be approximately 340 seconds, or just under six minutes.

8.8.10 The BRRC report (Volume IV Appendix 8.1) considers an upper limit level of 115 dBL_{Amax} to protect human hearing from noise-induced hearing loss (NIHL), and notes that there are no dwellings within the 115 dB noise contour for operational noise associated with launches or engine tests.

8.8.11 With reference to Drawing 8.3, showing the predicted L_{Amax} contours for launches from all three pads of the Proposed Project, the highest predicted level occurs at NSR1 during launches from Pad 1, with a predicted level of 102 dBL_{Amax}. With reference to Table 8.11 and Figure 8.1, the predicted noise level at NSR1 is below 60 dB after approximately 80 seconds.

8.8.12 In a highly conservative assumption, the $L_{EP,d}$ has been calculated assuming that the 102 dB noise level occurs throughout the 80 second period. Using the equation provided in para. 8.2.9 above, the resultant $L_{EP,d}$ is 76 dB. This is substantially below the LEAV and the impact magnitude at this worst affected NSR is therefore **low**.

8.8.13 With reference to Table 8.7 above, the resultant effect significance for high sensitivity receptors is slight. Noise effects associated with launches are therefore not significant, resulting in **no likely significant effect**.

8.8.14 When considering potential increased sensitivity to noise during the night-time period, it is noted that the BRRC report states SEL values greater than 90 dB generally lead to sleep disturbance. Further, given a predicted 102 dBL_{Amax} level at NSR1, and assuming a reduction of approximately 30 dB to external levels provided by the building envelope, it is highly likely that launches during the night-time period would result in internal noise levels above 45 dBL_{Amax} with resultant potential awakening of sleeping population at all NSRs within the study area, as per GCN guidance.

8.8.15 SaxaVord Spaceport has confirmed that of the proposed 30 launches per year, in any one month there may be up to three launches, however, at present it is unknown how many of these will be undertaken by the applicant. Given the proposed frequency of launches and the short duration of the noise events associated with launches, with reference to the 2006 Basner study, whereby restricting additional awakenings due to aircraft noise to a maximum of one event per night is anticipated to have no adverse effect on human health, adverse effects associated with sleep disturbance due to night-time launches are considered to be minimal. This is considered to further reduce the likely effect significance of launch noise during the night-time period and place short-duration, high intensity noise events into context.

Noise from non-launch activities and plant

8.8.16 SaxaVord Spaceport has committed to meeting boundary noise limits for fixed plant, such that appropriate noise limits derived using BS4142 will be met at all NSRs. This assessment assumes that fixed plant associated with SaxaVord Spaceport will be specified such that the noise limits will be met.

8.8.17 No significant sources of noise are anticipated associated with the Proposed Project apart from noise emission from launch; therefore, noise associated with pre- and post-launch activities will arise only from operation of the SaxaVord Spaceport's own plant and has been assessed previously. Skyrora XL Launch Vehicles will be transported to the launch pads using a Transporter Erector Launcher (TEL) vehicle specified such that it does not result in breaches of BS4142-derived noise limits at NSRs.

8.8.18 The resultant worst-case predicted specific noise level at the closest receptor, NSR1, is 24 dB. In accordance with the BS4142 method, noise from fixed plant is not anticipated to include audible tonal, intermittent or impulsive characteristics, therefore the rating level is equal to the specific level, 24 dB.

8.8.19 With reference to Section 8.5 (above), the typical background noise level in the vicinity of the Proposed Project is 22 dB. This level is representative of both the daytime period and the night-time period and is objectively a very low background level. In accordance with BS4142, whereby a rating noise level of less than five dB above the background level is indicative of a low impact, the noise limit for fixed and mobile plant at NSR1 is 27 dB.

8.8.20 The predicted worst-case rating level for fixed and mobile plant of 24 dB is 3 dB below the derived noise limit. Referring to Table 8.5, the impact magnitude is therefore low. With reference to Table 8.7, the resultant effect significance is slight. At more distant NSRs the rating level will be lower, and the result effect significance will be similar or lower than at NSR1. Noise effects associated with fixed and mobile plant at NSR1 are therefore not significant, resulting in **no likely significant effect**.

Road traffic noise

8.8.21 Projected traffic flows associated with the SaxaVord Spaceport total 81 vehicle movements per day, based on an average of monthly traffic movements. This assessment assumes that projected movements for the SaxaVord Spaceport include movements associated with the Proposed Project.

8.8.22 Noting that:

- The 2019 estimated flow at the closest Department for Transport (DfT) monitoring location to the Proposed Project, located on the A968 near the centre of Unst, is 494 (details of the DfT data are provided in Volume IV Appendix 8.4);
- This is below the 1,000 vehicle movements per day minimum threshold for the calculation of noise for low traffic flow roads provided in CRTN. Baseline traffic flows are therefore considered to be 'very low';
- An increase of 81 vehicle movements per day represents an increase of 16% over baseline flows and corresponds to an increase in road traffic noise of approximately 1 dB or lower; and

- Most of the vehicle movements will be associated with daily operation of SaxaVord Spaceport and the Proposed Project will comprise a small number of vehicle movements per launch.

8.8.23 This assessment considers that road traffic movements associated with launches were factored into the total provided for the SaxaVord Spaceport AEE and no additional movements would arise associated with the Proposed Project.

8.8.24 Referring to Table 8.3 the impact magnitude of operational road traffic noise is negligible, and the resultant effect significance is neutral. Road traffic noise effects during the operational phase are therefore not significant, resulting in **no likely significant effect.**

Vibration from engine tests and launches

8.8.25 Predicted unweighted L_{max} noise contours associated with launches are provided in Drawing 8.4. With reference to this drawing there are no NSRs within the 120 dBL_{max} contour, a small number of NSRs (five representative NSRs, approximately 10 properties in total) within the 111 dB contour, with the remainder of NSRs lying outside the 111 dB contour. With reference to Table 8.6 (above) the impact magnitude ranges from negligible to low. Referring to Table 8.7 the resultant significance of effect ranges from neutral to slight and is therefore not significant, resulting in **no likely significant effect.**

8.9 Additional Mitigation

8.9.1 As there are no likely significant effects, no additional mitigation is required.

8.10 Residual Effects

8.10.1 No additional mitigation is proposed, beyond the committed standard mitigation measures. Residual effects associated with operations remain unchanged resulting in **no likely significant effect**.

8.11 Cumulative Assessment

8.11.1 There are no intra-project cumulative effects that have the potential to result in significant effects and so no intra-project cumulative assessment is required.

8.11.2 This assessment considers up to 16 launches of the Skyrora XL Launch Vehicle per year which, from 2029 when maximum launch cadence is reached, will make up just over one half of the SaxaVord Spaceport environmental budget of 30 launches per year. As the primary noise metric (L_{den}) considers cumulative annual noise and cannot meaningfully be applied to the Proposed Project in isolation; cumulative effects from other launches taking place at SaxaVord Spaceport have therefore been inherently considered within the assessment.

8.11.3 Shetland Islands Council confirmed during the planning application for SaxaVord Spaceport that there were no other committed development or infrastructure projects which needed to be considered in that assessment and there has been no change subsequent to planning consent. As such, as far as the Applicant is aware, there are no like for like or similar projects within the noise study area and therefore, no significant issues are likely to arise from developments other than the SaxaVord Spaceport.

8.12 Summary

8.12.1 Potential noise and vibration effects associated with the Proposed Project have been robustly assessed with regard to launches and associated non-launch activities.

8.12.2 The assessment of noise and vibration relies primarily on modelling and calculations undertaken by BRRC.

8.12.3 Noise effects associated with road traffic and non-launch activities have been assessed as not significant, resulting in **no likely significant effect**.

8.12.4 Noise during engine tests (should they occur – not currently planned) and launches will be audible at NSRs within and beyond the study area and levels will exceed the criterion for community annoyance associated with aircraft noise. Instantaneous noise levels will be below the threshold at which damage to hearing may occur.

8.12.5 The short duration of audible noise 'events' associated with engine tests and launches, and their infrequent occurrence, will reduce the associated levels of annoyance to below that which may be associated with aircraft noise from conventional airports. Accordingly, adverse health effects are not anticipated. Noise at NSRs associated with launches is below the level at which the potential for cosmetic damage to structures is likely. Noise effects launches have therefore been assessed as not significant, resulting in **no likely significant effect**.

8.12.6 Vibration (air overpressure) associated with launches has been evaluated and found to result in a low likelihood of damage complaints and has therefore been determined to be not significant, resulting in **no likely significant effect**.

8.12.7 Standard mitigation has been considered in the derivation of effect significance. Committed mitigation measures include a commitment to meeting noise limits for fixed and mobile plant items and assisting SaxaVord Spaceport in maintaining good communications with the local community with regard to all activities of the Proposed Project.

8.13 References

Basner, M., Samel, A., & Isermann, U. (2006). *Aircraft noise effect on sleep: application of the results of a large polysomnographic field study*. The Journal of the Acoustical Society of America, 119(5).

Civil Aviation Authority. (2014). *Survey of noise attitudes 2014: Aircraft*. Environmental Research and Consultancy Department, Policy Programmes Team.

Civil Aviation Authority et. al. (2021). *Guidance for the assessment of environmental effects.*

Department for Transport. (2021). *Guidance to the regulator on environmental objectives relating to the exercise of its functions under the Space Industry Act 2018*.

Abbott, P. G. & Nelson, P. M (2002). *Converting the UK traffic noise index LA10,18h to EU noise indices for noise mapping*. TRL Ltd.

British Standards Institute. (2019). *BS4142:2014+A1:2019 - Methods for rating and assessing industrial and commercial sound.*

International Organization for Standardization (1996). *ISO 9613:1996 Acoustics — Attenuation of sound during propagation outdoors.* ISO.

Scottish Government (2011). *Planning Advice Note (PAN) 1/2011*. Available at: https://www.gov.scot/publications/planning-advice-note-1-2011-planning-noise

Scottish Government (2011). *Technical Advice Note (TAN) to Planning Advice Note (PAN) 1/2011*. Available at: https://www.gov.scot/publications/technical-advice-note-assessment-noise/

Scottish Government. *The Environmental Noise (Scotland) Regulations 2006*. Available at: https://www.legislation.gov.uk/ssi/2006/465/contents/made

UK Government. *The Control of Noise at Work Regulations 2005*. (2005). https://www.legislation.gov.uk/uksi/2005/1643/contents/made

UK Government (1974). *Control of Pollution Act 1974*. Date. Available at: https://www.legislation.gov.uk/ukpga/1974/40.

UK Government (1974). *Consultation Response on UK Airspace Policy: A framework for balanced decisions on the design and use of airspace*. 2017. Department for Transport. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/918784/consultation-response-on-uk-airspace-policy-web.pdf.

UK Government (1988). *Calculation of Road Traffic Noise*. Department of Transport Welsh Office.

World Health Organization (2018). *Environmental Noise Guidelines for the European Region (2018)*. Available at: https://www.euro.who.int/en/health-topics/environment-and-health/noise/publications/2018/environmental-noise-guidelines-for-the-european-region-2018

World Health Organization (1999). *Guidelines for Community Noise*. Available at: https://www.who.int/docstore/peh/noise/Comnoise-1.pdf

Chapter 9 Climate Change

9. Climate Change

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9. Climate Change

9.1 Introduction

9.1.1 This chapter evaluates the potential impact of the Proposed Project on climate change due to its greenhouse gas emissions (GHG), as well as assessing the vulnerability of the Proposed Project to climate change and the need for adaptation measures where relevant.

9.1.2 The Proposed Project will have an impact on climate change due to GHG emissions resulting from transportation and fuel consumption. A reasonable worst-case scenario for carbon emissions associated with the Proposed Project has been quantified as part of a greenhouse gas (GHG) assessment.

9.1.3 Following the identification of potential effects, suitable mitigation measures have been proposed, and an assessment of residual effects on environmental receptors sensitive to climate change has been undertaken.

9.2 Legislation, Policy and Guidelines

Space Industry Act

9.2.1 The Space Industry Act (2018) regulates all spaceflight activities carried out in the United Kingdom, and associated activities. The Act requires any person or organisation to obtain the relevant licence to:

- launch a launch vehicle from the UK;
- return a launch vehicle launched elsewhere than the UK to the UK landmass or the UK's territorial waters;
- operate a satellite from the UK;
- conduct suborbital activities from the UK;
- operate a spaceport in the UK; or
- provide range control services from the UK.

9.2.2 As the Applicant wishes to become a spaceflight operator and launch Skyrora XL Launch Vehicles from the UK, they are required to apply for a launch operator licence, and as part of this application, submit an AEE of the proposed project.

Space Industry Regulations 2021

9.2.3 The Space Industry Regulations 2021 (the Regulations) set out in more detail the requirements for each licence the Regulators Licensing rules, which specify what information the UK Civil Aviation Authority (CAA), the regulator, requires in support of an application.

Additional Legislation

9.2.4 Relevant legislation and guidance documents have been reviewed as part of this climate change assessment. Of particular relevance are:

- The Climate Change (Scotland) Act 2009 which required ministers to establish Scotland's programme for climate change adaptation (Scottish Government, 2009);
- The Paris Agreement 2015 which sets a target for net zero global carbon emissions in the second half of the 21st century to limit the global temperature increase to less than 2°C above pre-industrial levels. A key aim of this agreement is to strengthen national responses to combat climate change and adapt to its effects. The Paris Agreement was ratified by the UK in 2016 (UNFCCC, 2015);

- Climate Change (Emissions Reduction Targets) (Scotland) Act 2019 which sets Scottish targets for the reduction of GHG emissions to deliver on the Paris Agreement, and makes provision about advice, plans and reports in relation to those targets. The Act sets an interim 56% reduction target for 2020 and a Net Zero target for 2045 (Scottish Government, 2019); and,
- Scottish Government Climate Change Plan (CCP) (2018-2032) which is a roadmap for Scotland to transition to a low carbon economy. The plan sets out how Scotland will reduce emissions by 66% over the period to 2032 (Scottish Government, 2018).

Planning Policy

9.2.5 The following policies have been taken into consideration:

- Scottish Government Climate Change Plan (CCP) (2018-2032) sets out how Scotland will continue to improve resilience to climate change and reduce emissions over the period to 2032 (Scottish Government, 2018);
- Shetland Islands Council Carbon Management Plan 2015-2020 (still extant) outlines a 5-year implementation plan for achieving its desired carbon emissions reduction target of 42% by 2020 (SIC, 2015); and,
- Shetland Islands Local Development Plan 2014 policies GP1 (Sustainable Development) and GP2 (General Requirements for All Development).

Guidance

9.2.6 Best practice guidance for assessing climate change effects in an AEE has been taken into account:

- Guidance for the Assessment of Environmental Effects (CAA, 2021)
- 2015 IEMA guidance on Climate Resilience and Adaptation in EIA (amended in 2020) provides a framework for the effective consideration of climate change resilience and adaptation through EIA procedures. It includes case studies of EIAs which have considered climate adaptation and resilience issues, reflecting legislative developments and evolving practice (IEMA, 2015).
- Guidance to the Regulator on Environmental Objectives relating to the exercise of its functions under the Space Industry Act 2018 (Department for Transport, 2021)

Considerations noted in the DfT guidance for the regulator

9.2.7 The DfT guidance notes several subject areas which are recommended for consideration by the regulator when assessing AEE reports. The CAA has not yet provided detailed guidance on the exact treatment of these areas; but for completeness, the provisional approaches are summarised below.

Alternative fuels

9.2.8 Calculated emissions per launch of the Skyrora XL Launch Vehicle in this AEE assume that kerosene is the fuel of choice in each case with high test peroxide (HTP) acting as the oxidant. Greenhouse gas emissions per launch using other liquid or solid hydrocarbon fuels will be of a similar magnitude and other primary fossil hydrocarbon fuels would produce a similar quantity of GHGs.

9.2.9 Liquid hydrogen can represent a low or zero GHG fuel depending on the means of production – green (renewably-powered electrolytic) hydrogen is still at a very early developmental stage in the UK as a commercial proposition. The hydrogen fuel used by NASA, for instance, is produced from steam methane reformation and uses a methane feedstock. The residual carbon dioxide is most likely emitted to air meaning that this option cannot be considered low carbon.

Liquid hydrogen fuel howsoever derived requires cryogenic cooling, which currently carries disproportionate weight and energy penalties for small launch vehicles. It is not considered a viable alternative to kerosene for the Proposed Project at the time of writing.

Skyrora is pioneering the development of Ecosene, a kerosene substitute derived from post-industrial and post-consumer waste plastic materials. The process is currently in the developmental phase and the exact lifecycle GHG emissions from this new product are yet to be fully defined; however, it appears likely that this alternative feedstock will mean a fuel with a lower overall GHG impact.

Efficiency savings

9.2.10 There are not expected to be material opportunities for fuel savings (and hence GHG reductions) on a per-launch basis as fuel is inherently optimised to allow maximum payload per launch plus contingency. Incremental gains in efficiency through design iterations and use of more lightweight materials may be possible as the relevant technologies develop.

Ozone depletion

9.2.11 Stratospheric ozone depletion by the reaction with kerosene exhaust compounds is reported to be related to the action of black carbon caused by the incomplete combustion of hydrocarbons in the kerosene blend. Black carbon increases radiative forcing in the stratosphere, which leads in turn to warming in that atmospheric layer and an increase in the rate of reactions which contribute to ozone depletion.

This issue is most effectively mitigated in practice by optimising fuel mixing ratios during combustion; the desired outcome is for the maximum calorific value to be extracted from the fuel rather than wastage from incomplete combustion and black carbon formation.

The most effective mitigation against black carbon will be the sectoral transition to carbon-free fuels. Whilst it is possible that emissions from non-carbon fuels such as hydrogen and hydrazine will also lead to the formation of ozone-depleting chemical species, they are likely to be more reactive than black carbon and hence possess a shorter atmospheric residence time.

Meteorology

9.2.12 Local meteorological conditions are not considered a relevant consideration in the context of the climate effects of this Project but are considered by the Air Quality assessment in terms of their influence on dispersion of potential air pollutants formed by combustion.

Offsetting

9.2.13 Offsetting is not currently under consideration as a mitigation strategy. The Proposed Project has no scope for direct offsetting as it is a transient activity with no physical footprint where land use change could be explored. The purchase of third-party carbon credits is not considered to offer a guarantee of genuine additive GHG savings in the current market.

9.3 Assessment Methodology and Significance Criteria

9.3.1 The following assessments have been undertaken as part of this chapter:

- a GHG assessment to evaluate the potential effects of the Proposed Project on climate change;
- an assessment of potentially significant climate change variables on the Proposed Project; and,
- an assessment of the residual effects on environmental receptors sensitive to climate change.

Environmental Zone of Influence

9.3.2 For the purposes of this AEE, the Environmental Zone of Influence (EZI) is based on and comprises the proposed launch flight corridor and all study areas required for the technical disciplines included in the AEE, as presented on drawing 3.6.

9.3.3 The scope of the GHG assessment includes operational emissions of the Proposed Project which are predominated by emissions from launches.

9.3.4 The study area for the assessment of the potential adverse climate change effects on the Proposed Project is therefore restricted to the Proposed Project boundary and the transport network utilised for the transport of materials and personnel.

Desk Study

9.3.5 An assessment has been undertaken of current and future climate trends in the study area, including mean air temperature, wind speed and precipitation rate. The following sources were used to characterise existing or future baseline conditions:

- Met Office UK Climate Averages (Met Office, 2020a);
- UKCP18 Climate Projections (Met Office, 2020b); and,
- UK local authority and regional carbon dioxide emissions national statistics (BEIS, 2019).

Assessment of Potential Effect Significance

9.3.6 For the purposes of this chapter, two assessments of potential effect significance have been carried out, a GHG assessment to evaluate the potential effects of the Proposed Project on climate change and an assessment of potentially significant climate change impacts on the Proposed Project, both at the time of the first launch and at the further future year covered by the climatic modelling considered.

9.3.7 The sensitivity of the receptor has been evaluated, along with the significance of effect and the magnitude of the impact, based on the subjective judgement of the assessor. The terminology used has been defined below.

Sensitivity

9.3.8 An evaluation of the sensitivity of the Proposed Project in terms of climate change and the sensitivity of the global atmospheric environment as the receiving body for GHG emissions, was undertaken using the following terminology:

- High Sensitivity - Absolutely reliant on specific climate/global atmospheric conditions prevailing.
- Medium Sensitivity - Affected by changes in climate/global atmospheric conditions but not dependent on specific conditions.
- Low Sensitivity - Hardly influenced by climate/global atmospheric conditions at all.

Magnitude of impact

9.3.9 The magnitude of the impacts on baseline conditions has been assessed, and the following terminology has been used to define magnitude:

- High - A fundamental change (positive or negative) to the baseline condition of the receptor, leading to total loss or major alteration of character. An impact on regional GHG emissions which causes a large net increase;

- Medium - A material change (positive or negative) leading to partial loss or alteration of character. An impact on regional GHG emissions which causes an appreciable net increase;
- Low - A slight, detectable, alteration of the baseline condition which may be positive or negative. An impact on regional GHG emissions which causes a measurable net increase;
- Negligible - A barely distinguishable change from baseline conditions. Changes in GHG emissions so low as to not be practically measurable.

Significance of effect

9.3.10 Based on the sensitivity of receptors and magnitude of impact, the significance of effect has been professionally evaluated. Under environmental impact assessment legislation, major and moderate impacts are to be considered as significant:

- Major - A significant effect that is likely to be a material consideration in its own right. GHG emissions which represent a major proportion of regional totals;
- Moderate - A significant effect that may be a material consideration in combination with other significant effects but is unlikely to be a material consideration in its own right. GHG emissions which represent a recognisable change in regional totals;
- Minor - An effect that is not significant but may be of local concern. GHG emissions which though measurable do not materially affect regional totals; and
- Negligible - An effect that would result in no change to the existing environment.

Requirements for Mitigation

9.3.11 Standard mitigation measures must be implemented to lessen the impact of potentially significant climate effects on the Proposed Project, these have been outlined in Section 9.7.

9.3.12 IEMA best practice guidance considers all GHG emissions to be significant due to their contribution towards climate change; however, to assign any GHG emissions which are additive to the prevailing baseline as being of major significance is to ignore local context, which is why the magnitude and significance descriptors above have been developed.

9.3.13 To mitigate against potential significant effects, a baseline carbon footprint is calculated and then used as a basis to reduce emissions.

Limitations to Assessment

9.3.14 The principal sources of uncertainty are:

- Natural climate variability resulting from natural external influences on climate or changes in the energy received from the sun;
- Climate models represent an incomplete understanding of Earth system processes; and,
- Uncertainty in future GHG emission trends in transport vectors associated with the Proposed Project.

9.4 Baseline Conditions

Current baseline – climatic conditions

9.4.1 A local climate baseline is provided by Met Office Historic Climate Data which presents a set of 30-year averages, covering the period 1981-2010 for a range of parameters. The nearest meteorological Met Office data station to the site is Baltasound No. 2, which is located approximately 8 km to the south-west (60.749, -0.854). The data available for the Baltasound No. 2

data station comprises a representative baseline for the Proposed Project due to its close proximity, comparable altitude of 15 m above mean sea level, and the similar maritime setting on the east coast of Unst, Northern Shetland. The data is presented in Table 9.1 and summarised below:

- The Baltasound No. 2 data station recorded an average annual maximum temperature of 10.2°C, 0.5°C lower than the average annual minimum temperature for Scotland.
- The average annual minimum temperature of 5.4°C was 1.2°C warmer than the average annual minimum temperature for Scotland (4.2°C).
- An annual average of 1,108.1 mm of rain was recorded by the Baltasound No. 2 data station. This is significantly less than the average annual rainfall for Scotland between 1981-2010 which stands at 1,570.9 mm.
- The monthly mean wind speed at 10 m on Unst is 13.4 knots, with the highest average wind speed recorded in the month of January, an average of 16.7 knots.

Table 9.1 Climate averages 1981-2010 recorded by Baltasound No. 2 Station

Month	Maximum temperature (°C)	Minimum temperature (°C)	Days of air frost (days)	Rainfall (mm)	Days of rainfall ≥1 mm (days)	Monthly mean wind speed at 10 m (knots)
January	6.4	2	7.8	123	22	16.7
February	6	1.3	7.7	95.7	17.5	15.7
March	7.1	2.1	6.3	107.4	20.1	15.3
April	8.9	3.7	3.5	64.7	13.7	13.1
May	11	5.6	0.5	52.3	11.8	11.4
June	13.1	8	0	56.6	11	10.9
July	15	10.2	0	59.9	12	10.3
August	15.2	10.4	0	82.1	13.4	10.5
September	13.4	8.8	0.1	96	16.7	12.6
October	10.7	6.5	0.5	122.6	20.6	14.4
November	8.2	3.8	3.6	128	20.5	15
December	6.8	2.1	7.8	119.8	20.7	14.5
Annual	10.2	5.4	37.7	1108.1	200	13.4

Current baseline – GHG emissions

9.4.2 Local and regional CO_2 emissions data tables published by the UK Government contain historic emissions data for the period 2005 - 2019 for all UK local authorities and councils; at the time of writing in 2022 this is still the most recent dataset available. The total emissions and emissions per capita in the Shetland Islands for the reported period are reproduced in Table 9.2 below and include all fossil fuel and land use / land use change factor (LULUCF) related GHG emissions. Between 2005 and 2019, CO_2 emissions per capita in the Shetland Islands have decreased consistently.

Table 9.2 Shetland Islands Local Authority CO2 emissions estimates 2005-2019 (kilotons CO2)

Year	Kilotons CO_2	Population ('000s)	Per Capita Emissions (tonnes)
2005	621.4	22.3	27.9
2006	618.4	22.2	27.8
2007	610.2	22.4	27.3
2008	594.3	22.5	26.4
2009	576.1	22.8	25.3
2010	581.2	23.1	25.2
2011	567.9	23.2	24.4
2012	564.0	23.2	24.3
2013	555.5	23.2	23.9
2014	545.8	23.2	23.5
2015	532.4	23.2	22.9
2016	516.0	23.2	22.2
2017	506.8	23.1	22.0
2018	502.2	23.0	21.8
2019	495.5	22.9	21.6

Future baseline

9.4.3 Climate projections for the periods 2020-2048 and 2050-2078 have been analysed to account for changing conditions over the proposed 50-year maximum design life of the built assets at the Proposed Project.

9.4.4 Representative Concentration Pathway 8.5 (RCP8.5) was utilised to capture the worst-case scenario future trends. RCP8.5 represents a pathway in which global population doubles to 12 billion, technology development and GDP growth is slow, and high fossil fuel consumption is sustained. This scenario assumes a culmination in radiative forcing levels of 8.5 W/m^2 by 2100.

9.4.5 The climate variables considered relevant to this assessment are mean air temperature, maximum air temperature, wind speed and precipitation.

9.4.6 The future baseline data is presented as a series of 12 thumbnail maps each representing a "member". Each member represents a plausible future climate scenario, with the ensemble members differing due to natural climate variability and uncertainty in global model physics. The 12 members therefore display the range of uncertainty in climate projections.

9.4.7 In general, the trends become more pronounced over time with more extreme trends arising by the late 2070s.

Mean Air Temperature

9.4.8 An increase in mean air temperature in Unst is expected in the 21st century. For the period 2020 - 2048, the annual mean air temperature at Unst is projected to be 1°C -2°C higher than the 1981-2010 average. This rises to 2-3°C above baseline levels for the 2050 - 2078 timescale, according to 75% of member scenarios.

9.4.9 An identical trend is predicted for the maximum air temperature anomaly. However, there is greater uncertainty in predictions for the annual average minimum air temperature anomaly, this variable is projected to rise by between 1°C - 4°C above baseline levels under the RCP8.5 scenario.

9.4.10 The baseline maximum temperature recorded at Baltasound, Unst is 15.2°C for the month of August (see Table 9.1), and the highest temperature ever recorded by this weather station is 25°C in July 1958. The average maximum temperature in Unst over the baseline period is significantly lower than the UK average maximum temperature of 19.4°C for the month of July. As such, despite the projected warming, temperatures in Unst will remain comparatively low.

Wind Speed

9.4.11 In all member scenarios covering the 2020-2048 and 2050-78 periods, the annual average wind speed is predicted to be between 0-0.5 m/s lower than the 1981-2010 baseline levels. This minor decrease in wind speed applies to all seasons.

9.4.12 The baseline monthly mean wind speed at 10 m in Unst is 13.4 knots (6.9 m/s), which is higher than the UK average. Therefore, average wind speed in Unst will remain comparatively high, despite the projected reduction.

Precipitation rate

9.4.13 A slight increase in the annual average precipitation rate is expected over the climatic modelling period. Throughout both the 2020 - 2048 and 2050 - 2078 periods, two thirds of member scenarios predict a 0-10% increase in the annual average precipitation rate in Unst compared to baseline levels.

9.4.14 Seasonal variation is predicted, with summer months expected to experience a slight decrease in the average precipitation rate, whilst winter months will see an increase.

9.5 Receptors Brought Forward for Assessment

9.5.1 The sensitive receptors in the instance of this climate change assessment are the Skyrora XL Launch Vehicles and attendant vehicles and personnel for the Proposed Project itself. In terms of climate vulnerability and the global atmospheric environment as the receiving body for GHG emissions. No individual receptors have been selected for assessment.

9.6 Standard Mitigation

9.6.1 A range of standard mitigation measures will be implemented to lessen the impact of potentially significant climate effects on the Proposed Project:

- Lamba Ness has localised areas at risk from pluvial surface water flooding, meaning the site is vulnerable to heavy rainfall. Within the SaxaVord Spaceport site there are small unnamed natural streams and watercourses, and drainage ditches have been cut in the flatter areas to aid drainage into these natural streams. A comprehensive drainage system will be implemented by SaxaVord Spaceport at the site, and this will act to mitigate flood risk during operation of the Proposed Project. Drainage works will be the responsibility of SaxaVord Spaceport, but the Applicant will adhere to any associated management/operational plans required by SaxaVord Spaceport.

- Proposed Project activities will be suspended during extreme weather events to mitigate against health and safety risks for site personnel and potential damage to structures and equipment.

9.6.2 IEMA best practice guidance considers all GHG emissions to be significant due to their contribution towards climate change. Therefore, to mitigate against potential significant effects caused by the Proposed Project, the following measures will be applied to reduce resulting GHG emissions:

- Future iterations Proposed Project will potentially benefit from Skyrora's development of Ecosene fuel and other alternatives to fossil hydrocarbon fuels (e.g. biokerosene) which are under wider development; and
- Surface and marine vehicle transport will similarly decarbonise over the later 2020s and 2030s reducing GHG emissions from these sources.

9.7 Potential Effects

Influence of the development on climate change

9.7.1 An assessment of the likely GHG emissions resulting from the Proposed Project has been undertaken in accordance with the methodology specified in Section 9.4 above.

9.7.2 A number of input parameters were required in order to quantify the carbon footprint, these are specified in Table 9.3 below.

9.7.3 A full overview of the emissions factors and calculation data is provided in Appendix 9.1.

Table 9.3 GHG Assessment Boundaries

Source of GHG Emissions	Input Data	Emissions Factor Source	Description
Transport	Distance travelled by HGV and ferry	UK Government GHG Conversion Factors for Company Reporting	GHG emissions from vehicles transporting launch vehicles and fuel to site
Launches	Mass of fuel consumed	UK Government GHG Conversion Factors for Company Reporting	GHG emissions resulting from fuel consumption during launches

9.7.4 The transportation of payloads to site were excluded from the assessment due to high levels of uncertainty around their source destinations. It can be assumed that this contribution would be very small for domestically produced payload items.

9.7.5 The emissions associated with a single launch of the Skyrora XL Launch Vehicle were calculated and can be simply factored to represent the emissions from multiple launches.

Table 9.4 GHG Assessment (per launch)

Source of GHG Emissions	GHG Emissions (tCO_2e)
Launch	23.3
Transport of Skyrora XL Launch Vehicle	9.3
Total	**32.7**

9.7.6 The major contributor to GHG emissions will be the combustion of fuel during the actual launches.

9.7.7 The other major component of GHG emissions will be from the transportation of the Skyrora XL Launch Vehicles to the launch site. These are anticipated to be sourced from Skyrora's works in central Scotland. Emissions from the transportation of the Skyrora XL Launch Vehicle, fuel and oxidant are assumed to require a total of four fully laden articulated lorries, travelling the distance from the works at Loanhead (as the furthest facility) to Aberdeen with onward transport by ferry. A combination of ferry and road transport is assumed to deliver the loads to the SaxaVord Spaceport.

9.7.8 Distance and emission factor assumptions are presented in Appendix 9.1.

9.7.9 GHG emissions are assessed as a low impact given that they are too large to be considered negligible but do not represent a significant proportion of regional emissions. As such they are considered to represent **no significant effect**.

9.7.10 The effects of the GHG emissions caused by the Proposed Project are theoretically reversible as natural processes and emerging technologies such as Direct Air Capture can fix atmospheric carbon dioxide on a temporary or permanent basis. However, the Precautionary Principle suggests that these removal vectors should not be assumed and that the effects be considered permanent.

Vulnerability of the development to climate change

High wind speeds

9.7.11 Damage to the Skyrora XL Launch Vehicle may occur as a result of high wind loading. Launches may be delayed due to the suspension of ferry routes and flights. The Proposed Project is considered moderately sensitive to the effects of high wind speeds.

9.7.12 Met Office climate models anticipate that there will be a barely distinguishable change from baseline wind speed conditions between 2020 - 2078.

9.7.13 The annual average wind speed is predicted to be between 0-0.5 ms^{-1} lower than the 1981 - 2010 baseline levels. This minor decrease in wind speed can be considered a negligible impact of climate change. Although climate change is likely to result in a negligible decrease in wind speed for the northern Shetland Islands, extreme wind events will remain a risk to the Proposed Project site as the baseline annual mean wind speed for Unst is amongst the highest in the UK at 13.4 knots. Consequently, wind speed can be considered to pose a moderate adverse effect to the Proposed Project.

9.7.14 To mitigate against launch failure during extreme wind conditions, the weather needs to be closely monitored in the days preceding a launch and the launch delayed if wind speeds are deemed high enough to potentially cause damage to the Skyrora XL Launch Vehicle, payload or on-site structures. Furthermore, to minimise the effect that transport route suspensions may have on launches, goods and services will be sourced as close to the Proposed Project site as practicable. Following the implementation of these mitigation measures, the effect of strong winds on the Proposed Project can be considered minor adverse with **no significant effect**.

Heavy precipitation

9.7.15 Extreme rainfall events could cause pluvial surface water flooding which may impact upon operation of the Proposed Project. On-site roads and off-site access routes may experience erosion through scour caused by surface water flooding events. This may result in access restrictions for equipment and staff critical to the launch. In addition, electrical equipment may fail due to water ingress. Due to the potential for delay to launches, the receptors are deemed to be moderately sensitive to heavy rainfall.

9.7.16 A slight increase in the annual average precipitation rate is expected from first launch until the late 2070s. Throughout both the 2020-2048 and 2050- 2078 periods, two thirds of scenarios predict a 0-10% increase in the annual average precipitation rate in Unst, compared to baseline levels. The projected slight increase in precipitation can be considered a minor adverse impact of climate change due to the low magnitude of change above baseline levels.

9.7.17 Due to the above factors, prior to the implementation of mitigation, pluvial flooding caused by heavy rainfall has the potential to have a moderate adverse impact on the Proposed Project.

9.7.18 A drainage strategy and system has been designed by SaxaVord Spaceport to mitigate against localised surface water pooling and flooding, and the implementation of this strategy will reduce the potential effect of heavy rainfall on the operation of the Proposed Project to minor adverse with **no significant effect**.

High temperatures

9.7.19 High temperatures may result in heatwaves and droughts, which could cause personnel welfare impacts (for example, heat stress), damage to machinery through overheating, and an increased risk of fire.

9.7.20 Throughout the climatic modelling window examined at the Proposed Project site, an increase in mean air temperature in northern Shetland is predicted. For the period 2020-2048, the annual mean air temperature in Unst is projected to be 1-2°C higher than the 1981-2010 average. This rises to 2-3°C above baseline levels for the 2050-2078 timescale, according to 75% of member scenarios.

9.7.21 Based on Met Office climate data from 1981 - 2001, temperatures in Unst are consistently low; the baseline maximum temperature is 15.2°C for August, compared to an average of 19.1°C across the UK. Furthermore, extreme hot weather events occur infrequently and are of a low magnitude; the hottest temperature ever recorded at Baltasound was 25°C in July 1958. The predicted trend towards rising temperatures may increase the frequency of heatwaves and droughts in Unst. However, extreme temperatures are unlikely to be of a high enough magnitude to have a significant impact on the Proposed Project site, so this constitutes a minor climate change impact.

9.7.22 Considering the sensitivity of the receptor of human health and the potential for the magnitude of impact to rise throughout the design life of the Proposed Project, high temperatures have the potential to have a minor effect.

9.7.23 Appropriate standard mitigation measures will be applied in the event of high temperature conditions. Personnel will be provided with appropriate personal protective equipment (PPE) to mitigate against the health and safety risks posed by heat and the availability of drinking water confirmed. Following the implementation of these measures, heat will pose a negligible risk to the Proposed Project and therefore result in **no significant effect**.

9.8 Residual Effects

9.8.1 No significant residual effects have been identified following the implementation of mitigation measures.

9.9 Cumulative Assessment

9.9.1 The climate resilience risks identified are limited in their spatial extent to the Proposed Project and therefore no cumulative effect with other committed developments is considered in this climate change impact assessment.

9.10 Summary

9.10.1 An assessment of the potential effects of GHG emissions associated with the Proposed Project on climate change has been undertaken.

9.10.2 The assessment considered emissions arising from the operation of the Proposed Project including transportation and combustion of Skyrora XL Launch Vehicle fuel.

9.10.3 A climate resilience assessment has been carried out to assess the vulnerability of the Proposed Project to climate change.

9.10.4 The assessment evaluated the impact of climatic variables such as wind speed, precipitation and temperature on sensitive receptors associated with the Proposed Project.

9.10.5 The climate baseline was characterised using Met Office climate data for the period 1981-2001.

9.10.6 Potential climate change effects caused by GHG emissions associated with the Proposed Project should be considered significant in accordance with IEMA best practice guidance. These GHG emissions in the context of overall annual emissions by the Shetland Islands are considered of minor significance.

9.10.7 Mitigation measures including the development of low carbon kerosene substitutes and the continued decarbonisation of passenger and freight transport will contribute to reducing GHG emissions.

9.10.8 Climate resilience impacts on the Proposed Project associated with high temperatures are considered to be of negligible significance.

9.10.9 High wind speeds are predicted to have an effect of minor significance on the Proposed Project.

9.10.10 The effects of heavy precipitation on the Proposed Project are considered to be of minor significance.

9.10.11 Standard mitigation has been considered in the inference of effect significance. Committed mitigation measures include suspending activities during extreme weather events and providing personnel with appropriate PPE.

9.11 References

BEIS. (2021). *BEIS UK Local authority and regional carbon dioxide emissions national statistics: 2005-2019*. Retrieved from https://www.gov.uk/government/statistics/uk-local-authority-and-regional-carbon-dioxide-emissions-national-statistics-2005-to-2019

BEIS. (2022). *BEIS Greenhouse Gas Reporting: Conversion Factors 2020*. Retrieved from https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2021

European Parliament. (2011). *The EIA Directive 2011/92/EU3*. Retrieved from https://ec.europa.eu/environment/eia/eia-legalcontext.htm

European Parliament. (2014). *The EIA Directive 2014/52/EU*. Retrieved from https://ec.europa.eu/environment/eia/eia-legalcontext.htm

IEMA. (2015). *Institute of Environmental Management and Assessment Guidance on Climate Resilience and Adaptation in EIA*. Retrieved from https://www.iema.net/resources/

Met Office. (2022a). *Meteorological Office UK Climate Averages*. Retrieved from https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages -

Met Office. (2022b). *Meteorological Officd UKCP18 Climate Projections*. Retrieved from https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index

Scottish Government. (2009). *Climate Change (Scotland) Act 2009*. Retrieved from https://www.legislation.gov.uk/asp/2009/12/contents

Scottish Government. (2017). *The Town and Country Planning (Environmental Impact Assessment) Regulations 2017*. Retrieved from https://www.legislation.gov.uk/ssi/2017/102/contents/made

Scottish Government. (2017). *Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017 (as amended)* .

Scottish Government. (2018). *Climate Change Plan 2018-2032*. Retrieved from https://www.gov.scot/publications/scottish-governments-climate-change-plan-third-report-proposals-policies-2018-9781788516488/

Scottish Government. (2019). *Climate Change (Emissions Reduction Targets) (Scotland) Act 2019*. Retrieved from https://www.legislation.gov.uk/asp/2019/15/enacted

SIC. (2015). *Shetlands Islands Council Carbon Management Plan 2015-2020*. Retrieved from https://www.shetland.gov.uk/coins//viewDoc.asp?c=e%97%9Dd%90lz%8E

UNFCCC. (2015). *United Nations Framework Convention on Climate Change Paris Agreement*. Retrieved from https://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf

Chapter 10 Marine and Transboundary

10. Marine & Transboundary Effects

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10. Marine & Transboundary Effects

10.1 Introduction

10.1.1 This chapter considers the marine and transboundary effects from the Proposed Project.

10.1.2 Transboundary effects of the Proposed Project are significant environmental effects that may arise in a different country as a consequence of the Proposed Project.

10.1.3 The majority of the potential environmental effects are expected at or near the Proposed Project. However, Skyrora XL Launch Vehicles will splashdown in international waters and potentially interact with the marine environment. The scope of the transboundary effects chapter is therefore concerned with assessment of the marine environmental effects of returning Skyrora XL Launch Vehicle stages or debris arising. Therefore, this chapter considers the potential marine receptors present within the effects range of the predicted impact points from returning Skyrora XL Launch Vehicles.

10.1.4 The UK Government has consulted with the governments of countries where the launch vehicles are predicted to land, specifically Norway, Faroe, Greenland and Iceland, to come to an agreement to allow stages to fall in their waters (Applicant, 2020).

10.2 Legislation, Policy and Guidelines

Legislation and Guidance

10.2.1 This Assessment of Environmental Effects has been produced under the following the Space Industry Act 2018, as transposed into The Space Industry Regulations 2021. It has been informed using:

- Guidance to the Regulator on Environmental Objectives Relating to the Exercise of its Functions under the Space Industry Act 2018; and
- Guidance for the Assessment of Environmental Effects 2021.

Planning Policy

10.2.2 The launch aspect of Scotland's space sector is emergent in nature. As such developments occur only on land, the space sector has not been considered in marine planning policy such as Scotland's National Marine Plan (Scottish Government, 2015). Despite not being considered as a specific activity in Scotland's National Marine Plan (the Plan), policies are included in the Plan that may need consideration when assessing the Proposed Project. In order to address this potential, the Plan policies have been reviewed (Appendix 10.1) and screened to determine which of the policies are of relevance to the Proposed Project. Where policies are considered relevant, the related sections of the AEE have been signposted (Table 10.1) to ensure that the content of the AEE demonstrates due consideration of the issues highlighted by the Plan policies.

10.2.3 The screening of policies for relevance to the Proposed Project considered if the Plan policies were sector specific and therefore not relevant, or if the Plan policies related to a specific geographic location and were therefore not relevant to the Proposed Project. The reason for not including policies in the process is noted in the summary table presented in Appendix 10.1.

10.2.4 The results of the Plan policy review and screening process indicate that the following policies are of relevance to the marine environment and the Proposed Project:

- GEN 1 General planning principle;
- GEN 2 Economic benefit;

- GEN 3 Social benefit;
- GEN 4 Co-existence;
- GEN 5 Climate change;
- GEN 6 Historic environment;
- GEN 7 Landscape/seascape;
- GEN 8 Coastal process and flooding;
- GEN 9 Natural heritage;
- GEN 10 Invasive non-native species;
- GEN 11 Marine litter;
- GEN 12 Water quality and resource;
- GEN 13 Noise;
- GEN 14 Air quality;
- GEN 15 Planning alignment A;
- GEN 16 Planning alignment B;
- GEN 17 Fairness;
- GEN 18 Engagement;
- GEN 19 Sound evidence;
- GEN 20 Adaptive management;
- GEN 21 Cumulative impacts;
- FISHERIES 1, 2 and 3;
- AQUACULTURE 1 and 2;
- WILDFISH 1;
- OIL & GAS 4, 5, and 6;
- CCS 2;
- TRANSPORT 1, 3 & 6; and
- AGGREGATES 1.

10.2.5 Table 10.1 lists these Plan policies and indicates the section of the AEE where information is presented to account for the requirements of the policy.

Table 10.1 Scotland National Marine Plan policies and cross-reference to section where information is presented to account for the requirements of the policies

Policy ID	Policy Text	Relevant Section of AEE Report
GEN 1	*There is a presumption in favour of sustainable development and use of the marine environment when consistent with the policies and objectives of this Plan.*	Section 10
GEN 2	*Sustainable development and use which provides economic benefit to Scottish communities is encouraged when consistent with the objectives and policies of this Plan.*	Section 10
GEN 3	*Sustainable development and use which provides social benefits is encouraged when consistent with the objectives and policies of this Plan.*	Section 10
GEN 4	*Proposals which enable coexistence with other development sectors and activities within the Scottish marine area are encouraged in planning and decision-making processes, when consistent with policies and objectives of this Plan.*	Section 10
GEN 5	*Marine planners and decision makers must act in the way best calculated to mitigate, and adapt to, climate change.*	Section 10.13
GEN 6	*Development and use of the marine environment should protect and, where appropriate, enhance heritage assets in a manner proportionate to their significance.*	Section 10.13, Sections 10.10.114 - 10.10.122
GEN 7	*Marine planners and decision makers should ensure that development and use of the marine environment take seascape, landscape and visual impacts into account.*	Section 10.13
GEN 8	*Developments and activities in the marine environment should be resilient to coastal change and flooding, and not have unacceptable adverse impact on coastal processes or contribute to coastal flooding.*	Section 10.13
GEN 9	*"Development and use of the marine environment must:*	Section 10.13
GEN 10	*(a) Comply with legal requirements for protected areas and protected species.*	Section 10.13
GEN 11	*(b) Not result in significant impact on the national status of Priority Marine Features.*	Section 10.13
GEN 12	*(c) Protect and, where appropriate, enhance the health of the marine area."*	Section 10.13

Policy ID	Policy Text	Relevant Section of AEE Report
GEN 13	*Opportunities to reduce the introduction of invasive non-native species to a minimum or proactively improve the practice of existing activity should be taken when decisions are being made.*	Section 10.13
GEN 14	*Developers, users and those accessing the marine environment must take measures to address marine litter where appropriate. Reduction of litter must be taken into account by decision makers.*	Section 10.13
GEN 15	*Developments and activities should not result in a deterioration of the quality of waters to which the Water Framework Directive, Marine Strategy Framework Directive or other related Directives apply.*	Section 10
GEN 16	*Development and use in the marine environment should avoid significant adverse effects of man-made noise and vibration, especially on species sensitive to such effects.*	Section 10
GEN 17	*Development and use of the marine environment should not result in the deterioration of air quality and should not breach any statutory air quality limits.*	Section 10
GEN 18	*Marine and terrestrial plans should align to support marine and land-based components required by development and seek to facilitate appropriate access to the shore and sea.*	Section 10.3
GEN 19	*Marine plans should align and comply where possible with other statutory plans and should consider objectives and policies of relevant non-statutory plans where appropriate to do so. <applies to inshore waters only>*	Section 10
GEN 21	*Cumulative impacts affecting the ecosystem of the marine plan area should be addressed in decision making and plan implementation.*	Section 10.13.14

Policy ID	Policy Text	Relevant Section of AEE Report
FISHERIES 1	*Taking account of the EU's Common Fisheries Policy, Habitats Directive, Birds Directive and Marine Strategy Framework Directive, marine planners and decision makers should aim to ensure:* - *Existing fishing opportunities and activities are safeguarded wherever possible.* - *An ecosystem-based approach to the management of fishing which ensures sustainable and resilient fish stocks and avoids damage to fragile habitats.* - *Protection for vulnerable stocks (in particular for juvenile and spawning stocks through continuation of sea area closures where appropriate).* - *Improved protection of the seabed and historical and archaeological remains requiring protection through effective identification of high-risk areas and management measures to mitigate the impacts of fishing, where appropriate.* - *That other sectors take into account the need to protect fish stocks and sustain healthy fisheries for both economic and conservation reasons.* - *Delivery of Scotland's international commitments in fisheries, including the ban on discards.* - *Mechanisms for managing conflicts between fishermen and/or between the fishing sector and other users of the marine environment.*	Section 10.10.77
FISHERIES 2	*The following key factors should be taken into account when deciding on uses of the marine environment and the potential impact on fishing:* - *The cultural and economic importance of fishing, in particular to vulnerable coastal communities.* - *The potential impact (positive and negative) of marine developments on the sustainability of fish and shellfish stocks and resultant fishing opportunities in any given area.* - *The environmental impact on fishing grounds (such as nursery, spawning areas), commercially fished species, habitats and species more generally.* - *The potential effect of displacement on: fish stocks; the wider environment; use of fuel; socio-economic costs to fishers and their communities and other marine users.*	Section 10.10.77

Policy ID	Policy Text	Relevant Section of AEE Report
FISHERIES 3	*Where existing fishing opportunities or activity cannot be safeguarded, a Fisheries Management and Mitigation Strategy should be prepared by the proposer of development or use, involving full engagement with local fishing interests (and other interests as appropriate) in the development of the Strategy. All efforts should be made to agree the Strategy with those interests. Those interests should also undertake to engage with the proposer and provide transparent and accurate information and data to help complete the Strategy. The Strategy should be drawn up as part of the discharge of conditions of permissions granted.* *The content of the Strategy should be relevant to the particular circumstances and could include:* - *An assessment of the potential impact of the development or use on the affected fishery or fisheries, both in socio-economic terms and in terms of environmental sustainability.* - *A recognition that the disruption to existing fishing opportunities/activity should be minimised as far as possible.* - *Reasonable measures to mitigate any constraints which the Proposed Project or use may place on existing or proposed fishing activity.* - *Reasonable measures to mitigate any potential impacts on sustainability of fish stocks (e.g., impacts on spawning grounds or areas of fish or shellfish abundance) and any socio-economic impacts.* *Where it does not prove possible to agree the Strategy with all interests, the reasons for any divergence of views between the parties should be fully explained in the Strategy and dissenting views should be given a platform within the Strategy to make their case.*	Section 10.10.77
WILD FISH 1	*The impact of development and use of the marine environment on diadromous fish species should be considered in marine planning and decision-making processes. Where evidence of impacts on salmon and other diadromous species is inconclusive, mitigation should be adopted where possible and information on impacts on diadromous species from monitoring of developments should be used to inform subsequent marine decision making.*	Section 10.10.77

Policy ID	Policy Text	Relevant Section of AEE Report
OIL & GAS 4	*All oil and gas platforms will be subject to 9 nautical mile consultation zones in line with Civil Aviation Authority guidance.*	Sections 10.10.86 - 10.10.93
OIL & GAS 5	*Consenting and licensing authorities should have regard to the potential risks, both now and under future climates, to oil and gas operations in Scottish waters, and be satisfied that installations are appropriately sited and designed to take account of current and future conditions.*	Sections 10.10.86 - 10.10.93
OIL & GAS 6	*Consenting and licensing authorities should be satisfied that adequate risk reduction measures are in place, and that operators should have sufficient emergency response and contingency strategies in place that are compatible with the National Contingency Plan and the Offshore Safety Directive.*	Sections 10.10.86 - 10.10.93
TRANSPORT 1	*Navigational safety in relevant areas used by shipping now and in the future will be protected, adhering to the rights of innocent passage and freedom of navigation contained in UN Convention on the Law of the Sea (UNCLOS). The following factors will be taken into account when reaching decisions regarding development and use:* - *The extent to which the locational decision interferes with existing or planned routes used by shipping, access to ports and harbours and navigational safety. This includes commercial anchorages and defined approaches to ports.* - *Where interference is likely, whether reasonable alternatives can be identified.* - *Where there are no reasonable alternatives, whether mitigation through measures adopted in accordance with the principles and procedures established by the International Maritime Organization can be achieved at no significant cost to the shipping or ports sector.*	Sections 10.10.104 – 10.10.113
TRANSPORT 3	*Ferry routes and maritime transport to island and remote mainland areas provide essential connections and should be safeguarded from inappropriate marine development and use that would significantly interfere with their operation. Developments will not be consented where they will unacceptably interfere with lifeline ferry services.*	Sections 10.10.104 – 10.10.113

Policy ID	Policy Text	Relevant Section of AEE Report
TRANSPORT 6	*Marine planners and decision makers and developers should ensure displacement of shipping is avoided where possible to mitigate against potential increased journey lengths (and associated fuel costs, emissions, and impact on journey frequency) and potential impacts on other users and ecologically sensitive areas.*	Sections 10.10.104 – 10.10.113

10.2.6 In addition to the policies in Scotland's National Marine Plan, the Shetland Local Development Plan (the Shetland Plan) (Shetland Islands Council, 2014) has also been reviewed to determine if any policies exist that may be relevant to the Proposed Project. The Shetland Plan outlines several policies that must be considered in applications for new development. The policies that are of relevance to the marine environment and the Proposed Project include:

- GP 1 Sustainable Development;
- GP2 General Requirements for All Development;
- GP 3 All Development: Layout and Design
- NH1 International and National Designations;
- NH2 Protected Species;
- NH3 Furthering the Conservation of Biodiversity;
- NH4 Local Designations;
- NH 6 Geodiversity;
- NH 7 Water Environment;
- NH 1 Historic Environment;
- HE4 Archaeology; and,
- CST1 Coastal Development.

10.2.7 Table 10.2 lists these Shetland Plan policies and indicates the section of the AEE where information is presented to account for the requirements of the policy.

Table 10.2 Shetland Local Development Plan policies and cross-reference to section where information is presented to account for the requirements of the policies

Policy ID	Policy Text	Relevant Section of the AEE Report
GP 1	*"Development will be planned to meet the economic and social needs of Shetland in a manner that does not compromise the ability of future generations to meet their own needs and to enjoy the area's high quality environment. Tackling climate change and associated risks is a major consideration for all development proposals.* *New residential, employment, cultural, educational and community developments should be in or adjacent to existing settlements that have basic services and infrastructure in order to enhance their viability and vitality and facilitate ease of access for all. This will be achieved through Allocations, Sites with Development Potential and Areas of Best Fit."*	Section 10
GP 2	*"Applications for new buildings or for the conversion of existing buildings should meet all of the following General Requirements:* *a. Developments should not adversely affect the integrity or viability of sites designated for their landscape and natural heritage value.* *b. Development should not occur any lower than 5 metres Above Ordnance Datum (Newlyn) unless the development meets the requirements of Policy WD1;* *c. Development should be located, constructed and designed so as to minimise the use of energy and to adapt to impacts arising from climate change, such as the increased probability of flooding; water stress, such as water supply; health or community impacts as a result of extreme climatic events; and a change in richness of biodiversity.* *d. Suitable water, waste water and surface water drainage must be provided;* *e. All new buildings shall avoid a specified and rising proportion of the projected greenhouse gas emissions from their use, through the installation and operation of low and zero-carbon generating technologies (LZCGT). The proportion of such emissions shall be specified in the council's Supplementary Guidance – Design. That guidance will also set out the approach to existing buildings which are being altered or extended, including historic buildings, and the approach to applications where*	Section 10

Policy ID	Policy Text	Relevant Section of the AEE Report
	developers are able to demonstrate that there are significant technical constraints to using on-site low and zero carbon generating technologies. *f. Suitable access, car parking and turning should be provided;* *g. Development should not adversely affect areas, buildings or structures of archaeological, architectural or historic interest;* *h. Development should not sterilise mineral reserves;* *i. Development should not sterilise allocated sites as identified within the Shetland Local Development Plan;* *j. Development should not have a significant adverse effect on existing uses;* *k. Development should not compromise acceptable health and safety standards or levels;* *l. Development should be consistent with National Planning Policy, other Local Development Plan policies and Supplementary Guidance."*	
GP 3	*"All new development should be sited and designed to respect the character and local distinctiveness of the site and its surroundings.* *The Proposed Project should make a positive contribution to:* *• maintaining identity and character* *• ensuring a safe and pleasant space* *• ensuring ease of movement and access for all* *• a sense of welcome* *• long term adaptability, and* *• good use of resources* *The Planning Authority may request a Masterplan and/ or Design and Access Statement in support of development proposals.* *A Masterplan should be submitted with applications where Major Development is proposed; Major Development is defined in the Town and Country Planning (Hierarchy of Developments) (Scotland) Regulations 2009, Reg 2 (1). Further details for these requirements are set out in Supplementary Guidance."*	Section 10

Policy ID	Policy Text	Relevant Section of the AEE Report
NH 1	*"Any development proposal that is likely to have a significant effect on an internationally important site, (Special Area of Conservation (SAC), Special Protection Areas (SPA) or Ramsar Sites) and is not directly connected with or necessary to the conservation management of that site will be subject to an assessment of the implications for the site's conservation objectives. Development that could have a significant effect on a site will only be permitted where:* • *An appropriate assessment has demonstrated that it will not adversely affect the integrity of the site, or* • *There are no alternative solutions, and* • *There are imperative reasons of over-riding public interest that may, for sites not hosting a priority habitat type and/or priority species, be of a social or economic nature.* *Development that affects a National Scenic Area (NSA), National Nature Reserve (NNR) or a Site of Special Scientific Interest (SSSI) will only be permitted where:* • *It will not adversely affect the integrity of the area or the qualities or protected features for which it has been designated, or* • *Any such adverse effects are clearly outweighed by social, environmental or economic benefits of national importance. "*	Section 10.13
NH 2	*"Where there is good reason to suggest that a species protected under the Wildlife and Countryside Act 1981 (as amended), Annex IV of the Habitats Directive or Annex 1 of the Birds Directive is present on site, or may be affected by a Proposed Project, the Council will require any such presence to be established. If such a species is present, a plan should be provided to avoid or mitigate any adverse impacts on the species, prior to determining the application.* *Planning permission will not be granted for development that would be likely to have an adverse effect on a European Protected Species unless the Council is satisfied that:* • *The development is required for preserving public health or public safety or for other imperative reasons of overriding public interest including those of a social or*	*Section 10.13*

Policy ID	Policy Text	Relevant Section of the AEE Report
	economic nature and beneficial consequences of primary importance for the environment; and • *There is no satisfactory alternative; and* • *The development will not be detrimental to the maintenance of the population of the European Protected Species concerned at a favourable conservation status in their natural range.* *Planning permission will not be granted for development that would be likely to have an adverse effect on a species protected under Schedule 5 (animals) or 8 (plants) of the Wildlife and Countryside Act 1981 (as amended) unless the Council is satisfied that:* • *Undertaking the development will give rise to, or contribute towards the achievement of, a significant social, economic or environmental benefit; and* • *There is no satisfactory solution.* *Planning permission will not be granted for development that would be likely to have an adverse effect on a species protected under Schedules 1, 1A or A1 (birds) of the Wildlife and Countryside Act 1981 (as amended), unless the Council is satisfied that:* *o The development is required for preserving public health or public safety; and* *o There is no other satisfactory solution.* *Applicants should submit supporting evidence for any development meeting these criteria, demonstrating both the need for the development and that a full range of possible alternative courses of action have been properly examined and none found to acceptably meet the need identified.* *The Council will apply the precautionary principle where the impacts of a Proposed Project on natural heritage are uncertain but potentially significant. Where development is constrained on the grounds of uncertainty, the potential for research, surveys or assessments to remove or reduce uncertainty should be considered. "*	

Policy ID	Policy Text	Relevant Section of the AEE Report
NH 3	*"Development will be considered against the Council's obligation to further the conservation of biodiversity and the ecosystem services it delivers. The extent of these measures should be relevant and proportionate to the scale of the development.* *Proposals for development that would have a significant adverse effect on habitats or species identified in the Shetland Local Biodiversity Action Plan, Scottish Biodiversity List, UK Biodiversity Action Plan, Annexes I and II of the Habitats Directive, Annex I of the Birds Directive (if not included in Schedule 1 of the Wildlife and Countryside Act) or on the ecosystem services of biodiversity, including any cumulative impact, will only be permitted where it has been demonstrated by the developer that;* • *The development will have benefits of overriding public interest including those of a social or economic nature that outweigh the local, national or international contribution of the affected area in terms of habitat or populations of species; and* • *Any harm or disturbance to the ecosystem services, continuity and integrity of the habitats or species is avoided or reduced to acceptable levels by mitigation."*	*Section 10.13*
NH 4	*"Development that affects a Local Nature Conservation Site or Local Landscape Area will only be permitted where:* • *It will not adversely affect the integrity of the area or the qualities for which it has been identified; or* • *Any such effects are clearly outweighed by social, environmental or economic benefits. "*	*Section 10.13*

Policy ID	Policy Text	Relevant Section of the AEE Report
NH 6	*"Development will only be permitted where appropriate measures are taken to protect and/or enhance important geological and geomorphological resources and sites, including those of educational or research value.* *Proposals that will have an unavoidable effect on geodiversity will only be permitted where it has been demonstrated that:* • *The development will have benefits of overriding public interest including those of a social or economic nature that outweigh the local, national or international contribution of the affected area in terms of its geo-diversity;* • *Any loss of geodiversity is reduced to acceptable levels by mitigation, and a record is made prior to any loss.* *For certain scales of development where a soil management plan is required, reference should also be made to geodiversity on site."*	*Section 10.13*
NH 7	*"Development will only be permitted where appropriate measures are taken to protect the marine and freshwater environments to an extent that is relevant and proportionate to the scale of development. Development adjacent to a watercourse or water body must be accompanied by sufficient information to enable a full assessment of the likely effects.* *Where there is potential for the development to have an adverse impact the applicant/developer must demonstrate that:* • *There will be no deterioration in the ecological status of the watercourse or water body;* • *It does not encroach on any existing buffer strips and that access to these buffer strips has been maintained; and* • *Both during the construction phase and after completion it would not significantly affect:* *o Water quality flows in adjacent watercourses or areas downstream* *o Natural flow patterns and sediment transport processes in all water bodies or watercourses."*	*Section 10.13*

Policy ID	Policy Text	Relevant Section of the AEE Report
HE 1	*The Council should presume in favour of the protection, conservation and enhancement of all elements of Shetland's historic environment, which includes buildings, monuments, landscapes and areas.*	Section 10.13, Sections 10.10.114 - 10.10.122
HE 4	*"Scheduled monuments, designated wrecks and other identified nationally important archaeological resources should be preserved in situ, and within an appropriate setting. Developments that have an adverse effect on scheduled monuments and designated wrecks or the integrity of their settings should not be permitted unless there are exceptional circumstances.* *All other significant archaeological resources should be preserved in situ wherever feasible. Where preservation in situ is not possible the planning authority should ensure that developers undertake appropriate archaeological excavation, recording, analysis, publication and archiving in advance of and/ or during development."*	Section 10.13, Sections 10.10.114 - 10.10.122
CST 1	*"Proposals for developments and infrastructure in the coastal zone (above Mean Low Water Mark of Ordinary Spring Tides) will only be permitted where the proposal can demonstrate that:* • *It will not have a significant impact, either individually or cumulatively, on the natural, built environment and cultural heritage resources either in the sea or on land;* • *The location, scale and design are such that it will not have a significant adverse impact.* • *It does not result in any deterioration in ecological status or potential for any water body or prevent it from achieving good ecological status in the future;* • *There is no significant adverse impact on other users of marine resources, and/or neighbouring land.* *Proposals for marine aquaculture developments or amendments to existing fish farm developments will require to have regard to the foregoing criteria and will be assessed against the Supplementary Guidance Policy for Aquaculture.* *All proposals will be assessed against the Shetland Islands Marine Spatial Plan that sets out a spatial strategy and policy framework to guide marine developments in the coastal waters around Shetland. The Marine Spatial Plan identifies the constraints developers are required to consider when contemplating development in the coastal area and will form supplementary guidance to this plan."*	Section 10.13

10.3 Consultation

10.3.1 Extensive consultation on the scope of the Marine Environmental Risk Assessment (MERA) matters was carried out during preparation and determination of the planning application for the SaxaVord Spaceport, from where the Proposed Project will operate. Where directly relevant to this AEE, consultation responses received during the SaxaVord Spaceport planning application period have been summarised in Table 10.3.

Table 10.3 SaxaVord Spaceport Consultation Responses directly relevant to this AEE

Consultee and Date	Issue Raised	Response/Action Taken
Marine Scotland 28/05/2020	The Marine Scotland Licensing Operations Team do not have anything to add in relation to the planning or construction aspects of the Space Centre, nor are we suitably placed to inform you as to what should or should not be scoped into your MERA. However, you should ensure we are contacted regarding marine licensing requirements of launch activities taking place at the Space Centre. We would also recommend that you consult with the MMO (Marine Management Organisation) to confirm whether or not there are any further UK licensing requirements.	A response was provided by email to assure that marine licensing requirements had already been discussed and addressed, and that these did not fall within the scope of the MERA. The MMO were consulted with (see below).
Scottish Environmental Protection Agency (SEPA) 17/06/2020	The information provided suggest that marine issues appear to be further away offshore and is therefore not within SEPA's remit to provide advice. Following your statement in the email below; it is unfortunate that the proposals seem to be one that would be polluting the marine environment especially the Arctic as it is stated that, it is not expected that any part of the launch vehicles will be retrieved. In regard to the impact on the marine environment, it appears the 4 bullet points that have been scoped out would need to be considered because planned launches which go wrong may end up landing in the waters close to Marine Protected Areas (MPA) and offshore oil platforms rather than in the arctic.	Acknowledged. As assessed in the MERA, the impact is predicted to be minor at worst. The 4 bullet points to which the email refers (offshore marine protected areas; offshore renewable developments; offshore oil and gas platforms; aggregated extraction areas) were characterised as part of the baseline for the EZI in Section 10.6. The EZI encompasses the launch site, so as to be precautionary about where the impact zones will be.
Royal Society for the Protection of Birds (RSPB) 03/06/2020	We feel that consideration of the assessment approach required for the return of parts of launch vehicles to the marine environment is somewhat outwith our expertise. However, in general terms, looking at the receptors that you intend to scope in, my opinion would be that you seem to be covering all relevant factors. Also, the receptors being scoped out seem acceptable.	Acknowledged; no further action required.

Consultee and Date	Issue Raised	Response/Action Taken
Maritime and Coastguard Agency (MCA) [Offshore Renewables Advisor] 03/06/2020 and 04/06/2020 [via phone discussion]	A series of clarification queries were raised by the MCA via return email. Issues raised in relation to the MERA included: Have the scoped-out receptors been checked with current datasets? Will 'Shipping Activities' cover all vessel types; recreational, fishing, commercial and other offshore users including oil and gas, and dredging? Has vessel traffic been assessed in the study area to make this conclusion [that in-combination effects can be ruled out]?	Clarification was provided via a phone call on 04/06/2020. The scoped-out receptors were characterised as part of the baseline for the EZI in Section 10.6. Shipping activities, characterised in Section 10.6, have assessed all vessel types. Vessel traffic has been described in Section 10.6 and assessed in Section 10.10. Effects on shipping and navigation have been considered in the cumulative assessment in Section 10.13.14. Acknowledged, no further action required.
09/09/2020 [via email]	Based on [the further information provided in response to previous questions], I believe (at this point) that the impact on shipping and navigation should be suitably addressed through your approach to the MERA. I can only respond within the MCA's remit and you will of course need to consult with other interested parties to ensure nothing has been omitted from the approach.	
Marine Management Organisation (MMO) 29/05/2020 [via phone discussion]	Enquiries with regards to marine licensing should be submitted through our online marine licensing portal the Marine Case Management System (MCMS).	A response was provided by email to assure that marine licensing requirements had already been discussed and addressed, and that these did not fall within the scope of the MERA

10.4 Scope of Assessment

Environmental Zone of Influence

10.4.1 For the purposes of this AEE, the Environmental Zone of Influence (EZI) is based on and comprises the proposed launch flight corridor and all study areas required for the technical disciplines included in the AEE, as presented on drawing 3.6.

10.4.2 Within the EZI, the study area(s) required for each technical discipline assessed vary.

10.4.3 Orbital (Skyrora XL) and suborbital (Skyrora Skylark L) launches are predicted to occur from the SaxaVord Spaceport. The impact dispersion area from all launch pad complexes for both suborbital and orbital launch vehicles is contained within the area demarcated as the orbital Environmental Zone of Influence (EZI) presented in Drawing 10.1. This assessment considers the potential effects of orbital launches of the Skyrora XL Launch Vehicle as a precautionary measure, as these are predicted to have greater effects across all impact pathways.

10.4.4 For the purposes of this AEE, the EZI is based on the proposed orbital launch flight corridors and corresponding launch areas of the Skyrora XL Launch Vehicle. The proposed trajectory of the Skyrora XL Launch Vehicle will have an overall northerly direction from the SaxaVord Spaceport. There will be two impact zones arising from a launch, based on two of the three stages. Considering the impact zone for the payload fairing, up to three impact zones are expected per launch (Stage 1, the payload fairing, and Stage 2). The third stage carries the payload into orbit and will be on a trajectory that will result in burn-up upon re-entry into the atmosphere. The impact zones are expected to occur at an approximate minimum distance of 617 km from the launch site (Stage 1), and up to an approximate maximum distance of 4,007 km (Stage 2). The indicative locations of impact zones have been provided by the Applicant, and a precautionary buffer has been drawn around them to ensure that the study area is large enough to capture all reasonably foreseeable locations where the Skyrora XL Launch Vehicle will return under currently planned trajectories. In order to be precautionary, it has been assumed throughout this assessment that components could return anywhere within the EZI.

10.4.5 The trajectories and likely impact zone for returning material from suborbital launches is spatially limited compared to orbital launches, as suborbital launch vehicles are smaller and have a reduced range. The area of impact for suborbital launches is encompassed within the larger EZI.

10.4.6 The EZI falls within the jurisdiction of several countries including Scotland, Norway, Faroe Islands (Denmark), Iceland, and Greenland (Denmark)[1]. It also falls within areas beyond national jurisdiction. The northern part of the EZI (Stage 2) lies within the Arctic Circle, of which the southern limit is at a latitude of 66˚N. The EZI lies mostly within OSPAR Region 1: Arctic Waters, with the waters up to 200 km north of Shetland falling within Region II: Greater North Sea (OSPAR, 2020).

Desk Study

10.4.7 This assessment comprises a desk study. The primary resources used to inform this chapter include:

- OSPAR resources;
- Conservation of Arctic Flora and Fauna (CAFF) 2017 State of the Arctic Marine Biodiversity Report;
- National Snow and Ice Data Center (NSIDC) Sea Ice Index;
- National Oceanic and Atmospheric Administration (NOAA) resources;
- European Marine Observation and Data network (EMODnet);

[1] Note that whilst the Skyrora XL Launch Vehicle will interact with Canadian airspace, no debris associated with Stage 1, payload fairing, Stage 2, or Stage 3 will interact with marine waters associated with the Canadian Economic Zone.

- ICES landings data;
- National Biodiversity Network (NBN) Atlas;
- NatureScot resources;
- Marine Scotland resources, including the National Marine Plan interactive viewer;
- Consultation responses;
- Project-specific Navigational Risk Assessment; and,
- Published and unpublished literature.

10.5 Assessment Methodology

10.5.1 To assess the level of potential impact (likely significant effects) resulting from launch events at the Proposed Project, a methodology has been developed to establish the level of environmental risk of the Proposed Project to a range of receptors. This takes account of the sensitivity of the receptor, the exposure of the receptor to effects and the magnitude of the effects over and above the baseline condition. Therefore, for the purposes of this assessment, the term 'risk assessment' can be used interchangeably for 'impact assessment'.

10.5.2 More information on the criteria considered when determining levels of sensitivity, exposure and magnitude is provided below. In all cases, the assessment considers impacts, over and above those that may have already occurred, to determine whether the proposal constitutes a significant risk (likely significant effect) to the water quality, biodiversity or human and human activity environment in the vicinity of the EZI. It should also be noted that where receptors are grouped together, or where a wide range of scores exists, the worst-case scores of sensitivity (comprising worst-case scores of tolerance, adaptability and recoverability), exposure and magnitude are taken for each of the individual receptors.

Criteria Employed to Determine Levels of Sensitivity, Exposure and Magnitude

Sensitivity

10.5.3 The sensitivity assessment used is an assessment of the relative sensitivity of the receptor features within the EZI to effects associated with returning Skyrora XL Launch Vehicle components. In relation to this assessment, sensitivity has been defined in terms of the receptor's value (importance, quality and rarity), and as a product of tolerance, adaptability and recoverability to a pressure/effect:

- Tolerance is the susceptibility (ability to be affected or unaffected) of a receptor from an external factor;
- Adaptability relates to the ability of the receptor to adapt to, or avoid, an external factor; and,
- Recoverability is the ability of a receptor to return to a state close to that which existed before the activity or event caused change within a specified period of time.

10.5.4 For each receptor, consideration is given to each of these component parts of the sensitivity assessment, with overall sensitivity being governed by the combined scores for each part. The scores for each element range from 0-3 (Negligible to High) and are determined based on consideration of the available evidence.

10.5.5 The sensitivity assessments of the receptors (grouped or their component sub-features) are based upon a series of scientific review documents. These include Tyler-Walters and Hiscock (2005) and the Marine Habitats Reviews (Jones *et al.*, 2000). Further detailed consideration of sensitivity (specifically in the context of benthic receptors but also more widely applicable) is provided at the MarLIN website. (MarLIN, 2019).

10.5.6 A combination of screening against sensitivity criteria per receptor/grouped receptors and expert judgement, based upon supporting statements within the baseline, have then been used to deliver the sensitivity assessment component of the risk assessment.

10.5.7 Where grouped receptors have been used (e.g., for some parts of the benthic ecology assessment), then the receptor with the known highest sensitivity (greatest intolerance) to the pressure assessed has been used as the benchmark. This has allowed a conservative/precautionary assessment process for sensitivity to feed into the risk assessment matrix.

10.5.8 In practice, to determine the sensitivity of a receptor each characteristic (value, adaptability, tolerance and recoverability) is scored from 0-3. In most cases, 0 represents a negligible score whereas 3 will indicate a high value for the characteristic. In the case of recoverability, adaptability, and tolerance, a low score indicates that the receptor is capable of withstanding the impact pressure and should reduce the sensitivity score, whereas a high score for these characteristics will lead to a high sensitivity.

10.5.9 The following limits have subsequently been used to determine whether the sensitivity of the receptor is negligible, low, medium, or high:

Combined Score	Sensitivity
0-3	Negligible (0)
4-6	Low (1)
7-9	Medium (2)
10-12	High (3)

10.5.10 The sensitivity score is then carried forward to the final risk assessment (see below).

Exposure

10.5.11 Exposure is defined in terms of how the impacts affect a receptor, including the spatial extent of the impact, its longevity above baseline levels and the frequency at which the impact occurs.

10.5.12 In practice, to determine the exposure of a receptor to a particular impact, each characteristic (spatial extent, longevity and frequency) is scored from 0-3. The combined scores are then used to determine the level of exposure that a receptor will experience.

10.5.13 The following limits have subsequently been used to determine whether the exposure to the impact is negligible, low, medium or high:

Combined Score	Exposure
0	Negligible (0)
1-4	Low (1)
5-7	Medium (2)
8-9	High (3)

10.5.14 The exposure score is then carried forward to the final risk assessment (see below).

Magnitude

10.5.15 Magnitude is defined in terms of the level of the impact above background conditions and natural variability by whatever parameters are measurable.

10.5.16 In practice, to determine the magnitude of an impact, each characteristic (level above background, level in the context of natural variability) is scored from 0-3. The combined scores are then used to determine the level of exposure that a receptor will experience.

10.5.17 The following limits have subsequently been used to determine whether the magnitude of the impact is negligible, low, medium, or high:

Combined Score	Magnitude
0	Negligible (0)
1-2	Low (1)
3-4	Medium (2)
5-6	High (3)

Summary of Methodology Used to Determine Level of Environmental Risk

10.5.18 As noted, the methodology adopted for this assessment utilises three elements: receptor sensitivity, exposure to impact and the magnitude of impact. As described, limits have been defined to assist in ascribing relevant values to these elements for all the receptors and potential impacts considered. The parameters adopted to ascribe values to the level of sensitivity, exposure, and risk (impact) have been adjusted according to the nature of the receptor and the impact.

Environmental Risk Assessment Matrix

10.5.19 An environmental risk assessment matrix has been developed to determine the risk posed by a range of impacts to a range of receptors. The matrix is illustrated in Figure 10.1 below. In practice, to determine the level of risk posed by an impact to a receptor, the scores resulting from the assessment outlined above are multiplied to determine the level of risk.

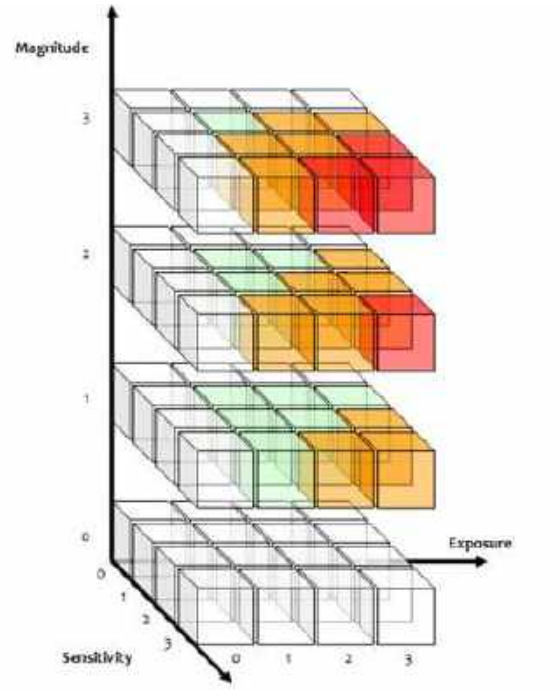

Figure 10.1 The risk assessment matrix

For the purposes of this assessment, the following limits have been set.

Score		Risk Value
0	=	Negligible
1-5.99	=	Low
6-17.99	=	Medium
18-27	=	High

10.5.20 Table 10.4 below presents the transposition of the risk values into the terminology used in the wider AEE Report.

Table 10.4 Risk assessment values and transposition into wider AEE Report terminology

Risk Value	AEE terminology	Potential Significant Effect
Negligible	Negligible	No Likely Significant Effect
Low	Minor	No Likely Significant Effect
Medium	Moderate	Likely Significant Effect
High	Major	Likely Significant Effect

10.5.21 It should be noted that broad receptor groups e.g., benthic habitats, are made up of a range of individual receptors e.g. bivalves, polychaetes, corals, sponges etc. As such, the risk assessment has been undertaken to account for the most sensitive elements of the broad receptor groups, with an overall risk summary for each broad group presented in the document.

Requirements for Mitigation

10.5.22 For the purposes of this assessment, risk scores of <6 (Low or Negligible Risk) are considered insignificant, and mitigation is unnecessary as no likely significant effects arise.

10.5.23 Risk scores of 6-17.99 (Medium Risk) are considered to result in likely significant effects. Where mitigation can be applied impacts may be reduced to Low or Negligible Risk resulting in residual effects equating to no likely significant effect. If specific mitigation measures are not applied likely significant effects will remain.

10.5.24 Risk scores ≥18 (High Risk) are considered to result in likely significant effects and impacts are likely to be mitigated only through application of specifically targeted measures and/or acquisition of further environmental information to better determine impact significance. If specific mitigation measures are not applied significant effects will remain.

Assessment of Residual Effect Significance

10.5.25 Where mitigation practices are required to reduce the level of risk to no likely significant effect, these measures are presented along with a subsequent assessment of likely residual effect.

Limitations to Assessment

10.5.26 Following the risk assessment, a consideration of the confidence of the assessment has been undertaken based on the nature of evidence used, and the application of the evidence, to determine the risk of the proposals.

10.6 Baseline Conditions

10.6.1 The baseline conditions are described in terms of their water quality, biodiversity and humans/human activities for the EZI. Parameters included in the assessment are water quality, biodiversity and human activities which are discussed in detail in Appendix 10.2.

10.7 Receptors Brought Forward for Assessment

10.7.1 Following characterisation of the baseline, certain receptors have been screened out due to a lack of presence in the EZI and/or pathway of effect.

10.7.2 Physical features have been screened out for the EZI due to a lack of pathway of effect.

10.7.3 It is noted that through consultation, the Oil and Gas Authority confirmed that there was negligible risk to the oil and gas surface infrastructure present to the west and north-east of Shetland. Accordingly, oil and gas surface infrastructure has not been considered further in this AEE.

10.7.4 As described in the baseline environment, there is negligible presence of other sea users and socio-economics/tourism in the study area. Accordingly, these human activities have not been considered futher in this AEE.

10.7.5 Details of which features/receptors are being taken forward for assessment are presented in Table 10.5 below.

Table 10.5 Receptors taken forward in the assessment

Receptor	Taken Forward
Water and Sediment quality	
Contaminants	Yes
Microplastics	Yes
Biodiversity	
Physical features	No
Plankton	Yes
Benthic species	Yes
Fish and shellfish	Yes
Marine ornithology	Yes
Marine megafauna	Yes
Marine protected area	Yes
Human/human activities	
Shipping and navigation	Yes
Oil and gas infrastructure	No
Cables and pipelines	Yes
Military	Yes
Other sea users	No
Socioeconomics/tourism	No
Marine archaeology	Yes
Commercial fisheries	Yes

10.8 Assessment Envelope

10.8.1 As per the AEE Regulations, the impact assessment should be based on the worst-case parameters, known as the Rochdale envelope.

10.8.2 Certain worst-case scenarios, such as the maximum number of launches or maximum rocket size, are already known and have been set as limits as part of the project design.

10.8.3 A full description of the proposal is provided in Chapter 3 Proposed Project. For completeness, this assessment envelope presents a subset of the project description that is relevant to this chapter.

Launch Vehicles

10.8.4 The effects of the returning Skyrora XL Launch Vehicle components on the marine environment will depend on the physical properties of the Skyrora XL Launch Vehicle as well as the marine environmental receptor at the specific EZI. The physical properties of the returning Skyrora XL Launch Vehicle which may influence the level of effect include aspects such as the amount of residual fuel, the materials present and their reaction in the marine environment, and the dimensions of the components.

10.8.5 The frequency of operations is also relevant to the magnitude of effects. It is noted that there will be a maximum of 16 launches in any given year.

Physical properties

10.8.6 The Skyrora XL Launch Vehicle is approximately 24 m long, three-stage liquid fuelled orbital launch vehicle intended to place customer payloads into sun synchronous or polar orbits.

10.8.7 Indicative parameters for the Skyrora XL Launch Vehicle are summarised in Table 10.6.

Table 10.6 Approximate parameters associated with Skyrora XL Launch Vehicle

Parameter	Stage 1	Stage 2	Stage 3*	Payload Fairing*
Maximum height (m)	15.0	5.3	1.57	5.7
Maximum diameter (m)	2.2	2.2	1.9	2.2
Gross lift off weight (kg)	55,838			
Payload weight (kg)	Up to 315			
Dry mass (kg)	4,000	1,200	300	215
Potential elements contained within	Avionics Propellant tank 9x Helium tanks 9× engines	Avionics Propellant tank 3x Helium tank 1× engine	Avionics Propellant tank 1x engine	Fairing materials Payload adapter Payload
Indicative materials present	Lightweight carbon-fibre composite material Lithium ion batteries Aluminium tank Composite overwrapped pressure vessel High density polyethylene liner Aluminium, stainless steel, INCONEL alloy 718 engine components Copper	Lightweight carbon-fibre composite material Lithium ion batteries Aluminium tank Composite overwrapped pressure vessel Aluminium, stainless steel, INCONEL alloy 718 engine components High density polyethylene liner Copper	Lithium ion batteries Propellant tank High density polyethylene liner Aluminium, stainless steel, INCONEL alloy 718 engine components Copper	3-layer composite shell (2 halves), with honeycomb filler Carbon-fibre composite bearing layers

Parameter	Stage 1	Stage 2	Stage 3*	Payload Fairing*
Propellant and other gases	High Test Peroxide (HTP) Jet A-1 Kerosene Helium Nitrogen CO_2	HTP Jet A-1 Kerosene Helium Nitrogen CO_2	HTP Jet A-1 Kerosene Helium Nitrogen CO_2	
Approximate amount of propellant left upon re-entry	485 kg HTP 195 kg Jet A-1 Kerosene	231 kg HTP 55 kg Jet A-1 Kerosene	It has been assumed that the worst-case amount of propellant to be used for launch will not exceed 57,000 kg. The amount of propellant in the Skyrora XL Launch Vehicle at launch will be precisely measured so that the minimum amount is used to meet the launch requirements. All fuel is expected to be used during the launch. However, there is the possibility that some fuel will remain upon re-entry of the stage(s). The effects of these have been assessed as a precautionary measure.	
Likely fate		Exact separation heights will vary mission-to-mission but will lie within the range outlined here. Stage 1 is jettisoned first at a height of approximately 66 km. Ignition of the Stage 2 engine occurs, followed by fairing separation and jettison at an approximate height of 113 km. At an approximate height of 233 km, Stage 2 is shut down, and Stages 2 and 3 are separate. Once this has occurred Stage 3 will continue into orbital phase for payload deployment. For a typical trajectory the first ignition of Stage 3 occurs between a height of 234-474 km, followed by a coast flight. Subsequent Stage 3 ignition(s) occur(s) at a height of approximately 500 km (noting there may be a second and third ignition), followed by payload separation. It is anticipated that significant sections of the Skyrora XL Launch Vehicle and associated composite materials will burn up in the atmosphere resulting in debris components. Stage 1 will enter the marine environment intact after launch. The payload fairing and Stage 2 will		

Parameter	Stage 1	Stage 2	Stage 3*	Payload Fairing*
		fragment whilst returning to Earth and lead to debris entering the marine environment. Stage 3 is planned to re-enter the atmosphere on a trajectory that would result in total burn up. The worst-case scenario would be to assume that the Skyrora XL Launch Vehicle components do not burn up and instead enter the marine environment.		
Indicative impact zone/Environmental zone of influence		See section below		

*Stage 3 payload adapter and payload components will not splash down, and thus will not interact with the marine environment

Indicative impact zones/Environmental zones of influence

10.8.8 Drawing 10.2 presents the representative impact points of the different components in the EZI based on example trajectories provided by Skyrora in relation to the three-stage Skyrora XL Launch Vehicle. However, in order to be precautionary, it has been assumed throughout this assessment that components could return anywhere within the EZI.

10.9 Standard Mitigation

10.9.1 The Federal Aviation Administration (FAA) methodology will be applied to define an exclusion zone, which will apply to sea and air. Using FAA defined exclusion zones ensures a precautionary approach. The direction from land will vary with the launch azimuth, with bearings currently projected to range from 330 to 030 True. The exclusion zone will fan between the aforementioned bearings and will extend outwards from the SaxaVord Spaceport as described in Chapter 3. Once an exclusion zone has been identified, the area will be registered on Marine Charts and will be activated via a Notice to Mariners.

10.9.2 An exclusion zone is not anticipated to be required for the stages and fairings. For these, a Notice to Mariners will be published, with the exact areas dependent upon individual launches.

10.10 Potential Effects

10.10.1 A series of effect pathways on the marine environment have been identified as a result of the return of launch vehicles to Earth.

10.10.2 The effects of direct strike on vessels have been screened out. There is no pathway for effect due to the standard operating procedure of implementing a Notice to Mariners and an exclusion zone around the Skyrora XL Launch Vehicle.

Table 10.6 Impacts considered for the impact assessment of launches.

Key: ✓ = Impact present; ✗ = Impact not present

Impact	Launches
Effects on Sea Ice, Water, and Sediment Quality, and Ecological Receptors from Fuel Spillage	✓
Effects on Sea Ice, Water, and Sediment Quality, and Ecological Receptors from Metal Corrosion and Toxic Contamination	✓
Effects on Sea Ice, Water, and Sediment Quality, and Ecological Receptors from Debris and Microplastics (Including Ingestion)	✓
Smothering of Marine Organisms, Habitat Alteration (Including Reef Effects) and Habitat Loss via Deposition of Material on the Seabed or Sea Ice	✓
Direct Strike	✓
Acoustic Disturbance (including Underwater Noise) from the Impact of the Jettisoned Objects Hitting the Sea Surface or Sea Ice	✓
Thermal Effects of Jettisoned Objects	✓
Visual Disturbance	✓
Displacement of Fish	✓
Damage to Human Infrastructure (Subsea Cables/Pipelines)	✓
Interference with Military Exercise Areas	✓
Impacts to Vessel Navigation Including Floating Debris, Changes to Topography and Re-routing of Vessel Traffic	✓
Damage to Marine Archaeology/Shipwrecks	✓
Interference with Marine and Coastal Tourism Activities/Industry	✗

10.10.3 The risk assessment matrices that correspond to the written description of the environmental effects in the sections below are provided in:

- Appendix 10.3 – water quality risk matrix (Volume IV Technical Appendix 10.3);
- Appendix 10.4 – biodiversity risk matrix (Volume IV Technical Appendix 10.4);
- Appendix 10.5 –human activity risk matrix (Volume IV Technical Appendix 10.5); and,
- Appendix 10.6 –water quality risk matrix for accidental aeronautical events (Volume IV Technical Appendix 10.6).

Effects on Sea Ice, Water, and Sediment Quality and Ecological Receptors from Fuel Spillage

10.10.4 As detailed in Table 10.6, it has been assumed that the worst-case scenario of total residual propellant upon re-entry would be 966 kg. This amount would be split across 2 stages: Stage 1 - 485 kg HTP/195 kg Jet A-1 Kerosene; Stage 2 - 231 kg HTP/55 kg Jet A-1 Kerosene.

10.10.5 The impact zones for Stage 1 and the payload fairings fall within the marine environment. Stage 1 will enter the marine environment intact after launch. The payload fairing will fragment whilst returning to Earth and lead to debris entering the marine environment. The bulk of the fairings is predicted to burn up on re-entry, with only small fragments of modelled maximum diameter 0.3 m and modelled maximum thickness of 0.02 m making impact (up to 1 kg total). The potential impacts of Stage 1 and payload fairings within the EZI have been considered for the aquatic marine environment.

10.10.6 The impact area for Stage 2 falls within an area of the Arctic where year-round ice cover is present. This area is within the 30 year (1981-2010) mean minimum ice extent (NSIDC, 2022). It is therefore likely that this stage will make impact with sea ice. The bulk of this stage is predicted to burn up on re-entry, with only fragments of maximum 30-40 kg, forming (as a maximum) spheroid with diameter of 0.3 m making impact (up to 300 kg total). These fragments are predicted to remain on the sea ice, as the impact site is inland of the lowest recorded sea ice extent (12 September 2012), and far within the mean extent for September (1981-2010), when sea ice is at a minimum (NSIDC, 2022). Therefore, the potential impacts of Stage 2 within the EZI have been considered both on sea ice and in the aquatic marine environment, as a precautionary measure.

10.10.7 The propellant will comprise High-Test Peroxide (HTP) and kerosene. HTP is a high-density, highly concentrated form of hydrogen peroxide H_2O_2, which decomposes into steam and oxygen. It is considered a 'green' propellant by the European Space Agency (ESA). This compound is miscible in water, is rapidly biodegraded under environmental conditions, and has a surface water half-life of five days. Hydrogen peroxide acute toxicity for non-target aquatic organisms is classed as low-to moderate, with no expected bioaccumulation or biomagnification (Hosseini, 2014).

10.10.8 NOAA (2019) has provided a description of the effects of kerosene in the marine environment. Kerosene-type oils spread very quickly on water to form a thin film, which may be less than 0.01 mm thick. When forming this film, approximately 1,000 US gallons are present per square nautical mile of coverage. Considering the total amount of residual kerosene (250 kg/310 L), the maximum size of the surface film from 310 L of kerosene would be approximately 0.082 square nautical miles, equivalent to ~0.28 km². Kerosene has a low boiling point and viscosity, meaning that, when spilled on water or sea ice, most of the fuel will evaporate or naturally disperse within a day or less. Kerosene that is dispersed in the water column can adhere to sediment and be transported to the sea bottom, however this is highly unlikely in the EZI given the low sediment load. As stated by NOAA (2019), this process is not likely to result in measurable sediment contamination for small spills like those potentially associated with this assessment. Small spills of kerosene that reach the shoreline would be expected to quickly penetrate the sediment and/or be washed off. Kerosene can be completely degraded in the marine environment on the timescale of 1-2 months.

10.10.9 It is anticipated that any residual propellant in the returning stages will be expelled upon impact on the sea surface or on sea ice. Due to the nature of kerosene-like fuels, only the very surface of the water column is anticipated to be within the zone of effect from propellant release. The marine biodiversity receptors that have the potential to be in this zone of effect for a non-negligible period of time are plankton. The biodiversity receptors that have the potential to be in the zone of effect for a sea ice impact are primarily bacteria or microalgae. All other marine biodiversity receptors are present in the surface waters or edge of sea ice (circumpolar) on a transient basis and so would not be exposed to potential residual propellants for any notable period of time.

10.10.10 It is possible that aquatic organisms that come into direct contact with naturally dispersed and entrained propellant will be killed (NOAA, 2019). However, given the small area of effect and the abundance and turnover of plankton, this is not anticipated to cause significant changes to the marine community.

10.10.11 Though effects to marine organisms higher up the food web have been excluded, it is worth noting that NOAA (2019) confirms that fish kills are unlikely to occur as a result of jet fuel spills in the open ocean due to evaporation and therefore concentrations are below lethal effects. This is expected to be applicable to other marine megafauna too.

10.10.12 The water quality and biodiversity of the EZI has an important environmental value. The biodiversity receptor which may be impacted by hydrocarbons, plankton, may experience lethal effects as a result of exposure to hydrocarbons. Hydrocarbons are anticipated to remain at the sea surface, over a small area, and be present over a short timescale (1-2 months). Given this and the abundance and turnover of plankton, the sensitivity of these receptors is moderate.

10.10.13 Water quality and biodiversity receptors may be exposed to the effects of contaminants over an extensive period of time i.e., the full duration of the licence. Within the licence timeframe, launches are anticipated to occur up to a maximum of 16 times per year, equivalent to two launches per month. It is noted that, due to the large spatial extent over which the Skyrora XL Launch Vehicle components could return, it is extremely unlikely that the receptors would be exposed more than once, further reducing the frequency at which they could be exposed to hydrocarbon spills. It is also noted that the event of a hydrocarbon spill is unlikely. The zone of effect of hydrocarbon spills is anticipated to be spatially limited, to the immediate vicinity (<0.5 km²) of the Launch Vehicle stages. Therefore, overall exposure of the receptors to the effect is low.

10.10.14 Direct effects on the hydrocarbon concentration of the sea water or sea ice is likely to be measurable above natural variability, as there are limited other sources of hydrocarbons in the marine environment. Similarly, potential impact to the water or ice quality is likely to be measurable above the baseline in that the hydrocarbon concentration will be elevated. However, only a small percentage change above the baseline or natural variation is predicted due to the small amount and rapid evaporation/dispersion of kerosene in the marine environment. The magnitude of the impact is therefore low.

10.10.15 Moderate sensitivity, combined with low exposure and low magnitude, means that the risk to these receptors is low, which is equivalent to minor risk. **No likely significant effect.**

Effects on Sea Ice, Water, and Sediment Quality and Ecological Receptors from Metal Corrosion and Toxic Contamination

10.10.16 As detailed in Table 10.6, the metals that have the potential to enter the marine environment are lithium (from the batteries), aluminium (from the kerosene tank liner and main engines), stainless steel and INCONEL alloy 718 (from the Skyforce engines in Stage 1 and Stage 2) and copper. These are all present in Stages 1, 2, but not the fairing (Table 10.6). The marine environment of the EZI is therefore described in terms of these specific metals.

10.10.17 Lithium (Li) in the open ocean is present in low concentrations in seawater (typically 1 ppm) (SAMCO, 2018). The main input of lithium to the ocean is weathering of continental crust, though there has been a reported increase in anthropogenic inputs near populated areas (e.g., Choi *et al.*, 2019). Lithium is a non-essential nutrient to marine biota (Campbell *et al.*, 2005). Campbell *et al.* (2005) reported that, for Arctic waters, lithium is present in high concentrations in zooplankton as a result of bioconcentration from seawater. The concentration in zooplankton was several orders of magnitude lower than in seals, fish, and birds, which indicates that lithium decreases trophically through the food web (Campbell *et al.*, 2005). Lithium therefore only has the potential to affect the zooplankton and such lower levels in the food chain. The lithium that may be introduced to the environment will only come from one set of batteries per impact zone, therefore it is predicted to be a small amount that will only lead to localised increases. Given that only a small proportion of the food web (zooplankton) has the potential to be affected, and that zooplankton are abundant and have high turnover, the effects are expected to be negligible.

10.10.18 Aluminium (Al) is one of the most resistant metals to corrosion in the marine environment, and so is used widely in the shipping industry (Almet-Marine, 2020). The primary natural input of aluminium to the marine environment is from aeolian sources, though this input is limited in Arctic waters. Here, aluminium is low in surface waters and increases with depth (Wong *et al.*, 1983). Aluminium is present in seawater in trace levels, ranging from 5-20 nmol/L, and is non-essential to marine life (Wong *et al.*, 1983; Gilmore, 2014). The low number of studies on species' sensitivity to aluminium has shown there is great interspecies variability (Gilmore, 2014). So far, it has been reported that species of urchin, coral and macroalgae are tolerant, whereas some species of molluscs and phytoplankton show toxicity responses to lower concentrations of aluminium (Gilmore, 2014). The potential effects of elevated aluminium on marine life are therefore highly variable and species-specific. Nevertheless, it is unlikely that the introduction of aluminium as a result of the presence of the Skyrora XL Launch Vehicle components would increase aluminium concentration to levels where a toxic effect occurred, except in the immediate vicinity of the Skyrora XL Launch Vehicle component.

10.10.19 Stainless steel (with a pitting resistance equivalent number greater than 40) is one of the most resistant metals to corrosion in the marine environment, and thus is used widely by numerous marine industry sectors (Davis, 2020). Stainless steel derives its resistant properties via the formation of a protective chromium oxide skin on the surface of the metal, protecting the base metal (and importantly the iron present). This prevents exposure to moisture, mitigating the formation of iron oxide or rust (Thyssenkrup, 2022). In addition, the inclusion of molybdenum in stainless steel present within the composition of the alloy used in the Skyforce engines will help to stop the salt water causing pitting or crevice corrosion. As an alloy metal, stainless steel is not naturally present in the marine environment. However, many anthropogenic structures and vessels present within the Arctic circle use steel and stainless steel, such as oil and gas platforms. Iron (the base metal of stainless steel) occurs naturally in the marine environment, but generally in very low concentrations (being at its lowest in surface waters and increasing with depth) (Wong *et al.*, 1983; Street and Payton, 2005). Iron is used primarily by phytoplankton in the marine environment, as it is required for the synthesis of chlorophyll and for the reduction of CO_2, $SO_4(2-)$, and $NO_3(-)$ during the photosynthetic production of organic compounds (Street and Paytan, 2005). Considering the low corrosion potential of stainless steel, and the fact that it is not considered a toxic metal for marine species (no great sensitivity is known) (UKMSACP, 1995), and factoring the small amounts of material composing the debris fields, then the effects of introducing stainless steel into the environment are expected to be negligible.

10.10.20 INCONEL alloy 718 is a composite metal alloy containing: nickel (Ni) (plus cobalt (Co)); chromium (Cr); niobium (Nb) (plus tantalum (Ta)); titanium (Ti); aluminium (Al); cobalt (Co); carbon (C); manganese (Mn); silicon (Si); phosphorus (P); sulphur (S); boron (Bo); copper (Cu); and iron (Fe). The properties of this nickel-based super alloy means that it is well-suited to applications requiring high strength in temperature ranges from cryogenic up to 760°C (Special Metals Corporation, 2007). Special Metals Corporation (2007) states "*The ease and economy with which INCONEL alloy 718 can be fabricated, combined with good tensile, fatigue, creep, and rupture strength, have resulted in its use in a wide range of applications*". Most notable are components for aerospace application such as liquid-fuelled rockets, rings, casings, and various formed sheet metal parts for aircraft gas turbine engines, and cryogenic tankage (Special Metals Corporation, 2007; deBarbadillo and Mannan, 2012). INCONEL alloy 718 is known to demonstrate excellent corrosion resistance to many media. Nickel contributes to corrosion resistance in many oxidizing environments and throughout wide ranges of acidity and alkalinity. It also is useful in resisting chloride-ion stress-corrosion cracking. Alloy 718 has a proven record (>50 years) of corrosion resistance in the marine environment associated with its long and widespread use by the oil and gas sector (oilfield fasteners, valves, drill tools, and completion equipment) (Kolts and Jurin, 1989; Klapper *et al.*, 2017). In addition, as early as 1972, NASA assessed the corrosion resistance of alloy 718 for use in seawater recoverable space shuttle boosters (King, 1972); specifying its resistance to corrosion, stress corrosion and electrolytic corrosion. It is also noted that at water depths around 3,800 m alloy 718 does not corrode (Special Metals Corporation, 2007). The water depths associated with the Stage 1 EZI are between 3,000-4,000 m depth, and thus any engine debris that splashes down and sinks to the seabed will remain inert and not corrode or leach into the marine aquatic environment. Any debris from the single engine associated with Stage 2 that lands upon sea ice, is also expected to remain in an environmentally benign state (due to the minimal corrosive atmosphere associated with Arctic conditions and freshwater moisture not being present in a liquid state; let alone the corrosion-resistant nature of alloy 718 to freshwater). Due to the inert nature and corrosion resistance of alloy 718, no exposure of any of the elemental metals composing the alloy are expected to interact with the marine aquatic or sea ice environments and associated floral and faunal receptors.

10.10.21 In the Atlantic Ocean, copper (Cu) concentration increases with depth and latitude (Pohl *et al.*, 1993). Copper concentration is higher near the shelf due to dissolution from shelf sediments and higher inputs from freshwater sources (Pohl *et al.*, 1993). There is no interannual variation in copper levels in the Atlantic and Arctic oceans (Pohl *et al.*, 1993). The input of copper into the marine environment has increased four-fold since the start of the industrial era (Lopez *et al.*, 2019). Most copper it deposited through the atmosphere into the surface layer (Lopez *et al.*, 2019). Of the total copper that is inputted to the surface layers, only a fraction is soluble and so able to be used by marine life

(Lopez *et al.*, 2019). Copper is an essential nutrient in the marine environment; hence it is typically present in high concentrations in all marine life across all trophic levels and does not bioaccumulate (Campbell *et al.*, 2005). At high concentrations in seawater copper can be toxic to phytoplankton, though this is typically in areas subject to heavy anthropogenic emissions (Lopez *et al.*, 2019). It is unlikely that the copper concentrations in the EZI are sufficiently high as to be toxic, as it is away from most anthropogenic inputs. As copper in the EZI is not predicted to be present in toxic levels, and is an essential nutrient, a small, localised increase in copper concentrations in seawater is not likely to be detrimental to marine life.

10.10.22 The water quality and biodiversity of the EZI has an important environmental value, with certain biodiversity features also having an important cultural value. The most sensitive receptor is expected to be slightly tolerant and adaptable to increase in the contaminant levels. The source of contaminants (components of the Skyrora XL Launch Vehicles) will either sit atop the multi-year sea ice or pass through the water column and then rest on the seabed. Biodiversity receptors will be exposed to increased contaminants as the Skyrora XL Launch Vehicle component passes through the area of the water column that they occupy. Water quality will be affected throughout the passage of the component. Given the predicted small increase in concentration of contaminants, it is anticipated that biodiversity and water quality receptors will be able to recover within short timescales (<1 year). The sensitivity of these receptors is therefore low.

10.10.23 Water quality and biodiversity receptors may be exposed to the effects of contaminants over an extensive period of time i.e., the full duration of the licence. Within the licence timeframe, launches are anticipated to occur up to a maximum of 16 times per year, equivalent to two launches per month. It is noted that, due to the large spatial extent over which the Skyrora Launch Vehicle components could return, it is extremely unlikely that the receptors would be exposed more than once, further reducing the frequency at which they could be exposed. The zone of effect of contaminants is anticipated to be highly spatially limited, to the immediate vicinity (i.e., metres) of the Skyrora Launch Vehicle components. Therefore, overall exposure of the receptors to the effect is low.

10.10.24 Any impact is likely to be small and slightly above the range of natural variation in the marine environment. This is suitably precautionary as little is known about the fine-scale variation of contaminant concentration in the marine environment of the EZI. Potential effects on the water quality are expected to be measurable above the present baseline, though for biodiversity it is anticipated that potential effects will not affect the baseline. The magnitude of the impact is therefore low.

10.10.25 Low sensitivity, combined with low exposure and low magnitude, means that the risk to these receptors is low, which is equivalent to minor risk. **No likely significant effect.**

Effects on Sea Ice, Water, and Sediment Quality and Ecological Receptors from Debris and Microplastics (Including Ingestion)

10.10.26 As detailed in Table 10.6 above, there is the potential for plastic to enter the marine environment as plastic is used for liners of the propellant tanks. Plastic may be present in Stages 1, 2, and 3 (Table 10.6).

10.10.27 As detailed in 10.10.5, Stage 2 of the Skyrora XL Launch Vehicle is predicted to impact in an area where multi-year sea ice is present, therefore as a precautionary measure the impact of debris on sea ice has been included here.

10.10.28 The plastic class that would be used for liners is high-density polyethylene (HDPE). HDPE is already present in the baseline of the marine environment as it is a type of plastic commonly found in marine litter, specifically plastic milk and juice jugs (Andrady, 2011). HDPE has been reported in the Arctic and given that the Arctic is a hotspot for plastics, it is likely that HDPE is already present in notable concentrations in the EZI (Obbard *et al.*, 2014). HDPE has a specific gravity of 0.94, less than the 1.025 of seawater, indicating that it floats in the marine environment (Andrady, 2011). The average specific surface degradation rate for HDPE in the marine environment is 4.3 µm/year

(Chamas *et al.*, 2020). HDPE in the marine environment has an estimated half-life of 58 years, shorter than in landfill/compost/soil conditions (250 years) (Chamas *et al.*, 2020). It is anticipated that any plastic present in the returning components would be large (>5 mm), and so classified as macroplastics at the point of entry (NOAA, 2020a), but would breakdown over a period of time during which microplastics (<5 mm) would be emitted.

10.10.29 Macroplastics on the sea ice may be ingested by seabirds, pinnipeds, or polar bears, during periods where the impact site overlaps with their range. These animals are circumpolar, therefore for the majority of launches it is unlikely that they will be present in significant quantities within the EZI. These animals are known to ingest plastics, however limited data prevents the establishment of baselines or impacts (Collard and Ask, 2021).

10.10.30 Microplastics are readily ingested by marine organisms either through direct ingestion or indirectly by trophic transfer from contaminated prey (Nelms *et al.*, 2018). There are records of microplastic polyethylene ingestion in a range of holoplankton and meroplankton, including ichthyoplankton, though the recorded taxa are likely an underestimation due to the frequency of not reporting plastic class (Botterell *et al.*, 2019). As summarised by the review of Nelms *et al.* (2018), there has been many inferences of trophic transfer of microplastics due to the recorded presence of microplastics in the faeces and stomach contents of species groups at higher trophic levels including fish, birds, and marine mammals.

10.10.31 Studies on the biological effects of microplastics in the field are rare (Botterell *et al.*, 2019). In smaller organisms, microplastic ingestion has been shown to cause detrimental physiological impacts such as reducing feeding capacity, energy reserves, and reproductive output (Nelms *et al.*, 2018). The effects on higher marine organisms are not well known. A few studies have shown that microplastics can be excreted after some days in the stomach, indicating a lower likelihood of the more severe physiological effects seen in small organisms (Nelms *et al.*, 2018).

10.10.32 Debris, which would primarily comprise carbon composite, may also enter the environment from the stages or the fairing of the Skyrora XL Launch Vehicle (Table 10.6). The carbon composite used as part of the Skyrora XL Launch Vehicle is a material consisting of carbon fibre overwrapping either an HDPE or aluminium liner. The degradation of this material in the marine environment, and the effect of subsequent contaminants on marine life are not well studied, and few experimental data are available (Davies *et al.*, 2016; Wang *et al.*, 2016). When returning to earth, the stages and fairing will hit the ocean or sea ice at high velocity and therefore incur mechanical damage upon impact. The carbon composite is likely to sink upon entry into the marine environment, as has been recorded for other returning rocket stages. For impacts with sea ice, the materials are likely to further fracture and remain at the impact site. The rocket components are designed to withstand the extreme conditions of launch and travel; therefore, it is considered likely that any corrosion would be limited and only occur over long timeframes. To illustrate, the thrust chamber of one of the first stage F-1 rocket engines to launch the Saturn V rocket over 50 years ago has been recently detected on the seafloor, intact, and has been recovered (Space.com, 2013) (noting that these were made from aluminium and not a composite structure). The worst-case scenario, of a limited amount of corrosion or fragmentation of the composite material, may result in an increase in various contaminants in the marine environment, however due to the large quantity available for dilution of relatively small parts, toxic concentrations are not likely to occur.

10.10.33 The water quality and biodiversity of the EZI has an important environmental value, with certain biodiversity features also having an important cultural value. The most sensitive receptor, plankton, is expected to be slightly tolerant to low levels of microplastic ingestion which could potentially occur as a result of plastic from the Skyrora XL Launch Vehicle entering the marine environment. As a result of this potential ingestion and subsequent change plankton could be noticeably affected. The source of microplastics (plastic liners) will be of unknown size upon entering the marine environment, though it is considered likely that they will enter as macroplastics and will sink through the water column and then rest on the seabed. As the Skyrora XL Launch Vehicle components break down, microplastics will be released which will be buoyant in the water column and as such biodiversity and water quality receptors will be exposed to increased microplastics on passage

through the area of the water column that the Skyrora XL Launch Vehicle components occupy. Given the predicted small increase in concentration of microplastics, the high turnover and abundance of the most sensitive receptor (plankton), and the potentially short residence time in the gut of larger marine organisms, it is anticipated that biodiversity and water quality receptors will be able to recover within short timescales (<1 year). The sensitivity of these receptors is therefore moderate.

10.10.34 Water quality and biodiversity receptors may be exposed to the effects of microplastic over an extensive period of time i.e., the full duration of the licence. Within the licence timeframe, launches are anticipated to occur up to a maximum of 16 times per year, equivalent to two launches per month (excluding winter months of November to February). It is noted the large spatial extent of the EZI will act to reduce the likelihood of exposure to any individual. The zone of effect of microplastics is anticipated to be spatially limited, with concentrations of microplastics decreasing to below effect levels outside of the immediate vicinity of the Skyrora Launch Vehicle components. Therefore, overall exposure of the receptors to the effect is moderate.

10.10.35 Any increase in microplastics is likely to be small and slightly above the range of natural variation in the marine environment. This is suitably precautionary as there is minimal information on natural variation, though background levels are predicted to be high in the Arctic waters that overlap the EZI. The impact on water quality is expected to be measurable above the present baseline, at a local scale, though for biodiversity it is anticipated that potential impacts will not affect the baseline. The magnitude of the impact is therefore low.

10.10.36 Moderate sensitivity, combined with moderate exposure and low magnitude, means that the risk to these receptors is low, which is equivalent to minor risk. **No likely significant effect.**

10.10.37 It is noted that there are elements of uncertainty in the overall impact assessment of debris and microplastics, particularly with regards to the assessment envelope. However, the conclusions of the assessment concurs with the conclusion of the Draft Environmental Impact Statement for the Mars 2020 Mission (NASA, 2020) for impact of contaminants on the local marine environment, which assessed significantly larger rockets than the Proposed Project.

Smothering of Marine Organisms, Habitat Alteration (Including Reef Effects) and Habitat Loss via Deposition of Material on the Seabed or Sea Ice

10.10.38 The EZI is poorly understood in terms of its benthic habitats, as described in Appendix 10.2. It is likely that the most species rich group is arthropods, followed by polychaetes and molluscs (Figure A10.3). Vulnerable Marine Ecosystems (VMEs) are also present in the EZI (Figure A10.4; Drawing 10.3). VMEs are sensitive to benthic pressures, though protection measures from these pressures are only applicable where they arise from fishing. There are a few MPAs in the region that have designated benthic habitat features, therefore, the benthic habitats receptor is considered to have a high value.

10.10.39 The landing of Stage 2 of the Skyrora XL Launch Vehicle on sea ice may directly impact the ice surface habitat. It is predicted that the fragments that impact on sea ice will be stationary following impact and only impact the habitat directly within the footprint of each fragment. There is not anticipated to be a smothering effect of the material on any sensitive habitat on the sea ice. For sensitivity to direct impacts see section 10.10.49.

10.10.40 The landing of the components at the seabed may directly impact benthic habitats in the EZI. If the component lands in/on a sensitive benthic habitat, it would likely be intolerant of the change and unable to adapt, with potentially lethal or destructive effects. It is anticipated that following impact, the Skyrora XL Launch Vehicle Stage 1 will likely remain at the water surface for a number of hours before sinking (maximum 12 hours; 1-2 hours probable time frame). Studies of surface water circulation in the Norwegian basin using Lagrangian drifters indicate that typical horizontal drift is not predicted to exceed 10 km in 24 hrs (Poulain *et al.*, 1996; Jakobsen *et al.*, 2003). Eddies further contribute to constraining the region. Therefore, it is not likely that debris will drift outside of the predicted greater impact area before (or after) sinking. After sinking through the water column, it is predicted to come to rest at a single place at the seabed. It will not move once at the seabed,

thereby only impacting the habitat directly within the footprint (maximum of 15 m by 2.2 m, with a volume of ~60 m³). The footprint of the impact is likely to be smaller than the full extent of the benthic habitat in a given area. Therefore, it is likely that once the component has fully broken down, the surrounding benthic habitat will enable the impacted zone to be recolonised, though this can only happen over a long timescale. There is also the possibility that the novel infrastructure surface could be colonised whilst intact on the seabed i.e., act like an artificial reef, though this is not confirmed. The introduction of artificial habitats into an environment are known to have a number of impacts on the local environment. The addition of hard substrate may allow for the colonisation of species that would otherwise be unable to exist in the local environment. Fish aggregating device effects may also result from the addition of hard substrate within the environment, causing a localised increase in species richness and abundance, and potentially decreasing these measures in the surrounding area. Further, increased biological activity surrounding the debris may result in an increased level of local nutrient levels through increased deposition flow of organic material. All of these effects are however likely to be confined to the close vicinity of any debris. Over the next 30 years it is anticipated that up to 428 launches will take place, resulting in a total debris volume of approximately 38,520 m³ for all stages and fairings combined. Stage 2, which is expected to fall on sea ice, will be a total of 128,400 kg over 30 years, fragmented into 30-40 kg pieces. It is likely that these pieces will remain at their impact site across years, but will be covered by snow, until the sea ice retreats, and they enter the marine environment. However, it is critical to note that it is not foreseeable that this debris will interact with any other anthropogenically sourced material. When compared to the total volume of the EZI, this potential reef volume is likely to have a negligible impact on the marine environment. It is also likely that larger bits of debris will break up with time, further reducing the total volume of potential reef. In conclusion, the most sensitive benthic habitats have a low tolerance or adaptability, though the habitat may recover on a long timescale.

10.10.41 Due to the high value, low tolerance, adaptability, and recoverability, benthic habitats are considered to have high sensitivity to direct loss of seabed habitat via deposition of material on the seabed.

10.10.42 The Proposed Project will have a maximum plan of up to 16 launches per year. Although the licence term is considered to have high longevity, the likelihood of Skyrora XL Launch Vehicle components impacting the same area of benthic habitat is extremely low, considering the total extent over which the Skyrora XL Launch Vehicle components could enter the marine environment. Therefore, the longevity of the impact has been reduced to low to reflect this short time period per impact.

10.10.43 As evidenced by Figure A10.4 and Drawing 10.3, VMEs (Vulnerable Marine Ecosystems) are numerous in the EZI, particularly around the coasts of landmasses. There are only a few MPAs with benthic features, though these are typically large in extent. The impact zone around a Skyrora XL Launch Vehicle stage/fairing is extremely small in comparison to the areas of sensitive and/or protected benthic habitats. Therefore, the spatial extent of the impact is low.

10.10.44 An overall low longevity and spatial extent result in a low exposure of benthic habitats to direct loss caused by the returning component.

10.10.45 Any potential impact to benthic habitats is likely to result in a small measurable change to the baseline in the immediate vicinity of the component. This change is likely to be measurable above natural variability, as sensitive benthic habitats such as VMEs are long-lived and there are few other sources of direct loss. Therefore, the magnitude of impact in terms of baseline and natural variability is low.

10.10.46 High sensitivity, combined with low exposure and low magnitude, mean that the risk to benthic habitats from direct loss caused by the returning Skyrora XL Launch Vehicle component is minor. **No likely significant effect.**

Direct Strike

10.10.47 Marine ecological receptors that have the potential to be present at, above, or just below the sea surface, concurrent with a returning Skyrora XL Launch Vehicle component, include seabirds and marine megafauna. Many species of these ecological receptor groups are protected under various nature conservation legislation and constitute and essential part of the ecosystem. Accordingly, the receptors that may be affected by this impact pathway have been ascribed a high value.

10.10.48 The maximum i.e., worst-case mass of a returning Skyrora XL Launch Vehicle stage is anticipated to not exceed approximately 4,680 kg, calculated from the maximum dry mass of the First Stage plus the assumed amount of residual fuel. The returning components will be travelling at considerable speed at the point of entry into the marine environment. The return speed is expected to fall between 125-130 m/s for the Second Stage.

10.10.49 The return of the Skyrora XL Launch Vehicle components through the Earth's atmosphere and into the marine environment has potential to cause injury and/or death to marine ecological receptors which are in the return flightpath. A component may collide with species that spend time at, above, or just below, the sea's surface. The ecological receptors and their specific behaviours which may lead to them being affected by a returning Skyrora XL Launch Vehicle component include:

- Foraging or migrating seabird species, which may be flying above the water;
- Foraging or loafing seabird species, which may be floating on the water surface;
- Pinniped species, which may be at or just below the water surface, or resting on sea ice;
- Polar bear *Ursus maritimus*, which may be foraging or resting on sea ice;
- Cetacean species, which may be at or just below the water surface;
- Basking shark *Cetorhinus maximus* and oceanic sunfish *Mola mola*, which may be at or just below the water surface; and,
- Designated seabird features of MPAs, behaving as described above.

10.10.50 Given the size of the components and the speed at which they are predicted to return, it is anticipated that any receptors struck by the returning component would experience mortality. Larger animals such as baleen whales may experience serious physical injury if not directly struck, however this is also considered likely to lead to mortality, albeit indirectly. Individual marine ecological receptors are not tolerant, adaptable, or able to recover from mortality events.

10.10.51 A high ecological and cultural value, combined with no tolerance, adaptability, and recoverability, results in the aforementioned ecological receptors having a high sensitivity to direct strike from returning Skyrora XL Launch Vehicle components within the EZI.

10.10.52 The Proposed Project will have a maximum plan of up to 16 launches per year, therefore the longevity of the potential impact is high. The frequency of the impact is low at a maximum of two launches per month. This is further reduced when it is considered that a single individual is only likely to exposed to this impact up to once in a lifetime. The returning Skyrora XL Launch Vehicle component will only impact the area directly where it lands, which, compared to the total available habitat within the EZI (including the entire water column below the surface layers and total air space for flying birds), is low.

10.10.53 A low frequency and spatial extent, combined with a high longevity, result in a low exposure of ecological receptors to direct strike from the returning component.

10.10.54 The likelihood of such an impact occurring is considered to be very low. Should it occur, it is expected that only single individuals would be affected. Collisions between these ecological receptor groups and vessels (in water) or anthropogenic infrastructure (in air) is not an uncommon occurrence. Similarly, the natural level of mortality in these species would mean that the additional mortality of a limited number of individuals would not affect the population baseline nor be detectable above the natural variability of populations which fluctuates on a range of timescales. Therefore, the magnitude of effect is negligible.

10.10.55 A high sensitivity, combined with a low exposure, and negligible magnitude, mean that the risk to ecological receptor populations (seabirds, marine megafauna, and MPAs) in the EZI from direct strike by the returning Skyrora XL Launch Vehicle component is negligible. **No likely significant effect**.

Acoustic disturbance (including underwater noise) from the impact of the jettisoned objects hitting the sea surface or sea ice

10.10.56 The occurrence of excessive noise input into the ocean can elicit a range of responses in marine ecological receptors, such as mortality, physiological injury, auditory injury (either permanent or temporary), disturbance, and masking. The magnitude of the response is dependent on the properties of the sound source, such as the loudness, frequency, and duration, as well as the state of the receiving individual. The marine ecological receptor groups with demonstrated sensitivity to noise include plankton, fish, and marine megafauna. Benthic habitats are also known to be sensitive to noise but given the probable water depths at the point of Skyrora XL Launch Vehicle component return, it is unlikely that the received noise at the seabed will be above the threshold to cause a response. Seabirds have limited sensitivity to underwater noise and are also highly unlikely to be present in the water in the immediate vicinity of the Skyrora XL Launch Vehicle component when the noise occurs, therefore these are not considered further.

10.10.57 The characteristics of the acoustic emission produced by the Skyrora XL Launch Vehicle component hitting the water or sea ice is not known. Taking into consideration the speed at which the component will be travelling (Stage 2 estimated impact speed 125-130 m/s), the maximum size (Stage 1: 15 m × 2.2 m), and the weight (<4,000 kg), it is likely that the sound will comprise a single pulse, of high intensity and short duration (impulsive). Stage 2 is likely to fragment into 30-40 kg pieces (300 kg total) through burning up on re-entry, therefore the sound from these fragments will likely be slightly less intense but with multiple pulses near-simultaneously. These acoustic properties are similar to the sound produced by explosive detonation in the marine environment. As considerably more is known about the sound emissions of explosives, this source has been used a proxy for the sound emitted by returning Skyrora XL Launch Vehicle components in this assessment.

10.10.58 Explosive noise is characterised as broadband i.e., occurs across a wide frequency range, with a peak energy content in the low frequency bands of 63-500 Hz (Paro *et al.*, 2015). It has a high peak sound pressure level that can exceed 200 dB re 1µPa at distances around 200-300 m distance from the source (Paro *et al.*, 2015).

10.10.59 Due to the high intensity of the noise, it is possible that marine receptors in the immediate vicinity (i.e., metres) of the impact would experience physiological trauma and therefore experience a mortality effect. At increased distances, the severity of the response will decrease. Noise from sea ice impact of Stage 2 is likely to propagate through the sea ice, however attenuation is higher than in sea water (Mikhalevsky, 2001), and little transference from surface impact into the sub-ice aquatic marine environment is predicted. As biological noise is concentrated in the marginal ice zones near the edge of the sea ice, noise generated from impact is not likely to cause significant disturbance.

10.10.60 As explosive noise is broadband, with peak content in the low frequency band, it falls within the hearing range of many marine ecological receptor groups. All fish species have a hearing range that overlaps this low frequency band, including hearing specialists (such as Atlantic herring) and hearing generalists (such as basking sharks). All marine mammal hearing groups, including low-, mid- and high- frequency cetaceans, and pinnipeds in water, would be able to detect the noise produced as it falls within the lower end of their hearing range (NOAA, 2018). Zooplankton have been shown to be sensitive to low frequency underwater noise from seismic sources which produce sound in a similar frequency range to explosions (McCauley *et al.*, 2017).

10.10.61 The potential impact ranges for the different receptors are as follows. The assessment of impact ranges has been based on an environmental assessment of drilling and blasting by National Grid (2018). In this assessment, the maximum injury ranges were as follows: 104 m for low-frequency

cetaceans; 43 m for mid-frequency cetaceans; 171 m for high-frequency cetaceans; 65 m for phocid pinnipeds; and 14 m for fish. The maximum disturbance ranges were: 139 m for low-frequency cetaceans; 57 m for mid-frequency cetaceans; 227 m for high-frequency cetaceans; and 87 m for phocid pinnipeds (fish were not assessed for disturbance). With regards to zooplankton, McCauley *et al.* (2017) reported that, for seismic airguns, impacts were reported out to the maximum 1.2 km sampled.

10.10.62 The Proposed Project will have a maximum of up to 16 launches per year, therefore the longevity of the potential impact is high. The frequency of the impact is moderate at a maximum of two launches per month. The returning Skyrora XL Launch Vehicle components will create an impact zone with a radius of 10s of metres for seabirds, 14 m for fish, 277 m for marine mammals, 1.2 km for plankton. The spatial extent of these impact zones is low when compared to the total available habitat within the EZI for these marine ecological receptors.

10.10.63 A low frequency and spatial extent, combined with a high longevity, result in a moderate exposure of ecological receptors to direct strike from the returning component.

10.10.64 The likelihood of a severe disturbance impact occurring is considered to be very low. Should it occur, it is expected that only a low proportion of the population would be affected (in the region of <0.01%). The proportion of the population that could experience a minor disturbance effect could be an order of magnitude greater, as the impact zones for such effects are typically larger, but this would still be a small proportion in the context of the population. As such, it is considered that the impact of disturbance from the component returning would not affect the baseline nor be detectable above the natural variability. Therefore, the magnitude of effect is negligible.

10.10.65 A high sensitivity, combined with moderate exposure, and negligible magnitude, mean that the risk to ecological receptors (plankton, fish, marine megafauna, seabirds) in the EZI from disturbance by the returning components is negligible. **No likely significant effect.**

Thermal effects of jettisoned objects

10.10.66 While it is likely that the Skyrora XL Launch Vehicle component will have associated thermal energy, any heating of the marine environment will be highly localised. Heated fragments from Stage 2 impact will cool quickly through exposure to low air temperatures and thick sea ice surface. Tidal and wind driven currents will allow for heated water to dissipate into the surrounding waters rapidly. It is highly unlikely that any marine receptors will be impacted as a result of these temporary heating events. Due to heating being highly localised and temporary, thermal effects are likely to have a footprint similar to those determined for Direct Strike effects. Thermal effects are therefore considered negligible. **No likely significant effect.**

Visual Disturbance

10.10.67 Once the Skyrora XL Launch Vehicle component has impacted the surface of the marine environment, it will likely remain at the water surface for a number of hours before sinking through the water column. For the very short period of time it is at the surface or in the water column there is the potential for visual disturbance to marine ecological receptors. The component will be stationary once in the water, moved only by the ocean movements. In essence, it is anticipated to behave like a large item of marine litter. The size of the component will be a maximum of 15 m × 2.2 m, corresponding with the size of Stage 1. Given the short timeframe before the component sinks to the sea-bed, the potential for visual disturbance is considered to be low.

10.10.68 Skyrora XL Launch Vehicle Stage 1 will sink through the water column and come to rest at a single place at the seabed, and not move once at the seabed, thereby only impacting the habitat directly within the footprint (maximum of 15 m by 2.2 m, with a volume of ~60 m^3).

10.10.69 As detailed in 10.10.5, the fragments of Stage 2 are likely to remain on the sea ice. Whilst on the sea ice there is a high potential these fragments will be covered by snow. Over a period of 30 years, with a maximum of 428 anticipated launches, the accumulation of debris will be a total of 128,400 kg. However, this will be comprised of smaller fragments (30-40 kg) and will be spread over

the impact area, with a maximum of 600 kg deposited in any month (assuming two launches per month excluding winter period November to February). The impact area is predicted to fall within the central multi-year ice sheet, at a distance to any megafaunal biological receptors. It is considered unlikely that the debris will cause any significant visual disturbance to marine ecological receptors. There is a possibility, though unlikely in the near future, that sea ice will retreat to such a degree that this debris could enter the marine environment. If this were to happen, the effects would fall within the scope of those outlined here for an aquatic marine impact.

10.10.70 In general, fish species are not considered sensitive to visual disturbance (Natural England, 2017). Though basking shark has been observed to show visual disturbance from moving craft, they are unlikely to show a response to a stationary object (Natural England, 2017). Fish are therefore not considered sensitive to potential visual disturbance from the components in the water. Marine mammals have been observed showing behavioural response to non-motorised craft, which is almost certainly due to visual disturbance as opposed to noise disturbance (Natural England, 2017). However, the likelihood of a behavioural response occurring is variable. To illustrate, only half of common bottlenose dolphin encounters with kayaks in Cardigan Bay resulted in the dolphins moving away (Natural England, 2017). It is considered highly unlikely that the stationary presence of a Skyrora XL Launch Vehicle component would cause any impacts, therefore marine mammals are also not considered further for visual disturbance.

10.10.71 Seabirds have been reported as showing visual disturbance to vessels whilst in air and also on water (Natural England, 2017). Similarly, certain species of seabird have been reported to avoid large anthropogenic structures in the marine environment such as wind farms, though these cover a much larger extent than the proposed components. The distance at which birds typically initiate a flight response and flush from an area as a result of visual disturbance is typically <40 m (Natural England, 2017). This disturbance distance is applicable to the scenario of the Skyrora XL Launch Vehicle component floating towards seabirds loafing on the sea surface. The most sensitive seabirds have been assumed to show a visual disturbance effect up to 4 km from large marine infrastructure such as windfarms. As windfarms are several orders of magnitude larger than the size of Skyrora XL Launch Vehicle components, with an associated high degree of visibility/sightlines above relative sea level, it is anticipated that the disturbance zone for the component would be several orders of magnitude smaller than this i.e., in the tens of metres.

10.10.72 The marine ecological receptor groups that have the potential to are either commercially, environmentally and/or culturally important and therefore for the purpose of this assessment have been ascribed a high value.

10.10.73 A high ecological and cultural value, combined with no tolerance, adaptability, and recoverability, results in the aforementioned ecological receptors having a high sensitivity to disturbance effects from returning launch vehicles within the EZI.

10.10.74 A low frequency and spatial extent, combined with a high longevity, result in a moderate exposure of ecological receptors to direct strike from the returning component.

10.10.75 The likelihood of a severe disturbance impact occurring is considered to be very low. Should it occur, it is expected that only a low proportion of the population would be affected (in the region of <0.01%). The proportion of the population that could experience a minor disturbance effect could be an order of magnitude greater, as the impact zones for such effects are typically larger, but this would still be a small proportion in the context of the population. As such, it is considered that the impact of disturbance from the component returning would not affect the baseline nor be detectable above the natural variability. Therefore, the magnitude of effect is negligible.

10.10.76 A high sensitivity, combined with moderate exposure, and negligible magnitude, mean that the risk to ecological receptors (plankton, fish, marine megafauna, seabirds) in the EZI from disturbance by the returning Skyrora XL Launch Vehicle components is negligible. **No likely significant effect.**

Displacement of Fish

10.10.77 The commercial fishing activity in the EZI is described in Appendix 10.2. The EZI comprises an important area for commercial fisheries from several different nations, with primarily benthopelagic and pelagic fish targeted. Figure A10.7 displays commercial fishing vessel activity, as recorded by AIS transmission, showing that most AIS datapoints are located in the southern portion of the EZI, with decreasing effort with distance north. As the fisheries industry in the EZI is valuable and culturally important to several countries, the receptor is considered to have a high value.

10.10.78 The landing of the components on the sea surface may indirectly impact commercial fisheries. If the component lands in a productive fishing ground, target fish species may be disturbed and displaced from the location, thus reducing the productivity of said fishing ground. Whilst displacement can be considered a negative impact, it is possible that this impact will act as mitigation against the displacement of fishing vessels. If the landing of the component displaces target fish species from the impact zone, the abundance of fish in other fishing grounds may increase. As fish species are highly mobile, they have a high tolerance and adaptability to displacement.

10.10.79 Due to their mobility, and the short period of impact and low magnitude of disturbance, fish species will be able in return to the impact zone within a short timescale of the component passing through. Therefore, the recoverability of fish stocks is high.

10.10.80 Despite the high value, a high tolerance, adaptability, and recoverability result in fish stocks having a low sensitivity to displacement caused by the components entering the marine environment.

10.10.81 The Proposed Project will have a maximum of up to 16 launches per year. Therefore, the frequency of the impact is low at a maximum of two launches per month. Although the full licence term is considered to have high longevity, displacement to fishing stock is predicted to happen only on a short-term scale whilst the Skyrora XL Launch Vehicle component is present in that specific area. Therefore, the longevity of the impact has been reduced to low to reflect this short time period per impact.

10.10.82 As evidenced by the AIS data (displayed in Figure A10.7), fishing grounds in the EZI are wide-spread and of high spatial extent. The impact zone around a component is extremely small in comparison to the fishing grounds. Therefore, the spatial extent of the impact is low.

10.10.83 A low frequency, longevity, and spatial extent result in a low exposure of fish stocks to displacement caused by the returning component.

10.10.84 Fish are highly mobile and often make use of a range of habitats and rarely remain in one specific location for extended periods. As the displacement caused by the returning components is of small spatial and temporal scale, the magnitude of impact in terms of baseline and natural variability is negligible.

10.10.85 Low sensitivity, combined with low exposure and negligible magnitude, mean that the risk to fish stocks from displacement caused by the returning Skyrora XL Launch Vehicle components is negligible. **No likely significant effect.**

Damage to Human Infrastructure (Subsea Cables/Pipelines)

10.10.86 As described in Appendix 10.2 there are several subsea cables and pipelines in the EZI, concentrated in the southern portion of the area. The subsea cables are operated by companies of several different nationalities and are of significant commercial and communications value to the countries where cable landfall is made. The oil and gas pipelines in the EZI supply nearby countries with hydrocarbons, and so is also of significant value. Accordingly, subsea cables and pipelines in the EZI as a whole has been ascribed a high value.

10.10.87 The landing of the components at the seabed may directly impact subsea cables and pipelines in the EZI. If the component lands on such infrastructure, there is a possibility that the integrity of the cable or pipeline would be compromised, and significant structural damage could occur. The likelihood of this is reduced where such infrastructure is buried, however for the purpose of this

assessment it is assumed that they are not buried. If a subsea cable or pipeline was compromised it would not be possible to tolerate, adapt, or recover from the impact (without anthropogenic intervention).

10.10.88 Due to the high value, and lack of tolerance, adaptability, and recoverability from the worst-case scenario effects, subsea cables and pipelines are considered to have high sensitivity to direct impact via deposition of material on the seabed.

10.10.89 The Proposed Project will have a maximum of up to 16 launches per year. Although the licence term has a high longevity, with a high associated number of launches, the likelihood of a Skyrora XL Launch Vehicle component impacting the same subsea cable or pipeline is extremely low, considering the total extent over which the component could enter the marine environment. Therefore, the frequency of the impact has been reduced to low to reflect this.

10.10.90 Subsea cables and pipelines are restricted in their distribution in the EZI. It is anticipated that the maximum size of any single component that comes to rest on the seabed will be a maximum 15 m × 2.2 m, to which the footprint of the impact will be limited. The receptor will therefore be impact over a low spatial scale.

10.10.91 An overall low longevity and spatial extent result in a low exposure of benthic habitats to direct loss caused by the returning component.

10.10.92 There is no natural variation in subsea cables and pipelines as they are a constant presence on the seabed. Any potential impact to subsea cables or pipelines would cause a measurable change to the baseline, though this change would be temporary as it would require reparation. In addition, it is noted that, considering the small footprint of the impact, and the total area over which the Skyrora XL Launch Vehicle components will return, the likelihood of the impact occurring is negligible. Therefore, the magnitude of impact is low.

10.10.93 High sensitivity, combined with low exposure and low magnitude, mean that the risk to subsea cables and pipelines from direct impact of returning Skyrora XL Launch Vehicle components is minor. **No likely significant effect.**

Interference with Military Exercise Areas

10.10.94 As described Appendix 10.2, the EZI is utilised for military exercises by a variety of nations on an intermittent basis. Military activities are of significant financial and defence importance, and therefore have been assigned a high value.

10.10.95 Any military activity that occurs in the EZI concurrently with the return of Skyrora XL Launch Vehicle components has the potential to be affected. It is anticipated that, to ensure navigational safety, an exclusion zone will be implemented around the predicted landing position of the returning component. As the return to Earth of the components are monitored, communication with vessels operating nearby will be maintained to provide updates on the location and predicted impact zone of the components.

10.10.96 If the impact zone of a Skyrora XL Launch Vehicle component is within an operational military exercise area, any vessels in the location would be temporarily displaced/excluded. Displacement or exclusion of military vessels whilst on transit could result in increased expenditure on fuel and sundries, and increased time for vessels to reach their destination due to having to take alternative routes/detours. Displacement of military vessels whilst on exercise would perhaps cause them to relocate the exercise, but this is unlikely to cause significant issues as the exercises are not location-specific (at the fine-scale of several kilometres). Therefore, with standard safety and communications in place, military activities are considered to have a high tolerance and adaptability to displacement, as military vessels are mobile and can easily adjust their course and positioning as required.

10.10.97 Once the Skyrora XL Launch Vehicle and associated exclusion zone has passed, military vessels would be able to return to the area immediately. Therefore, military vessels have a high recoverability to displacement effects.

10.10.98 A high value, and high tolerance, adaptability, and recoverability, mean the sensitivity of military exercises within the EZI to displacement from returning components is low.

10.10.99 The Proposed Project will comprise a maximum of 16 launches per year. Although the licence term has a high longevity, with many associated launches, the exclusion zones will only be in place for the duration of the return of the Skyrora XL Launch Vehicle, and therefore the longevity of the impact has been reduced to low to reflect this short time period per launch. Furthermore, to our knowledge, military exercises are not regular and only occur on an intermittent basis in the EZI and so the frequency of exposure is further reduced.

10.10.100 Representative impact points are displayed in Drawing 10.2; however, in order to be precautionary, it is assumed that components could return anywhere within the EZI. There is therefore the potential that the components could return in an area of military exercise. However, it is noted that such exercises are not spatially restricted in the EZI, and indeed could occur over large areas. The small spatial extent of the exclusion zone, which will be limited to the immediate vicinity of the Skyrora XL Launch Vehicle return, will therefore affect a small proportion of the total area that could be used by military activity. Therefore, the spatial extent of the impact is low.

10.10.101 A low frequency, high longevity, and low spatial extent result in a low exposure of military activity to displacement from returning components.

10.10.102 Vessels are mobile and are often required to relocate for a variety of reasons, including adverse weather and displacement from other vessels. As the displacement caused by returning components of small spatial and temporal scale, the magnitude of impact in terms of baseline and variability is negligible.

10.10.103 Low sensitivity, combined with low exposure and negligible magnitude, mean that the risk to military activities from interference arising from recovery of Skyrora XL Launch Vehicle components is negligible. No likely significant effect.

Impacts to Vessel Navigation Including Floating Debris, Changes to Topography and Re-routing of Vessel Traffic

10.10.104 As described in Appendix 10.2, shipping and commercial fishing activity within the EZI is relatively high. In particular, the southern portion of the EZI, which has considerable fishing effort (Figure A10.7) and is a main area of vessel traffic (Figure A10.5) and shipping density (Figure A10.6). Due to this level of activity, it is possible for returning components and the associated exclusion zone to have an impact on shipping and commercial fishing vessels. The high level of activity indicates the financial importance of the area to the surrounding countries; therefore, the value of the receptor is high.

10.10.105 It is anticipated that, to ensure navigational safety, an exclusion zone will be implemented around the predicted landing position of the returning component. At the time of writing, it is not expected that any components will be recovered. As the return of the component is monitored, communication with vessels operating nearby will be maintained to provide updates on the location and predicted impact zone of the component.

10.10.106 If the impact zone of a Skyrora XL Launch Vehicle is within fishing grounds or along vessel transit routes, any vessels in the location would be temporarily displaced. Displacement of vessels or interruptions to transit routes can result in increased expenditure on fuel and increased time for vessels to reach their destination due to having to take alternative routes/detours. Displacement of fishing vessels from fishing grounds can result in loss of income as catch per unit effort is likely to be reduced if alternative productive fishing grounds cannot be exploited whilst the temporary exclusion zone is in place. The majority of the EZI is offshore therefore it is anticipated that most fishing vessels and shipping in the area will be large and so able to adapt their movements. Therefore, with standard safety and communications in place, shipping and commercial fishing activities have high tolerance and adaptability, as vessels are mobile and can easily react to adjust their course and positioning as required.

10.10.107 Once the Skyrora XL Launch Vehicle component has entered the marine environment, exclusion zones can be removed and therefore transiting vessels and active fishing vessels can return to normal operation immediately. The recoverability is therefore considered high.

10.10.108 A high value, and high tolerance, adaptability, and recoverability, mean the sensitivity of shipping and commercial fishing activities within the EZI to displacement from returning components is low.

10.10.109 The Proposed Project will have a maximum of up to 16 launches per year. Although the licence term has a high longevity, with many associated launches, the exclusion zones will only be in place for the duration of the return of the Skyrora XL Launch Vehicle, and therefore the longevity of the impact has been reduced to moderate to reflect this short time period per launch.

10.10.110 Representative impact points are displayed in Drawing 10.2; however, in order to be precautionary, it is assumed that components could return anywhere within the EZI. There is therefore the potential that the components could return in an area of high shipping density such as near the coast of a landmass, or in a key fishing area. However, it is noted that such areas of high fishing and shipping activity are widespread in the EZI. The small spatial extent of the exclusion zone, which will be limited to the immediate vicinity of the component return, will therefore affect a small proportion of the total area used highly by shipping and fishing vessels. Therefore, the spatial extent of the impact is low.

10.10.111 A low frequency, moderate longevity, and low spatial extent result in a low exposure of shipping and commercial fishing activity to displacement from returning components.

10.10.112 Vessels are mobile and are often required to take alternative routes or use other fishing grounds for a variety of reasons, including adverse weather and displacement from other vessels. As the displacement caused by returning Skyrora XL Launch Vehicle components of small spatial and temporal scale, the magnitude of impact in terms of baseline and variability is negligible.

10.10.113 Low sensitivity, combined with low exposure and negligible magnitude, mean that the risk to shipping and commercial fishing activities from interference arising from launches and payload recovery is negligible. No likely significant effect.

Damage to Marine Archaeology/Shipwrecks

10.10.114 As described in Appendix 10.2, it has not been possible to determine the extent of the presence of marine archaeological features in most of the EZI. For the purpose of this assessment, however, it is assumed that marine archaeological features are present and so have the potential to be impacted by the proposed operations.

10.10.115 The value of marine archaeological features can vary depending on the feature type and level of preservation. As a worst-case scenario, it is assumed that any given marine archaeological feature in the EZI has a high value, due to its cultural and historical significance.

10.10.116 The landing of the components at the seabed may directly impact marine archaeological features in the EZI. If the component lands on such a feature, there is a possibility that the integrity would be compromised, and significant structural damage could occur. The likelihood of this is reduced where such infrastructure is buried, however for the purpose of this assessment it is assumed that they are not buried. If a marine archaeological feature were compromised it would not be possible to tolerant, adapt, or recover from the impact.

10.10.117 Due to the high value, and lack of tolerance, adaptability, and recoverability from the worst-case scenario effects, marine archaeological features are considered to have high sensitivity to direct impact via deposition of material on the seabed.

10.10.118 The Proposed Project will have a maximum of up to 16 launches per year. Although the licence term has a high longevity, with many associated launches, the likelihood of the Skyrora XL Launch Vehicle components impacting the same marine archaeological features is negligible

considering the total extent over which the components could enter the marine environment. Therefore, the frequency of the impact has been reduced to low to reflect this.

10.10.119 It is anticipated that the maximum size of any single component that comes to rest on the seabed will be a maximum 15 m × 2.2 m, to which the footprint of the impact will be limited. The Skyrora XL Launch Vehicle components are expected to sink through the water column and come to rest at a single place at the seabed, and not move once at the seabed, thereby only impacting the features directly within the footprint the receptor will therefore be impact over a low spatial scale.

10.10.120 An overall high longevity, low frequency and low spatial extent result in a low exposure of marine archaeological features to direct loss caused by the returning component.

10.10.121 There is no natural variation in the presence of marine archaeological features although the amount of coverage by sediment may vary with time. Any potential impact to marine archaeological features would cause a measurable change to the baseline, though it is noted that there may not be a record of this change the eventual location of the component will not be monitored. In addition, it is noted that, considering the small footprint of the impact, and the total area over which the Skyrora XL Launch Vehicle component may return, the likelihood of the impact occurring is extremely low. Therefore, the magnitude of impact is low.

10.10.122 High sensitivity, combined with low exposure and low magnitude, mean that the risk to marine archaeological features from direct impact of returning Skyrora XL Launch Vehicle components is minor. No likely significant effect.

10.11 Accidental Aeronautical Events - Failure During Flight

10.11.1 In addition to the potential effects of planned events identified in the subsections above, this subsection considers the potential effects of accidental aeronautical events, such as failure during flight. In the context of this chapter, failure during flight is expected to result in the maximum case scenario that the entirety of the Skyrora XL Launch Vehicle, including fuels and payloads, enters the marine environment in the open ocean prior to separation of the first stage.

Effects on Sea Ice, Water, and Sediment Quality and Ecological Receptors from Fuel Spillage

10.11.2 In the instance that the entire Skyrora XL Launch Vehicle enters the marine environment, the total propellant would not exceed 57,000 kg of Jet A-1 Kerosene. This amount is inclusive of both stages. Due to difficulties in predicting the realistic quantity of propellant entering the marine environment in the event of a failure during flight, it has been assumed that the total propellant is equal to the maximum propellant capacity required to achieve a successful flight (<57,000 kg). In the event that the entire Skyrora XL Launch Vehicle simultaneously combusts, the potential resulting impact on the environment from residual (unburnt) fuel spillage is considered similar to that of a successful flight.

10.11.3 Kerosene-type oils spread very quickly on water to form a thin film, which may be less than 0.01 mm thick NOAA (2019). When forming this film, approximately 1,000 US gallons are present per square nautical mile of coverage. Considering the total amount of kerosene (57,000 kg/~46,000 L/~12,152 US gallons), the maximum size of the surface film from 310 L of kerosene would be approximately 12.2 square nautical miles, equivalent to ~41.8 km². Kerosene has a low boiling point and viscosity, meaning that, when spilled on water or sea ice, most of the fuel will evaporate or naturally disperse within a day or less. Spills of kerosene that reach the shoreline would be expected to quickly penetrate the sediment and/or be washed off. Kerosene can be completely degraded in the marine environment on the timescale of 1-2 months.

10.11.4 It is anticipated that propellant will be expelled upon impact on the sea surface. The maximum case scenario of failure prior to separation of the first stage would not interact with sea ice. Due to the nature of kerosene-like fuels, only the very surface of the water column is anticipated to be within the zone of effect from propellant release. The marine biodiversity receptors that have the highest

potential to be in this zone of effect for a non-negligible period of time are plankton. All other marine biodiversity receptors are present in the surface waters on a transient basis and so would not be exposed to potential residual propellants for any notable period of time. Plankton receptors may be exposed to potential propellants for 1-2 months. Marine mammal receptors may be exposed when coming to the surface to breathe.

10.11.5 It is possible that aquatic organisms that come into direct contact with naturally dispersed and entrained propellant will be killed (NOAA, 2019). NOAA (2019) confirms that fish kills are unlikely to occur as a result of jet fuel spills in the open ocean due to evaporation and therefore concentrations are expected to be below lethal effects. However, given the potential extent of the unplanned spill, there may be a risk of lethal effects upon air-breathing marine organisms that may interact with the propellant on the surface.

10.11.6 The water quality and biodiversity of the EZI has an important environmental value. some biodiversity receptors which may be impacted by hydrocarbons may experience lethal effects as a result of exposure to hydrocarbons. As such, the sensitivity of these receptors is considered moderate.

10.11.7 The potential for accidental aeronautical events will exist for an extensive period of time i.e., the full duration of the licence. Within the licence timeframe, launches are anticipated to occur up to a maximum of 16 times per year, equivalent to two launches per month. However, the likelihood of an unplanned aeronautical event in the worst case scenario (entry into the marine environment intact with full fuel volume) is considered extremely low. It is therefore extremely unlikely that the receptors would be exposed more than once, further reducing the frequency at which they could be exposed to hydrocarbon spills. Therefore, overall exposure of the receptors to the effect is low.

10.11.8 Direct effects on the hydrocarbon concentration of the sea water is likely to be measurable above natural variability, as there are limited other sources of hydrocarbons in the marine environment. Similarly, potential impact to the water quality is likely to be measurable above the baseline in that the hydrocarbon concentration will be elevated. However, only a small percentage change above the baseline or natural variation is predicted due to the surficial nature and rapid evaporation/dispersion of kerosene in the marine environment. The magnitude of the impact is therefore moderate.

10.11.9 Moderate sensitivity, combined with low exposure and moderate magnitude, means that the risk to these receptors is Low, which is equivalent to minor risk. **No likely significant effect**.

Effects on Sea Ice, Water, and Sediment Quality and Ecological Receptors from Metal Corrosion and Toxic Contamination

10.11.10 As detailed in Table 10.6, the metals that have the potential to enter the marine environment are lithium (from the batteries), aluminium (from the kerosene tank liner and main engines), stainless steel and INCONEL alloy 718 (from the Skyforce engines in Stage 1 and Stage 2) and copper. These are all present in Stages 1, 2, but not the fairing (Table 10.6).

10.11.11 Due to similarities in the inert materials that may enter the marine environment in the case of a failure during flight, this impact is not considered significantly different to the impact assessed for successful launches. **No likely significant effect**.

Effects on Sea Ice, Water, and Sediment Quality and Ecological Receptors from Debris and Microplastics (Including Ingestion)

10.11.12 Due to similarities in the type of plastics that may enter the marine environment in the case of a failure during flight, and the baseline level of microplastic in coastal and arctic waters, this impact is not considered significantly different to the impact assessed for successful launches. **No likely significant effect**.

Smothering of Marine Organisms, Habitat Alteration (Including Reef Effects) and Habitat Loss via Deposition of Material on the Seabed or Sea Ice

10.11.13 Due to similarities in the type and extent of material that may enter the marine environment in the case of a failure during flight, and the minute size of the Skyrora XL Launch Vehicle compared to seabed habitat, this impact is not considered significantly different to the impact assessed for successful launches. **No likely significant effect**.

Direct Strike

10.11.14 Due to similarities in the type and extent of material that may enter the marine environment in the case of a failure during flight, in the case that the Skyrora XL Launch Vehicle experiences a failure during flight, it is expected that the potential for direct strike to marine organisms will be similar in effect to that assessed for a successful flight. **No likely significant effect**.

10.12 Additional Mitigation

10.12.1 No additional mitigation has been proposed to mitigate the effects from the aforementioned pathways.

10.13 Residual Effects

Effects on Sea Ice, Water and Sediment Quality and, Ecological Receptors from Fuel Spillage

10.13.1 As stated above, no additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is minor. **No likely significant effect**.

Effects on Sea Ice, Water and Sediment Quality, and Ecological Receptors from Metal Corrosion and Toxic Contamination

10.13.2 As stated above, no additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is minor. **No likely significant effect**.

Effects on Sea Ice, Water and Sediment Quality, and Ecological Receptors from Debris and Microplastics (Including Ingestion)

10.13.3 As stated above, no additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is minor. **No likely significant effect**.

Smothering of Marine Organisms, Habitat Alteration (Including Reef Effects) and Habitat Loss via Deposition of Material on the Seabed or Sea Ice

10.13.4 As stated above, no additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is minor. **No likely significant effect**.

Direct Strike

10.13.5 As stated above, no additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is negligible. **No likely significant effect**.

Acoustic Disturbance (including Underwater Noise) from the Impact of the Jettisoned Objects Hitting the Sea Surface or Sea Ice

10.13.6 As stated above, no additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is negligible. **No likely significant effect**.

Thermal Effects from Jettisoned Objects

10.13.7 As stated above, no additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is negligible. **No likely significant effect**.

Visual Disturbance

10.13.8 As stated above, no additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is negligible. **No likely significant effect**.

Displacement of Fish

10.13.9 As stated above, no additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is negligible. **No likely significant effect**.

Damage to Human Infrastructure (Subsea Cables/Pipelines)

10.13.10 As stated above, no additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is minor. **No likely significant effect**.

Interference with Military Exercise Areas

10.13.11 As stated above, no additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is negligible. **No likely significant effect**.

Impacts to Vessel Navigation Including Floating Debris, Changes to Topography and Re-routing of Vessel Traffic

10.13.12 As stated above, no additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is negligible. **No likely significant effect**.

Damage to Marine Archaeology/Shipwrecks

10.13.13 As stated above, no additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is minor. **No likely significant effect**.

Accidental Aeronautical Events – Failure During Flight

10.13.14 As stated above, no additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is minor. **No likely significant effect**.

10.14 Cumulative Assessment

10.14.1 The cumulative assessment aims to determine the potential for effects of the Proposed Project to combine with other 'reasonably foreseeable projects and plans'. Reasonably foreseeable projects can comprise projects that are planned but not yet operational, be they under construction, or under approval for construction. Projects and plans that are fully implemented and in operation are not considered under the cumulative assessment as they will have been considered under the baseline environment within each of the chapters.

Identification of Projects and Plans

10.14.2 The key sources utilised to provide a long list of reasonably foreseeable plans and projects are:

- 4C Offshore Global Offshore Wind Map;
- Submarine Cable Map;
- KIS-ORCA Offshore Renewables and Cables Awareness;
- Marine Scotland's National Marine Plan interactive site;
- The Crown Estate Scotland maps;
- UK Oil and Gas Authority;
- Norwegian Petroleum Directorate;
- NATO exercises website (https://shape.nato.int/nato-exercises); and,
- Shetland Islands Draft Regional Marine Plan.

10.14.3 All reasonably foreseeable plans and projects that have the potential to act cumulatively with the marine effect pathways associated with the Proposed Project are presented in Table 10.7 below. Plans and projects have been identified for offshore wind, marine renewables, oil and gas, other Scottish spaceports and subsea cables. With regard to the sectors of military, recreation and tourism, and disposal sites, no proposed plans or projects have been identified.

10.14.4 Shipping and navigation, commercial and recreational fishing, and tourism, have not been considered as future projects and plans for the purposes of this cumulative assessment. Although it is understood that these sectors may increase over time in the EZI, this is not as part of any specific plan or project. The potential impacts to these receptors as a result of cumulative effects has been considered.

10.14.5 Table 10.8 below details which of the effect pathways included in the assessment are applicable to each of the projects or plans. The pathways which have the potential to act cumulatively between the Proposed Project and the reasonably foreseeable projects and plans have been taken forward in the assessment.

Table 10.7: All reasonably foreseeable plans and projects in the Environmental Zone of Influence

Plan/Project	Description	Location	Stage	Source
Hywind Tampen Floating Offshore Wind Farm	The Hywind Tampen is being developed by Equinor ASA in Norwegian waters. The windfarm capacity is 88 MW and will comprise floating turbines.	Norway, adjacent to the south-east corner of the EZI	Pre-construction	4COffshore (2020)
Celtic Norse Subsea Cable	The Celtic Norse cable will be ready for service in 2022. It connects Grindavik, Iceland, Killala, Ireland, Caithness, Scotland, and Øysanden, Norway. It is approximately 2,000 km in length and is owned by Eidsiva Energi, NTE, and TrønderEnergi.	Norway, Iceland, Scotland, crossing the southern part of the EZI	Pre-construction	Submarine Cable Map (2020)
UK Offshore Licensing Round for Oil and Gas	There have been several UK Offshore Licensing rounds for Oil and Gas in recent years, most recently the 32nd Offshore Licensing Round in 2019. These licensing rounds have included blocks and part-blocks in the EZI. It is likely that a proportion of these recently licensed blocks will be developed, either by drilling exploration wells, undertaking seismic surveys, or field development planning.	West of Shetland, Faroe-Shetland Basin, East Shetland Platform	Exploration and Pre-development	Oil and Gas Authority (2020)
Norway Offshore Licensing Round for Oil and Gas	Similar to the UK, Norway also undertakes licensing for its offshore oil and gas blocks. The latest announcement of new blocks up for award in pre-defined areas was in June 2020. Blocks awarded in previous rounds may be developed in the future	Norwegian waters of the EZI. Examples of overlapping blocks are Licence 933 and 993	Exploration and Pre-development	Offshore Mag (2020) Norwegian Petroleum Directorate (2020)
Faroese Licensing Round for Oil and Gas	Similar to the UK, the Faroe Islands also undertakes licensing rounds for its offshore oil and gas blocks. In 2019 the 5th Faroese Licensing Round occurred, in conjunction with the UK's 32nd Licensing Round. The blocks on offer were near to the boundary of the UKCS. There is therefore potential for future oil and gas exploration and production in these blocks.	Faroese waters of the EZI, specifically in the south-west of the EZI near the border with the UKCS	Exploration and Pre-development	Jardfeingi (2019)

Plan/Project	Description	Location	Stage	Source
Jan Mayen oil exploration	There has been interest in the potential oil and gas reserves of Jan Mayen. Although there have been no recent updates on progress (in the last five years), there is the potential that exploration and production activities could occur in the future.	Jan Mayen EEZ of the EZI	Exploration and Pre-development	Reuters (2013)
Faroe Islands marine renewable energy	Minesto have signed an agreement to install two tidal kites in Faroese waters. Site development is in progress; installation of the first kite happened in Q2 2020, with the second unit also planned for 2020.	Faroese coastal waters, just outside the EZI	Pre-construction	Minesto (2020)
Space Hub Sutherland	Space Hub Sutherland EIA report identifies Risk Assessment Study Area (area of likely debris impact zones).	Faroese coastal waters, within and just outside the EZI	Pre-construction	Planning application reference 20/00616/FUL

Table 10.8 Screening exercise assessing which of the pressures relevant to the Proposed Project apply to other projects screened in for cumulative assessment

Key: ✓ = pressure applied to both projects; ✗ = no exposure pathway for this pressure from the other project

Plan/Project	Fuel Spillage	Metal Corrosion	Microplastics	Disturbance/ Displacement/ Interference	Impact At Seabed	Direct Strike
Hywind Tampen Floating Offshore Wind Farm	✗	✓	✗	✓	✓	✗
Celtic Norse Subsea Cable	✗	✗	✓	✓	✓	✗
UK Offshore Licensing Round for Oil and Gas	✓	✓	✓	✓	✓	✗
Norway Offshore Licensing Round for Oil and Gas	✓	✓	✓	✓	✓	✗

Plan/Project	Fuel Spillage	Metal Corrosion	Microplastics	Disturbance/ Displacement/ Interference	Impact At Seabed	Direct Strike
Faroese Licensing Round for Oil and Gas	✓	✓	✓	✓	✓	×
Jan Mayen oil exploration	✓	✓	✓	✓	✓	×
Faroe Islands marine renewable energy	×	✓	×	✓	✓	×
Space Hub Sutherland	×	✓	✓	✓	✓	✓

Methodology

10.14.6 The potential cumulative effects of the plans and projects listed in Table 10.7 above are considered on individual receptors in the subsequent sections. It should be noted that there is limited information on the plans and projects that are less progressed, and therefore less certainty on the potential cumulative effects of the projects.

10.14.7 As part of the AEE Report, the effect upon a receptor may be concluded as negligible or minor risk. However, an effect that has negligible or minor risk from the project alone cannot be ruled out from the cumulative assessment as there is the potential for an increased risk as effects may accumulate with other plans or projects. Therefore, all effects for which there are pathways with the receptors have been considered.

10.14.8 The assessment of cumulative effects between the project and the associated EZI and other plans and projects takes into account the:

- Potential for project/plan effect envelopes to overlap temporally and spatially with a specific receptor;
- Magnitude of cumulative effect (where known or possible to deduce); and,
- Receptor-specific sensitivity (including their value), as determined as part of the AEE Report process.

Assessment

10.14.9 In recognition of the level of information availability regarding the projects screened into this assessment, a detailed matrix-based risk (impact) assessment (see methodology detailed in Section 10.4) is not feasible. Expert judgment is used to consider all information available and determine the potential for combination of effects to cause increased effects on regional fish and shellfish populations.

Water Quality

10.14.10 Sections 10.9.5,10.9.16 and 10.9.23 above provide a risk assessment of the potential impacts on the water quality environment from the Proposed Project. The potential effects on water quality are the increase in hydrocarbons from fuel spills, metal from corrosion, and microplastics.

10.14.11 The projects and plans detailed in Table 10.8 above all comprise construction in the marine environment. The primary material used for construction will be metals for most projects (such as oil and gas, offshore wind etc), with subsea cables comprising plastic (on the outer layer) and metal. All infrastructure placed in the marine environment as part of these projects will have been designed to have a long lifespan with minimal breakdown as this would impact infrastructure integrity. Returning items from Space Hub Sutherland will likely be similar in nature to those of the Proposed Project. Therefore, the combined input of metals and microplastics as a result of project infrastructure in combination with the Proposed Project is negligible. **No likely significant effect**.

10.14.12 Microplastics may enter the marine environment from offshore platforms as part of the waste produced e.g., wastewater. However, this is controlled by international regulations and standard operating procedures to minimise the input (Press and Journal, 2018), therefore this input of microplastics alongside the Proposed Project is considered negligible. **No likely significant effect**.

10.14.13 Of the additional plans and projects, the input of hydrocarbons will likely only arise from oil and gas operations. Hydrocarbons can enter the marine environment through accidental events such as spills or intentional means such as through the deposition of drill cuttings at the seabed. The oil and gas sector is governed by international regulations on drill cuttings (OSPAR Decision 2000/3 and Recommendation 2006/5) and has standard operating procedures to reduce the likelihood and severity of oil spills, thereby minimising the potential for hydrocarbon input into the marine environment. Taking into account the low likelihood and severity of hydrocarbon input from oil and gas projects, as well as the proposed launches, the in-combination risk is considered negligible. **No likely significant effect**.

Biodiversity Receptors

10.14.14 The potential effects on biodiversity receptors are the increase in contaminants (hydrocarbons, metal, microplastic), direct strike from components, disturbance and displacement from components, payloads and vessels, and direct loss of seabed habitat.

10.14.15 The results of the assessment of cumulative effects on water quality as a result of contaminant pathways is directly applicable to the biodiversity receptors within the marine environment. Accordingly, there is negligible risk of cumulative effects on biodiversity receptors as a result of contaminants from the Proposed Project in-combination with other reasonably foreseeable plans and projects. **No likely significant effect**.

10.14.16 The other projects and plans that also have the potential to result in direct strike of marine ecological receptors are Space Hub Sutherland and tidal arrays. Impacts from returning items from Space Hub Sutherland will likely be similar in nature to those of the Proposed Project and considered not significant. Historically, the risk of collision from tidal array has been of concern during developments and has resulted in significant pre-construction modelling and post-construction monitoring. At present there is still poor understanding of the real-life level of collision risk for marine ecological receptors. It is noted that, with regards to marine mammals, there have been no reports of collisions as the animals have been shown to instead display an avoidance response (NERC, 2013). Even though there is limited information, it is likely that the number of individuals lost from a population as a result of tidal turbines is low. To illustrate, collision risk modelling for MeyGen, Pentland Firth, Scotland, concluded that up to 243 salmon would collide with an array of 200 turbines per year. The number of individuals from other receptor groups that may be affected is likely to be much smaller (it is high in fish due to shoaling behaviour). In addition, the number of individuals affected is further reduced as it is highly unlikely that any tidal arrays in the EZI would comprises such a large array of turbines. The subsequent low number of affected individuals is anticipated to comprise a negligible proportion of the marine ecological receptor populations in the EZI. Therefore, it is considered that the risk of mortality as a result of direct strike from the Proposed Project in combination with other projects is negligible. **No likely significant effect**.

10.14.17 The projects and plans detailed in Table 10.7 above have the potential to disturb marine ecological receptors through either visual pathways, i.e. physical presence of the infrastructure and associated vessel traffic, or acoustic pathways i.e. through underwater noise emitted. The area of displacement associated with these projects is anticipated to be similar in scale to the displacement for the proposed project i.e., no more than several kilometres around the disturbance source. Perhaps one type of activity which could lead to larger areas of disturbance is piling, which can be used for fixing infrastructure to the seabed such as offshore wind or tidal devices, however it is not known if piling will be used for the additional projects. It is considered highly unlikely that the area of disturbance around a project or plan will overlap with the area of disturbance around returning Skyrora XL Launch Vehicle component, due to the safety issue of being nearby a returning launch vehicle. Therefore, the area of displacement is unlikely to increase due to two potential sources of effects within a single disturbance zone. No launches would occur simultaneously from Space Hub Sutherland and SaxaVord Spaceport and so no cumulative disturbance from this activity will occur. For other identified projects, there is the potential that the disturbance zones around projects in the EZI will be additive, increasing the total amount of area from which a marine ecological receptor is displaced. However, given the total habitat available to marine ecological receptors across the EZI, this is determined to have negligible risk at the population-level. **No likely significant effect**.

10.14.18 The benthic habitat in the EZI comprises predominantly deep-sea habitats that are expected to be homogeneous. Also present in the EZI are sensitive benthic habitats, VMEs and MPA features, however these are widespread and large in spatial extent, respectively. The majority of projects and plans detailed in Table 10.7 will have a limited seabed footprint as they comprise a single impact area, single infrastructure or a series of single infrastructure. The exception is the Celtic Norse subsea cable, which will have a considerably larger seabed footprint. All these projects will be required to undertake an assessment of the seabed conditions prior to development, including an assessment of benthic habitats with focus on any protected species or habitats. Should protected

habitats be discovered, it is anticipated that the project location will be amended to minimise effects, as per international regulations and best practice. Therefore, due to the minimised effect from the proposed projects and plans, in conjunction with the extremely low likelihood of effect from the Proposed Project, the cumulative risk is considered negligible. **No likely significant effect**.

Human and Human Activities

10.14.19 The potential effects on humans and human activities are direct impact from Skyrora XL Launch Vehicle components at the seabed and disturbance and displacement from the Skyrora XL Launch Vehicle itself.

10.14.20 The two human activities which may be affected by pathways at the seabed are subsea cables and pipelines and marine archaeology. All of the proposed projects and plans detailed in Table 10.7 above will result in some level of seabed disturbance due to emplacement of infrastructure. However, as the existing infrastructure at the seabed described in the baseline are already known, they will form part of the baseline assessment of future projects, prior to construction at the seabed. Therefore, avoidance of infrastructure should occur and negate the possibility that future projects and plans will affect pre-existing infrastructure at the seabed, such as subsea cables. Therefore, there is no pathway for these projects to act cumulatively with effects from launch operations as a result of Proposed Project. Similarly, future projects and plans will have to undertake an assessment of the presence of marine archaeological features in the project footprint and minimise effects to these features through amending the location. Therefore, the likelihood that the proposed plans and project detailed in Table 10.7 above will affect the marine archaeological features that have the potential to interact with the launch operations from the Proposed Project is mitigated through accepted best practice planning procedures and assessments.

10.14.21 The human and human activities in the EZI that utilise vessels have the potential to be affected via disturbance. No launches would occur simultaneously from Space Hub Sutherland and SaxaVord Spaceport and so no cumulative disturbance from this activity will occur. For other identified projects, disturbance from the Proposed Project can arise during the return of Skyrora XL Launch Vehicle components. An exclusion zone will be implemented around returning launch components, thereby excluding other human activities from the area on a temporary basis (the exact duration is not yet known). It is likely that future infrastructure projects (except subsea cables) will also implement an exclusion zone around the infrastructure, to ensure safety to navigation in their immediate vicinity (noting that subsea cable installation vessels also implement safety exclusion zones whilst installing the cables). In the case of oil and gas offshore platforms, such safety zones are typically 500 m (Step Change in Safety, 2017). The spatial extent of the area from which vessels are excluded will therefore be added to by each infrastructure project and associated exclusion zone. The cumulative area of exclusion is anticipated to be small in the context of the total area of navigation available to vessels. In the case of commercial fishing vessels, cumulative displacement from fishing grounds can result in loss of income as catch per unit effort is likely to be reduced. However, the exclusion zones around other future infrastructure will be permanent, as opposed to the temporary exclusion zone for the Proposed Project, therefore the fishers will have already modified their fishing areas to accommodate these zones. It is considered that the small size of the area of exclusion in the context of total area available to navigation, or the area available for fishing, will result in a negligible cumulative risk of the Proposed Project with other projects and plans. **No likely significant effect**.

Impact Zone Overlap with Space Hub Sutherland

10.14.22 Multiple launches within the Applicant's own EZI are not anticipated to produce significant cumulative effects due to the fact that the likelihood of Skyrora XL (or Skyrora Skylark L) Launch Vehicle components from one launch impacting the same marine feature/area as those from another launch is considered to be negligible when taking into account the total extent over which the components could enter the marine environment. In the same way, components from Skyrora XL orbital launches are highly unlikely ever to be deposited in the exact same area as those from launches from the Space Hub Sutherland, and therefore the potential for significant cumulative effects, particularly given the low frequency and number of launches proposed by the Applicant, is considered to be negligible. **No likely significant effect**.

Conclusion

10.14.23 Negligible risk has been determined for all receptors screened into this assessment for in combination effects from the Proposed Project with reasonably foreseeable plans and projects. **No likely significant effect**.

10.15 Summary

10.15.1 This chapter considers the marine and transboundary effects from the Proposed Project. Effects on the marine environment will arise from the return to earth of Skyrora XL Launch Vehicle components. Such marine effects may occur in Scottish waters or in the waters of other countries (i.e., transboundary effects), specifically; Denmark (Faroe Islands, Greenland), Iceland, and Norway (including Jan Mayen).

10.15.2 The EZI encompasses an area between the SaxaVord Spaceport and approximately 4,007 km north of the launch pad. The EZI encompasses the expected impact zones associated with debris from Stage 1, the payload fairing and Stage 2. Stage 3 will burn-up upon re-entry to atmosphere and will have no associated debris field.

10.15.3 The EZI comprises mostly deep water with a small amount of continental shelf and many bathymetric features. The water quality of the EZI is high, in that it does not have significant local input of anthropogenic contaminants such as metals, microplastics, and hydrocarbons. The EZI supports numerous marine biota such as plankton, benthic habitats, fish and shellfish, seabirds, and marine mammals. The EZI has few marine protected areas (Drawing 10.3).

10.15.4 In the EZI, human activities are concentrated in the southern portion (as far as the Faroe Islands to the north). This includes shipping and navigation, oil and gas, other spaceports, cables and pipelines, and commercial fishing (Drawings 10.4 – 10.6). There is occasional use of the area for military activities. Marine archaeology is poorly known and so assumed to be present. There is presence of oil and gas infrastructure, subsea cables and pipelines, marine renewable energy, dredge disposal sites, tourism, and marine archaeological features as shown on Drawings 10.4 – 10.6.

10.15.5 Launches have the potential to affect the aforementioned water quality, biodiversity and human activities. The pathways of effect have been identified: impacts from the presence of the Skyrora XL Launch Vehicle and associated materials, such as metals, microplastics, and hydrocarbons; impacts from direct strike and impact at the seabed from when the returning components come to rest.

10.15.6 The potential impacts on water quality, biodiversity, and human activities in the EZI have been assessed. All pathways have a negligible or minor risk of a likely significant effect on the receptors. **No likely significant effect**.

10.15.7 Because the risk is negligible or minor there is no requirement to apply mitigation in order to reduce the risk further. Accordingly, the residual effects to the receptors is also negligible or minor. **No likely significant effect**.

10.16 References

4C Offshore (2020). *Global Offshore Wind Map.* Available at: https://www.4coffshore.com/offshorewind/. Accessed on 10 August 2021.

ABPmer (2020). *Balloon and Sounding Rocket Navigational Risk Assessment.* ABPmer Report No. R.3389. A report produced by ABPmer for Shetland Space Centre, May 2020.

Almet-Marine (2020). *Corrosion behaviour of aluminium in marine environments.* Available at: http://www.almet-marine.com/images/clients/EN/Aluminium-users-guide/Ch10-corrosion-behaviour-of-aluminium-in-marine%20environments.pdf. Accessed May 2022.

Andrady, A. (2011). *Microplastics in the marine environment*. Marine Pollution Bulletin 62: pp.1596-1605.

Applicant (2020). *Questions and Answers*. Available at: https://shetlandspacecentre.com/questions-and-answers/. Accessed May 2022.

Barceló, D., and Picó, Y. (2019). *Microplastics in the global aquatic environment: Analysis, effects, remediation and policy solutions.* Journal of Environmental Chemical Engineering, 7: p.103421.

Barret, R.T., Chapdelaine, G., Anker-Bilssen, T., Mosbech, A., Montevecchi, W.A., Reid, J.B., and Veit, R.R. (2006). *Seabird numbers and prey consumption in the North Atlantic*. ICES Journal of Marine Science, 63(6): pp.1145-1158.

Boertmann, D., Lyngs, P., Merkel, F. R., and Mosbech, A. (2004). *The significance of Southwest Greenland as winter quarters for seabirds.* Bird Conservation International, 14(2): pp.87-112.

Botterell, Z.L.R., Beaumont, N., Dorrington, T., Steinke, M., Thompson, R.C., and Lindeque, P.K. (2019). *Bioavailability and effects of microplastics on marine zooplankton: A review.* Environmental Pollution, 245: pp.98-110.

Buhl-Mortensen, L., Burgos, J.M., Steingrund, P., Buhl-Mortensen, P., Ólafsdóttir, S.H., and Ragnarsson, S.Á. (2019). *Vulnerable marine ecosystems (VMEs): Coral and sponge VMEs in Arctic and sub-Arctic waters–Distribution and threats*. Vol. 2019519. Nordic Council of Ministers. Available at: https://books.google.co.uk/books?id=jDCZDwAAQBAJ&pg=PA9&lpg=PA9&dq=arctic+vmes&source=bl&ots=GrC9ZBwerK&sig=ACfU3U18Fwfx6vQbh08pGiooSkRWyOGqfw&hl=en&sa=X&ved=2ahUKEwiBhOGs1czqAhXZShUIHSyOCzkQ6AEwAHoECAoQAQ#v=onepage&q=arctic%20vmes&f=false. Accessed May 2022.

CAFF (2017). *State of the Arctic Marine Biodiversity Report.* Conservation of Arctic Flora and Fauna International Secretariat, Akureyri, Iceland. 978-9935-431-63-9.

Campbell, L.M., Norstrom, R.J., Hobson, K.A., Muir, D.C.G., Backus, S., and Fisk, A.T. (2005). *Mercury and other trace elements in a pelagic Arctic marine food web (Northwater Polynya, Baffin Bay).* Science of the Total Environment, 351-352: pp.247-263.

Carey, M.J. (2009). *The effects of investigator disturbance on procellariform seabirds: A review.* New Zealand Journal of Zoology, 36: pp.367-377.

Chamas, A., Moon, H., Zheng, J., Qiu, Y., Tabassum, T., Jang, J.-H., Abu-Omar, M., Scott, S. L., and Suh, S. (2020) *Degradation Rates of Plastics in the Environment*. ACS Sustainable Chemistry & Engineering, 8(9): pp. 3494-3511. doi: 10.1021/acssuschemeng.9b06635

Choi, H-B., Ryu, J-S., Shin, W-J., and Vigier, N. (2019). *The impact of anthropogenic inputs on lithium content in river and tap water*. Nature Communications, 10: pp.5371.

CMS (2020). *Memorandum of Understanding on the Conservation of Migratory Sharks: Basking Shark Fact Sheet.* Available at: https://www.cms.int/sharks/sites/default/files/document/cms_sharks-mos3_inf_15_a_basking%20shark.pdf. Accessed May 2022.

Collard, F., Ask, A. (2021). *Plastic ingestion by Arctic fauna: A review*. Science of The Total Environment, 786: p. 147462. doi: 10.1016/j.scitotenv.2021.147462.

Davies, P. (2016) Environmental degradation of composites for marine structures: new materials and new applicationsPhil. Trans. R. Soc. A.374:20150272. doi: 10.1098/rsta.2015.0272

Davis, J.R. (2000). *Alloy Digest Sourcebook: Stainless Steels*, ASM International, p. 8, ISBN 978-0-87170-649-2.

deBarbadillo, J.J., Mannan, S.K. (2012). *Alloy 718 for Oilfield Applications*. Journal of Metals. 64: pp. 265–270. Available at: https://doi.org/10.1007/s11837-012-0238-z. Accessed May 2022.

Dickey-Collas, M., Nash, R.D., Brunel, T., Van Damme, C.J., Marshall, C.T., Payne, M.R., Corten, A., Geffen, A.J., Peck, M.A., Hatfield, E.M. and Hintzen, N.T. (2010). *Lessons learned from stock collapse and recovery of North Sea herring: a review.* ICES Journal of Marine Science, 67(9): pp.1875-1886.

EMODnet (2019). *EUSeaMap (2019) Broad-Scale Predictive Habitat Map - EUNIS classification 800m simplification*. Available at: https://www.emodnet-seabedhabitats.eu/access-data/launch-map-viewer/?zoom=3&center=0.826,66.270&layerIds=1&baseLayerId=-3&activeFilters&fbclid=IwAR05clrMWqiJZkqnVRjUovspEQNkakZBHqZuoRd7rvT7vYQwIp6KAOd_JpI. Accessed May 2022.

EMODnet (2020). *Geoviewer.* Available at: https://www.emodnet.eu/geoviewer/#!/. Accessed May 2022.

FAO (2020a). *VME indicators, thresholds and encounter responses adopted by R(F)MOs in force during 2019.* Available at: http://www.fao.org/in-action/vulnerable-marine-ecosystems/vme-indicators/en/. Accessed May 2022.

FAO (2020b). *Handling and Processing Blue Whiting.* Available at: http://www.fao.org/3/x5952e/x5952e00.htm#Contents. Accessed May 2022.

FIRMS (2009). *Northeast Atlantic NEAFC high seas fisheries.* Available at: http://firms.fao.org/firms/fishery/479/156951/en. Accessed May 2022.

FishSource (2019). *FishSource Profiles.* Available at: https://www.fishsource.org/about. Accessed May 2022.

Gilmore, M. (2014). *Toxicity of aluminium in seawater: diatom sensitivity*. Honours Thesis at the University of Wollongong. Available at: https://ro.uow.edu.au/cgi/viewcontent.cgi?article=1125&context=thsci. Accessed May 2022.

Holst, J.C., and Slotte, A. (1998). *Effects of juvenile nursery on geographic spawning distribution in Norwegian spring-spawning herring (Clupea harengus L.).* ICES Journal of Marine Science, 55(6): pp.987-996.

ICES (2003). *Environmental status of European seas.* ICES.

ICES (2005). *Spawning and life history information for North Atlantic cod stocks.* ICES/GLOBEC Working Group on Cod and Climate Change.

ICES (2019a). *Norwegian Sea ecoregion – Fisheries overview.* Available at: https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2019/2019/FisheriesOverviews_Norwegian%20Sea_2019.pdf. Accessed May 2022.

ICES (2019b). *Icelandic Waters ecoregion – Fisheries overview.* Available at: https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2019/2019/FisheriesOverview_IcelandicWaters_2019.pdf. Accessed May 2022.

ICES (2020). *Dataset Collections: Catch Statistics*. Available at: https://www.ices.dk/data/dataset-collections/Pages/Fish-catch-and-stock-assessment.aspx. Accessed May 2022.

Jakobsen, P. K., Ribergaard, M. H., Quadfasel, D., Schmith, T., and Hughes, W. (2003). *Near-surface circulation in the northern North Atlantic as inferred from Lagrangian drifters: Variability from the mesoscale to interannual*. Journal of Geophysical Research, 108(C8): p. 3251.

Jakobsson, J., and Stefánsson, G. (1999). *Management of summer-spawning herring off Iceland.* ICES Journal of Marine Science, 56(6): pp.827-833.

Jardfeingi (2019). *5th Licensing Round*. Available at: http://jf.fo/en/olju-og-gassleiting/undanfarnu-utbjodingarumfor/5-utbjodingarumfar/. Accessed May 2022.

JNCC (2020a). *MPA Mapper*. Available at: https://jncc.gov.uk/mpa-mapper/. Accessed on 10 August 2021.

Josefsson, D. (1998). *Anthropogenic Radionuclides in the Arctic Ocean: Distribution and Pathways.* Doctoral dissertation, Lund University.

Johnson, P. O. (1977). *A review of spawning in the north Atlantic mackerel, Scomber scombrus.* Cefas, Lowestoft.

King, W. M. (1972). *Feasibility study of a pressure-fed engine for a water recoverable space shuttle booster*. Design data book. [online] Available at: https://ntrs.nasa.gov/api/citations/19720018059/downloads/19720018059.pdf. Accessed May 2022.

Klapper, H.S., Zadorozne, N.S., and Rebak, R.B. (2017). *Localized Corrosion Characteristics of Nickel Alloys: A Review*. *Acta Metallurgica Sinica*. (Engl. Lett.) 30: **pp.** 296–305. Available at: https://doi.org/10.1007/s40195-017-0553-z. Accessed May 2022.

Kolts and Juri. (1989). *Alloy 718 for the oil and gas industry*. Superalloy 718: pp. 329-344. Available at: https://www.tms.org/Superalloys/10.7449/1989/Superalloys_1989_329_344.pdf. Accessed May 2022.

Kroodsma, D.A., Mayorga, J., Hoghberg, T., Miller, N.A., Boerder, K., Ferreti, F., Wilson, A., Bergman, B., White, T.D., Block, B.A., Woods, P., Sullivan, B., Costello, C., and Worm, B. (2018). *Tracking the global footprint of fisheries.* Science, 359(6378): pp.904-908.

Lopez, J.S., Lee, L., and Mackey, K.R.M. (2019). The toxicity of copper to *Crocosphaera watsonii* and other marine phytoplankton: A systematic review. Frontiers in Marine Science. Available at: https://www.frontiersin.org/articles/10.3389/fmars.2018.00511/full. Accessed May 2022.

Marine Scotland (2018). *Marine Scotland Consenting and Licensing Guidance*. Available at: https://www.gov.scot/binaries/content/documents/govscot/publications/consultation-paper/2018/10/marine-scotland-consenting-licensing-manual-offshore-wind-wave-tidal-energy-applications/documents/00542001-pdf/00542001-pdf/govscot%3Adocument/00542001.pdf. Accessed May 2022.

Marine Scotland (2020). *National Marine Plan Interactive*. Available at: https://marinescotland.atkinsgeospatial.com/nmpi/default.aspx. Accessed May 2022.

McCauley, R.D., Day, R.D., Swadling, K.M., Fitzgibbon, Q.P., Watson, R.A., and Semmens, J.M. (2017). *Widely used marine seismic survey air gun operations negatively impact zooplankton*. Nature Ecology and Evolution, 1(7): 0195.

Minesto (2020). *Faroe Islands / DGIM.* Available at: https://minesto.com/projects/faroe-islands. Accessed May 2022.

MMO (2019). *UK Sea Fisheries Statistics 2018.* Available at: https://www.gov.uk/government/statistics/uk-sea-fisheries-annual-statistics-report-2018. Accessed May 2022.

Morgana, S., Ghigliotti, L., Estévez-Calvar, N., Stifanese, R., Wieckzorek, A., Doyle, T., Christiansen, J.S., Faimali, M. and Garaventa, F. (2018). *Microplastics in the Arctic: A case study with sub-surface water and fish samples off Northeast Greenland*. Environmental Pollution, 242: pp.1078-1086.

NAMMCO (2019). *Pinniped management areas*. Available at: https://nammco.no/wp-content/uploads/2017/09/management-areas_pinnipeds_sc26_2019.pdf. Accessed May 2022.

NAMMCO (2020). *North Atlantic Marine Mammal Commission. An Intergovernmental Organisation.* Available at: https://nammco.no/. Accessed May 2022.

Natural England (2017). *Marine recreation evidence briefing: non-motorised watercraft including paddlesports.* Available at: http://publications.naturalengland.org.uk/file/5298151744864256. Accessed May 2022.

NatureScot (2019). *Minke whale.* Available at: https://www.nature.scot/plants-animals-and-fungi/mammals/marine-mammals/minke-whale. Accessed May 2022.

NatureScot (2020a). *Fetlar to Haroldswick NCMPA - designation documents.* Available at: https://www.nature.scot/professional-advice/safeguarding-protected-areas-and-species/protected-areas/national-designations/marine-protected-areas/nature-conservation-9. Accessed May 2022.

NatureScot (2020b). *Marine Protected Area - Site Summary - Faroe-Shetland Sponge Belt.* Available at: http://data.jncc.gov.uk/data/411ea794-b135-4877-9fc8-e3e6c054eef9/FSSB-1-SiteSummaryDocument-July14.pdf. Accessed May 2022.

NatureScot (2020c). *Protected Areas.* Available at: https://www.nature.scot/professional-advice/protected-areas-and-species/protected-areas. Accessed May 2022.

NASA (2020). *Draft Environmental Impact Statement for the Mars 2020 Mission.* Available at: https://www.nasa.gov/sites/default/files/files/Mars2020_Section4.pdf. Accessed May 2022.

National Grid (2018). *Underwater Construction Noise Modelling and Assessment report – Effects upon Marine Mammals and Fish*. Available at: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN020015/EN020015-000793-5.9.2.18_App%209.18_Underwater%20Construction%20Noise%20Modelling%20and%20Assessment%20Report.pdf. Accessed May 2022.

NBN Atlas (2020). *Species accounts.* Available at: https://species.nbnatlas.org/. Accessed May 2022.

NOAA (2012). *Arctic Sea Ice Maximum 2012.* Available at: https://earthobservatory.nasa.gov/images/77513/arctic-sea-ice-maximum-2012. Accessed May 2022.

NOAA (2018). *2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0).* NOAA technical Memorandum NMFS-OPR-59.

NOAA (2019). *Kerosene and Jet Fuel Spills*. Available at: https://response.restoration.noaa.gov/sites/default/files/Kerosene-Jet-Fuel.pdf. Accessed May 2022.

NOAA (2020a). *What are microplastics?* Available at: https://oceanservice.noaa.gov/facts/microplastics.html. Accessed May 2022.

NOAA (2020b). *Bathymetric Data Viewer*. Available at: https://maps.ngdc.noaa.gov/viewers/bathymetry/. Accessed May 2022.

NOAA (2020c). *Annual temperature [°C] climatology at the surface (one-degree grid).* Available at: https://www.nodc.noaa.gov/cgi-bin/OC5/woa18f/woa18f.pl. Accessed May 2022.

NOAA (2020d). *Annual salinity at the surface (one-degree grid).* Available at: https://www.nodc.noaa.gov/cgi-bin/OC5/woa18f/woa18f.pl. Accessed May 2022.

Nordregio (2020). *Sea Routes and Ports in the Arctic*. Available at: https://nordregio.org/maps/sea-routes-and-ports-in-the-arctic/. Accessed May 2022.

Norwegian Petroleum Directorate (2020). *FactMaps.* Available at: https://factmaps.npd.no/factmaps/3_0/. Accessed May 2022.

Nova Innovation Ltd (2018a). *EU Flagship Tidal Energy Project Gets Green Light for Next Stages of Delivery.* Available at: https://www.novainnovation.com/post/eu-flagship-tidal-energy-project-gets-green-light-for-next-stages-of-delivery. Accessed May 2022.

Nova Innovation Ltd (2018b). *Crown Estate Scotland Extends Nova's Shetland Seabed Lease to Support Tidal Project Growth.* Available at: https://www.novainnovation.com/post/crown-estate-scotland-extends-nova-s-shetland-seabed-lease-to-support-tidal-project-growth. Accessed May 2022.

Nova Innovation Ltd (2020). *Bluemull Sound; Shetland Tidal Array, Scotland*. Available at: https://www.novainnovation.com/bluemull-sound. Accessed May 2022.

NPC (2015). *Arctic Potential: Realizing the Promise of U.S. Arctic Oil and Gas Resources.* Available at: https://www.npc.org/AR-2015-3-27_NPC-Council_Meeting-FINAL.pdf Accessed May 2022.

Obbard, R.W., Sadri, S., Wong, Y.Q., Khitun, A.A., Baker, I., and Thompson, R.C. (2014). *Global warming releases microplastic legacy frozen in Arctic Sea ice.* Earth's Future, 2(6): pp.315-320.

Ocean Sunfish (2020). *Species and Distribution*. Available at: https://oceansunfish.org/species-and-distribution/. Accessed May 2022.

Offshore Mag (2004). *Faroe Islands hold exploration potential.* Available at: https://www.offshore-mag.com/geosciences/article/16756976/faroe-islands-hold-exploration-potential. Accessed May 2022.

Offshore Mag (2020). *Norway opens latest offshore licensing round.* Available at: https://www.offshore-mag.com/regional-reports/article/14178187/norway-opens-latest-offshore-licensing-round. Accessed May 2022.

Oil and Gas Authority (2020). *Licensing Rounds*. Available at: https://www.ogauthority.co.uk/licensing-consents/licensing-rounds/. Accessed May 2022.

Orkustofnun (2008). *Petroleum Geology of the Dreki area on the Jan Mayen Ridge*. Available at: https://orkustofnun.is/media/radstefnur/Thorarinn_Arnarson_IEC_2008.pdf. Accessed May 2022.

OSPAR (2010). *Quality Status Report 2010: Chapter 5 Hazardous Substances*. Available at: https://qsr2010.ospar.org/en/media/chapter_pdf/QSR_Ch05_EN.pdf. Accessed May 2022.

OSPAR (2016). *Fourth Periodic Evaluation of Progress Towards the Objective of the OSPAR Radioactive Substances Strategy.* Available at: https://www.ospar.org/news/radioactive-discharges-from-the-nuclear-sector-to-the-north-east-atlantic-reduced. Accessed May 2022.

OSPAR (2017). *Intermediate Assessment 2017: Pressure from Human Activities: Contaminants.* Available at: https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/contaminants/. Accessed May 2022.

OSPAR (2020). *The North-East Atlantic*. Available online at: https://www.ospar.org/convention/the-north-east-atlantic. Accessed May 2022.

Oceanwide Expeditions, 2020. *Birds of the North: 29 Arctic Birds and Seabirds*. Available at: https://oceanwide-expeditions.com/blog/22-enchanting-arctic-birds-and-their-most-fascinating-facts. Accessed May 2022.

Paro, A.D., Alvarez-Rosario, A., and Padovese, L.R. (2015). *Sound pressure levels measurements and transmission loss models for explosions in coastal waters.* 2015 IEEE/OES Acoustics in Underwater Geosciences Symposium (RIO Acoustics).

Pohl, C., Kattner, G., and Schulz-Baldes, M. (1993). *Cadmium, copper, lead and zinc on transects through Arctic and Eastern Atlantic surface and deep waters.* Journal of Marine Systems, 4(1): pp.17-29.

Poulain, P. M., Warn-Varnas, A., and Niiler, P. P. (1996). *Near-surface circulation of the Nordic seas as measured by Lagrangian drifters*. Journal of Geophysical Research, 101(C8): pp. 18237-18258.

Reuters (2013). *UPDATE 1-Oil majors eye oil and gas off Arctic Jan Mayen island.* Available at: https://uk.reuters.com/article/norway-arctic/update-1-oil-majors-eye-oil-and-gas-off-arctic-jan-mayen-island-idUKL5N0F71BH20130701. Accessed May 2022.

RSPB (2020). *Find a bird.* Available at: https://www.rspb.org.uk/birds-and-wildlife/wildlife-guides/bird-a-z/. Accessed May 2022.

SACMO (2018). *Is it possible to extract lithium from seawater?* Available at: https://www.samcotech.com/is-it-possible-to-extract-lithium-from-seawater/. Accessed May 2022.

Scholik, A.R., and Yan, H.Y. (2001). *Effects of underwater noise on auditory sensitivity of a cyprinid fish.* Hearing Research, 152: pp.17-24.

Scottish Government (2014). *Seal Haul Out Maps.* Available at: https://www2.gov.scot/Topics/marine/marine-environment/species/19887/20814/maps. Accessed May 2022.

Scottish Government (2015). *Scotland's National Marine Plan.* Available at: https://www.gov.scot/publications/scotlands-national-marine-plan/. Accessed May 2022.

Scottish Government (2017a). *Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017.* Available at: http://www.legislation.gov.uk/ssi/2017/102/contents/made. Accessed May 2022.

Scottish Government (2017b). *Sandeels.* Available at: http://www2.gov.scot/Topics/marine/marine-environment/species/fish/sandeels. Accessed May 2022.

SEAPOP (2020). *SEATRACK Seabird Tracking*. Available at: http://seatrack.seapop.no/map/?_ga=2.55289835.1525943888.1594302703-348817288.1594302703. Accessed May 2022.

Skov, H., Durinck, J., Danielsen, F., and Bloch, D. (1995). *Co-occurrence of cetaceans and seabirds in the Northeast Atlantic*. Journal of Biogeography, 22: pp.71-88.

Skyrora (2019). *Payload User's Guide: Skyrora XL.* Available at: https://www.skyrora.com/skyrora-xl. Accessed May 2022.

Space.com (2013). *Apollo Moon Rocket Engines Raised from Seafloor by Amazon CEO.* Available at: https://www.space.com/20317-apollo-moon-rocket-engines-bezos.html. Accessed May 2022.

Special Metals Corporation (2007). *INCONEL alloy 718.* Publication Number SMC-045.

Street, J.H. and Paytan, A. (2005). *Iron, phytoplankton growth, and the carbon cycle*. Journal of Meteorological Ions and Biological Systems, 43: pp. 153-93. doi: 10.1201/9780824751999.ch7.

Step Change in Safety (2017). *Marine operations: 500m safety zone.* Available at: https://www.guidance.eu.com/assets/_managed/cms/files/MarineOperations500mzoneguidance.pdf. Accessed May 2022.

TeleGeography (2020). *Submarine Cable Map.* Available at: https://www.submarinecablemap.com/#/. Accessed May 2022.

The Barents Observer (2020). *Russia claims to have demonstrated complex exercise outside Norway.* Available at: https://thebarentsobserver.com/en/security/2019/04/russia-demonstrated-complex-bastion-defense-exercise-outside-norway. Accessed May 2022.

Thyssenkrupp (2020). *Stainless steel*. Available at: https://www.thyssenkrupp-materials.co.uk/marine-grade-stainless-steel.html. Accessed May 2022.

(UKMSACP) UK Marine Special Areas of Conservation Project (1995). *Iron*. Available at: http://ukmpa.marinebiodiversity.org/uk_sacs/activities/water-quality/wq8_12.htm. Accessed May 2022.

Virtual Hebrides (2014). *Virtual Hebrides: Hebridean birds.* Available at: https://www.virtualheb.co.uk/hebridean-birds-western-isles-birdlife/. Accessed May 2022.

Visit Faroe Islands (2020). *Birds of the Faroe Islands*. Available at: https://old.visitfaroeislands.com/media/181923/Visit-Faroe-Islands-Birds_UK-singlepages.pdf. Accessed May 2022.

Wang, J., GangaRao, H., Liang, R., Liu, W. (2016) Durability and Prediction Models of Fibre-Reinforced Polymer Composites Under Various Environmental Conditions: A Critical Review Journal of Reinforced Plastics and Composites 35:179 – 211. doi: 10.1177/0731684415610920

Wong, C.S., Boyle E., Bruland, K.W., Burton, J.D., and Goldber, E.D. (Eds) (1983). *Trace Metals in Sea Water*. Springer Science & Business Media.

Woodward, I., Thaxter, C.B., Owen, E., and Cook, A.S.C.P. (2019). *Desk-based revision of seabird foraging ranges used for HRA screening*. BTO Research Report No. 724.

Chapter 11 Landscape, Seascape and Visual Impact

11 Landscape, Seascape and Visual Impact

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11.1 Introduction

11.1.1 This chapter provides an assessment of the effects on landscape resources and visual amenity that are likely to result from the Proposed Project.

11.1.2 The LVIA (Landscape and Visual Impact Assessment) chapter has been prepared by a Chartered Landscape Architect at Hermitage Environmental Planning and Landscape Architecture Limited (Hepla) with over 20 years of professional experience.

11.1.3 This chapter describes: the baseline landscape and visual conditions currently existing within the Proposed Project site and the surrounding landscape and visual impact study area; the likely significant effects on the landscape and visual resource; the mitigation measures included to avoid, prevent, reduce or offset adverse effects; and the likely residual effects after these measures have been employed. The assessment is based on a potential reasonable 'worst case' scenario and the parameters that have defined this are set out in the methodology.

11.1.4 The LVIA concentrates on the key landscape and visual issues identified during the Environmental Impact Assessment (EIA) scoping stage undertaken as part of the planning application process for the SaxaVord Spaceport, from which the Proposed Project will operate. During the previous planning process, consultation was undertaken with Shetland Islands Council and Scottish Natural Heritage (now NatureScot) in relation to:

- landscape effects – both physical changes to constituent elements of the landscape fabric, and how changes in the character and qualities of the landscape and designated areas are perceived by people, as a result of the Proposed Project; and
- visual effects – changes to views or visual amenity, as experienced by people, from key viewpoints, the surrounding sea, settlements, roads, footpaths and cycle routes, as a result of the Proposed Project.

11.1.5 Due to the proximity of the Proposed Project to the coastal edges of the northern islands of Shetland, the LVIA also considers effects on the coastlines and seascape. References to landscape effects used in this chapter also refer to effects on the coastlines and seascape.

11.1.6 The location of the Proposed Project and the extent of the application boundaries is shown on Drawing 11.1.1 and the Proposed Project described in detail in Chapter 3.

LVIA Contents

11.1.7 The LVIA is organised into the following main sections, with additional written data also included in appendices, as described below:

- Introduction;
- Project Description;
  - a description of the aspects of the Proposed Project with the potential to influence landscape and visual amenity within the landscape and visual impact study area;
- Design Optimisation and Mitigation Measures;
  - a description of how the layout and design has responded to potential landscape and visual effects over the duration of the Assessment of Environmental Effects process, and reference to the embedded mitigation measures incorporated at the design stage, aimed at avoiding, reducing or minimising potentially adverse landscape and visual effects;
- Policy;
  - a review of the policy context relevant to landscape and visual matters;

- Consultation;
  - a summary of the consultation completed to agree the scope of the assessment and how matters raised during the consultation process have been addressed;
- Methodology;
  - an explanation of how the LVIA has been carried out, with reference to recommended methodologies and guidelines;
- Existing Environment;
  - a description of the existing landscape and visual amenity and receptors identified within the application area and the wider EZI;
- Assessment of Landscape and Visual Effects;
  - a detailed assessment of the likely significant effects arising from the operation of the Proposed Project on the landscape resources and the perception of landscape character and designated areas within the landscape and visual impact study area;
  - an assessment of likely significant effects on visual amenity arising from the operation of the Proposed Project, including an assessment from a range of viewpoints identified and agreed through consultation with Shetland Islands Council and NatureScot;
- A Summary of In-combination Landscape and Visual Effects;
  - an assessment of the effects arising from the operation of the separate elements of the Proposed Project in combination. Note that this is incorporated into the main assessment under consideration of each receptor rather than being presented separately;
- Summary
  - a summary of the key landscape effects (including seascape and coastal) and visual effects arising from the Proposed Project, and conclusions on the significance of effects.

Supporting Graphics

11.1.8 The LVIA chapter should be read alongside the following plans, photographs and visualisations, which are included in Volume III.

11.1.9 The baseline landscape and visual context is illustrated in: Drawing 11.1.1, LVIA study area; Drawing 11.1.2, Landscape Designations; and Drawing 11.1.3, Landscape/Coastal/Seascape Character Areas. Viewpoint locations are shown in Drawing 11.1.4.

11.1.10 The assessment of landscape and visual effects is supported by the Zone of Theoretical Visibility (ZTV) maps in Drawings 11.2.1 to 11.2.2, and viewpoint photographs and photomontages in Drawings 11.3.1.1 – 11.3.1.10 and 11.3.2.1 – 11.3.2.5.

Appendices

11.1.11 This chapter is accompanied by Appendices 11.1 to 11.5 in Volume IV. These provide greater detail and background information on:

- Appendix 11.1, LVIA Methodology;
- Appendix 11.2, Landscape Character Areas within the study area;
- Appendix 11.3, Coastal Character Areas within the study area;

- Appendix 11.4, Seascape Character Areas within the study area; and,
- Appendix 11.5, Special Qualities Assessment, Shetland National Scenic Area.

Project Description

11.1.12 The Proposed Project comprises the preparation and launch of the Skyrora XL launch vehicle from any of three terrestrial vertical launch pads at the SaxaVord Spaceport situated at Lamba Ness on Unst, Shetland.

11.1.13 The Applicant is applying for a maximum environmental budget of 16 launches per year which, from 2029 when maximum launch cadence is reached, will make up just over one half of the SaxaVord Spaceport environmental budget of 30 launches per year.

11.1.14 The Proposed Project consists of the following, and where appropriate throughout, the term "Proposed Project" shall mean all of the following elements:

- Preparation of Launch Vehicle;
- Storage and Handling of Launch Vehicle Propellant;
- Operation of Ground Segment and Launch Complex; and
- Launch of Skyrora XL launch vehicle (including discarded Stage impact zones).

11.1.15 The Proposed Project will utilise the following existing SaxaVord Spaceport infrastructure:

- Launch Site: located on the Lamba Ness peninsula and comprising three launch pad complexes, 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;
- Integration Hangars –
    - Launch Site Processing Facility (LSPF) hangar buildings (two): located on the Lamba Ness peninsula, a building where the Skyrora XL Launch Vehicles will be assembled and the payload(s) integrated;
    - 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; and
- Support Infrastructure: located on the Lamba Ness peninsula including access, an internal track system and a series of small temporary buildings.

11.1.16 A full description of the Proposed Project is provided in AEE Report Volume II, Chapter 3.

Design Optimisation

11.1.17 Consideration of landscape and visual effects of the Proposed Project has been considered as part of the evolution of the wider SaxaVord Spaceport initiative project design via LVIA at the planning stage and as such mitigation of the effects of the Proposed Project have been embedded into the design of the Spaceport itself. As such, all the effects which are described herein are essentially residual effects.

11.2 Legislation, Policy and Guidance

11.2.1 The legislation, policies and guidance relevant to the LVIA are set out below, and Drawing 11.1.2, Volume III identifies the location and extent of the landscape policy designations.

Legislation

Space Industry Act

11.2.2 The Space Industry Act (2018) regulates all spaceflight activities carried out in the United Kingdom, and associated activities. The Act requires any person or organisation to obtain the relevant licence to:

- launch a launch vehicle from the UK;
- return a launch vehicle launched elsewhere than the UK to the UK landmass or the UK's territorial waters;
- operate a satellite from the UK;
- conduct suborbital activities from the UK;
- operate a spaceport in the UK; or
- provide range control services from the UK.

Policy

11.2.3 Whilst there is no policy specific to the assessment of the landscape and visual effects of launches from spaceports; given the Proposed Project's characteristics, it is possible to follow existing guidance with regard to the effects of development from the planning regime.

National Policy

Scottish Planning Policy

11.2.4 Scottish Planning Policy (SPP) is the statement of the Scottish Government's policy on nationally important land-use planning matters. The 2014 document provides the core principles, statutory guidance, planning policies, and expectations of the Scottish planning system.

11.2.5 SPP acknowledges the importance of protecting valuable landscapes at an international, national and local level to ensure that "the character and quality of a landscape which is important or particularly valued locally or regionally" is safeguarded or enhanced. (Para 199)

11.2.6 SPP goes on to state that "the siting and design of development should take account of local landscape character" and notes that "developers should seek to minimise adverse impacts through careful planning and design, considering the services that the natural environment is providing and maximising the potential for enhancement." (Para 202)

11.2.7 Development of the land will aim to retain and enhance the positive aspects of the site's natural features, whilst addressing potential impacts on both the environment of the adjoining residential areas and the wider setting by promoting a proactive mitigation strategy.

Regional Policy

The Shetland Local Development Plan, 2014

Policy GP3, All Development: Layout and Design

11.2.8 Policy GP3 states that: *"All new development should be sited and designed to respect the character and local distinctiveness of the site and its surroundings,"* and goes on to set out that *"development should make a positive contribution to"* a number of considerations, including, *"maintaining identity and character."*

Policy NH1, International and National Designations

11.2.9 Policy NH1 states that: *"Development that affects a National Scenic Area…will only be permitted where:*

- It will not adversely affect the integrity of the area or the qualities or protected features for which it has been designated, or
- Any such adverse effects are clearly outweighed by social, environmental or economic benefits of national importance."

Policy NH4, Local Designations

11.2.10 Policy NH4 states that: "Development that affects a Local Nature Conservation Site or Local Landscape Area will only be permitted where:

- It will not adversely affect the integrity of the area or the qualities for which it has been identified; or
- Any such effects are clearly outweighed by social, environmental or economic benefits."

Policy HE5, Gardens and Designed Landscapes

11.2.11 Policy HE5 states that: *"Development affecting gardens and designed landscapes should protect, preserve and enhance such places and should not impact adversely upon their character, upon important views to, from and within them, or upon the site or setting of component features that contribute to their value."*

Guidance

Guidance for the Assessment of Environmental Effects

11.2.12 The Civil Aviation Authority "Guidance for the Assessment of Environmental Effects" (2021) explains the process for completing an assessment of environmental effects as part of a licence application under the Space Industry Act and sets out the environmental topics likely to be affected by the proposed activities.

11.2.13 The guidance requires that potential direct and indirect significant effects of proposed spaceflight activities on environmental features are considered. The guidance further requires that:

- Specific potential effects are identified and, where possible, quantified;
- The focus of the AEE should be on significant effects arising from the proposed activities;
- The AEE should explain what other environmental assessments have been conducted in relation to the proposed activities and whether they are being used in support of the AEE;
- Applicants for a launch operator licence set an environmental budget, comprising a maximum number of launches per launch vehicle type which can take place over the course of a year that can be carried out in an environmentally sustainable manner, taking into account the cumulative effect of all launches; and
- The AEE must address a range of environmental topics, including population and human health.

11.3 Consultation

Scoping

11.3.1 Extensive statutory consultation on LVIA was carried out during preparation and determination of the planning application for the SaxaVord Spaceport, from where the Proposed Project will operate. The information provided to consultees included a draft zone of theoretical visibility (ZTV) and a list of suggested viewpoints with grid coordinates, which it was proposed would be assessed within the LVIA for EIA.

11.3.2 Where directly relevant to this AEE, consultation responses received during the SaxaVord Spaceport planning application period have been summarised in Table 11.1.

Table 11.1 SaxaVord Spaceport Consultation Responses directly relevant to this AEE

Consultee	Comment
Shetland Islands Council - Natural Heritage Officer Comments, 1st July 2020	Please use the current advice, which is Assessing impacts on Wild Land Areas -Technical Guidance note Consultation - NatureScot Jan 2017 The standard reference that describes landscape character in Shetland is now the "Scottish Landscape Character Types Map and Descriptions" (NatureScot, 2019) - https://www.nature.scot/professional-advice/landscape/landscape-character-assessment/scottish-landscape-character-types-map-and-descriptions, rather than the 1998 Gillespies report referred to. I'm pleased to see that the LVIA will include coastal character assessment, but I suggest you also assess to include the character of 20. Skaw Coastal Character Area, as well as area 16. East Unst Coastal Character Area I am of the view that the LVIA should also include an assessment of the landscape and visual impact as viewed from the sea; namely, its impact in relation to its seascape character type (as described in "An assessment of the sensitivity and capacity of the Scottish seascape in relation to offshore windfarms. Scottish Natural Heritage Commissioned Report No.103, Scott, K.E., Anderson, C., Dunsford, H., Benson, J.F. and MacFarlane, R. (2005)). The [Proposed Project] site is remote, isolated and essentially undeveloped with extensive visibility from the sea. That report describes 2 seascape character types for Shetland, namely: Type 1: Remote High Cliffs Type 13: Low, rocky island coasts The area for the Proposed Project is described as Low, rocky island coasts. I should be happy to discuss how that might be achieved. In terms of the Key Questions for Consultees

Consultee	Comment
	➢ I confirm that GLVIA3 is the correct framework for the methodology; ➢ I am content with the proposed 15 km extent of the [study area]; ➢ I am content with the proposed viewpoint selection, which are sufficiently representative; ➢ The only other documents I suggest you refer to are noted above; ➢ I am not aware of any other development proposals that should be considered in the cumulative assessment; ➢ I am content with the important landscape and visual receptors selected.
Scottish Natural Heritage (now NatureScot), Jonathan Swale, 7th July 2020	We are content with the scope of your proposed LVIA.

11.4 Assessment Methodology and Significance Criteria

11.4.1 This chapter is supported by Appendix 11.1, which contains a detailed description of the method of assessment.

Guidance

11.4.2 The Landscape and Visual Assessment methodology follows good-practice guidance and advice on the assessment of the impacts of development on landscape and visual resources. A key source of guidance is the Guidelines for Landscape and Visual Impact Assessment (Third Edition, 2013) (GLVIA 3). Other documents specific to photography and visualisation techniques, and cumulative impacts have also been referred to. These are listed in full in Appendix 11.1 Volume IV.

Overview of Methodology and Limitations

11.4.3 The approach to the LVIA included the following key tasks:

- Desk study: A desk study was undertaken to define the baseline landscape and visual resource within the study area and identify the main users of the area, key viewpoints and key features. Refer to Appendix 11.1 for further details;
- Field survey: The landscape and visual resource identified through the Desk Study was then verified through field survey work. This allowed the assessor to gain a full appreciation of the relationship between the Proposed Project and the landscape. Refer to Appendix 11.1 for further details;
- Confirmation of scope, methodology and confirmation of the viewpoints to be included in the assessment was completed through correspondence with Shetland Islands Council and NatureScot. Viewpoints are used as a proxy in order to understand effects across the study area, because it is not feasible to make an assessment of every visual receptor across an extensive area. This is standard practice;
- Baseline assessment of landscape and visual resources (consisting of desk study, field survey and reporting) reviews the existing landscape and visual resource of the study area in terms of its character, quality (i.e., the baseline condition) and establishes

sensitivity of the resources/receptors. The baseline assessment forms the basis against which to assess the magnitude and significance of the predicted landscape and visual effects arising from the Proposed Project;

- Layout and design optimisation, seeking to develop the design and layout of the Proposed Project based upon a combination of landscape and visual factors alongside, ecology, ornithology and peat constraints;
- Assessment of landscape and visual effects. The assessment describes the changes in the character and quality of the landscape and visual resources that are expected to result from the Proposed Project. In assessing landscape impacts, the potential direct effects on the fabric of the landscape are considered, together with the effects on the perception of landscape character. The baseline landscape character assessment together with an assessment of the effects on each character area is included in the assessment, along with consideration of the extent of potential significant effects. The visual assessment includes a viewpoint analysis which has been carried out to identify and evaluate the effects on visual amenity arising from the Proposed Project at specific representative locations in the study area; and,
- Assessment of in-combination effects sets out the scope of work undertaken for the assessment of the potential landscape and visual effects arising from the interaction of the separate elements of the Proposed Project.

11.4.4 Limitations of the standard approach include the use of agreed viewpoints as a proxy in order to understand effects across a wide area, and the limitations of the ZTV modelling, which can only be as accurate as the underlying data and the resolution at which this is available (50 m Digital Terrain Model).

Environmental Zone of Influence (EZI) and Study Area

11.4.5 For the purposes of this AEE, the Environmental Zone of Influence (EZI) is based on and comprises the proposed launch flight corridor and all study areas required for the technical disciplines included in the AEE, as presented on drawing 3.6.

11.4.6 Within the EZI, the study area(s) required for each technical discipline assessed vary. The study area for the LVIA is defined by a 15 km radius oval offset from the outermost edge of the Proposed Project, as shown in the context of the AEE on Drawing 2.1 and reproduced in greater detail on Drawing 11.1.1.

Process of Assessing Effects and their Significance

11.4.7 Once the baseline situation in relation to landscape and visual receptors has been reviewed, this information is combined with an understanding of the proposed change or development that is to be introduced, in order to identify and describe the landscape and visual effects. As the mitigation is embedded as part of the design, potential effects and residual effects will be the same. The assessment process determines whether the level of an effect will be significant or not through methodical consideration of, firstly, the sensitivity of landscape and visual receptors relative to changes as a result of the Proposed Project and, secondly, the magnitude of change that they will experience.

11.4.8 A more detailed description of the principles used in assigning sensitivity to change to landscape and visual receptors and evaluating the likely magnitude of change that will be experienced in relation to the Proposed Project, and in the subsequent consideration of sensitivity and magnitude in determining the level and overall significance of resultant effects, as informed by GLVIA 3, is set out in Appendix 11.1.

Level of Effects and Determination of Significance

11.4.9 The level of any identified landscape or visual effect has been assessed as major, moderate, minor or no effect, or intermediate categories (e.g., major/moderate) between these. These categories

have been determined by consideration of the sensitivity of landscape or visual receptor and the predicted magnitude of change that will be experienced as a result of the Proposed Project, as summarised above and described in detail in Appendix 11.1, Volume IV. The following matrix in Table 11.2 is used as a guide to correlate sensitivity and magnitude to determine the level of predicted effects and their significance.

Table 11.2 - Significance of Effects on Landscape and Visual Receptors

Sensitivity	Magnitude of Change			
	Substantial	**Moderate**	**Slight**	**Negligible**
High	Major	Major to Moderate	Moderate	Moderate to Minor
Medium	Major to Moderate	Moderate	Moderate to Minor	Minor
Low	Moderate	Moderate to Minor	Minor	Minor to None
Negligible	Moderate to Minor	Minor	Minor to None	Minor to None

11.4.10 This assessment has been calibrated such that the threshold of significance in terms of AEE is major to moderate. In this assessment, moderate level effects, and those below this level are not considered to be significant. Where, for the purpose of this assessment, the landscape or visual effect has been classified as major or major/moderate, this is considered to be a significant effect.

11.4.11 The table is not used as a prescriptive tool, and the methodology and analysis of effects at any particular location must make allowance for the exercise of professional judgement. Thus, in some instances, a particular parameter may be considered as having a determining effect on the analysis.

Supporting Graphics

11.4.12 The LVIA is supported by a range of Drawings including viewpoint photography. These have been prepared in adherence to the principles presented in the Landscape Institute's Advice Note *TGN 06/19 Visual Representation of development proposals,* GLVIA3, and NatureScot's *Visual Representation of Wind Farms*, Version 2.2, 2017.

11.5 Baseline Conditions

11.5.1 This section provides a general description of the landscape and visual context of the Proposed Project and study area. It briefly describes the historical and cultural context within the study area, identifying both sensitive locations and receptors to be addressed in the subsequent impact assessment.

The Application Site

11.5.2 The location of the Proposed Project is shown in Drawing 11.1.1.

Proposed Project

11.5.3 The Proposed Project is located between Inner Skaw and Lamba Ness on the peninsula which extends east into the North Sea to the north east of Norwick on Unst. The peninsula falls into the Coastal Edge landscape character area (LCA), to the east of the Major Uplands LCA, as identified on the online NatureScot data: Scottish Landscape Character Types Map and Descriptions. The surrounding seascape is described in the Shetland Coastal Character Assessment (2016), falling within the East Unst coastal character area (CCA).

11.5.4 The broad, flat, grassed headland, now used for rough grazing, is accessed via a narrow tarmac track, with a regular scattering of derelict buildings and bunkers which formed part of the extensive former Skaw Radar Station. The complex of approximately 50 buildings and structures is now designated as a scheduled monument. At the edges of the peninsula the land falls away steeply through steep cliffs to the surrounding sea, frequent sea stacks, skerries and inlets with the constant movement of waves and wind. The peninsula is seen against the backdrop of the rising uplands at Saxa Vord to the west, with expansive views across the sea at Nor Wick to the Hill of Clibberswick and island of Balta to the south, and the headland at Blue Jibs and the Holm of Skaw to the north.

11.5.5 The peninsula lies at approximately 11 m AOD, rising to high point of 31 m AOD at Lamba Ness. To the west the land begins to rise at Skaw, reaching 60 m at the minor road (Holsens Road), and then rising steeply beyond to the Ward of Norwick to the west at 181 m AOD.

The Wider Study Area

11.5.6 The wider study area includes the exposed upland landscapes to the north and west with the Herma Ness headland to the north west and the adjoining uplands around Saxa Vord to the north east; the pronounced north-south ridge bounds the study area along the western side of Unst at Valla Field. These upland landscapes contrast with the more sheltered central and eastern landscapes, with the long north – south central valley and rolling hills of central Unst, and the settled farmland along the east coast at Balta Sound, Nor Wick and Harold's Wick. Topographical elevations range from 0 m to approximately 250 m Above Ordnance Datum (AOD).

General Characteristics and Features of the Study Area

Extent of the Study Area

11.5.7 The 15 km radius study area, focussed on north-eastern Unst, encompasses the northern and middle extent of the Island of Unst and the archipelago of islets.

Topographical Features

11.5.8 The western edge of Unst comprises a linear ridge of higher ground between Hermaness Hill (200 m AOD), Snuega (131 m AOD) and Valla Field (216 m AOD), which is dominated by peat moorland. This ridgeline shelters the undulating eastern portion of the island which is interspersed with areas improved grassland, rough grazing and heathland. The interlocking network of hills including Saxa Vord (250 m AOD), Ward of Norwick (186 m AOD), Housi Field (122 m AOD) and the Hill of Clibberswick (160 m AOD) frame the core of the study area at Skaw, Lamba Ness and Norwick. The lower lying and sheltered land to the east around the coast, voes and sounds, as well as inland valleys are settled, with areas of enclosed farmland.

Natural Heritage Features

11.5.9 The EZI covers a diverse range of landscapes, encompassing coastal, maritime, lowland and upland areas that support a variety of flora and fauna. In addition, the geology of the region provides a broad range of sites of geological and geomorphological interest. The key natural heritage attributes can be broadly summarised as follows:

- upland/moorland habitats;
- rock outcrops;
- areas of acid grassland;
- littoral habitats;
- intertidal habitats; and,
- maritime habitats.

11.5.10 The non-porous nature of the metamorphosed sedimentary bedrock, the presence of boulder clay and the cool and damp climate have combined to create large expanses of peatland across the ridgeline along the western edge of Unst. The eastern area of Unst has an undulating landform with Serpentine and Greenstone bedrock, often close to the surface, with a surface layer of shattered rock and glacial drift. There are areas of improved grassland, good rough grazing land and heathland without peat, resulting from the nature of the underlying rock.

11.5.11 The eastern area of Unst has particular geological interest, formed from a fragment of the ancient Lapteus Ocean. The unusual serpentinite rocks are a focus for local geological interpretation, giving rise to a strange landscape of peat free rusty-brown crags, with rare minerals, flower-rich heathland and bare gravel that supports rare plants.

11.5.12 There is comparatively little farmland, with small pockets of improved and rough grassland concentrated along the coastal strip, around voes, inlets and along valleys, related to areas of boulder clay and other glacial drift deposits.

Archaeological Features

11.5.13 The study area has a long cultural history with evidence of man's actions extending over some 8,000 years. Neolithic and Bronze Age settlement occurred in more favourable climatic conditions and as a result, occupied diverse locations across the islands. Subsequent patterns of settlement and land use have exploited the most productive land on the lower slopes of sheltered coasts and voes, benefitting from access to both hills for grazing and the sea for fishing and transport.

11.5.14 There are 392 Scheduled Monuments in Shetland ranging from Bronze Age burial chambers to later medieval features and Second World War defence infrastructure. The following Scheduled Monument sites are located on or close to the site:

- Skaw, radar station: The monument comprises the remains of a Second World War Chain Home radar station. The station is spread over two sites, a main and a reserve site, with over 50 buildings and structures reflecting its core early warning function and with supporting infrastructure and domestic blocks. It is located on rough grazing land over two headlands. Within the Proposed Project site at Lamba Ness and at Blue Jibs to the north; and,
- Inner Skaw, houses and field system, Unst: The monument comprises the remains of a series of farmhouses, the earliest of which may be of early Norse date, and a nearby series of abandoned fields of various dates and forms which would have been associated with different phases of the farming settlement.

11.5.15 These features are noted as visitors are attracted to them and are potential visual receptors.

Built and other Heritage Features

11.5.16 Other important sites which may attract visitors, and hence be of relevance as potential visual receptors within the EZI include:

- Skaw, Boat-Roofed Shed – Category C Listed Building: Outbuilding to N of Skaw Cottage comprising roughly oval battered random rubble base with door centred to SE side, roofed with over-turned and tarred former lifeboat.

- Norwick, The Banks, including cottage, outbuilding, ruin, boundary and sea walls – Category C Listed Building: Group of crofting buildings, dry stone walls and sea wall with a traditional character.
- Unst Heritage Centre, Haroldswick;
- Unst Boat Haven;
- Cromite Horse Mill at Hagdale; and,
- Viking Unst: The Shetland Amenity Trust promote the understanding and interpretation of the period of Viking settlement in Unst. This includes interpretation, display and a sequence of trails. Specific sites relevant to the EZI include:
    - The Skidbladner (replica Gokstad ship), and the Viking Longhouse reconstruction, both located at Haroldswick.
    - Harald's Grave, on the hillside above Harold's Wick.

Settlement

11.5.17 The extensive upland and exposed coastline to the north-west of Unst is uninhabited. The climatic conditions place a strong emphasis for settlement in areas where the landform affords shelter from the high winds. The sheltered voes, sounds and inland valleys are, as a consequence, extremely important and these areas have been the focus for continued settlement and activity since the Iron Age. The adjoining productive low-lying land between the moorland hills and the sea, providing for grazing and fishing respectively.

11.5.18 Unst retains this traditional settlement pattern. In northern Unst, settlement is focussed on the low-lying land between Burra Firth, Harold's Wick and Nor Wick with clusters of settlement at Haroldswick, Valsgarth and Norwick with scattered farming settlement between. Through mid Unst settlement is focussed through the lowlands around Balta Sound and the farming lands to the west with the main centre of settlement at Baltasound.

Roads

11.5.19 Roads have replaced the sea as the main way of travel. In the recent past many of the smaller winding roads have been straightened and widened and the engineering works associated with road upgrades has had a considerable effect on the character of the landscape in places.

11.5.20 The main A698 road, crosses Unst from the ferry port at Belmont in the south (receiving traffic from the mainland and Yell) and connects to Baltasound in the north-east. This road has been upgraded and forms an intrusive corridor through the wild landscape of the interior with modified vegetative cover related to the road's verges cuttings and embankments. The B9087 connects Baltasound to Valsgarth and settlement on the north-east coast of Unst; and B9086 connects to Burrafirth in the north. Minor spur roads connect to the smaller hamlets along the coastlines.

Cycle Network

11.5.21 National Cycle Route 1 connects from Sumburgh in the south of the Mainland through to Skaw in north-eastern Unst. On Unst the route follows the main road, A968, and continues on the B9087.

Walking Routes

11.5.22 There are no national walking routes defined on Shetland however, there are extensive opportunities for walking throughout the islands. Shetland Islands Council has designated a core path network to provide a reasonable level of public access in the Shetland Core Paths Plan. Key routes on Unst relevant to the Proposed Project include a loop around Clibberswick Hill, a route at Haroldswick and a circular route at Hagdale.

11.5.23 A longer linear core path provides access to the north-western coastline and Hermaness Hill from Burrafirth and a linear route from Houlland at the southern edge of the Loch of the Cliff through to Woodwick.

Tourism and Recreation

11.5.24 Many tourists travel to Unst as one of their main destinations on Shetland. Opportunities for tourism and recreation within the EZI focus on outdoor pursuits such as walking, sea kayaking, bird watching, fishing, and visiting the numerous archaeological sites and geoparks. These activities tend to take place in the coastal areas enjoying the dramatic contrasts between sea, sky and land.

11.5.25 Visitor attractions on the island include important areas for bird watching on the coastal nature reserves around Herma Ness, Saxa Vord and Muckle Flugga stacks on the north and north-western coasts of Unst. At Baltasound the Unst Boat Haven and Unst Heritage Centre are a focus for tourist visits. Informal visitor attractions in the EZI include the beaches at Norwick and Skaw.

Baseline Landscape Resources

11.5.26 The character and value of the EZI has been reviewed in greater detail against existing landscape character assessments, landscape designations, and other relevant non-designated areas, as set out below.

Landscape Character Assessment

Scottish Landscape Character Types Map and Descriptions Online (NatureScot, 2022)

11.5.27 NatureScot has used a system of landscape character assessment to identify, describe, classify and map Shetland. Using accepted, systematic methods of landscape character assessment, the countryside has been subdivided into different Landscape Character Types (LCTs) and Landscape Character Areas (LCAs), each with a distinctive character based upon local patterns of geology, land form, land use, cultural and ecological features. These provide information that can be used to guide landscape change and provide a baseline against which to make judgements on the likely effects of the Proposed Project upon landscape character.

Shetland Coastal Character Assessment, NAFC Marine Centre (NAFC), 2016

11.5.28 In addition to the landscape character areas, the NAFC Marine Centre has prepared the Shetland Coastal Character Assessment, 2016 which provides a characterisation of the Shetland seascape. The coastal character assessment identifies and maps different Coastal Character Areas (CCAs).

An assessment of the sensitivity and capacity of the Scottish seascape in relation to offshore windfarms, Scottish Natural Heritage Commissioned Report No.103, 2005

This document defines seascape character types around the Scottish coast, combining coastal and marine character to define seascape character.

11.5.29 These studies provide an assessment of the landscape, seascape and coastal character of the area, and consider the likely pressures and opportunities for change in the landscape / seascape. The LCTs, SCAs and CCAs that fall within the 15 km radius EZI are illustrated in Drawing 11.1.3 Volume III and described in detail in Appendix 11.2, Appendix 11.3 and Appendix 11.4 respectively.

11.5.30 The Proposed Project includes parts of the 355 - Coastal Edge LCT and 349 - Major Uplands LCT as identified in the Scottish Landscape Character Types Mapping.

11.5.31 The Coastal Edge Landscape Type is described as follows:

"The dramatic Coastal Edge Landscape Character Type occurs in several narrow strips around the exposed, mainly rocky coastline of Shetland. It forms the edge of upland and lowland Landscape Character Types, and includes dramatic coastal features, including towering sea cliffs, stacks and natural arches."

11.5.32 Key characteristics of the Coastal Edge LCT are described as follows:

- *"Narrow, indented coastal edge of rocky headlands, inlets and promontories on exposed parts of the coast.*
- *Mainly high to moderately high cliffs with frequent features of coastal erosion including stacks, arches, blowholes, caves and storm beaches.*
- *Diversity of colour and rock forms derived from the wide variety of bedrock.*
- *Short, colourful swards of maritime heath and grasslands on cliff tops and some sheltered cliffs, with bare, scoured rock in exposed locations.*
- *Many prehistoric and wartime archaeological relics revealed in short grassy landcover.*
- *Diverse and dramatic coastal scenery with a variety of coastal views.*
- *Remote, exposed, open and highly natural landscape with wild character."*

11.5.33 The Major Uplands Landscape Type is described as follows:

"The Major Uplands Landscape Character Type occurs as several upland hill masses incorporating the highest land in Shetland, forming the main physical structure of Shetland. The Landscape Character Type occupies large parts of central and south Shetland Mainland, with western and eastern outliers at Bressay, Sandness Hill, Ronas Hill, Foula, Fair Isle and in the north at Unst. The landcover is dominated by peatland and heather moorland peaty mires."

11.5.34 Key characteristics of the Major Uplands LCT are described as follows:

- *"Rounded hills, occurring either in series connected by high level rounded ridges along a linear band, or as isolated single hills or hill groups.*
- *Often steep slopes at the coast, or cliff edges with dramatic natural coastal landforms.*
- *Mainly simple landcover of peat bog and heather moorland grading to rough grassland on some lower slopes, contrasting with the ordered fields of adjoining lowlands and the intricate coastline.*
- *Hill grazing and low-key peat cutting.*
- *Mainly uninhabited and often difficult to access on foot or by road, with roads mainly absent on higher land.*
- *Exposed high land with panoramic views, forming landmark features which themselves are often visible for miles.*
- *Relatively expansive, although scale is difficult to discern and reduced by the*
- *presence of manmade structures.*
- *A sense of remoteness and wild character in places."*

11.5.35 The Farmed and Settled Voes Landscape Type is described as follows:

"The Farmed and Settled Voes and Sounds Landscape Character Type occurs in Shetland around the enclosed coastal waters which are distributed around most parts of the islands... They are dominated by pasture and rough grassland resulting from long established farming. The type includes Shetland's main towns and many harbour settlements. Along with the Farmed and Settled Lowlands and Coasts, these areas constitute the majority of Shetland's most productive farmland."

11.5.36 Key characteristics of the Farmed and Settled Voes LCT are described as follows:

- *"Narrow, low lying coastal strips of gently sloping or undulating land around enclosed waters.*

- *Complex, indented coastline which provides shelter.*
- *Mainly agricultural land use on improved and unimproved pastures with heathland, wetland and wet pastures which add variety.*
- *Unusual grassland and heathland on base-rich soils on Unst and Fetlar.*
- *Scarce broadleaf tree cover found in very small remnant woodland patches and recent plantations.*
- *Mostly traditional crofting in linear or scattered patterns, with some estates.*
- *Larger settlements around harbours with historic built heritage.*
- *Mainly inland, minor road network with branches to beaches and harbours.*
- *Abundant archaeology across all periods of human settlement.*
- *Rural areas provide a contrasting backdrop and setting for settlements.*
- *Rural areas and settlements contrast with the surrounding, large scale hill land.*
- *Views are ever-changing due to the complex coastline and interlocking landforms.*
- *Remote settlements have a strong sense of isolation and tranquillity."*

11.5.37 In undertaking the preliminary assessment and review of baseline material against the visibility mapping of the Proposed Project, and through subsequent fieldwork, it is considered that (leaving aside a launch which will have wider visibility and is considered separately), beyond a 15 km radius the Proposed Project will be seen as a distant element in the landscape and that there will be only a limited influence on the characteristics, defining features and/or special qualities of the LCTs/SCAs/CCAs. Although there may be some effects on landscape character beyond a 15 km radius from the Site, these are not likely to be significant and, in this regard, LCTs/SCAs/CCAs (as well as sub-units of the Shetland NSA, WLAs and LLAs) beyond 15 km of the Proposed Project Site have not been assessed further. LCTs/SCAs/CCAs within a 15 km radius of the Proposed Project have been reviewed in detail and provide an appropriate basis to describe the landscape/seascape/coastal character of the area surrounding the Proposed Project.

11.5.38 There are 12 LCTs/SCAs/CCAs within 15 km of the Proposed Project. Of these CCA 13 Bura Firth, Unst, CCA 19, Hermaness, and SCA 1: Remote High Cliffs will experience limited or no visibility to the Proposed Project and have therefore not been considered further in this assessment.

11.5.39 The nine remaining LCTs/ SCAs/CCAs have the potential to be significantly affected by the Proposed Project, as listed in Table 11.3 and are included in the detailed assessment reporting in Section 11.7.

Table 11.3 Summary of LCTs / CCAs within 15 km of the Proposed Project and within the Zone of Theoretical Visibility

Landscape Character / Seascape / Coastal Character Area (CCA)	Source	Value	Susceptibility	Overall Sensitivity to Change Associated with the Proposed Project
349 Major Uplands	NatureScot Online Maps and Descriptions	High	High	High
350 Peatland and Moorland	NatureScot Online Maps and Descriptions	Medium	Medium	Medium
352 Inland Valleys	NatureScot Online Maps and Descriptions	Medium	Medium	Medium

Landscape Character / Seascape / Coastal Character Area (CCA)	Source	Value	Susceptibility	Overall Sensitivity to Change Associated with the Proposed Project
353 Farmed and Settled Lowlands and Coast	NatureScot Online Maps and Descriptions	High	Medium	High Medium
354 Farmed and Settled Voes and Sounds	NatureScot Online Maps and Descriptions	Medium	Medium	Medium
355 Coastal Edge	NatureScot Online Maps and Descriptions	High	Medium	High Medium
CCA 16, East Unst	SCCA, NAFC 2016	High	High	High
CCA 20, Skaw	SCCA, NAFC 2016	High	High	High
Seascape Character Type 13 D: Islands, Sounds and Voes	Sensitivity and Capacity of the Scottish Seascape, NatureScot, 2005	High	High	High

Landscape Designations and Other Relevant Areas

11.5.40 Landscape designations are important in the context of the LVIA with regard to the effects of the Proposed Project on the landscape quality and visual amenity of designated areas within the EZI.

11.5.41 Landscapes designated at the national scale include National Scenic Areas (NSAs). Local Landscape Areas (LLAs) are designated by Shetland Islands Council. The location and extent of these designations within the EZI are shown in Drawing 11.1.2 and are described below.

National Scenic Areas

11.5.42 Within Scotland, NSAs are areas of outstanding scenic value in a national context. There are 40 designated NSAs in Scotland, which cover approximately 13% of Scotland, with policies for protecting the NSAs set out in development plans. In 2007 and 2008 NatureScot, working in partnership with Historic Scotland and the Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS), surveyed all NSAs to list the landscape qualities that make each special, as set out in The Special Qualities of the National Scenic Areas, Scottish Natural Heritage Commissioned Report No.374, 2010.

11.5.43 Seven small areas of coastal landscape in Shetland have been identified as being of outstanding scenic interest. These designated areas that make-up the Shetland NSA comprise Shetland's scenic highlights and epitomise the range of coastal forms varying across the island group.

11.5.44 One NSA sub-unit, Hermaness, is located within the EZI. The identified special qualities of the Hermaness sub-unit are as follows:

- *"The stunning variety of the extensive coastline;*
- *The hidden coasts;*
- *The effects and co-existence of wind and shelter;*
- *A sense of remoteness, solitude and tranquillity;*
- *The notable and memorable coastal stacks, promontories and cliffs;*

- *The distinctive cultural landmarks; and*
- *Northern light."*

11.5.45 The following additional notes relevant to the special qualities for the Hermaness NSA sub-unit are set out in the report:

"The stunning variety of the extensive coastline

At Hermaness on Unst, the coastal topography varies from the 175m high cliffs at the Neap, to the sandy beach and machair at the head of the narrow Burrafirth.

The notable and memorable coastal stacks, promontories and cliffs

Where open to the full fury of the Atlantic Ocean, the sea has carved impressive cliffs, forming spectacular, towering, vertical scenery, varying greatly in colour according to the complex geology.

The coast also contains many distinctive stacks, promontories and other features that form memorable images. Within the NSA these include:

The imposing cliffs of Hermaness itself, with its nesting seabirds."

Local Landscape Areas

11.5.46 In 2014 Shetland Islands Council published the Current Local Landscape Areas, as draft supplementary planning guidance. This document which follows on from the Shetland Local Landscape Designation Review, 2011, sets out for each of the proposed Local Landscape Areas (LLAs): the location and boundaries; the key characteristics; a designation statement; and provides development guidelines.

11.5.47 Three LLAs are identified within the EZI. Analysis of the ZTV indicates that there is very limited very long-distance visibility (in excess of 15 km), or no theoretical visibility of the Proposed Project from two of the LLAs that lie within or overlap with the EZI, as follows:

- Colvadale and Muness, Unst LLA: A small are of distant visibility from Muness, at distances of around 15 km; and,
- Gloup Voe and Bluemull Sound LLA: No visibility.

11.5.48 Owing to the very limited and long-distance nature of visibility, or absence of visibility, these LLAs will not be affected by the Proposed Project to a level that could result in significant effects therefore, they have not been considered further as part of this assessment. The draft designation statements for the remaining LLA at Haroldswick and Skaw taken from Current Local Landscape Areas, 2014 are set out below.

Proposed LLA 15: Haroldswick and Skaw

"Key characteristics:

- *Part of the most northerly area of Shetland and Britain*
- *Highly visible military defence infrastructure, including active and disused elements*
- *Rugged, exposed northern coast, with sheltered sandy bays*
- *Rich geology visible at the surface*
- *Actively settled area undergoing redevelopment as former military uses decline and new uses are found."*

Designation statement:

"This is a rugged landscape with a great variety in landform. The rocky headlands and dramatic folded cliffs of the north coast are topped with moorland, contrasting in its smoothness. This moorland continues upwards to a group of rounded hills, the highest being Saxa Vord."

Inventory Gardens and Designed Landscapes

11.5.49 The Inventory of Gardens and Designed Landscapes in Scotland is a list of nationally important Gardens and Designed Landscapes (GDLs) that meet the criteria published in Historic Scotland's 2011 publication, Scottish Historic Environment Policy.

11.5.50 Belmont House lies approximately 18 km from the Proposed Project and is screened from direct views. Effects will not be significant and have not been considered further in this assessment.

11.5.51 Table 11.4 below sets out a summary of the designated landscapes considered in the assessment and their sensitivity to the Proposed Project.

Table 11.4 - Summary of Landscape Designations within the Zone of Theoretical Visibility

Landscape Designation	Value	Susceptibility	Overall Sensitivity to Change Associated with the Proposed Project
Hermaness National Scenic Area	High	High	High
Haroldswick and Skaw, Local Landscape Area	High/Medium	Medium	Medium

Baseline Visual Resources

11.5.52 A key component of the assessment is the consideration of effects from key locations within the EZI. This assessment is undertaken through analysis of visibility mapping and confirmation of the extent of visibility, through the preparation of wireframes and use of these in the field in combination with photomontages.

Settlements

11.5.53 Settlement within the EZI is located in sheltered locations close to sheltered voes and sounds, typically comprising open settlements and dispersed aggregations of crofts.

11.5.54 In accordance with the criteria outlined in the detailed methodology in Appendix 11.1, residential receptors within settlements have a high susceptibility to change as views are experienced regularly for prolonged periods. Residential receptors are generally considered to have a high sensitivity overall to the Proposed Project.

11.5.55 The following table lists the principal areas of settlements into the zone of theoretical visibility of the Proposed Project where significant effects may arise, as illustrated in Drawings 11.2.1-11.2.2. and identifies those settlements which require further assessment.

Table 11.5 - Summary of Settlements within the Zone of Theoretical Visibility

Settlement	Approximate Distance to Proposed Project	Theoretical Visibility of the Proposal
Within 5 km of the Launch Pads		
The Haa, Skaw	750 m	No visibility.
Booths/Houlanbrindy	660 m	Partial visibility to the integration hangar/TEL building, boundary fencing, tracking station, Skyrora XL Launch Vehicle, and lightning masts.

Settlement	Approximate Distance to Proposed Project	Theoretical Visibility of the Proposal
Norwick/Kirkaton	1.2 km	Partial visibility to the gate house, LSPF, boundary fencing, tracking station, integration hangar/TEL building, Skyrora XL Launch Vehicle and lightning masts.
Valsgarth/Saxa Vord	2.3 km	Partial visibility to the gate house, LSPF, boundary fencing, tracking station, integration hangar/TEL building, Skyrora XL Launch Vehicle, and lightning masts.
Haroldswick	3.2 km	No visibility.
Ungirsta/Stove	3.5 km	No visibility.
Within 10 km of the Launch Pads		
Burrafirth Cluster	4.36 km	No visibility.
Quoys	4.46 km	Uninhabited.
Baltasound Cluster (closest location at garage)	5.29 km	No visibility.
Within 15 km of the Launch Pads		
Westing Cluster	13.4 km	No visibility.

Routes

11.5.56 Vehicular and non-vehicular route corridors within the EZI, include roads and designated cycle routes. The following table lists route corridors within 15 km of the Proposed Project, falling within the zone of theoretical visibility, as illustrated in Drawings 11.2.1-11.2.2. The table identifies which routes or parts of routes require further assessment.

Table 11.6 - Review of visibility from Routes within the EZI

Route	Theoretical Visibility of the Proposal
A968 (National Cycle Route 1)	No visibility to Proposed Project; no visibility south of Hagdale.
B9086	Intermittent visibility from higher ground around Ungrista to Proposed Project; limited visibility elsewhere - Included in the detailed assessment.
B9087 (National Cycle Route 1)	Extensive visibility north of Valsgarth/Saxa Vord to the Proposed Project- Included in the detailed assessment.

Viewpoint Selection

11.5.57 Viewpoints for the visual assessment were identified following production of the ZTV and a list of viewpoints were selected and confirmed with consultees as part of the scoping exercise, as summarised in Section 11.3. The types of receptors considered included the following:

- different LCTs/CCAs/SCAs;
- designated and other sensitive landscapes;

- settlements (towns and villages, as well as smaller groups of residential properties);
- roads (main and minor);
- footpaths and cycle routes including Core Paths and the National Cycle Network (NCN) Routes;
- marked/ popular viewpoints;
- other outdoor recreational resources (including frequently visited historical and archaeological sites); and,
- visitor/ tourist facilities such as camp sites, hotels and visitor attractions.

11.5.58 In order to confirm the appropriateness of the viewpoint selection, field survey verification was carried out. This involved checking the viewpoint grid references on the ground, to ensure that there will be views of the Proposed Project from these locations.

11.5.59 The viewpoints taken forward for full assessment include 21 viewpoints that cover a range of representative landscape and visual receptors, distances from the Proposed Project, altitudes and directions, with the aim of achieving a reasonable distribution at compass points around the application site. Viewpoints were visited as part of the baseline visual assessment, and panoramic photographs of the existing views were taken. The final list of viewpoints, agreed through written correspondence with Shetland Islands Council and NatureScot, is shown in Table 11.7, and their locations are illustrated in Drawing 11.1.4. Photographs of the existing views from these viewpoints are shown in Drawings 11.3.10.1 – 11.3.2.5. The existing and predicted views of the Proposed Project are described in the assessment of effects in Section 11.8.

Table 11.7 – Selected Viewpoints

No.	Viewpoint Location	Distance and Direction to Proposed Project	Receptors	Grid Reference
Viewpoints to the Proposed Project				
1.1	Bluejibs above the Wick of Skaw	1.1 km to the south.	Local Landscape Area and recreational walkers, representative of views from the north-east coast of Unst.	466309, 1216806
1.2	The Haa, Wick of Skaw	860 m to the south.	Local Landscape Area and residential settlement.	465968, 1215187
1.3	The Garths, Lamba Ness	320 m to the east.	Local view to the launch pads.	465405, 1215187
1.4	Car park at The Taing, Norwick	800 m to the north east.	Local Landscape Area and residential settlement.	465172, 121459
1.5	The cemetery, Norwick	1.2 km to the north.	Local Landscape Area and residential settlement.	465188, 1214128
1.6	B9087 Norwick	1.6 km to the north east.	Local Landscape Area and residential settlement.	464872, 1213830
1.7	Hill of Clibberswick	2.4 km to the north.	Local Landscape Area and recreational walkers.	466351, 1212904
1.8	Hermaness Hill	5.32 km to the east.	National Scenic Area, Recreational walkers.	460648, 1217592

No.	Viewpoint Location	Distance and Direction to Proposed Project	Receptors	Grid Reference
1.9	Lay by on A968 above Harold's Wick	4.4 km to the north east.	Road users and cyclists on NCR1. Recreational walkers.	463144, 1210817
1.10	Headland to the north of Saxa Vord radar station	3.3 km to the east.	National Scenic Area, Recreational walkers.	462970, 1217656

Other Baseline Built/ Consented Infrastructure

11.5.60 At the time of writing, other significant infrastructure development within the EZI is confined to the recent reactivation of the Saxa Vord remote radar head. The Royal Air Force radar station is named after Saxa Vord which is the highest hill on Unst at 285 m AOD. The infrastructure at Saxa Vord includes the remains of the Saxa Vord radar station built in 1941, the access tracks, the associated radar infrastructure to the north of Saxa Vord and to the east at the Ward of Norwick, and the former RAF camp and domestic accommodation buildings at Valsgarth/Saxa Vord which are now privately owned as the Saxa Vord Resort complex. The remains of the former Skaw Radar Station, also built in 1941, are scattered across the peninsula of land between Inner Skaw and Lamba Ness, comprising the Skaw scheduled monument site. As this infrastructure is already part of the current landscape and visual baseline resource it is considered as an integral part of the baseline within the main assessment of landscape and visual effects in Sections 11.7 and 11.8.

11.6 Assessment of Effects

11.6.1 This section comprises the assessment of the effects on landscape and visual resources arising from the Proposed Project. The effects can be thought of as 'residual' effects because they take into account embedded mitigation measures included already in the previous design and construction stages of the SaxaVord Spaceport, from where the Proposed Project will operate, as summarised below.

Existing 'Embedded Mitigation

11.6.2 Design iteration of the SaxaVord Spaceport was undertaken as part of the LVIA at the planning stage to reduce the visual effects from operations including preparation and launch of launch vehicles. The assessment of LVIA for this Skyrora XL Launch Vehicle AEE has, therefore, been completed taking into account the following embedded mitigation measures.

Topography and Landform

11.6.3 The buildings and roads of the SaxaVord Spaceport are sited so as to have minimised the requirement for major ground modelling thereby reducing the extent of earth moving and the need to alter the previously existing landform within the site.

Massing and Form

11.6.4 Through careful site planning an integrated relationship has been developed between the SaxaVord Spaceport buildings and infrastructure and the existing site roads and former radar infrastructure, which are listed as scheduled monuments, to create a simple harmony that builds on the existing grain of the landscape.

11.6.5 Visual integration of the Proposed Project has been secured through the careful orientation, positioning of buildings and structures at the SaxaVord Spaceport. As the Proposed Project will utilise SaxaVord Spaceport infrastructure, a summary of the development and design strategy for the SaxaVord Spaceport is set out below for information.

SaxaVord Spaceport Inner Skaw Assembly Building Cluster

11.6.6 A cluster of buildings forming the entrance to SaxaVord Spaceport is located in the western sector of the Lamba Ness site at Inner Skaw. Access from this point is via an upgraded road following the existing track to provide general site access. A side road leads to an area set aside for launch vehicle assembly and the storage of associated materials

SaxaVord Spaceport Satellite Tracking Station

11.6.7 A satellite tracking station is located mid-way along the spaceport site, an area of hardstanding and four separate telemetry devices, housed within geodesic radomes.

TEL Hangar

11.6.8 The transporter erector launcher is located in a large hangar rising to 14 m, with a footprint of 61 m x 41 m, located to the south of the three launch pads and the main access track. The hangar is linked to the launch pads through the upgraded access track and the new tracks leading to each of the separate launch pads.

Launch Pads

11.6.9 Launch Pad 1 is positioned to the northern side of the Lamba Ness peninsula, carefully set between the structures of the former radar station. Two more launch pads are located on the northern side of The Garths, spaced approximately 180 m apart and integrated as far as possible between the substantially retained structures of the former radar station.

11.6.10 Each launch pad comprises a central area of hard standing flanked by earth sheltered gabion walls which shelter further areas of hardstanding where temporary control buildings, storage containers and fuel stores will be placed during the course a mission. When the launch pad is not in use these temporary building and containers will not be present on the site.

11.6.11 The launch pads have at their centre a simple permanent pedestal and gantry which will receive the Skyrora XL Launch Vehicle.

11.6.12 Permanent lightning masts are positioned either side of the launch pads, comprising telescopic towers which will be extended during a launch to their operational height of 46 m. At all other times the lightning masts will be retracted to their un-extended configuration of 25 m. As with other permanent structures on the site they will be finished in a recessive grey colour.

11.6.13 Adjacent to each launch pad there is a water tank / pump house to deliver water inundation during launches. The dimensions, base heights and overall heights for the structures are as follows: water tank 4 m x 4 m x 2 m high located at ground level; pump house 10 m x 6 m x 4 m high (to apex).

11.6.14 The earth sheltered bunds comprise a grassed earth bund on the inner face and rock filled gabion walls on the outer faces. The grassed faces are vegetated with grass turves won from the site. The gabion walls are filled with locally won rock to ensure effective integration with the surrounding rock type seen in the surrounding landscape and coastline. These measures ensure that the simple structure of the launch pad sites recedes in views against the wider setting and marry in with the existing structures of the former radar station.

Colour

11.6.15 The SaxaVord Spaceport buildings use colour themes and palettes that draw upon colours seen in buildings across Unst and natural colours occurring within the local Unst landscape.

11.6.16 A graduation of colours in the elevations is used to assist in breaking up the elevations of the larger buildings, with a transition from red, through tan, to the cool grey tones seen in the fast-moving cloudscape, a colour which will also be seen reflected in the foreground of the surrounding seascape.

Lighting

11.6.17 Lighting has been considered as an important element of the Proposed Project. Potential light sources will be associated with flood lighting the launch pads during launches.

11.6.18 A sympathetic lighting strategy has been developed within the context of the design of the SaxaVord Spaceport buildings to minimise any potential adverse effects. In addition, a number of measures are employed to minimise the unwanted effects associated with light sources. These include:

- Cowls/shielding of lights to prevent glare;
- Minimisation of light spread through the use of directional lighting;
- Minimising the potential for sky glow by avoiding the potential for upward reflected light;
- Reducing the operational hours of the lighting to reduce the potential for disturbance; and,
- In some areas, intelligent dimming technology may be used to activate lighting through activity.

11.6.19 These measures will minimise light pollution and reduce night-time glare, whilst providing appropriate night-time illumination for the Proposed Project.

Assessment of Effects on the Landscape Resource

11.6.20 The landscape resource is the distinctive physical pattern of components and features that combine to form and characterise the landscape. The effects of the Proposed Project on this resource are those that will directly alter this physical pattern and will thus have an effect on the character of the landscape. These effects will occur within the landscape character area in which the Proposed Project is located. Beyond this, changes to the landscape character will be confined to indirect changes to the landscape resource. The assessment of the effects on the landscape resource is subdivided into direct effects on the landscape resource and indirect effects on landscape character.

11.6.21 The following assessment of landscape effects addresses:

- Effects on the application sites;
- Effects on Landscape Character; and,
- Effects on Designated Landscapes

11.6.22 Identification of the potential for significant effects has been undertaken following a review of the visualisations provided in Drawings 11.3.1.1 to 11.3.2.5. This is in addition to comprehensive field work assessment and the use of computer-generated visualisations in order to inform the judgements made by the landscape professional undertaking the assessment.

Duration and Reversibility of the Landscape and Visual Effects

11.6.23 The magnitude of changes that will be experienced by receptors as a result of the Proposed Project relates in part to the duration of effects and their permanence/reversibility. The effects will be permanent on completion of the Proposed Project.

Effects During a Launch Sequence

11.6.24 The assessment of effects set out below is based on the configuration of the Proposed Project and its associated landscape and visual effects during the day to day operation of the Proposed Project. During the run up to and the launch of the Skyrora XL Launch Vehicle, there will be a range of

additional landscape effects experienced during run up to and 'take off' sequence of a launch. These effects will largely be associated with the launch of the Skyrora XL Launch Vehicle itself however, it is acknowledged that at certain times of year, and particularly during the summer tourist season, the launch of a Skyrora XL Launch Vehicle in itself will be a notable attraction for tourists and visitors to Unst. Therefore, there are also likely to be additional short-term landscape and visual effects deriving from the attraction of visitors and associated traffic during their visits to the area.

Typical Characteristics of a Launch

11.6.25 Prior to the launch, temporary vehicles and containers will be moved into position within the earth sheltered areas of hard standing, beside the launch pad. As the Skyrora XL Launch Vehicle is prepared for launch it will be taken from the Integration Hangar to the launch pad on a transporter-erector-launcher (TEL). The Skyrora XL Launch Vehicle will be erected to a vertical position at the launch pad and held in place with a 'strongback', a metal structure that supports the launch vehicle in an upright before it launches. In the same period the lighting masts will be extended to their maximum length.

11.6.26 Close to the launch, as propellants and fuels are loaded, there will be additional effects arising through the emission of occasional vapours, as well as the presence of activity and lighting. The Skyrora XL Launch Vehicle may be at the launch pad for several days prior to launch and may be brightly illuminated at night during this time.

11.6.27 The launch of the Skyrora XL Launch Vehicle will be very short in duration and give rise to a range of very short term but significant and widespread landscape and visual effects. As the ignition sequence commences, a process of water inundation is commenced as a measure to both reduce the roar of the launch but also to protect the Skyrora XL Launch Vehicle from its own flames. The resulting interaction of the flames and water will give rise to a localised plume of water vapour and smoke at the base of the launch pad. This will quickly dissipate after take-off and is expected to flow away to the north-east given the predominant wind direction.

11.6.28 The launch itself will be very quick, with the Skyrora XL Launch Vehicle moving above the strongback within approximately three seconds of initial firing, the overall noise and emissions reaching a peak up to 10 seconds into the launch, immediately reducing thereafter. The Skyrora XL Launch Vehicle will be seen to speed away from the launch site, reaching an altitude of approximately 1 km after approximately 23 seconds into the launch, and 2 km after approximately 30 seconds. There may at times be a visible trail or plume, however, it is expected that the principal feature of the lift -off will be the rapidly ascending cone of super-heated exhaust gases, immediately beneath the Skyrora XL Launch Vehicle.

11.6.29 The short-term effects of the actual launch will give rise to temporarily significant but very short-term effects on landscape and visual receptors with primary visibility extending across northern areas of Unst, largely coincident with the landscape and visual receptors reviewed in the assessment of operational effects. The Skyrora XL Launch Vehicle itself will be visible thereafter for much greater distances extending across Unst, for a very short period of time as it rises through the lower atmosphere; however, from these distances the launch and the Skyrora XL Launch Vehicle will appear very small, with the Skyrora XL Launch Vehicle becoming visually smaller still as it travels up through the atmosphere. As such this is not considered to present a significant effect. In addition, the trajectory of all launches will arc away from the Shetland Islands to the north across the North Sea and therefore it is noted that direct visibility will rapidly decay.

11.6.30 These effects will give rise to short term changes in qualities of tranquillity experienced within the EZI, giving rise to very short-term disturbance. As such, whilst the effects of an individual launch will be short lived, it is noted that there will be an ongoing requirement to inform and consult with the public on issues arising from launches.

11.6.31 Following any launch, the strongback will be lowered and removed back to the TEL Hangar, the lightning masts retracted, and the temporary vehicles and containers removed from the launch pad. The launch pad will return to its normal configuration within a few days.

Assessment of Direct Effects on the Landscape Resource

Location

11.6.32 The baseline assessment identifies the gently sloping peninsula of land between Inner Skaw and Lamba Ness as the context for the Proposed Project.

11.6.33 The main land use on the SaxaVord Spaceport site has historically been pasture for sheep grazing, with subdivision by stock proof fencing and sections of drystone dyke into a series of large fields. Steep cliffs surround the coastal edge of the site, with a small area of the northern site shelving to a small beach at the Sand of Inner Skaw.

Landscape Sensitivity

11.6.34 It is considered that the sensitivity of the Landscape to change is Medium. The factors which have contributed to this judgement are as follows:

Value

11.6.35 Medium/High: The site lies within the Haroldswick and Skaw Local Landscape Area. The site area encompasses the Skaw Radar Station scheduled monument site.

Susceptibility to Change

11.6.36 The simple grassland across the site is not a scarce resource in this area and can accommodate the level of change proposed however, areas of wetland and the remaining structures within the scheduled monument sites are vulnerable to change and will be protected where possible.

Magnitude of Change

11.6.37 The overall magnitude of change to the existing landscape fabric across the site as a result of the SaxaVord Spaceport will be Substantial and this has been used as a precautionary approach for the assessment of the Proposed Project. It is noted, however, that in reality the Spaceport Infrastructure will already be in existence before the Proposed Project operates and therefore, the Proposed Project in itself is not the cause of this substantial change.

Significance of Effect

11.6.38 The combination of the individual judgements of Medium sensitivity and Substantial magnitude of change on the landscape fabric of the site are considered to result in a Major/Moderate effect, which in the context of this assessment is considered to be Significant. As discussed in the methodology, not all change is adverse and whilst the Proposed Project, within the context of the wider SaxaVord Spaceport, represents a significant effect upon the landscape resources of the site area, the Proposed Project is considered to represent a positive change to the existing landscape.

Assessment of Effects on Landscape Character and Designations

11.6.39 People's perceptions of the effects of development on landscape character and designated or other relevant landscape areas are closely related to the potential extent and nature of visibility of the development and ancillary infrastructure. An overview of the nature of the visibility of the Proposed Project, within the context of the wider SaxaVord Spaceport, within the EZI is therefore provided below.

General Appraisal of Visibility

11.6.40 The potential visual influence of the Proposed Project is closely related to a range of parameters, which include position, elevation, and distance. Due to the position of the SaxaVord Spaceport on the promontory of land at Lamba Ness, which extends approximately 2.5 km eastwards into the North Sea between the Blue Jibs peninsula to the north and the headland at the Hill of Clibberswick to the south, the Proposed Project will be seen locally in oblique views to the peninsula. It is considered that within 3 km, the Skyrora XL Launch Vehicle, when temporarily in launch

configuration rising up to approximately 24 m, and the lightning masts which in their operational extended configuration extend to 45 m will be the most clearly visible elements in the landscape. Although they may not necessarily be intrusive or prominent, these components of the Proposed Project have the potential to be an important and/ or readily noticeable element in the landscape.

11.6.41 The network of local hills and headlands including the Ward of Norwick to the west, 186 m AOD, Ritten Hamar to the north-west, 132 m AOD, Housi Field to the south-west, 122 m AOD, and the Hill of Clibberswick to the south, 160 m AOD, together define a relatively tight visual envelope to the landward side. Visibility to the east is unrestricted and extends across the sea to the apparent horizon.

11.6.42 Local visibility encompasses the settlement at Norwick including the beach and houses close to the Taing and extends along the valley of the Burn of Norwick to include the northern edges of Valsgarth and the former RAF buildings at Saxa Vord. To the north, partial visibility is indicated around the isolated farmstead at Skaw.

11.6.43 Beyond this inner core area of visibility, the Proposed Project will recede in views and be seen as a component in the wider landscape, becoming less distinct, and appearing as distant new elements set in the context of wider views.

11.6.44 To the north-west visibility extends across the upland flank on the eastern side of Saxa Vord, 284 m AOD.

11.6.45 A narrow band of visibility extends to the south-west, to the north of the ridge of land at Valsgarth, across areas of lower lying farmland, encompassing the scattered farmsteads between Ungirsta, Stove, and Quoys. The rising ridge of land to the south west, Crussa Field and Muckle Hoeg, which form the backdrop to the lower lying farmland, define strong containment to views to the south.

11.6.46 Smaller patches of more distant visibility are picked up on the higher ridge of land at Valla Field to the south west, including the uplands at Houllna Gruna 153 m AOD at approximately 8 km and beyond 10 km the Ward of Houlland, 156 m AOD, and the Byre of Scord, 216 m AOD.

11.6.47 Drawings 11.2.1 - 11.2.2 indicate the zone of theoretical visibility of the Proposed Project within the EZI, a 15 km radius based on the maximum potential visibility of the Proposed Project during the launch configuration.

Assessment of Effects upon Landscape, Coastal and Seascape Character Areas (LCTs/CCAs/SCAs)

11.6.48 This section assesses effects upon LCTs/CCAs/SCAs within the EZI, as defined in the Scottish Landscape Character Types Map and Descriptions Online (NatureScot, 2022), the Shetland Coastal Character Assessment, 2016, and Scottish Seascape Areas defined in the NatureScot Report No.103, 2005.

11.6.49 The location of the LCTs/CCAs/SCAs is presented in Drawing 11.1.3. The ZTV of the Proposed Project overlaid with the LCTs/CCAs/SCAs and landscape designations is shown in Drawings 11.2.1 - 11.2.2 to a 15 km limit. The visibility indicated within these Drawings is derived from computer modelling and represents a bare-earth environment, i.e. the modelling does not include built development or localised changes in landform, all of which may screen the development, either in full or in part.

11.6.50 Areas of landward visibility beyond 15 km are very limited, due to the screening effects of landform. It is not considered that the resulting changes to perception of landscape character could give rise to significant effects beyond 15 km, and therefore no further assessment of LCTs/CCAs/SCAs beyond 15 km has been made.

11.6.51 This section describes the operational and in-combination effects resulting from the Proposed Project on the nine landscape, coastal and seascape character areas, as identified in the baseline in Table 11.3, where potentially significant effects may occur, as set out in Tables 11.8 – 11.16.

Table 11.8 Effects on LCT 349 Major Uplands

Location
The landscape character type covers the three main areas of uplands on Unst, at Saxa Vord, Hermaness and Valla Field. The western sector of the Proposed Project located within the LCT. The Hermaness and Valla Field sub-units are located at distances of 4 km and 8.2 km, respectively. The following development, which is within the LCT, currently influences the existing baseline landscape character within the core 15 km EZI: ➢ Saxa Vord Radar Station. ➢ Remnants of the former Skaw Radar Station at Inner Skaw – Lamba Ness.
Determination of Landscape Sensitivity
The sensitivity is considered to be **High**. The factors which have contributed to this judgement are as follows: *Value - High* ➢ Hermaness NSA; and, ➢ Part of the Haroldswick and Skaw LLA. *Susceptibility to Change – High to Medium* ➢ Very large-scale landscape; ➢ Long exposed mountain with steep sides; ➢ Low moorland vegetation; and, ➢ Perceptual Qualities: sense of remoteness due to the limited road access and settlement. Open and exposed.
Magnitude of Change
The magnitude of change to the Major Uplands LCT caused by the introduction of the Proposed Project is considered to be **Substantial** locally within the site at Inner Skaw and across the eastern flank of the Ward of Norwick, reducing over distance to **Slight** on the eastern flank of Saxa Vord Hill, and Negligible within the Hermaness and Valla Field sub units of the LCT. The factors which have contributed to this judgement are as follows: *Size or Scale* The landscapes of the Major Uplands are characterised by expansive views experienced from the exposed summits and flanks. From the eastern flanks of the Ward of Norwick and Saxa Vord, the Proposed Project will be seen extending across the headland at Lamba Ness. Closer to the site and from the minor road crossing the peninsula the large hangar buildings will appear as angular structures rising above the coastline, though the careful use of colour will assist in reducing their overall bulk. The prominence of the Proposed Project buildings and infrastructure will vary with light conditions, often receding during reduced light conditions or during haze but, more visible on clear sunny days. The Proposed Project will be viewed in the context of the large-scale,

expansive character of the landscape, and will form a visible addition to the landscape in views east, introducing clusters of new development within the context of the existing structures and track of the former Skaw Radar Station, influencing the perception of scale in wider views.

During the short duration of launches at the individual launch pads, the extended lightning masts, the Skyrora XL Launch Vehicle and the supporting strong back will be visible as additional vertical structures. However, within the context of the expansive views from the LCT, these elements will have only a limited additional influence.

The Proposed Project will not alter the openness and expansive nature of views from the uplands and will not substantially affect views between hills within the interior of the island or the visual relationships to the surrounding coastlines. However, some views immediately adjacent to the Proposed Project will be interrupted by the large new vertical structures.

Geographical Extent

The ZTV indicates that there will be visibility from the east facing flanks of the Ward of Norwick, Saxa Vord and Housi Field. There will be small areas of distant influence on the landscape at Houllna Gruna, the Ward of Houlland and the Byre of Scord, marking the higher points along the southern extent of the ridgeline at Valla Field, to the west of Unst, which intersects with a band of distant visibility. There will be no visibility from the western areas of the LCT. Viewpoint 1.3, Drawing 11.3.3 illustrates a local view from the minor road crossing to the west of the site beneath the Ward of Norwick.

Significance of Effect

The combination of the individual judgements of **Medium/High** sensitivity and a locally **Substantial** magnitude of change from Inner Skaw and the eastern flank of the Ward of Norwick are considered to result in a **Major/Moderate** local effect on the perception of the landscape, which in the context of this assessment is considered to be **Significant**.

Elsewhere effects on the LCT will give rise to no greater than a **Slight** magnitude of change, with a **Moderate/Minor** and Not Significant effect on the perception the landscape.

With distance and the topographic screening by the hills, the influence of the Proposed Project will reduce and will not give rise to any further significant effects on this LCT.

Table 11.9 Effects on LCT 350 Peatland and Moorland

Location

The landscape character type covers areas of rocky heather moorland areas of uplands on Unst, including the Hill of Clibberswick to the south and the ridge line between Muckle Heog and Crussa Field to the south-west, located at distances of 1.2 km and 4.3 km, respectively.

The following development, which is within the LCT, currently influences the existing baseline landscape character within the core 15 km EZI:

- Telecommunications masts at Muckle Heog.

Determination of Landscape Sensitivity

The sensitivity is considered to be **Medium**. The factors which have contributed to this judgement are as follows:

Value - Medium

- Part of the Haroldswick and Skaw LLA.
- Part of the Colvadale and Muness LLA.

Susceptibility to Change – Medium

- Medium-scale landscape, contrast between contained internal views and expansive coastal views, with few reference points or features against which to judge scale and perspective; and
- Low moorland vegetation.

Magnitude of Change

The magnitude of change to the Peatland and Moorland LCT caused by the introduction of the Proposed Project is considered to be **Moderate** from the north facing flank of the Hill of Clibberswick. There will be Minor influences, on both the north facing flanks of the ridgeline between Muckle Heog and Crussa Field, and from the Keen of Hamar. There will be more distant Negligible influences on the Hill of Colvadale. The factors which have contributed to this judgement are as follows:

Size or Scale

These lower hills provide vantage points across the adjacent lowlands. The open simple character of the moorlands contrasting abruptly with the settled coastlines and cultivated lowlands. The introduction of new built form on the peninsula is consistent with the prevailing character and whilst the new built forms will be noticeable, influencing the perception of scale in closer views, they will be experienced within the context of the modified lowlands and against the expansive views across hills and coastlines. The careful use of colour will assist in assimilating the new built form.

During the short duration of launches, the extended lightning masts, the Skyrora XL Launch Vehicle and the supporting strong back will have only a limited additional influence.

Geographical Extent

The ZTV indicates that there will be visibility from the north facing flanks of the Hill of Clibberswick at approximately 1.6 km. There will be areas of visibility from both the north facing flanks of the ridgeline between Muckle Heog and Crussa Field at approximately 4.5 km, and from the Keen of Hamar at approximately 5.5 km. There will be more distant Negligible influences on the Hill of Colvadale at 8.5 km, to the south of Baltasound, where parts of the LSPF will be seen at Inner Skaw. Viewpoint 1.7, Drawing 11.3.1.7 from the Hill of Clibberswick is representative of the typical views within this LCT, at approximately 2.8 km from the Proposed Project.

Significance of Effect
The combination of the individual judgements of **Medium** sensitivity and a locally **Moderate** magnitude of change from the Hill of Clibberswick are considered to result in a **Moderate** local effect on the perception of the landscape, which in the context of this assessment is considered to be **Not Significant**. Elsewhere effects on the LCT will give rise to no greater than a **Slight** magnitude of change, with a **Minor** and **Not Significant** effects on the perception the landscape.

Table 11.10 Effects on LCT 352 Inland Valleys

Location
Within the EZI the Inland Valleys landscape character type includes the area of incised land form, located to the south of Burrafirth and encompassing the lands around the Loch of Cliff, and the continuation of the same feature to the south lying to the east of Valla Field.
Determination of Landscape Sensitivity
The sensitivity is considered to be **Medium**. The factors which have contributed to this judgement are as follows: *Value - Medium* ➢ A small part of the Shetland NSA. *Susceptibility to Change – Medium* ➢ Medium scaled landscapes with channelled views, contained by the adjoining uplands; and ➢ Simple palette of land uses and limited settlement.
Magnitude of Change
The magnitude of change to the Inland Valleys LCT caused by the introduction of the Proposed Project is considered to be **Negligible** across the north-east facing flank of Houllna Gruna. The factors which have contributed to this judgement are as follows: *Size or Scale* The hill flanks surrounding the incised valleys reveal extended views to the adjacent lowlands. The simple character of the Inland Valley gives way to diverse settled landscapes of the coastlines and cultivated lowlands beyond. The introduction of new built form on the peninsula will be seen within the diverse landscapes beyond the Inland Valleys in distant views experienced within the context of the modified lowlands. The careful use of colour will assist in assimilating the new built form into the landscape. During the short duration of launches, the extended lightning masts, the Skyrora XL Launch Vehicle and the supporting strong back will have only a limited additional influence.

Geographical Extent

The ZTV indicates that visibility will be limited to the north-east facing flank of the hill slope at Houllna Gruna, at 7.5 km.

Significance of Effect

The combination of the individual judgements of **Medium** sensitivity and a **Negligible** magnitude of change from the north-east facing flank of the hill slope at Houllna Gruna are considered to result in a **Minor** local effect on the perception of the landscape, which in the context of this assessment is considered to be **Not Significant**.

Table 11.11 Effects on LCT 353 Farmed and Settled Lowlands and Coast

Location

Within the EZI the Farmed and Settled Lowlands and Coast landscape character type includes the areas farmland at Skaw, on the west of the island of Balta, at Woodwick on the west coast and along coastal edge of Colvadale.

Determination of Landscape Sensitivity

The sensitivity is considered to be of **High - Medium**. The factors which have contributed to this judgement are as follows:

Value - Medium

- Colvadale and Muness, Local Landscape Area
- Haroldswick and Skaw, Local Landscape Area

Susceptibility to Change – High-Medium

- This landscape is characterised by a small-scale crofting landscape, strongly associated with the sheltered voes and neighbouring uplands.
- The limited modern development and significant historic interest in this landscape, lend a higher degree of sensitivity.

Magnitude of Change

The magnitude of change to the Farmed and Settled Lowlands and Coast LCT caused by the introduction of the Proposed Project is considered to be **Moderate** at Skaw reducing to **Negligible** on the eastern side of the island of Balta. The factors which have contributed to this judgement are as follows:

Size or Scale

The open coastal grazing lands at Skaw are open to views to the headlands to the north and south of the Wick of Skaw which contribute to a diverse setting. The introduction of new built form on the peninsula to the south will be partially seen as new elements beyond the immediate setting of Skaw in views to the wider Wick of Skaw, adding new elements along the bounding skyline to the south.

During the short duration of launches, the extended lightning masts, the Skyrora XL Launch Vehicle and the supporting strong back will have additional influence.

Geographical Extent

The ZTV indicates that visibility will extend across the farmland at Skaw.

Very small areas of visibility are indicated in across the southern extent of Balta Island.

Significance of Effect

The combination of the individual judgements of **High-Medium** sensitivity and a **Moderate** magnitude of change from the pastures at Skaw are considered to result in a **Major/Moderate** local effect on the perception of the landscape, which in the context of this assessment is considered to be **Significant**.

Table 11.12 Effects on LCT 354 Farmed and Settled Voes and Sounds

Location

Within the EZI the Farmed and Settled Voes and Sounds landscape character type includes the low-lying settled farmland between Norwick, Haroldswick and Burrafirth, and a further area of settled farmland around Baltasound.

Determination of Landscape Sensitivity

The sensitivity is considered to be of **Medium**. The factors which have contributed to this judgement are as follows:

Value - Medium

- Haroldswick and Skaw, Local Landscape Area
- Partially within the Hermaness sub unit of the Shetland NSA however, the area of the LCT within the NSA will experience no intervisibility with the Proposed Project.

Susceptibility to Change – Medium

- This landscape is of a small scale with occasional settlements maintaining the traditional pattern of crofting settlement. There is a strong association with the coastal fringe and significant historic interest. Overall, the LCA has a medium sensitivity to development.

Magnitude of Change

The magnitude of change to the Farmed and Settled Voes and Sounds LCT caused by the introduction of the Proposed Project is considered to be **Moderate** at Norwick reducing to Slight at Valsgarth and **Negligible** further to the west. The factors which have contributed to this judgement are as follows:

Size or Scale

The open coastal settled farmland at Norwick is open to views to the adjoining headland at Lamba Ness and the Hill of Clibberswick to the south which form part of the wider and diverse backdrop to the LCT. The introduction of new built form on the peninsula to the north will be

partially seen as new elements beyond the immediate setting of Norwick, adding additional features along the skyline to the north.

During the short duration of launches, the extended lightning masts, the Skyrora XL Launch Vehicle and the supporting strong back will have additional influence.

Geographical Extent

The ZTV indicates that visibility will extend across the farmland at Norwick, with partial fragmented visibility at Saxa Vord, and then distant visibility to the south-west of the LCT.

No visibility is indicated around Baltasound.

Significance of Effect

The combination of the individual judgements of **Medium** sensitivity and a **Moderate** magnitude of change from the farmland at Norwick are considered to result in a **Moderate** local effect on the perception of the landscape, which in the context of this assessment is considered to be **Not Significant**.

Elsewhere effects on the LCT will give rise to no greater than a **Slight** magnitude of change, with a **Minor** and **Not Significant** effect on the perception the landscape.

Table 11.13 Effects on LCT 355 Coastal Edge

Location

Within the EZI the Coastal Edge landscape character type includes the eastern section of the headland at Lamba Ness, the coastal edge of the Hill of Clibberswick, the north eastern coastline of Unst, The eastern side of Balta Island, the headland at Muness and much of the western coastline of Unst.

The following development, which is within the LCT, currently influences the existing baseline landscape character:

- Remnants of the former Skaw Radar Station at Lamba Ness and Inner Skaw.

Determination of Landscape Sensitivity

The sensitivity is considered to be of **Medium-High** sensitivity, reducing to **Medium** sensitivity around Lamba Ness and Skaw. The factors which have contributed to this judgement are as follows:

Value - Medium

- Haroldswick and Skaw, Local Landscape Area
- Gloup Voe and Bluemull Sound, Local Landscape Area
- Colvadale and Muness, Local Landscape Area
- Hermaness subunit of the Shetland NSA

Susceptibility to Change – Medium

- This landscape has a rugged and irregular landform made up of complex coastal features. There is an absence of settlement and modern development that lends a higher degree of sensitivity. However locally at Skaw and Lamba Ness the presence of disused radar and defence infrastructure it has a locally low to moderate sensitivity to the Proposed Project.

Magnitude of Change

The magnitude of change to the Coastal Edge LCT caused by the introduction of the Proposed Project is considered to be locally **Substantial** at Lamba Ness, reducing to **Moderate** on the headland to the north at Bluejibs and to **Slight** over distance on the northern flank of the Hill of Clibberswick, and to **Negligible** in very distant partial views from Muness and Saxa Vord Hill sub units of the LCT. The factors which have contributed to this judgement are as follows:

Size or Scale

The landscapes of the Coastal Edge are heavily influenced by their close association with the surrounding coastline and sea. The large hangar buildings and launch pad infrastructure will extend across the headland at Lamba Ness, with large scale new structures and infrastructure extending across the coastal grasslands.

The prominence of the Proposed Project buildings and infrastructure will vary with light conditions, often receding during reduced light conditions or during haze but, more visible on clear sunny days. The Proposed Project will be viewed in the context of the large-scale, expansive character of the landscape, and will form a prominent addition to the landscape in views east, introducing clusters of new development within the context of the existing structures and the track of the former Skaw Radar Station, influencing the perception of scale in wider views.

During the short duration of launches at the individual launch pads, the extended lightning masts, the Skyrora XL Launch Vehicle and the supporting strong back will be visible as additional vertical structures.

The Proposed Project will introduce locally significant change to the headland.

Further afield the presence of new structures will be seen to alter the openness and expansive nature of views however, whilst the influence of the Proposed Project is localised, the landscapes closer to the Proposed Project will be altered by influence by the large new structures.

Geographical Extent

The ZTV indicates that there will be direct visibility across Lamba Ness, from the peninsula to the north at Bluejibs and across the north facing flanks of the Hill of Clibberswick.

There will be a distant influence on the eastern side of Balta Island over 6 km to the south and fragmented partial visibility to the lightning masts only from small areas of the headland to the north of Saxa Vord Hill to the west and from Muness to the south.

Viewpoint 1.1, Drawing 11.3.1.1 from the peninsula above Bluejibs and the Wick of Skaw to the north is representative of the typical nature of close views within this LCT, at approximately 1.1 km from the application site. Viewpoint 1.7, Drawing 11.3.1.7 illustrates a more distant view from the Hill of Clibberswick. Viewpoint 1.8, Drawing 11.3.1.8 illustrates the very limited partial views to the lightning masts from the headland to the north of Saxa Vord which lies within the Hermaness sub unit of the Shetland NSA.

Significance of Effect
The combination of the individual judgements of **Medium** sensitivity and a locally **Substantial** magnitude of change at Lamba Ness are considered to result in a **Major/Moderate** local effect on the perception of the landscape, which in the context of this assessment is considered to be **Significant**. Effects are reduced by distance to **Moderate** magnitude of change across the headland to the north of Bluejibs however, the sensitivity is **High**, giving rise to a with a **Major/Moderate** effect on the perception of landscape character, which in the context of this assessment is considered to be **Significant**. Elsewhere effects on the LCT will give rise to no greater than a **Slight** magnitude of change, with no greater than a **Moderate/Minor** and **Not Significant** effect on the perception the landscape.

Table 11.14 Effects on CCA 20: Skaw

Location
Within the EZI the Skaw Coastal Character Area runs from the Noup to Lamba Ness characterised by a rocky exposed coastline with small bays. The landscape is mainly heather moorland and coastal grasses ending in cliffs.
Determination of Landscape Sensitivity
The sensitivity is considered to be of **High** sensitivity, reducing to **Medium** sensitivity around Lamba Ness and Skaw. The factors which have contributed to this judgement are as follows: *Value – Medium-High* ➢ Haroldswick and Skaw, Local Landscape Area ➢ Edge of the Hermaness subunit of the Shetland NSA *Susceptibility to Change – Medium-High* ➢ The Skaw CCA is valued for its scenic qualities. The coast is of high sensitivity to the Proposed Project. However locally at Skaw and Lamba Ness the presence of disused radar and defence infrastructure it has a, locally lower, moderate sensitivity to the Proposed Project.
Magnitude of Change
The magnitude of change to the Skaw Coastal Character Area caused by the introduction of the Proposed Project is considered to be locally **Substantial** at Lamba Ness, reducing to **Moderate** on the headland to the north at Bluejibs. The factors which have contributed to this judgement are as follows: *Size or Scale* The Proposed Project will be seen, experienced in the context of the expansive coastal views, forming prominent elements in local views. The large hangar buildings and launch pad

infrastructure will extend across the headland at Lamba Ness, with large scale new structures, infrastructure extending across the coastal grasslands.

The new development will be seen within the context of the existing structures and the track of the former Skaw Radar Station, influencing the perception of scale in wider views.

During the short duration of launches at the individual launch pads, the extended lightning masts, the Skyrora XL Launch Vehicle and the supporting strong back will be visible as additional vertical structures.

Further afield the presence of new structures will be seen to alter the openness and expansive nature of views however, whilst the influence of the Proposed Project is localised, the landscapes closer to the Proposed Project will be altered by the influence of the large new structures.

Geographical Extent

The ZTV indicates that there will be direct visibility across Lamba Ness and from the peninsula to the north at Bluejibs.

Viewpoint 1.1, Drawing 11.3.1.1 from the peninsula above Bluejibs and the Wick of Skaw to the north, at from Viewpoint 1.2, Drawing 11.3.1.2 at Skaw Beach to the north west, are representative of the typical nature of close views within this CCA, at approximately 1.1 km and 1.2 km from the application site respectively.

Significance of Effect

The combination of the individual judgements of **Medium** sensitivity and a locally **Substantial** magnitude of change at Lamba Ness are considered to result in a **Major/Moderate** local effect on the perception of the coastal character, which in the context of this assessment is considered to be **Significant**.

Effects are reduced by distance to **Moderate** magnitude of change across the headland to the north of Bluejibs however, the sensitivity is **High**, giving rise to a with a **Major/Moderate** effect on the perception of the coastal character, which in the context of this assessment is considered to be **Significant**.

Elsewhere effects on the LCT will give rise to no greater than a **Slight** magnitude of change, with no greater than a **Moderate** and **Not Significant** effect on the perception the landscape.

Table 11.15 Effects on CCA 16: East Unst

Location

Within the EZI the East Unst Coastal Character Area runs from Lamba Ness in the north to Mu Ness in the south.

Determination of Landscape Sensitivity

The sensitivity is considered to be of **High** sensitivity. The factors which have contributed to this judgement are as follows:

Value – Medium

- Haroldswick and Skaw, Local Landscape Area

Susceptibility to Change – High

- Much of the East Unst CCA is devoid of modern development. The coast is of high sensitivity to the Proposed Project.

Magnitude of Change

The magnitude of change to the East Unst Coastal Character Area caused by the introduction of the Proposed Project is considered to be locally **Moderate** on the beaches at Nor Wick around the Taing and the coastline at the northern edge of the Hill of Clibberswick. The factors which have contributed to this judgement are as follows:

Size or Scale

The Proposed Project will be seen, experienced in the context of the expansive coastal views, introducing new structures along the headland at Lamba Ness. The large hangar buildings and launch pad infrastructure will be partially visible across the headland at Lamba Ness, influencing the perception of scale in wider views.

During the short duration of launches at the individual launch pads, the extended lightning masts, the Skyrora XL Launch Vehicle and the supporting strong back will be visible as additional vertical structures.

Further afield the presence of new structures will be seen to alter the openness and expansive nature of views however, whilst the influence of the Proposed Project is localised, the landscapes closer to the Proposed Project will be altered by the influence of the large new structures.

Geographical Extent

The ZTV indicates that there will be indirect visibility across the beaches at the Taing and along the coastal edge to the north of the Hill of Clibberswick. More distant visibility is indicated on the northern sector of Balta Island over approximately 6 km.

Viewpoint 1.4, Drawing 11.3.1.4 from The Taing at Nor Wick is representative of the typical nature of views within this CCA, at approximately 800 m from the application site.

Significance of Effect

The combination of the individual judgements of **High** sensitivity and a locally **Moderate** magnitude of change at The Taing and along the coastline north of the Hill of Clibberswick are considered to result in a **Major/Moderate** local effect on the perception of the coastal character, which in the context of this assessment is considered to be **Significant**.

Elsewhere effects on the LCT will give rise to no greater than a **Negligible** magnitude of change, with no greater than a **Minor** and **Not Significant** effects on the perception the landscape.

Table 11.16 Effects on Seascape Character Type 13 D: Islands, Sounds and Voes

Location
Within the EZI the Seascape Character Type 13 D: Islands, Sounds and Voes includes the areas of the North Sea adjoining the farmed and settled coastal lowlands to the east of Unst where a deeply indented coastline creates sounds and voes with fragmented islands. This sub type generally has an insignificant low, hard coastal edge, often appearing smooth and 'submerged'. Voes and sounds form sheltered narrow channels of coastal waters with open, gently sloping hinterland of pasture, rough grazing and scattered crofting. Views over small islands to open sea are often a feature.
Determination of Landscape Sensitivity
The sensitivity is considered to be of High sensitivity. The factors which have contributed to this judgement are as follows: *Value – Medium* ➢ Haroldswick and Skaw, Local Landscape Area *Susceptibility to Change – High* ➢ Development may affect the intricate land/sea relationship and views of outlying islands and the appreciation of the vertical scale of high cliffs where these are present. The perception of remoteness and wildland qualities of some coastal areas and the highly natural character of the outlying islands may also be affected by development.
Magnitude of Change
The magnitude of change to the Seascape Character Type 13 D: Islands, Sounds and Voes caused by the introduction of the Proposed Project is considered to be locally **Moderate** from the seas around the Wick of Skaw, beyond Lamba Ness and from Nor Wick. The factors which have contributed to this judgement are as follows: *Size or Scale* Whilst there be few receptors the Proposed Project will be seen in wider seascape, experienced in the context of the expansive coastal views, introducing new structures along the headland at Lamba Ness. The main visible structures will be the large hangar buildings on the headland, influencing the perception of scale in wider views. During the short duration of launches at the individual launch pads, the extended lightning masts, the Skyrora XL Launch Vehicle and the supporting strong back will be visible as additional vertical structures. Further afield the presence of new structures will diminish with distance, seen against the open and expansive nature of views. The strong influence of the Proposed Project is localised, limited to the closer inshore seascape which will be altered by the influence of the large new structures. However, the given the strong tidal movements around the headlands and the presence of overfalls which together influence a considerable area of the surrounding sea, for long periods, inshore receptors are limited to periods of rare calmer and benign sea conditions.

Geographical Extent

The ZTV indicates that there will be the potential for extensive visibility from the sea.

Significance of Effect

The combination of the individual judgements of **High** sensitivity and a locally **Moderate** magnitude of change to the inshore waters within the Wick of Skaw, around the headland at Lamba Ness and within Nor Wick, are considered to result in the potential for **Major/Moderate** local effect on the perception of the seascape, which in the context of this assessment is considered to be **Significant**.

Effects on seascape will reduce with distance and will give rise to no greater than **Slight** magnitudes of change, with **Moderate/Minor** and **Not Significant** effects on the perception the seascape.

Summary of Effects on Landscape, Coastal and Seascape Character Areas

11.6.52 Table 11.17 lists and summarises effects on Landscape, Coastal and Seascape Character Areas assessed above. It sets out their sensitivity to change, the magnitude of change that will arise as a result of the Proposed Project, and the level of resultant effects and their significance.

Table 11.17 Summary of Effects on Landscape, Coastal, and Seascape Character Areas

Landscape/ Coastal/ Seascape Character Areas	Overall Sensitivity to Change	Magnitude of Change	Level of Effect	Significance
349 Major Uplands	High	Locally Substantial Elsewhere Slight	Locally Major/Moderate Elsewhere Moderate / Minor	Locally Significant Elsewhere Not Significant
350 Peatland and Moorland	Medium	Locally Moderate Elsewhere Slight	Locally Moderate Elsewhere Minor	Not Significant
352 Inland Valleys	Medium	Negligible	Minor	Not Significant
353 Farmed and Settled Lowlands and Coast	High Medium	Moderate	Major/Moderate	Significant
354 Farmed and Settled Voes and Sounds	Medium	Locally Moderate Elsewhere Slight	Locally Moderate Elsewhere Minor	Locally Not Significant Elsewhere Not Significant

Landscape/ Coastal/ Seascape Character Areas	Overall Sensitivity to Change	Magnitude of Change	Level of Effect	Significance
355 Coastal Edge	High Medium	Locally Substantial (Lamba Ness) Moderate (Blue Jibs) Elsewhere Slight	Major/Moderate (Lamba Ness) Major/Moderate (Blue Jibs) Elsewhere Moderate/Minor	Locally Significant (Lamba Ness and Blue Jibs) Elsewhere Not Significant
CCA 16, East Unst	High	Locally Substantial (Lamba Ness) Moderate (Blue Jibs) Elsewhere Negligible	Major/Moderate (Lamba Ness) Major/Moderate (Blue Jibs) Elsewhere Minor	Locally Significant (Lamba Ness and Blue Jibs) Elsewhere Not Significant
CCA 20, Skaw	High	Locally Moderate Elsewhere Negligible	Locally Moderate Elsewhere Minor	Not Significant
Seascape Character Type 13 D: Islands, Sounds and Voes	High	Locally Moderate Elsewhere Slight	Locally Major/Moderate Elsewhere Moderate/Minor	Locally Significant Elsewhere Not Significant

Assessment of Effects on Designated Landscapes

11.6.53 This section considers the implication of the Proposed Project on designated landscapes falling within the EZI. The designated landscapes listed below have been considered in more detail, following the preliminary analysis of visibility of the Proposed Project, with some designated landscapes having been scoped out of the assessment because of the absence of visibility (see Table 11.4).

- Hermaness sub-unit of the Shetland NSA
- Haroldswick and Skaw, LLA

11.6.54 The analysis cross references to the assessment of landscape, coastal and seascape character, the assessment of visual effects, the assessment of in-combination effects, and has given regard to the special qualities and features for which each receptor has been designated. Designated landscapes are shown on Drawings 11.2.1 – 11.2.2 overlaid with the ZTVs of the respective components of the Proposed Project to a 15 km radius.

Shetland NSA

11.6.55 The Shetland NSA includes seven designated areas. Of these a very small area of the Hermaness sub-unit falls into the zone of theoretical visibility within 15 km of the Proposed Project. The overall special qualities of the Shetland NSA are described within The Special Qualities of the National Scenic Areas, NatureScot commissioned report, 2010, as:

- The stunning variety of the extensive coastline
- Coastal views both close and distant

- Coastal settlement and fertility within a large hinterland of unsettled moorland and coast
- The hidden coasts
- The effects and co-existence of wind and shelter
- A sense of remoteness, solitude and tranquillity
- The notable and memorable coastal stacks, promontories and cliffs
- The distinctive cultural landmarks
- Northern light

11.6.56 Some special qualities are generic to all the identified NSA areas, others are specific to each area within the NSA. For the Hermaness sub-unit the feeling of being at the northern limits of the British Isles is marked, and within the Shetland archipelago these areas have a greater degree of remoteness.

11.6.57 The Hermaness sub-unit of the Shetland NSA includes the following specific special qualities, which are described within the NatureScot report:

- "At Hermaness on Unst, the coastal topography varies from the 175 m high cliffs at the Neap, to the sandy beach and machair at the head of the narrow Burrafirth.
- Cultural landmarks include the western edge of the Hermaness area which contains the northerly military installations in the British Isles at Saxa Vord."

11.6.58 Drawings 11.2.1 – 11.2.2 illustrate the extent of theoretical visibility to the Proposed Project, indicating two very limited areas of visibility, firstly on the summit of Saxa Vord in the context of the existing radar dome over a distance of 2.5 km, and secondly limited visibility to lightning masts only from a very small area of the headland to the north of Saxa Vord Hill, in the context of dismantled radar masts over a distance of 3.3 km. Viewpoint 1.8, Headland to the north of Saxa Vord radar station, Drawing 11.3.1.8 illustrates the nature of views from the headland within the NSA.

11.6.59 The sub-unit of the NSA includes parts of LCT 349 Major Uplands, LCT 355 Coastal Edge, LCT 354 Farmed and Settled Voes and Sounds, CCA 19 Hermaness, and CCA 13 Burrafirth. The assessment of effects on LCTs and CCAs finds no significant effects on these areas within the area of the NSA, and no potential significant additional combined effects. This is due to the screening effects of topography. A Minor (Not Significant) effect was found to affect receptors at Viewpoint 1.8, Headland to the north of Saxa Vord Radar Station, Drawing 11.3.1.8.

11.6.60 A separate Special Landscape Qualities (SLQ) Assessment on the Special Qualities of National Scenic Areas based on the new draft NatureScot Guidance for Assessing the Effects on Special Landscape Qualities Working Draft November 2018, is set out in Appendix 11.5.

11.6.61 In summary, the special qualities of the Special Landscape Qualities of the Hermaness sub area of the Shetland NSA will not be at risk or compromised by the Proposed Project and the overall integrity and objectives of the Shetland NSA will be maintained.

Local Landscape Areas

11.6.62 Designation statements for Local Landscape Areas (LLAs) in Shetland are set out in the Shetland Islands Council Report, Local Landscape Designations Review (LLDR), 2011.

11.6.63 The Proposed Project lies within the Haroldswick and Skaw LLA which comprises the hills and headlands between Harold's Wick in the south and Burra Firth to the north-west, including the Hill of Clibberswick and Saxa Vord. The LLA has been identified with the following Key characteristics:

- *"Part of the most northerly area of Shetland and Britain;*
- *Highly visible military defence infrastructure, including active and disused elements;*

- *Rugged, exposed northern coast, with sheltered sandy bays;*
- *Rich geology visible at the surface;*
- *Actively settled area undergoing redevelopment as former military uses decline and new uses are found."*

11.6.64 The LLA comprises an extensive area of hills and headlands and the north-eastern extent of Unst. Drawings 11.2.1 – 11.2.2 illustrate the extent of theoretical visibility to the Proposed Project, indicating a swathe of visibility across the eastern flank of Saxa Vord Hill and the Ward of Norwick, the north flank of the Hill of Clibberswick, at Skaw to the north, and across Inner Skaw and the headland at Lamba Ness.

11.6.65 The LLA includes parts of LCT 349 Major Uplands, LCT 350 Peatland and Moorland, LCT 353 Farmed and Settled Lowlands and Coast, LCT 354 Farmed and Settled Voes and Sounds, and LCT 355 Coastal Edge, all of which experience areas of visual influence of the Proposed Project. The assessment of effects on LCTs found locally significant effects on each of the LCTs (excluding LCT 350) within the area of the LLA, and no potential significant in-combination effects. This is due to the influence of the Proposed Project which will be seen as a new relatively large-scale development across the headland between Inner Skaw and Lamba Ness. Whilst the Proposed Project will be seen in the context of the major uplands and expansive coastal views, locally the scale of the new built form will have an influence on landscape scale, forming large contrasting elements, seen against coastal views or the prevailing moorland backdrop.

11.6.66 The key characteristics and integrity of the LLA will be locally altered by the Proposed Project across the headland between Inner Skaw and Lamba Ness, with a reduction in the scenic qualities of the LLA.

11.7 Assessment of Effects on the Visual Resource

11.7.1 The following sections provide an assessment of the visual effects that will likely arise from the Proposed Project. The following assessment addresses effects on the visual amenity of people, through assessing:

- effects on settlements;
- effects on key transport routes; and,
- effects on viewpoints.

Assessment of Effects on Settlements

11.7.2 The following section provides an assessment of the predicted effects on the visual amenity that will be experienced by residents of principal settlements within the EZI. The assessment has been undertaken through field survey and the analysis of mapping ZTV and photomontage views, in order to confirm the likely nature of visibility.

11.7.3 In accordance with the criteria outlined in the detailed methodology in Appendix 11.1, residential receptors, within settlements in the EZI, have a high susceptibility to change as views are experienced regularly for prolonged periods, and are generally considered to have a high sensitivity overall to the Proposed Project.

11.7.4 An indication of the predicted extents of visibility for the Proposed Project across the settlements is provided within the visibility mapping in Drawings 11.2.1 to 11.2.2. All ZTV drawings are based on bare-ground conditions, in accordance with current good practice as indicated in GLVIA 3. For those settlements where the ZTV indicates theoretical visibility, buildings and, to a small degree land form, are likely to provide a degree of containment between receptors and the Proposed Project. Buildings and localised topography do not register on the ZTV and, therefore, views to the Proposed Project will tend to be more restricted and more intermittent than the ZTV indicates.

11.7.5 The settlements in the EZI with potential views of the Proposed Project, as identified in Table 11.5, are assessed below.

Table 11.18 Effects on settlement at Booths/Houlanbrindy

Location
The cluster of settlement at Booths/Houlanbrindy, approximately 660 m to the south-west of the site, lies sheltered to the rear of Nor Wick and beneath the Ward of Norwick. The properties face east across Nor Wick which is framed by the cliffs of the Lamba Ness headland to the north and the Hill of Clibberswick to the south. The following development currently weakly influences the existing baseline: ➢ Redundant derelict wartime buildings on Lamba Ness.
Determination of Visual Sensitivity
The settlement at Booths/Houlanbrindy is of High sensitivity. The factors which have contributed to this judgement are as follows: ***Value*** *– High* ➢ Residents are highly likely to be aware of any changes to their existing visual amenity. ***Susceptibility to Change*** *– Medium/High* ➢ Expansive coastal views; ➢ Orientation of buildings to the east; ➢ Influence of existing development at the former Skaw Radar Station.
Magnitude of Change
The magnitude of change to the settlement at Booths/Houlanbrindy caused by the introduction of the Proposed Project is considered to be **Moderate**. The factors which have contributed to this judgement are as follows: *Size or Scale* Elements of the Proposed Project including: partial view to the roofline of the LSPF; site fencing; partial view to the southern radome of the tracking station; the lightning masts; launch vehicles on pad 3, will be seen appearing above the cliffs to the north of Nor Wick, influencing the perception of scale in wider views. During the short duration of launches, the extended lightning masts, the Skyrora XL Launch Vehicle and the supporting strong back will be visible as additional vertical structures. *Geographical Extent* The ZTV indicates that there will be the potential for partial visibility away from the primary orientation of the views from the properties.

Significance of Effect
The combination of the individual judgements of **High** sensitivity and a locally **Moderate** magnitude of change are considered to result in the potential for **Major/Moderate** local effect on the settlement at Booths/Houlanbrindy, which in the context of this assessment is considered to be **Significant**.

Table 11.19 Effects on settlement at Norwick/Kirkaton

Location
The cluster of settlement at Norwick/Kirkaton, approximately 1.2 km to the south-west of the site, lies sheltered to the rear of Nor Wick and beneath the Ward of Norwick. The properties face east across Nor Wick which is framed by the cliffs of the Lamba Ness headland to the north and the Hill of Clibberswick to the south. The following development currently weakly influences the existing baseline: ➢ Redundant derelict wartime buildings on Lamba Ness.
Determination of Visual Sensitivity
The settlement at Norwick/Kirkaton is of **High** sensitivity. The factors which have contributed to this judgement are as follows: ***Value*** *– High* ➢ Residents are highly likely to be aware of any changes to their existing visual amenity. ***Susceptibility to Change*** *– Medium/High* ➢ Expansive coastal views; ➢ Orientation of buildings to the east; ➢ Influence of existing development at the former Skaw Radar Station.
Magnitude of Change
The magnitude of change to the settlement at Norwick/Kirkaton caused by the introduction of the Proposed Project is considered to be **Moderate**. The factors which have contributed to this judgement are as follows: *Size or Scale* Elements of the Proposed Project including: partial visibility to the gate house and LSPF; boundary fencing; the southern radomes of the tracking station; the Integration/TEL Building; Skyrora XL Launch Vehicle and lightning masts will be seen appearing above the cliffs to the north of Nor Wick, influencing the perception of scale in wider views. During the short duration of launches at each of the launch pads, the extended lightning masts, the Skyrora XL Launch Vehicle and the supporting strong backs will be visible as additional vertical structures.

Geographical Extent

The ZTV indicates that there will be the potential for partial visibility from the properties.

Significance of Effect

The combination of the individual judgements of **High** sensitivity and a **Moderate** magnitude of change are considered to result in the potential for **Major/Moderate** effects on the settlement at Norwick/Kirkaton, which in the context of this assessment is considered to be **Significant**.

Table 11.20 Effects on settlement at Valsgarth/Saxa Vord

Location

The cluster of settlement at Valsgarth/Saxa Vord, approximately 2.3 km to the south-west of the site, lies on elevated ground to the south of Northdale. The north-eastern properties have a relatively open aspect towards Norwick and the coastline around Nor Wick beyond.

The following development currently influences the existing baseline:

- Redundant derelict wartime structures between Inner Skaw and Lamba Ness.

Determination of Visual Sensitivity

The settlement at Valsgarth/Saxa Vord is of **High** sensitivity. The factors which have contributed to this judgement are as follows:

Value *– High*

- Residents are highly likely to be aware of any changes to their existing visual amenity.

Susceptibility to Change *– Medium/High*

- Expansive views, contrasting with truncated views between housing;
- Orientation of the north eastern edge towards Norwick;
- Influence of existing development at the former Skaw Radar Station.

Magnitude of Change

The magnitude of change to the settlement at Valsgarth/Saxa Vord caused by the introduction of the Proposed Project is considered to be **Moderate**. The factors which have contributed to this judgement are as follows:

Size or Scale

Elements of the Proposed Project including: partial visibility to the gate house and LSPF; boundary fencing; the southern radomes of the tracking station; the integration/TEL building, Skyrora XL Launch Vehicle and lightning masts will be seen appearing in more distant views above the cliffs to the north of Nor Wick, influencing the perception of scale in wider views.

During the short duration of launches at each of the launch pads, the extended lightning masts, the Skyrora XL Launch Vehicle and the supporting strong backs will be visible as additional vertical structures.

Geographical Extent The ZTV indicates that there will be the potential for partial visibility from the north-eastern edge of the settlement which has a sight line to the Proposed Project.
Significance of Effect
The combination of the individual judgements of **High** sensitivity and a **Moderate** magnitude of change are considered to result in the potential for **Major/Moderate** effects on the settlement at Valsgarth/Saxa Vord, which in the context of this assessment is considered to be **Significant**.

Table 11.21 Effects on settlement at Clibberswick

Location
The cluster of settlement at Clibberswick, approximately 1.05 km to the south east of the site, lies within open farmland to the south of Saxa Vord. The properties have a relatively open aspect towards Valsgarth/Saxa Vord seen beneath the Ward of Norwick.
Determination of Visual Sensitivity
The settlement at Clibberswick is of **High** sensitivity. The factors which have contributed to this judgement are as follows: ***Value*** *– High* ➢ Residents are highly likely to be aware of any changes to their existing visual amenity. ***Susceptibility to Change*** *– Medium/High* ➢ Expansive views across the open farmland and coastline.
Magnitude of Change
The Proposed Project has no influence on the settlement at Clibberswick.
Potential for in-Combination Effects
No combined effects are predicted.
Significance of Effect
No Effect.

Table 11.21 Effects on settlement at Haroldswick

Location
The cluster of settlement at Haroldswick, approximately 3.2 km to the south-west, lies within farmland at the head of Harold's Wick. The southern edge of the settlement extends along the foreshore and is visually screened from the Proposed Project. The more dispersed properties to the north are set on slightly elevated ground with more open views across the farmland to the north.

Determination of Visual Sensitivity
The settlement at Haroldswick is of High sensitivity. The factors which have contributed to this judgement are as follows: ***Value*** *– High* ➢ Residents are highly likely to be aware of any changes to their existing visual amenity. ***Susceptibility to Change*** *– Medium/High* ➢ Expansive views across the open farmland and coastline.
Magnitude of Change
The Proposed Project has no influence on the settlement at Haroldswick. *Size or Scale* Changes to the views from Haroldswick will be Negligible. *Geographical Extent* There will be the potential for partial visibility from the properties at the northern edge of Haroldswick.
Potential for In-Combination Effects
No combined effects are predicted.
Significance of Effect
No effect.

Table 11.22 Effects on settlement at Ungirsta/Stove

Location
Ungirsta and Stove encompass the dispersed crofting settlement to the north and west of Haroldswick, set across the farmed lowlands between the ridge at Crussa Field to the south and Housi Field to the north, approximately 3.05 km to the south west of the Proposed Project. The properties are dispersed and experience oblique views across the surrounding open farmland against the backdrop of low rounded hills.
Determination of Visual Sensitivity
The properties at Ungirsta and Stove are of **High** sensitivity. The factors which have contributed to this judgement are as follows: ***Value*** *– High* ➢ Residents are highly likely to be aware of any changes to their existing visual amenity.

Susceptibility to Change *– Medium/High*

- Views across the open farmland and to the surrounding hills.

Magnitude of Change

The Proposed Project has no influence on the scattered settlement at Ungirsta and Stove.

Size or Scale

The changes to the views from Ungirsta and Stove will be Negligible.

Geographical Extent

There will be the potential for partial visibility from the properties at the northern edge of Ungirsta and Stove.

Potential for In-Combination Effects

No combined effects are predicted.

Significance of Effect

No Effect.

Summary of Effects on Settlements

11.7.6 Table 11.23 lists and summarises effects on the settlements assessed above. It sets out their sensitivity to change, the magnitude of change that will arise as a result of the Proposed Project, and the level of resultant effects and their significance.

Table 11.23 Summary of Effects on Settlements

Settlement	Sensitivity to Change	Magnitude of Change	Level of Effect	Significance
Booths/ Houlanbrindy	High	Moderate	Major/Moderate	Significant
Norwick/ Kirkaton	High	Moderate	Major/Moderate	Significant
Valsgarth/ Saxa Vord	High	Moderate	Major/Moderate	Significant
Haroldswick	High	Negligible.	No effect	Not Significant
Ungirsta/ Stove	High	Negligible.	No effect	Not Significant

Assessment of Effects on Routes

11.7.7 The following section provides an assessment of the predicted effects of the Proposed Project on visual amenity that will be experienced by travellers using vehicular and non-vehicular route corridors within the EZI, including roads and designated cycle routes. The assessment has been undertaken through field survey and the analysis of mapping ZTV and wireframe views, in order to confirm the likely nature of visibility.

11.7.8 In accordance with the criteria outlined in the detailed methodology in Appendix 11.1, the sensitivity of receptors from cycle routes is generally considered to be high. Receptors using road routes (i.e., motorised vehicle users of cars/ motorbikes/ buses) are considered to range from low or low to medium (e.g., for trunk and main roads) through to medium (for B-roads, minor roads etc.) sensitivity, although vehicle users of routes promoted or noted for scenic value may be of medium to high sensitivity. There may also be value attached to specific views along the routes or particular stretches where they pass through or overlook designated landscapes.

11.7.9 An indication of the predicted extents of visibility route corridors is provided within the visibility mapping in Drawings 11.2.1 to 11.2.2.

11.7.10 The principal effects on these routes with potential views of the Proposed Project, as identified in Table 11.6, are assessed below.

Table 11.24 Operational Effects on A968/National Cycle Route 1

Route Description
The A968/NCR1 connects through the EZI between Gunnister in mid-Unst at approximately 15 km through to Haroldswick within 5 km of the Proposed Project. The following development currently weakly influences the existing baseline: ➢ Telecommunications relay building on the Hill of Caldback. ➢ Telecommunications mast on Little Hoeg. ➢ Radar radome on Saxa Vord Hill.
Determination of Visual Sensitivity
People in motorised vehicles using the route are considered to be of **Medium** sensitivity to changes resulting from the Proposed Project. Cyclists using the route are considered to be of **High** sensitivity to changes resulting from the Proposed Project. The factors which have contributed to this judgement are as follows: **Value** – Medium **Susceptibility to Change** – Medium/High ➢ Motorists travelling through or past the landscape on roads will focus on the route corridor; ➢ Cyclists are likely to be using the route for recreation and tourism purposes and will be aware of views to the surrounding landscape; ➢ Relative simplicity of landform with smooth and rounded pastures and expansive views.
Magnitude of Change
From a short 600 m section of the route as it passes across the col to the east Little Hoeg, there will be a locally **Slight** magnitude of change as the Proposed Project is partially seen on the horizon above Clibberswick. *Size or Scale* The LSPF at the western extent of the site will be partially visible to their rooflines, as a noticeable new element on the horizon in views to the north seen in the distance over approximately 4.5 km.

Geographical Extent

The ZTV indicates that there will be the potential for partial visibility over a short 600m section of the route.

Potential for In-Combination Effects

There will be a locally **Minor Not Significant** combined effect on a very short section of the route corridor over the short term.

Significance of Effect

Section of A968 / NCR 1	Sensitivity to Change	Magnitude of Change	Level of Effect	Significance
600m section of the route, east of Little Hoeg	Motorists – Medium Cyclists - High	Slight	Moderate/Minor to Motorists and Moderate to Cyclists	**Not Significant**

Table 11.25 Operational Effects on B9086

Route Description

The B9086 connects between Burrafirth and Haroldswick through the EZI at approximately 3.9 km from the Proposed Project and approximately 1.3k m from the LCC/RCC building.

The following development currently weakly influences the existing baseline:

- Telecommunications mast on Little Hoeg.
- Radar radome on Saxa Vord Hill.

Determination of Visual Sensitivity

People in motorised vehicles using the route are considered to be of **Medium** sensitivity to changes resulting from the Proposed Project. Cyclists using the route are considered to be of **High** sensitivity to changes resulting from the Proposed Project. The factors which have contributed to this judgement are as follows:

Value – Medium

Susceptibility to Change – Medium/High

- Motorists travelling through or past the landscape on roads will focus on the route corridor;
- Cyclists are likely to be using the route for recreation and tourism purposes and will be aware of views to the surrounding landscape;
- Relative simplicity of landform with smooth and rounded pastures and expansive views.

Magnitude of Change

Proposed Project

From a short 500 m section of the route, between the minor road leading to Ungirsta and the cross road junction at Lower House, there will be a locally **Slight** magnitude of change as the Proposed Project is partially seen on the distant horizon above Norwick.

Size or Scale

The LSPF at the western extent of the site will be partially visible to their rooflines, as a distant new element on the horizon in views to the north east, over approximately 3.9 km.

Geographical Extent

The ZTV indicates that there will be the potential for partial visibility over a short 500 m section of the route.

Potential for in-Combination Effects

There will be a locally **Minor Not Significant** combined effect on a very short section of the route corridor over the short term.

Significance of Effect

Section of B9086	Sensitivity to Change	Magnitude of Change	Level of Effect	Significance
1.2 km section of the route west of Haroldswick	Motorists – Medium Cyclists - High	Slight	Moderate/Minor to Motorists and Moderate to Cyclists	**Not Significant**

Table 11.26 Operational Effects on B9087

Route Description

The B9087 connects between Haroldswick and Norwick through the EZI with areas of closest visibility over approximately 1.3 km from the Proposed Project.

The following development currently influences the existing baseline:

- Telecommunications mast on Little Hoeg.
- Radar radome on Saxa Vord Hill.
- The former RAF base at Saxa Vord.

Determination of Visual Sensitivity

People in motorised vehicles using the route are considered to be of **Medium** sensitivity to changes resulting from the Proposed Project. Cyclists using the route are considered to be of **High** sensitivity to changes resulting from the Proposed Project. The factors which have contributed to this judgement are as follows:

Value – Medium

Susceptibility to Change – Medium/High

- Motorists travelling through or past the landscape on roads will focus on the route corridor;
- Cyclists are likely to be using the route for recreation and tourism purposes and will be aware of views to the surrounding landscape;
- Relative simplicity of landform with smooth and rounded pastures and expansive views.

Magnitude of Change
There will be increasing visibility between Saxa Vord and Norwick, with a locally **Moderate** magnitude of change as the Proposed Project is seen on the peninsula between Inner Skaw and Lamba Ness. *Size or Scale* Elements of the Proposed Project including: partial visibility to the gate house and LSPF; boundary fencing; the southern radomes of the tracking station; the integration hangar/TEL building; Skyrora XL Launch Vehicle and lightning masts will be seen appearing above the cliffs to the north of Nor Wick, influencing the perception of scale in wider views. During the short duration of launches at each of the launch pads, the extended lightning masts, the Skyrora XL Launch Vehicle and the supporting strong backs will be visible as additional vertical structures. *Geographical Extent* The ZTV indicates that there will be the potential for partial visibility over a 1.2 km section of the route.
Potential for In-Combination Effects
There will be a locally **Minor Not Significant** combined effect on a very short section of the route corridor over the short term.

Significance of Effect

Section of B9087	Sensitivity to Change	Magnitude of Change	Level of Effect	Significance
1.2 km section of the route west between Saxa Vord/ Valsgarth and Norwick.	Motorists – Medium Cyclists - High	Moderate	Moderate to Motorists and Major/Moderate to Cyclists	**Not Significant/ Significant**

Assessment of Effects at Viewpoints

11.7.11 The viewpoint assessment has been carried out to identify and evaluate the effects on visual amenity arising from the Proposed Project at specific representative locations in the EZI. The selection of viewpoints is discussed at paragraph 11.5.60.

11.7.12 The predicted views from each of the 15 viewpoint locations are illustrated using photomontages in Drawings 11.3.1.1 to 11.3.1.10 in respect of the Proposed. The visualisations are accurate graphic representations in terms of the positioning, spatial distribution and size of the Proposed Project.

11.7.13 For the purposes of assessing the effects on visual amenity, the sensitivity of the receptors is as defined in Appendix 11.1.

11.7.14 The following detailed analysis of the 15 viewpoints include a description of the existing and predicted view, an assignment of receptor sensitivity (including confirmation of receptor susceptibility and the value applied to the viewpoint), an analysis of the magnitude of change, and an assessment of the level of predicted effects on visual amenity, and a determination of their

significance. The supporting Drawings include existing photographic view alongside a photomontage visualisation of the Proposed Project. These visualisations have been prepared in adherence to the principles presented in the Landscape Institute's Technical Guidance Note TGN 06/19 Visual Representation of Development Proposals, as described in Appendix 11.1.

Duration and Reversibility of the Visual Effects

11.7.15 The magnitude of changes that will be experienced by visual receptors as a result of the Proposed Project relates in part to the duration of effects and their permanence/ reversibility. For the purposes of this assessment the effects are assumed to be permanent.

11.7.16 As the duration and reversibility of the effects of the Proposed Project will be common to all visual receptors, they have been implicitly considered with regard to the likely magnitude of change in all views but are not repeated with regard to each viewpoint to avoid repetition.

Proposed Project Viewpoints, Viewpoints 1.1 – 1.10

Table 11.27 Effects at Viewpoint 1.1, Bluejibs above the Wick of Skaw

Viewpoint 1.1, Bluejibs above the Wick of Skaw **Drawing 11.3.1.1 existing view and a panoramic photomontage of the Proposed Project.**	
Distance and Direction to the Proposed Project	Proposed Project: 1.1 km to the south
LCT/CCA and Designations	LCT355. Coastal Edge / East Unst CCA Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Walkers/Visitors – High
Theoretical visibility	Proposed Project only
Location and Rationale for Selection	
The viewpoint is located on the north-eastern peninsula of Unst, looking south across the Wick of Skaw. The headland at the northern tip of British Isles is a popular location for visitors and for walkers accessing the northern coastline of Unst. The following development currently influences the existing baseline: ➢ The derelict buildings and infrastructure associated with the former Skaw Radar Station both across the foreground of the headland and also as seen in more distant views across the peninsula to the south at Lamba Ness. ➢ The maritime navigation beacon on the Holm of Skaw. ➢ The radar radome on Saxa Vord hill to the west.	
Description of Existing View	
The existing view looks south across the Wick of Skaw to the peninsula between Inner Skaw and Lamba Ness. The Sand of Inner Skaw is seen to the right of the image, with the distant high cliffs of the Hill of Clibberswick beyond. Flowering cotton grass carpets the foreground of the view. The viewpoint, at 30 m AOD, provides an attractive vantage point for views to the surrounding coastlines. The intense tidal races around this headland with standing waves and overfalls at certain states of tides add local interest. Features of the former Radar Station on	

Lamba Ness are noticeable including the following: the earth banked building of the former receiver building at the end of Lamba Ness; the earth banked power house building towards the centre of the peninsula; and the further concrete power house block seen on the crest of the peninsula above the Sand of Inner Skaw.

Determination of Visual Sensitivity

The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for walkers and visitors who access the headland for recreation and therefore more susceptible to changes in the view:

Value – *Medium*

Susceptibility to Change – *High*

- Walkers will be engaged in the experience of the landscape, with a strong awareness of their surroundings and an expectation of remoteness.
- Elemental coastal scenery with expansive views.

Magnitude of Change

The overall magnitude of change on receptors at this viewpoint will be a **Substantial**.

Size or Scale

The Proposed Project will be seen extending across the headland between Inner Skaw and Lamba Ness. The new built form will appear on the horizon line to the south, adding new noticeable features along the peninsula. The radomes of the tracking station will be seen against the backdrop of coastal hills and cliffs beyond. The lightning masts will be seen as tall vertical elements punctuating the skyline. Launch pad three is illustrated in its extended pre-launch condition with the Skyrora XL Launch Vehicle and strongback erected and the lightning masts extended in full. Launch pads one and two are shown in their retracted state. The TEL hangar is seen between launch pads one and two, breaking the horizon line. The base infrastructure around launch pad one is also seen on top of the peninsula.

Geographical Extent

The Proposed Project across the Proposed Project will be seen over a 50° angle of view. Views of this nature will be experienced across the southern edge of the headland above the Wick of Skaw.

Potential for In -Combination Effects

No combined effects are predicted.

Significance of Effects

The combination of the individual judgements of **High** sensitivity and a **Substantial** magnitude of change are considered to result in a **Major** effect on walkers and visitors, which in the context of this assessment is considered to be **Significant**.

Table 11.28 Operational Effects at Viewpoint 1.2, The Haa, Wick of Skaw

Viewpoint 1.2, The Haa, Wick of Skaw **Drawing 11.3.1.2: existing view and a panoramic photomontage of the Proposed Project.**	
Distance and Direction to the Proposed Project	Proposed Project: 860 m to the south east
LCT/CCA and Designations	LCT 353. Farmed and Settled Lowlands and Coast/ East Unst CCA, Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Walkers/Visitors/Residents of the Haa – High
Theoretical visibility	Proposed Project only

Location and Rationale for Selection

The viewpoint is located at the rear of Skaw Beach, to the north-east of Unst, looking south-east across the Wick of Skaw. The beach which lies towards the northern tip of British Isles is a popular location for visitors and for walkers accessing the northern coastline of Unst.

The following development currently influences the existing baseline:

- The derelict buildings and infrastructure associated with the former Skaw Radar Station both across the headland at Lamba Ness.
- The maritime navigation beacon on the Holm of Skaw.
- The radar radome on Saxa Vord hill to the west.

Description of Existing View

The existing view looks south-east across the Wick of Skaw to Lamba Ness. The sandy beach in the foreground gives way to the rocky coastline and cliffs along the edge of the peninsula. The tidal races are seen in the distance across the bay, beyond the headland, with standing waves and overfalls at certain states of tides which add local interest. Features of the former Radar Station on Lamba Ness are noticeable at the end of Lamba Ness including: the earth banked building of the former receiver building and the associated cluster of radar buildings.

Determination of Visual Sensitivity

The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for walkers and visitors who access the beach for recreation and who are more susceptible to changes in the view:

Value *– Medium*

Susceptibility to Change *– High*

- Walkers will be engaged in the experience of the landscape, with a strong awareness of their surroundings and an expectation of remoteness.
- The landform orientates principal views from Skaw Beach east towards the bay and the North Sea beyond.

- Visitors will be focussed on the surrounding scenery and views.
- Relative simplicity of landform and expansive coastal views.

Magnitude of Change

The overall magnitude of change on receptors at this viewpoint will be a Moderate.

Size or Scale

The Proposed Project will be seen extending across the headland between Inner Skaw and Lamba Ness, with the development at Inner Skaw contained from view, and with restricted visibility to the TEL Hangar. The new built form will appear on the horizon line to the south, adding new noticeable features along the peninsula. The lightning masts will be seen as tall vertical elements punctuating the skyline. Launch pad three is illustrated in its extended pre-launch condition with the Skyrora XL Launch Vehicle and strongback erected and the lightning masts extended in full. Launch pads one and two are shown in their retracted state. The base infrastructure around launch pads one and two is also seen on top of the peninsula.

Geographical Extent

The Proposed Project across the Proposed Project will be seen over a 20° angle of view. Views of this nature will be experienced in views south from the beach at Skaw.

Potential for In-Combination Effects

No combined effects are predicted.

Significance of Effects

The combination of the individual judgements of **High** sensitivity and a **Substantial** magnitude of change are considered to result in a **Major** effect on walkers and visitors which in the context of this assessment is considered to be **Significant**.

Table 11.29 Effects at Viewpoint 1.3, The Garths, Lamba Ness

Viewpoint 1.3, The Garths, Lamba Ness **Drawing 11.3.1.3 existing view and a panoramic photomontage of the Proposed Project.**	
Distance and Direction to the Proposed Project	Proposed Project: 320 m to the east
LCT/CCA and Designations	LCT 349. Major Uplands/ East Unst CCA Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Walkers/Cyclists – High Road Users - Medium
Theoretical visibility	Proposed Project only

Location and Rationale for Selection

The viewpoint is located at the high point on Holsens Road, which connects between Norwick and Skaw Beach, located close to the south western site boundary. It has been selected to illustrate the effects on visitors, walkers and cyclists accessing the northern coastline of Unst.

The following development currently influences the existing baseline:

- The derelict buildings and infrastructure associated with the former Skaw Radar Station between Inner Skaw and Lamba Ness.

Description of Existing View

The existing view looks east across the rough pastures at Clinkapund and Inner Skaw and beyond to the Lamba Ness peninsula. The view looks beyond to the North Sea to the east and Nor Wick bay to the south. The tidal races are seen in the distance beyond the Lamba Ness peninsula. Features of the former Radar Station across Inner Skaw and Lamba Ness are noticeable including: the decontamination building to the left of the image, the earth banked building of the former power house building towards the centre of the peninsula and the earth banked receiver building and associated cluster of radar buildings on Lamba Ness.

Determination of Visual Sensitivity

The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for walkers, cyclists and visitors accessing area for recreation and **Medium** for road users:

Value – *Medium*

Susceptibility to Change – *High*

- Walkers and cyclists will be engaged in the experience of the landscape, with a strong awareness of their surroundings and an expectation of remoteness.
- Views are expansive across the simple landscape of the peninsula and to the North Sea beyond.
- Visitors will be focussed on the surrounding scenery and views.

Magnitude of Change

The overall magnitude of change on receptors at this viewpoint will be a **Substantial**.

Size or Scale

The Proposed Project will be prominently seen, with the large-scale LSPF, gate house and associated out buildings seen in the foreground at Inner Skaw. Whilst the hangar buildings have a similar character to the modern barns seen within the wider Unst landscape their scale is larger, despite the absence of features in the landscape can be easily scaled by eye.

The lightning masts will be seen as tall vertical elements however, they are seen against the backdrop of the sea beyond and are seen to recede in views. Launch pad three is illustrated in its extended pre-launch condition with the Skyrora XL Launch Vehicle and strongback erected

and the lightning masts extended in full. The TEL hangar is noticeable as new built form to the foreground. Launch pads one and two are contained from view though their lightning masts are visible. ***Geographical Extent*** The main structures at Inner Skaw are seen within a 20° angle of view, with further elements of the Proposed Project seen as a localised pocket of development at Lamba Ness. Views of this nature will be experienced in views east from Holsens Road.
Potential for In-Combination Effects
No combined effects are predicted.
Significance of Effects
The combination of the individual judgements of **High** and **Medium** sensitivity and a **Substantial** magnitude of change are considered to result in a **Major** effect on Walkers, Visitors and Cyclists, and a **Major/Moderate** effect on Road Users which in the context of this assessment are considered to be **Significant**.

Table 11.30 Effects at Viewpoint 1.4, Car Park at The Taing, Norwick

Viewpoint 1.4, Car Park at The Taing, Norwick **Drawing 11.3.1.4 existing view and a panoramic photomontage of the Proposed Project.**	
Distance and Direction to the Proposed Project	Proposed Project: 800 m to the north east
LCT/CCA and Designations	LCT 354. Farmed and Settled Voes and Sounds / East Unst CCA Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Walkers/Visitors/Residents – High
Theoretical visibility	Proposed Project only
Location and Rationale for Selection	
The viewpoint is located in the public car park at The Taing, Norwick Beach, looking east across the bay at Nor Wick. The beach and coastline are a popular destination for visitors and walkers and the viewpoint is representative of the nature of views experienced by residents at Booths. The following development currently influences the existing baseline: ➢ The derelict buildings and infrastructure associated with the former Skaw Radar Station as seen in more distant views across the peninsula to the north east at Lamba Ness.	

Description of Existing View

The existing view looks across the bay at Nor Wick and to the peninsula to the north between Inner Skaw and Lamba Ness. The outcrop of rock on the beach at Norwick, The Taing, is seen at the northern edge of the beach in the foreground. The cliffs along the southern edge of the peninsula frame the view to the north, contrasting with the waters of Nor Wick below. Features of the former Radar Station are noticeable in the distance on Lamba Ness; the most noticeable of which is the earth banked receiver building.

Determination of Visual Sensitivity

The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for walkers, visitors and residents who access the area for recreation and residents of who are more susceptible to changes in the view:

Value – *Medium*

Susceptibility to Change – *High*

- Residents are highly likely to be aware of any changes to their existing visual amenity.
- Walkers and visitors will be engaged in the experience of the landscape, with a strong awareness of their surroundings and an expectation of remoteness.
- The landform orientates principal views east towards the bay and the North Sea beyond.
- Visitors will be focussed on the surrounding scenery and views.
- Relative simplicity of landform and expansive coastal views.

Magnitude of Change

The overall magnitude of change on receptors at this viewpoint will be a **Moderate**.

Size or Scale

The LSPF will be seen above the cliffs at Inner Skaw. The southernmost radome of the tracking station will be seen above the cliffs towards the middle of the peninsula. Launch pad three is illustrated in its extended pre-launch condition with the Skyrora XL Launch Vehicle and strongback erected and the lightning masts extended in full, these elements are seen above the end of the peninsula at Lamba Ness. Launch pads one and two are hidden from view.

Whilst parts of the Proposed Project will be visible above the peninsula, breaking the skyline, the careful approach to the use of colour in the facades will assist in the new structures being seen to recede in views against the typically grey skies.

Geographical Extent

Views of this nature will be experienced from the beach and coastline at Norwick.

Potential for In-Combination Effects

No combined effects are predicted.

Significance of Effects
The combination of the individual judgements of **High** sensitivity and a **Moderate** magnitude of change are considered to result in a **Major/Moderate** effect on walkers, visitors and residents, which in the context of this assessment is considered to be **Significant**.

Table 11.31 Effects at Viewpoint 1.5, The Cemetery, Norwick

Viewpoint 1.5, The Cemetery, Norwick Drawing 11.3.1.5 existing view and a panoramic photomontage of the Proposed Project.	
Distance and Direction to the Proposed Project	Proposed Project: 1.2 km to the north east
LCT/CCA and Designations	LCT 354. Farmed and Settled Voes and Sounds / East Unst CCA Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Walkers/Visitors/Residents – High
Theoretical visibility	Proposed Project only
Location and Rationale for Selection	
The viewpoint is located at the north-eastern edge of the cemetery at Norwick which is raised on a platform above the adjoining farmland to the east of Norwick. The cemetery is a focus for local visits at Norwick and is representative of the nature of views experienced by residents. The following development currently influences the existing baseline: ➢ The derelict buildings and infrastructure associated with the former Skaw Radar Station as seen in more distant views across the peninsula to the north east at Lamba Ness.	
Description of Existing View	
The existing view looks north across the bay at Nor Wick, to the peninsula to the north between Inner Skaw and Lamba Ness, and to the North Sea beyond. The coastal views contrast with the foreground pastures. The Taing and Norwick beach are seen to the left of the view, beneath the cliffs at Braehead. Features of the former Radar Station are noticeable in the distance on Lamba Ness; the most noticeable of which is the earth banked receiver building on Lamba Ness, the earth banked structure of the power house to the west of Lamba Ness and the noticeable decontamination building at Inner Skaw.	

Determination of Visual Sensitivity

The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for walkers and visitors who access the area for recreation and residents of who are more susceptible to changes in the view:

Value – *Medium*

Susceptibility to Change – *High*

- Residents are highly likely to be aware of any changes to their existing visual amenity.
- Walkers and visitors will be engaged in the experience of the landscape, with a strong awareness of their surroundings.
- Visitors will be focussed on the surrounding scenery and views.

Magnitude of Change

The overall magnitude of change on receptors at this viewpoint will be a **Moderate**.

Size or Scale

The LSPF will be seen above the cliffs at Inner Skaw. The southernmost two radomes of the tracking station will be seen above the cliffs towards the middle of the peninsula. Launch pad three is illustrated in its extended pre-launch condition with the Skyrora XL Launch Vehicle and strongback erected and the lightning masts extended in full, these elements are seen above the end of the peninsula at Lamba Ness. The TEL Hangar is seen against the skyline to the west of Lamba Ness. Launch pads one and two are hidden from view.

Whilst parts of the Proposed Project will be visible above the peninsula, breaking the skyline, the careful approach to the use of colour in the facades assist in the new structures being seen to recede in views against the typically light grey skies.

Geographical Extent

Views of this nature will be experienced from in and around the settlement at Norwick.

Potential for In-Combination Effects

No combined effects are predicted.

Significance of Effects

The combination of the individual judgements of **High** sensitivity and a **Moderate** magnitude of change are considered to result in a **Major/Moderate** effect on walkers, visitors and residents, which in the context of this assessment is considered to be **Significant**.

Table 11.32 Effects at Viewpoint 1.6, B9087 Norwick

Viewpoint 1.6, B9087 Norwick **Drawing 11.3.1.6 shows: a) 90° existing view and a panoramic photomontage of the Proposed Project.**	
Distance and Direction to the Proposed Project	Proposed Project: 1.6 km to the north east
LCT/CCA and Designations	LCT 354. Farmed and Settled Voes and Sounds / East Unst CCA, Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Cyclists/Residents – High Road Users - Medium
Theoretical visibility	Proposed Project only
Location and Rationale for Selection	
The viewpoint is located on the B9087/NCR1 between Saxa Vord and Norwick, adjacent to the entrance to the property at 'Virse'. The view represents views experienced by road users and cyclists and is also representative of the nature of views experienced by residents form the surrounding scattered crofting settlement. The following development currently influences the existing baseline: ➢ The derelict buildings and infrastructure associated with the former Skaw Radar Station as seen in more distant views across the peninsula to the north east at Lamba Ness. ➢ Masts and radar equipment at the Ward of Norwick.	
Description of Existing View	
The existing view looks north across the settled farmland of Norwick Meadow and beyond to the settlement at Norwick, the bay at Nor Wick, the peninsula to the north between Inner Skaw and Lamba Ness, and the expansive North Sea beyond. Features of the former Radar Station are seen in relatively distant views to Lamba Ness and Inner Skaw, the most noticeable of which is the earth banked receiver building on Lamba Ness, the earth banked structure of the power house to the west of Lamba Ness and the noticeable decontamination building at Inner Skaw.	
Determination of Visual Sensitivity	
The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for Cyclists and Residents of who are more susceptible to changes in the view, and **Medium** for Road Users: ***Value*** *– Medium* ➢ The B9087 forms part of National Cycle Route 1. ***Susceptibility to Change*** *– High* ➢ Residents are highly likely to be aware of any changes to their existing visual amenity.	

- Cyclists will be engaged in the experience of the landscape, with a strong awareness of their surroundings.
- Motorists travelling through or past the landscape on roads will focus on the route corridor.

Magnitude of Change

The overall magnitude of change on receptors at this viewpoint will be a **Moderate**.

Size or Scale

The LSPF will be seen above the cliffs at Inner Skaw. The southernmost two radomes of the tracking station will be seen above the cliffs towards the middle of the peninsula. Launch pad three is illustrated in its extended pre-launch condition with the Skyrora XL Launch Vehicle and strongback erected and the lightning masts extended in full, these elements are seen above the end of the peninsula at Lamba Ness. The TEL Hangar is seen against the skyline to the west of Lamba Ness. Launch pads one and two are hidden from view however the lightning masts break the skyline.

Geographical Extent

Views of this nature will be experienced along the B9087 between Saxa Vord and Norwick.

Potential for In-Combination Effects

No combined effects are predicted.

Significance of Effects

The combination of the individual judgements of **High** and **Medium** sensitivity and a **Moderate** magnitude of change are considered to result in a **Major/Moderate** effect on cyclists and residents, and a **Moderate** effect on Road Users, which in the context of this assessment is considered to be **Significant** and **Not Significant** effects respectively.

Table 11.33 Effects at Viewpoint 1.7, Hill of Clibberswick

Viewpoint 1.7, Hill of Clibberswick **Drawing 11.3.1.7 existing view and a panoramic photomontage of the Proposed Project.**	
Distance and Direction to the Proposed Project	Proposed Project: 2.4 km to the north
LCT/CCA and Designations	LCT 355. Coastal Edge / East Unst CCA Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Walkers – High
Theoretical visibility	Proposed Project only

Location and Rationale for Selection

The viewpoint is located close to the summit of the Hill of Clibberswick, looking north across the Norwick. The headland is a popular route with walkers accessing the north eastern coastline of Unst.

The following development currently influences the existing baseline:

- The derelict buildings and infrastructure associated with the former Skaw Radar Station in distant views across the peninsula to the north at Lamba Ness.
- The maritime navigation beacon on the Holm of Skaw.
- The radar infrastructure at the Ward of Norwick, and the radome at Saxa Vord Hill (beyond the left-hand edge of the view).

Description of Existing View

The existing view looks north across Nor Wick to the peninsula between Inner Skaw and Lamba Ness, forming part of expansive views across the north eastern extent of Unst. The cliffs of the horns of Hagmark are seen in the foreground of the view. The viewpoint, at approximately 160m AOD, provides an elevated vantage point for views to the surrounding coastline. Features of the former Radar Station on Lamba Ness are noticeable including the following: the earth banked building of the former receiver building at the end of Lamba Ness; the concrete power house block seen on the crest of the peninsula; and the cluster of buildings including the decontamination building at Inner Skaw.

Determination of Visual Sensitivity

The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for walkers who access the headland for recreation and are therefore more susceptible to changes in the view:

Value – *Medium*

Susceptibility to Change – *High*

- Walkers will be engaged in the experience of the landscape, with a strong awareness of their surroundings and an expectation of remoteness.
- Elemental coastal scenery with expansive views.

Magnitude of Change

The overall magnitude of change on receptors at this viewpoint will be a **Substantial**.

Size or Scale

The Proposed Project will be seen extending across the headland between Inner Skaw and Lamba Ness. The new built form will appear across the peninsula to the north, adding new noticeable features. The radomes of the tracking station will be seen towards the centre of the peninsula. The lightning masts will be seen as tall vertical elements, seen against the sea beyond and will slightly recede in views. Launch pad three is illustrated in its extended pre-

launch condition with the Skyrora XL Launch Vehicle and strongback erected and the lightning masts extended in full. Launch pads one and two are shown in their retracted state, with the surrounding ancillary structures seen as distant features many of which are earth sheltered. The TEL hangar is seen in front of launch pad two, contrasting with the sea beyond. The base infrastructure around launch pad one is contained from view beyond Lamba Ness.

Geographical Extent

The components of the Proposed Project seen across the Proposed Project will extend over a 45° angle of view. Views of this nature will be experienced from the elevated north facing flank of the Hill of Clibberswick.

Potential for In-Combination Effects

No combined effects are predicted.

Significance of Effects

The combination of the individual judgements of **High** sensitivity and a **Moderate** magnitude of change are considered to result in a **Major/Moderate** effect on walkers, which in the context of this assessment is considered to be **Significant**.

Table 11.34 Effects at Viewpoint 1.8, Headland to the north of Saxa Vord Radar Station

Viewpoint 1.8, Headland to the north of Saxa Vord radar station Drawing 11.3.1.8 existing view and a panoramic photomontage of the Proposed Project.	
Distance and Direction to the Proposed Project	Proposed Project: 3.3 km to the east
LCT/CCA and Designations	LCT 355. Coastal Edge / Skaw CCA Herma Ness sub unit of the Shetland NSA
Receptor and Sensitivity to Change	Walkers – High
Theoretical visibility	Proposed Project – lightning masts only

Location and Rationale for Selection

The viewpoint is located on the remote headland to the north of the Saxa Vord radar station. The headland is accessible only by foot, with occasional walkers accessing the northern coastline of Unst.

The following development currently influences the existing baseline:

- The derelict radar equipment and fencing on the headland.
- The maritime navigation beacon on the Holm of Skaw seen in the distance.
- The radome and buildings associated with the radar station at Saxa Vord Hill.

Description of Existing View
The existing view looks west across the northern flank of Saxa Vord Hill and the headlands at Ritten Hamar and Hill Ness to the Holm of Skaw and Inner Flae beyond at the north-eastern edge of Unst. The viewpoint, at approximately 150 m AOD, provides an elevated vantage point for views across the northern coastline of Unst.
Determination of Visual Sensitivity
The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for walkers who access the headland for recreation and therefore more susceptible to changes in the view: ***Value*** *– High ((Herma Ness sub unit of the Shetland NSA)* ***Susceptibility to Change*** *– High* ➢ Walkers will be engaged in the experience of the landscape, with a strong awareness of their surroundings and an expectation of remoteness. ➢ Elemental coastal scenery with expansive views.
Magnitude of Change
The overall magnitude of change on receptors at this viewpoint will be **Negligible**. ***Size or Scale*** The tips of the lightning masts on launch pad 3 will be visible as very minor elements faintly visible extending above the line of cliffs above The Punds, only being visible during launch sequences when the lasts are extended. The remainder of the Proposed Project will be screened from view. ***Geographical Extent*** The lightning masts as shown on the ZTV in **Drawing 11.2.1a** over a very small area of the headland.
Potential for In-Combination Effects
No combined effects are predicted.
Significance of Effects
The combination of the individual judgements of **High** sensitivity and a **Negligible** magnitude of change are considered to result in a **Minor** effect on walkers, which in the context of this assessment is considered to be **Not Significant**. This minor effect will only be experienced as a temporary effect during launch sequences on launch pad three.

Table 11.35 Effects at Viewpoint 1.9, A968 beneath Little Hoeg

Viewpoint 1.9, A968 beneath Little Hoeg **Drawing 11.3.1.9 existing view and a panoramic photomontage of the Proposed Project.**	
Distance and Direction to the Proposed Project	Proposed Project: 4.4 km to the north
LCT/CCA and Designations	LCT 350. Peatland and Moorland / East Unst CCA
Receptor and Sensitivity to Change	Cyclist – High Road users - Medium
Theoretical visibility	Proposed Project
Location and Rationale for Selection	
The viewpoint is located on A968 as the route descends beneath Little Hoeg on the approach to Haroldswick. The viewpoint is representative of wider views for travellers using the road network on the north eastern extent of Unst. The following development currently influences the existing baseline: ➢ The radome and buildings associated with the radar station at Saxa Vord Hill. ➢ Telecommunications masts beside Little Hoeg.	
Description of Existing View	
The existing view looks north across Harold's Wick to Saxa Vord Resort on the ridge of land beneath Saxa Vord Hill and the Ward of Norwick. The Hill of Clibberswick frames the view to the right. The viewpoint, at approximately 54m AOD, provides a vantage point for views across the north eastern coastline of Unst.	
Determination of Visual Sensitivity	
The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for Cyclists and Residents of who are more susceptible to changes in the view, and **Medium** for Road Users: ***Value*** *– Medium* ➢ The B9087 forms part of National Cycle Route 1. ***Susceptibility to Change*** *– High* ➢ Residents are highly likely to be aware of any changes to their existing visual amenity. ➢ Cyclists will be engaged in the experience of the landscape, with a strong awareness of their surroundings. ➢ Motorists travelling through or past the landscape on roads will focus on the route corridor.	

Magnitude of Change
The overall magnitude of change on receptors at this viewpoint will be a **Slight**. ***Size or Scale*** The LSPF will be seen on the distant horizon to the right of the Saxa Vord Resort. The hangar buildings have a similar character to the large modern barns seen within the wider Unst landscape although their scale is larger. The careful approach to the use of colour in the facades assist in the new structures being seen to recede in views against the typically light grey skies. ***Geographical Extent*** Views of this nature will be experienced along a short 600m section of the A968 as crosses the low col between Baltasound and Haroldswick.
Potential for in-Combination Effects
There will be a **Negligible** magnitude of change with a **Minor** and **Not Significant** combined effects on Cyclists and Road Users.
Significance of Effects
The combination of the individual judgements of **High** sensitivity and a **Slight** magnitude of change are considered to result in a **Moderate/Minor** effect on Cyclists and Road Users, which in the context of this assessment is considered to be **Not Significant**.

Table 11.35 Effects at Viewpoint 1.10, Hermaness Hill

Viewpoint 1.10, Hermaness Hill **Drawing 11.3.1.10 existing view and a panoramic photomontage of the Proposed Project.**	
Distance and Direction to the Proposed Project	Proposed Project: 5.32 km to the east
LCT/CCA and Designations	LCT 349. Major Uplands/ Remote High Cliffs SCA Herma Ness sub unit of the Shetland NSA
Receptor and Sensitivity to Change	Walkers/Bird Watchers – High
Theoretical visibility	None

Location and Rationale for Selection
The viewpoint is located on the summit of Hermaness Hill at the remote Herma Ness headland to the west of the Saxa Vord radar station. The headland, which is accessible only by foot, forms part of the Hermaness National Nature Reserve popular with wildlife watchers and walkers accessing the north-western coastline of Unst. The following development currently influences the existing baseline: ➢ The radome and buildings associated with the radar station at Saxa Vord Hill. ➢ The radar equipment on the summit of the Ward of Norwick.
Description of Existing View
The existing view looks west to Saxa Vord Hill and the Ward of Norwick. The viewpoint, at approximately 200 m AOD, provides an elevated vantage point for views across the north western coastline of Unst.
Determination of Visual Sensitivity
The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for walkers and wildlife watchers who access the headland for recreation and therefore more susceptible to changes in the view: ***Value*** *– High ((Herma Ness sub unit of the Shetland NSA)* ***Susceptibility to Change*** *– High* ➢ Walkers and wildlife watchers will be engaged in the experience of the landscape and wildlife, with a strong awareness of their surroundings and an expectation of remoteness. ➢ Elemental coastal scenery with expansive views.
Magnitude of Change
The overall magnitude of change on receptors at this viewpoint will be **No Change**. ***Size or Scale*** The Proposed Project will be screened from view. ***Geographical Extent*** As shown on the ZTV in **Drawing 11.2.1a** the peninsula at Herma Ness experiences no visibility of the Proposed Project.
Potential for In-Combination Effects
No combined effects are predicted.

Significance of Effects
There will be no change to views experienced at Herma Ness.

Summary of Effects on Viewpoints

11.7.17 Table 11.41 lists and summarises effects on the viewpoints assessed above. It sets out their sensitivity to change, the magnitude of change that will arise as a result of the Proposed Project, and the level of resultant effects and their significance.

Table 11.41 Summary of Effects on Viewpoints

Viewpoint	Receptor and Sensitivity	Magnitude of Change	Level of Effect	Significance
Proposed Project, Viewpoints – 1.1 – 1.10				
1.1 - Bluejibs above the Wick of Skaw	Walkers/Visitors – High	Substantial	Major	**Significant**
1.2 - The Haa, Wick of Skaw	Walkers/Visitors/ Residents – High	Substantial	Major	**Significant**
1.3 - The Garths, Lamba Ness	Walkers/Cyclists – High Road Users - Medium	Substantial	**Major** - Walkers, Visitors and Cyclists **Major/Moderate** - Road Users	**Significant**
1.4 - Car park at The Taing, Norwick	Walkers/Visitors/ Residents – High	Substantial	**Major** - Walkers, Visitors and Residents	**Significant**
1.5 - The cemetery, Norwick	Walkers/Visitors/ Residents – High	Moderate	**Major/Moderate** - Walkers, Visitors and Residents	**Significant**
1.6 - B9087 Norwick	Residents/Cyclists – High Road Users - Medium	Moderate	**Major/Moderate** – Residents and Cyclists **Moderate** - Road Users	**Significant** Not Significant
1.7 - Hill of Clibberswick	Walkers – High	Moderate	**Major/Moderate** - Walkers	**Significant**
1.8 - Headland to the north of Saxa Vord radar station	Walkers – High	Negligible	**Minor** - Walkers	Not Significant
1.9 - A968 beneath Little Hoeg	Cyclists – High Road Users - Medium	Slight	**Moderate/Minor** – Cyclists and Road Users	Not Significant
1.10 - Hermaness Hill	Walkers/wildlife Watchers – High	No Change	None	No Effect

11.8 Assessment of Night-time Lighting Effects

11.8.1 The following section provides an overview of the predicted effects of night-time lighting at the Proposed Project.

11.8.2 Light pollution is a recognised problem in the UK, with lighting potentially contributing to an adverse effect on peoples' views, including their enjoyment of the night skies. NatureScot has noted the need to be cautious when proposing lighting in the UK's darker, more sensitive landscapes.

11.8.3 Night-time lighting will be required on the site for safety during launches. The need for lighting will extend visibility of the Proposed Project into hours of darkness. Outside of Launches the lighting at the SaxaVord Spaceport will be reduced to the minimum required for site security and occasional maintenance operations.

Baseline

11.8.4 The baseline environment of Shetland and of the site is generally dark and relatively light free at night, with the only lighting being associated with settlements and residential properties, lighting around the ferry terminals and piers (e.g., at Baltasound), and infrastructure such as fish farms or industrial operations such as the Sullom Voe Oil Terminal. Lighting on vehicles on roads, and on ferries at night, as well as on channel or hazard marker buoys in the sea between the islands also influences the night sky. Relative to the rest of the UK however, Shetland is characterised by very dark skies.

Assessment

11.8.5 Whilst lighting on the will be reduced to a minimum with cut off lighting used wherever possible there will be times when the launch pads and the Skyrora XL Launch Vehicle will need to lighted with directional lighting. The lights at the launch pads have the potential to be seen in clear conditions over long distances.

11.8.6 Shetland has long hours of daylight in the summer months, when the effects of safety lighting at the Proposed Project will be minimal, but there will be long hours of darkness in winter when the effects will extend over longer durations. In Shetland in winter at this latitude it can be dark from 3pm through to 9am, which includes times when people will be active and are more likely to be affected by the proposed lighting.

11.8.7 Lighting may also be seen to interfere with natural phenomena such as the Northern Lights, when they occur.

11.8.8 As such, the effects of lighting on night-time views have the potential to be Significant, particularly during launches. It has the potential to have a significant effect during hours of darkness at all locations within up to approximately 1-2 km (depending upon atmospheric conditions) where the Proposed Project is visible.

Seasonal variation in effects

11.8.9 The effect will be more noticeable and significant in winter months, when people are active during hours of darkness. In summer months however, when the islands are typically more populated with tourists and more people will be outside, most people will be asleep during the very short hours of darkness at this latitude, and the effect of the lighting will be not significant. Between these two extremes, the duration of lighting required and thus the level of significance of effects will gradually increase as the natural daylight tapers off.

Supporting Graphics – Night-time lighting Visualisations

11.8.10 Drawings are provided to illustrate the effects of lighting. The following viewpoint Drawings have been prepared to illustrate the effects of night-time lighting at two selected viewpoints, representative of the local residential clusters that will experience direct views towards the Proposed Project.

- Night-time Lighting Viewpoint 1: Virse, Norwick
  - Drawing 11.3.1a: Virse, Norwick – 90° Existing View (Dusk) and 90° Predicted Photomontage View (Cylindrical)
- Night-time Lighting Viewpoint 2: Skulhus, Sunnyside/Saxa Vord Resort
  - Drawing 11.3.2a: Skulhus, Sunnyside/Saxa Vord Resort – 90° Existing View (Darkness) and 90° Predicted Photomontage View (Cylindrical)

11.8.11 The individual assessment from these representative locations is provided below.

Table 11.42 Effects at Night-time Lighting Viewpoint 1, Virse, B9087 Norwick

Night-time Lighting Viewpoint 1, Virse, B9087 Norwick **Drawing 11.3.1 existing view and a panoramic photomontage of the Proposed Project (Darkness).**	
Distance and Direction to the Proposed Project	Proposed Project: 2 km to the north east
LCA/CCA and Designations	LCT 354. Farmed and Settled Voes and Sounds / East Unst CCA Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Residents – High Road Users - Medium
Theoretical visibility	Proposed Project
Location and Rationale for Selection	
The viewpoint is located on the B9087/NCR1 between Saxa Vord and Norwick, adjacent to the entrance to the property at 'Virse'. It has been selected to illustrate the effects of night-time lighting on local residents.	
Description of Existing View	
The existing view looks north across the settled farmland of Norwick Meadow and beyond to the settlement at Norwick, the bay at Nor Wick, the peninsula to the north between Inner Skaw and Lamba Ness, and the expansive North Sea beyond. Lighted windows visible at the scattered properties at Norwick are the only visible artificial light sources.	
Determination of Visual Sensitivity	
The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for residents of who are more susceptible to changes in the view, and **Medium** for Road Users:	

Value *– Medium*

Susceptibility to Change *– High*

- Residents are highly likely to be aware of any changes to their existing visual amenity.
- Motorists travelling through or past the landscape on roads will focus on the route corridor.

Magnitude of Change

The overall magnitude of change on receptors at this viewpoint will be a **Moderate**.

Size or Scale

The proposed lighting will be visible in the distance varying from being dimly visible at low light, more resolved and noticeable at dusk, to being seen as a clearly seen at darkness.

Light sources are likely to include:

- Cut off lighting at the launch pads.
- Directional lighting onto the Skyrora XL Launch Vehicle, strongback and the lightning masts.
- Low level lighting at the Integration/TEL Hangar, LSPF and gate house.

Geographical Extent

Views to the lighting will be experienced along the B9087 between Saxa Vord and Norwick.

Duration

The effect will be more noticeable in winter months, when people are active during hours of darkness. In summer months however, when the islands are typically more populated with tourists and more people will be outside, most people will be asleep during the very short hours of darkness at this latitude, and the effect of the lighting will not be significant. Between these two extremes, the duration and thus level of significance of effects will gradually increase as the natural daylight tapers off again.

Significance of Effects

The combination of the individual judgements of **High** and **Medium** sensitivity and a **Moderate** magnitude of change are considered to result in a **Major/Moderate** effect on Residents, and a **Moderate** effect on Road Users, which in the context of this assessment are considered to be **Significant** and **Not Significant** effects respectively.

Table 11.43 Operational Effects at Night-time Lighting Viewpoint 2, Skulhus, Sunnyside/Saxa Vord.

Night-time Lighting Viewpoint 2, Skulhus, Sunnyside/Saxa Vord. **Drawing 11.3.2 existing view and a panoramic photomontage of the Proposed Project (Dusk).**	
Distance and Direction to the Proposed Project	Proposed Project: 1.6 km to the north east
LCA/CCA and Designations	LCT 354. Farmed and Settled Voes and Sounds / East Unst CCA Haroldswick and Skaw LLA

Receptor and Sensitivity to Change	Residents – High Road Users - Medium
Theoretical visibility	Proposed Project

Location and Rationale for Selection

The viewpoint is located at the edge of Saxa Vord / Sunnyside, adjacent to the property at 'Skulhus'. It has been selected to illustrate the effects of night-time lighting on local residents.

Description of Existing View

The existing view looks to the north-east across the scattered settlement between Saxa Vord and Norwick. The peninsula between Inner Skaw and Lamba Ness is partly seen on the skyline below the tapering ridgeline of The Ward of Norwick. Lighted windows visible at the properties in the foreground are the only visible artificial light sources.

Determination of Visual Sensitivity

The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for Residents of who are more susceptible to changes in the view, and **Medium** for Road Users:

Value *– Medium*

Susceptibility to Change *– High*

- Residents are highly likely to be aware of any changes to their existing visual amenity.
- Motorists travelling through or past the landscape on roads will focus on the route corridor.

Magnitude of Change

The overall magnitude of change on receptors at this viewpoint will be a **Moderate**.

Size or Scale

The proposed lighting will be visible in the distance varying from being dimly visible at low light, more resolved and noticeable at dusk, to being seen as a clearly seen at darkness.

Light sources are likely to include:

- Cut off lighting at the launch pads.
- Directional lighting onto the Skyrora XL Launch Vehicle, strongback and the lightning masts.
- Low level lighting at the Integration/TEL Hangar, LSPF and gate house.

Geographical Extent

Views to the lighting will be experienced along the B9087 between Saxa Vord and Norwick.

Duration

The effect will be more noticeable in winter months, when people are active during hours of darkness. In summer months however, when the islands are typically more populated with

tourists and more people will be outside, most people will be asleep during the very short hours of darkness at this latitude, and the effect of the lighting will not be significant. Between these two extremes, the duration and thus level of significance of effects will gradually increase as the natural daylight tapers off again.

Significance of Effects

The combination of the individual judgements of **High** and **Medium** sensitivity and a **Moderate** magnitude of change are considered to result in a **Major/Moderate** effect on Residents, and a **Moderate** effect on Road Users, which in the context of this assessment are considered to be **Significant** and **Not Significant** effects respectively.

Summary

11.8.12 Shetland has long hours of daylight in the summer months, when the effects of safety lighting and task lighting will be minimal, but long hours of darkness in winter when the effects will extend over longer durations. In Shetland in winter at this latitude it can be dark from 3pm through to 9am, which includes times when people will be active and are more likely to be affected by the proposed lighting.

11.8.13 Lighting may also be seen to interfere with natural phenomena such as the Northern Lights when they occur.

11.8.14 As such, the effects of lighting on night-time views is likely to be Significant, particularly in closer views. It is likely to be Significant during hours of darkness at locations within approximately 1-2 km where visible.

11.8.15 The effect will be more noticeable and significant in winter months, when people are active during hours of darkness. In summer months however, when the islands are typically more populated with tourists and more people will be outside, most people will be asleep during the very short hours of darkness at this latitude, and the effect of the lighting will be not significant. Between these two extremes, the duration and intensity of lighting and thus level of significance of effects will gradually increase as the natural daylight tapers off.

11.9 Cumulative (In-Combination) Landscape and Visual Assessment

11.9.1 Cumulative effects can be either inter-project or intra-project effects.

11.9.2 Inter-project cumulative effects are those where an environmental topic/receptor is affected by impacts from more than one project at the same time and the impacts act together. Due to the location of the Proposed Project on the north coast of Unst, the most northerly of the Shetland Islands, there are no potential inter-project cumulative effects as there are no other existing or proposed developments in the EZI. Shetland Islands Council confirmed during the planning application for SaxaVord Spaceport that there were no other committed development or infrastructure projects which needed to be considered in that assessment and there has been no change subsequent to planning consent.

11.9.3 Intra-project cumulative effects are those where an environmental topic/receptor is affected by more than one impact from the same Proposed Project and the impacts act together. In LVIA these are termed in-combination effects.

11.9.4 The assessment of in-combination effects is incorporated into the main LVIA, with separate judgements for the combined effects presented within each of the tables throughout, for each landscape and visual receptor. This section summarises the key issues, informed by the analysis and assessment which has already been presented.

11.9.5 There will be short term combined effects on the settlement at Saxa Vord and areas around Northdale where parts of the Proposed Project will be seen in combined views and successive views. These effects are Not Significant in-combination effects.

11.10 Summary

11.10.1 A Landscape and Visual Impact Assessment has been undertaken for the Proposed Project, within the context of the wider SaxaVord Spaceport. It sets out the predicted effects on the landscape, which, in the context of Shetland and this assessment, also includes effects on coastal and seascape character.

11.10.2 The assessment includes consideration of effects upon designated landscapes including the Shetland NSA and other locally designated landscapes such the draft LLAs.

11.10.3 From a visual perspective, the assessment considers effects upon residents at settlements, users of roads and recreational routes, which include tourists. This was informed by assessment of visual effects at a series of representative viewpoints, which were agreed with NatureScot and Shetland Islands Council.

11.10.4 The assessment of in-combination effects between the component parts of the Proposed Project is incorporated into the main assessment of landscape and visual effects. Some limited in-combination interactions will occur.

11.10.5 The proposed launches will need to be lighted at night for a short time for reasons of safety. The lighting will extend visual effects into hours of darkness for local visual receptors.

11.10.6 Whilst it is always necessary to take account of and to balance the wide range of technical and environmental requirements, it is also a requirement to seek to optimise the layout design through mitigation measures embedded into the project design to reduce the resulting effects from a landscape and visual perspective. Landscape and visual input into the Proposed Project design has been provided through the design development stages of the project. These measures include the careful selection of colour in the proposed built forms, sensitive use of construction materials, and a careful approach to the manipulation of the land form to accommodate the new structures.

11.10.7 A number of significant effects are predicted including significant landscape effects on the landscape character of the site and its surroundings, visual effects on residents at settlements and tourists including recreational walkers.

Summary of Effects on the Landscape Resource

Effects on Landscape Fabric

11.10.8 The landscape is of Medium sensitivity, given the presence of the sensitive remains of the former Skaw Radar Station.

11.10.9 The Proposed Project, when considered as an integral part of the wider SaxaVord Spaceport, is considered to have a Substantial magnitude of change. There will be Major/Moderate and Significant effects on the fabric of the application sites in and around the immediate vicinity of the Proposed Project.

Effects on Landscape Character

11.10.10 The location of the Proposed Project includes parts of the 355 - Coastal Edge Landscape Character Type (LCT) and 349 - Major Uplands LCT as identified in the Scottish Landscape Character Types Mapping.

11.10.11 The Proposed Project is located within the Coastal Edge LCT and the eastern edge of the Major Uplands LCT and the implementation of the development will introduce additional built form and infrastructure to the peninsula between inner Skaw and Lamba Ness within the context of the derelict structures of the former Skaw Radar Station. The new buildings and infrastructure will reinforce development as a component of the prevailing landscape character. Although the Proposed Project will add to the influence of development on the peninsula, the presence of existing development will reduce the magnitude of change on the character and qualities of the LCTs.

11.10.12 Within the Coastal Edge LCT, there will be a locally Substantial magnitude of change, which in combination with the Medium/High sensitivity of the landscape, is considered to result in a locally Major/Moderate and Significant effect across the immediate site area and the LCT.

11.10.13 The rising ridgeline of the Ward of Norwick is open to direct views to the Proposed Project and there will be direct and indirect effects on the character of the Major Uplands LCT. There will a locally Substantial magnitude of change, which in combination with the High sensitivity of the landscape, is considered to result in a locally Major and Significant effect across the immediate site area and a generally Major/Moderate and Significant effect across the eastern extent of the LCT.

11.10.14 Whilst topography limits the influence of the Proposed Project there will be indirect impacts on the perceived qualities and characteristics of the Skaw unit of the Farmed and Settled Lowlands and Coast LCT to the north and the Norwick-Valsgarth area of the Farmed and Settled Voes and Sounds LCT to the south.

11.10.15 The Proposed Project between Inner Skaw and Lamba Ness will be seen in partial views. From the Farmed and Settled Lowlands and Coast LCT and the Farmed and Settled Voes and Sounds LCT there will be a generally Slight magnitudes of change, which in combination with the High/Medium and Medium sensitivities respectively of the landscape types, is considered to result in a Moderate and Not Significant effect.

11.10.16 During launches the lightning masts, hardbacks and the Skyrora XL Launch Vehicles, erected at separate times on any of the three launch pads, will be seen as prominent structures which will influence the setting of both LCTs. Launches will give rise to short term increases in the magnitude of change experienced from the Farmed and Settled Lowlands and Coast LCT and the Farmed and Settled Voes and Sounds LCT, with a Moderate magnitude of change, which in combination with the High/Medium and Medium sensitivities respectively of the landscape types, is considered to result in locally Major/Moderate and Significant effects.

11.10.17 There will also be areas of inter-visibility with the elevated coastal LCTs including the Blue Jibs area of the Coastal Edge LCT to the north, and the north facing flank of the Hill of Clibberswick to the south which includes sections of the Coastal Edge LCT and Peatland and Moorland LCT. Actual influence on the perception of landscape character is reduced by distance and there will be a Slight magnitude of change, which in combination with the High/Medium and Medium sensitivities respectively of the landscape types, is considered to result in locally Moderate and Not Significant effects.

11.10.18 During launches the lightning masts, hardbacks and the Skyrora XL Launch Vehicles, erected at separate times on any of the three launch pads, will be seen as prominent structures which will influence the setting of both LCTs. Launches will give rise to short term increases in the magnitude of change experienced from the Coastal Edge LCT and Peatland and Moorland LCT, with a Moderate magnitude of change, which in combination with the High/Medium and Medium sensitivities respectively of the landscape types, is considered to result in locally Major/Moderate and Significant effects on these LCTs.

11.10.19 Beyond 3 km, due to the effect of topography which provides containment to the site and also the effect of distance, the Proposed Project will be a less visible element in the landscape. The resultant effects on landscape character will only give rise to Slight or Negligible magnitudes of change beyond 3 km with effects on landscape character being Not Significant.

Effects on Coastal and Seascape Character

11.10.20 The Proposed Project, within the context of the wider SaxaVord Space, is located between the Skaw and East Unst Coastal Character Areas (CCA), and the Islands, Sounds and Voes Seascape Character Area (SCA) lies to the east. The implementation of the Proposed Project will temporarily introduce additional elements of development to the peninsula between inner Skaw and Lamba Ness.

11.10.21 There will be locally Moderate magnitudes of change on these CCAs/SCA, which in combination with the High sensitivity of the coastline/seascape, is considered to result in a locally Major/Moderate and Significant effects across the CCAs/SCA within the Wick of Skaw to the north and Nor Wick to the south and across the open sea to the east. As with the effects on landscape character there will be a greater short-term magnitude of change experienced from the CCAs/SCA during missions with the temporary infrastructure of extended lightning masts, strongback and Skyrora XL Launch Vehicle appearing as prominent temporary elements above the low profile of the coastal peninsula.

Effects on Designated Landscapes

11.10.22 Potential effects on the quality and setting of designated landscapes within the EZI were assessed, in particular relating to the Shetland NSA, LLAs and Inventory Gardens and Designed Landscapes.

11.10.23 Locally Major/Moderate and Significant effects are predicted upon the coastal edges of the Haroldswick and Skaw Local Landscape Area.

11.10.24 Minor and not significant effects are also predicted on a very limited area of the Hermaness sub-unit of the Shetland NSA where there will be very minor visibility of the lightning masts of Launch Pad 3, visible only during missions, moderated by the distinct separation of the Proposed Project from the designation and the diverse nature of views. There will not be important changes to the special qualities of the Shetland NSA. A detailed assessment of effects on the Shetland NSA is included at Appendix 11.5.

11.10.25 No significant effects as a result of the Proposed Project will occur in relation Inventory Gardens and Designed Landscapes.

Summary of Effects on Visual Amenity

11.10.26 The study included an assessment of the effects of the Proposed Project upon settlements, transport corridors and viewpoints representative of a range of receptors within the EZI.

Effects on Settlements, Transport Corridors and Recreational Routes

11.10.27 Effects were assessed on visual amenity from settlements. It is predicted that there will be Major/Moderate and Significant effects from the settlements at Booths, Norwick/Kirkaton and the north-eastern edge of Saxa Vord/Valsgarth. This effect is moderated by the existing presence of the structures of the former Skaw Radar Station development in the landscape, the effects of distance and the context of the Proposed Project within expansive and diverse coastal views.

11.10.28 During launches the lightning masts, strongbacks and Skyrora XL Launch Vehicles, erected at separate times on each of the launch pads, will be seen as prominent structures which will influence views from Norwick and the north-eastern edge of Saxa Vord/Valsgarth. The mission will give rise to short term increases in the magnitude of change.

11.10.29 Similar effects will be experienced by cyclists on the National Cycle Route 1 using the B9087 and also the minor road, Holsens Road, leading on from Norwick to Skaw.

11.10.30 Effects assessed on visual amenity from other settlements, roads and long-distance cycle ways within the EZI, are concluded to be Not Significant.

Effects on Viewpoints

11.10.31 The nature of the visibility of the Proposed Project was also assessed from 15 viewpoints. The viewpoints included settlements, route corridors, landmarks, hill summits and other visitor attractions.

11.10.32 The assessment of the viewpoints concluded that there will be significant effects on visual amenity from six of the selected viewpoints as follows:

- Viewpoint 1.1, Coastal footpath above Bluejibs and the Wick of Skaw: From the headland at Blue Jibs to the north of Skaw Beach the Proposed Project be seen in its full extent along the peninsula between Inner Skaw and Lamba Ness adding new built form within the remnant structures of the Skaw Radar Station and introducing significant local change with the outlines of the new hangars prominent on the skyline of the peninsula.
- Viewpoint 1.2, The Haa, Wick of Skaw, and Viewpoint 1.4, Car Park at The Taing, Norwick: From Skaw Beach to the north of the peninsula and from Taing Beach to the south the Proposed Project will be seen as new vertical elements visible along the profile of the peninsula.
- Viewpoint 1.3, Holsens Road, Clinkapund above the site entrance to Lamba Ness: The viewpoint is located at the western edge of the Proposed Project and affords a locally elevated position across the site between Inner Skaw and Lamba Ness. The proposed large hangars will be as noticeable new large scale-built form on the site.
- Viewpoint 1.5, Norwick Cemetery: The viewpoint is located at the eastern edge of the settlement at Norwick within Norwick Cemetery and in a slightly elevated position affording a direct view across Nor Wick to the peninsula to the north. The proposed hangar at the western sector of the site will be prominent on the skyline above the beach at Taing, whilst the TEL hangar, and the lightning mast will be visible as new vertical elements visible along the profile of the peninsula.
- Viewpoint 1.6, B9087, Norwick: Similar views will be experienced from the scattered houses at the north-eastern edge of Valsgarth/Saxa Vord.
- Viewpoint 1.7, Hill of Clibberswick: This viewpoint from the northern side of the Hill of Clibberswick illustrates the effect on view that will be experienced by recreational walkers accessing the elevated coastline to the south of Nor Wick. The elevated viewpoint looks down onto the peninsula and the Proposed Project will be noticeable in views.

11.10.33 At each of these viewpoints, during launches, the lightning masts, strongbacks and the Skyrora XL Launch Vehicles, erected at separate times on any of the three launch pads, will be seen as further prominent structures in these views. There will also be associated temporary night-time lighting effects.

11.10.34 From more distant viewpoint locations, the Proposed Project will appear in a large-scale and diverse landscape/coastal/seascape setting, which can accommodate the level of change associated with the Proposed Project and which will not give rise to further significant effects on visual amenity. The Proposed Project will recede within wider panoramic views, particularly with distance.

11.10.35 The Proposed Project is focussed away from the scattered settlement and coastal crofting land and is positioned on the Lamba Ness peninsula. The SaxaVord Spaceport site has previously been the focus for the large-scale development of the wartime Skaw Radar Station with many of the original structures, buildings and tracks remaining evident in this coastal landscape. Whilst the effects of the Proposed Project, within the context of the wider SaxaVord Space, will be significant locally to the site and for some visual receptors in local views to the site, it is considered that these can be accommodated in this open, diverse coastal landscape.

11.11 References

Countryside Agency and NatureScot. (2002). *Landscape Character Assessment: Guidance for England and Scotland*.

Historic Environment Scotland. (2016). *Scotland's Inventory of Gardens and Designed Landscapes*.

Landscape Institute and Institute of Environmental Assessment. (2013). *Guidelines for Landscape and Visual Assessment 3rd Edition*. (GLVIA 3).

Landscape Institute. (17th September 2019) *TGN 06/19 Visual Representation of development proposals*.

NatureScot. (2017). *Visual Representation of Windfarms: Guidance, Version 2.2*.

NatureScot. (March 2012). Assessing the Cumulative Impact of Onshore Wind Energy Developments.

NatureScot. (2010). *The Special Qualities of the National Scenic Areas*. NatureScot commissioned report.

NatureScot. (1998). *SNH Review 93 - A landscape assessment of the Shetland Isles*. NATURESCOT.

Shetland Islands Council. (2014). *The Shetland Local Development Plan, 2014*. Shetland Islands Council.

Shetland Islands Council. (2011). *Local Landscape Designations Review* (LLDR).

Websites

Scottish Government. (2014). *Supplementary Planning Policy* (SPP). Available at: *https://www.gov.scot/publications/scottish-planning-policy/* Accessed May 2022.

NatureScot. Scottish Landscape Character Types Map and Descriptions. Available at: https://www.nature.scot/professional-advice/landscape/landscape-character-assessment/scottish-landscape-character-types-map-and-descriptions Accessed May 2022.

Chapter 12 Accidents

12. Accidents and Disasters

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12. Accidents and Disasters

12.1 Introduction

12.1.1 This chapter considers the potential for the Proposed Project to cause major accidents or be affected by natural disasters, in both cases focussing on where harm to the environment as a consequence could reasonably occur.

12.1.2 The assessment is intended to inform management and mitigation of risks to the environment. It does not assess the probability of any major accident or disaster.

12.1.3 The chapter considers environmental hazards inherent to the Proposed Project, the receptor groups likely to be affected in the event of an accident event, and the potential severity of the impact. The management of these risks by design or further mitigation is discussed.

12.1.4 The chapter considers significant effects from major accidents and natural disasters, it does not represent an exhaustive treatment of every possible risk of environmental damage. "Major" is in this context defined as having the potential to cause permanent or long-term damage to a receptor, including loss of life or permanent destruction of habitat. Environmental hazards have been identified in collaboration with the Applicant's operations team and through co-operation with SaxaVord Spaceport.

12.2 Legislation, Policy and Guidelines

Legislation

12.2.1 The treatment of major accidents and disasters within an AEE is a requirement since the Space Industry Regulations 2021 came into force. Guidance document 'Guidance for the Assessment of Environmental Effects' (CAA et. al., 2021) states in paragraph 4.65:

'The AEE must include a description of the environmental effects of reasonable worst-case scenarios from accidents and disasters which could occur during, or as a result of, the proposed activities. These must include as a minimum:

- *Possible off-nominal launch scenarios, account for where these occur (for example, on the launch pad)*
- *Fuel and hazardous material storage and handling (for example, failure of containment).'*

12.2.2 The Proposed Project will be a workplace and The Health and Safety at Work Act (1974) (UK Government, 1974) and Management of Health and Safety at Work Regulations (1999) (UK Government, 1999) will apply. The Act's position on controlling risks, as interpreted by the Health and Safety Executive, to a level "As Low as Reasonably Practical" (ALARP) informs the approach to mitigation in the AEE Report context.

12.2.3 The Control of Major Accident Hazards Regulations (2015) (COMAH) (UK Government, 2015) and the Town and Country Planning (Hazardous Substances)(Scotland) Regulations 2015 (Scottish Government, 2017) will not apply to the Proposed Project as the thresholds for storage of the relevant hazardous materials (principally kerosene and high-test peroxide (HTP)) will not be exceeded.[1]

[1] The lower tier COMAH threshold is 2500 tonnes for aviation fuels including kerosene as a "Named Substance" in Schedule 1 Part 2 of the COMAH Regulations. The threshold for hydrogen peroxide as a Category 1 oxidising liquid (Schedule 1 Part 1) is 50 tonnes; this threshold will be likely be approached but not exceeded.

Guidance

12.2.4 Specific guidance for the production of Accidents chapters for AEE is currently limited and therefore reference has been made to examples of current practice shared by the Institute of Environmental Management and Assessment (IEMA, 2020).

12.2.5 The Health and Safety Laboratory (HSL) has produced the guidance document "Safety at Spaceports" (Health and Safety Laboratory, 2018) on behalf of the Civil Aviation Authority and the UK Space Agency. This assessment recognises this guidance and sets out a list of potential hazard areas to examine the potential environmental effects as the guidance suggests. The HSL guidance then recommends a tiered risk assessment process tailored more towards the protection of occupational groups, and as such diverges from the AEE process. This element of the risk assessment is therefore included separately in the Spaceport licence application safety case.

12.3 Assessment Methodology and Significance Criteria

12.3.1 Under the guidance and regulations accompanying the Space Industry Act 2018, a safety case and quantitative operational risk assessments is required to be produced by the Applicant for approval by the regulator. This assessment for AEE does not replace these requirements but rather separately considers reasonably realistic accident and disaster events in the context of their environmental consequences. It would be unrealistic to exclude workers and nearby residents as receptor groups from this assessment however, since any environmental changes would affect these groups as well as potentially wildlife and habitat sites.

12.3.2 A list of potential major accident and disaster events has been drafted on the basis of the Proposed Project's potential vulnerabilities and a range of reasonably plausible accident scenarios.

12.3.3 Events which could potentially meet the definition were considered in terms of the nature of the potential environmental effects, the potential severity and significance of the effect and the requirements for mitigation.

12.3.4 The meaning of "major" should be understood in the context of the Proposed Project. The "major" events assessed are expected to represent the potential events with the highest severity before, during and after the launch of a relatively small launch vehicles (LV). These "major" events would not necessarily be considered as such in the context of a much larger aerodrome or a facility which stored or used flammable materials in far greater quantities such as a petrochemical refinery.

12.3.5 For context, a maximum of 16 launches per year are proposed by Skyrora.

Environmental Zone of Influence and Study Area

12.3.6 For the purposes of this AEE, the Environmental Zone of Influence (EZI) is based on and comprises the proposed launch flight corridor and all study areas required for the technical disciplines included in the AEE, as presented on drawing 3.6.

12.3.7 Within the EZI, the study area(s) required for each technical discipline vary. A one-kilometre buffer area around the Proposed Project Launch Pad locations was considered for the potential effects of loss of containment and combustion events because effects meeting the definition of a major accident or disaster would be unlikely beyond this distance. Aeronautical events are treated in terms of a ground strike on Unst or a water strike downrange.

Assessment of Significance

12.3.8 Potential effect significance must be understood in the context of major accidents and disasters. These are inherently rare events, and it is entirely plausible that no major accident or disaster befalls any launch event. Even if such an event took place, it is also plausible that there might be no effects beyond the immediate vicinity of the Proposed Project and within the boundary of the SaxaVord Spaceport.

12.3.9 The terminology used in the assessment, to be consistent with other Chapters of the AEE Report and, notwithstanding the caveat in the above paragraph, are as follows:

- Sensitivity – all potential human, wildlife and habitat receptors are assumed highly sensitive on a precautionary basis;
- Magnitude of impact –The usual terminology for the significance of effect is irrelevant in this case as only events with potential for high impacts (loss of life or permanent damage to habitats) are considered; and,
- Significance of effect – Although receptors are assumed to all be of high sensitivity and impacts inherently large and adverse, the significance will still vary depending on the nature of the effect, particularly in terms of duration and reversibility. For instance, a catastrophic release of a corrosive fluid could have a major effect on a human receptor, with the potential for fatality, but a minor effect on a habitat which could readily regenerate following brief exposure. The scale of significance used, in descending order, is major, moderate, minor and negligible, with major and moderate being considered as significant effects in terms of AEE.

Requirements for Mitigation

12.3.10 Mitigation of the risk of significant adverse environmental effects is generally embedded in the design of the Proposed Project as influenced by iterative hazard identification exercises.

Assessment of Residual Effect Significance

12.3.11 The residual effects are intended to be the management of the risk of a major accident or disaster to a level that is ALARP, noting that this AEE Report represents a high-level assessment of such risks, with further assessment undertaken elsewhere in the Launch Operator Licence application.

Limitations to Assessment

12.3.12 The assessment is qualitative. It includes no probabilistic treatment of risk, simply identifying plausible major accident and disaster events and commenting on their potential severity and the outline approach to mitigation. It purposely considers environmental effects as its focus, and where effects on human health are noted, it is not intended to substitute for current and future safety case development.

12.4 Baseline Conditions

12.4.1 Baseline conditions are assumed to be routine launch vehicle operations at the SaxaVord Spaceport, rather than any physical description.

12.5 Receptors Brought Forward for Assessment

12.5.1 The following receptors have been brought forward for assessment:

- Habitats within a one-kilometre radius of the launch site were reviewed. Norwick Site of Special Scientific Interest (SSSI) is a geological designation and not considered sensitive. Norwick Meadows SSSI is a habitat designation for its sand dunes and valley fen which support several plant species of national and international interest.
- Wildlife receptors: The immediate vicinity of the Proposed Project will continue to be populated by species identified in Chapters 5 and 6. These have been treated generically as residents of, or visitors to, the vicinity of the Proposed Project.
- Human receptors: The nearest inhabited receptor points outside of the spaceport boundary are Banks Cottage and the village of Norwick, though both are considerably over one kilometre from the Proposed Project i.e. the launch pads. Employees and contractors working on the Proposed Project will therefore be the nearest human receptors considered.

12.6 Standard Mitigation

12.6.1 Standard mitigation measures have been informed by the safety case and risk assessment work undertaken as part of the application for launch operator licence. Standard mitigation will include the following:

- Development of a Safety Management System and operating procedures, contained in the Skyrora Safety Operations Manual (RP06-E-XL-01.04);
- Compliance with SaxaVord Spaceport procedures including Launch Site Safety User's Manual (SAXA-GRP-OPS-SSUM-001), Emergency Response Plan and Operational Environmental Management Plan. Third-party documents are reviewed against Skyrora equivalent documents to identify and resolve any incompatibility before launch campaigns begin;
- Establishment and maintenance of an appropriate exclusion when required;
- Minimal storage of reagents on site in favour of "just-in-time" delivery for any given launch campaign with bulk storage off-site (which will be managed by SaxaVord Spaceport as part of their service offering); and
- Propellant / oxidant transfer and storage on hardstanding with integral containment (i.e. a sump of sufficient volume to hold a spillage indefinitely).

12.7 Potential Effects

12.7.1 Major accident and disaster events which were screened out of assessment are shown in Table 15.1 below, along with reasons for no further consideration. They are generally natural disasters and extreme weather events with no serious risk of occurrence.

Table 12.1 Events screened out

Event	Reason for screening out
Tectonic activity	British Geological Survey records show no recorded earthquake above 4 local magnitude ("light") within 50 km of Unst since records began. A (British Geological Survey, 2020).
Extreme temperature	Highly unlikely under the most pessimistic climate change scenarios given Unst's latitude (see Chapter 9)
Extreme storm	Launches with the potential to be compromised by extreme weather conditions would be postponed until a storm event had passed.
Storm surge (inundation)	Elevation makes inundation highly unlikely. No accounts of storm surge at the Proposed Project launch site.

12.7.2 Climate-related risks are discussed in more detail in Chapter 9 of this AEE Report.

12.7.3 Events taken forward for assessment are summarised in Table 12.2 below. The events have been grouped into failure of containment (liquids), failure of containment (gases), ignition (liquids) and off-nominal launch scenarios. The nature of the hazards is discussed in the following sections.

Failure of containment (liquids)

12.7.4 The Skyrora XL requires around 7,300 kg of kerosene and 49,200 kg of HTP oxidant.

Kerosene

12.7.5 Kerosene will be delivered on a just-in-time basis by road tanker on a launch campaign basis.

12.7.6 The quantity (7,300 kilograms, which occupies around 8,900 litres) required represents just over a quarter-load for a typical UK fuel tanker truck, with approximate capacity of 35,000 litres.

12.7.7 It is assumed for this assessment that loss of containment, if uncontrolled by the mitigation measures in place at the Spaceport, could lead to damage to on-site soil and groundwater and ultimately designated habitat site and the wildlife supported.

Hydrogen peroxide

12.7.8 Hydrogen peroxide will be tankered to the launch site on a just-in-time basis, in quantities required for a given campaign vehicle as per other materials. The quantity used for a launch campaign would be less than two full road tanker loads.

12.7.9 Hydrogen peroxide is corrosive to organic matter at high concentrations and can exothermically decompose into water and oxygen on contact with many substrates. A catastrophic loss of containment could lead to human health effects and topical damage to on-site vegetation though is too unstable to percolate very far into groundwater and travel offsite.

Failure of containment (gases)

12.7.10 Relatively small quantities of carbon dioxide (12 kg) and helium (45 kg) will be transported to site in cylinders and added to each launch vehicle.

12.7.11 Failure of containment for either gas will not conceivably lead to a major incident and are noted in the interests of completeness.

12.7.12 Carbon dioxide and helium leaks may temporarily reduce atmospheric oxygen concentration within a built environment, but evacuation and ventilation would mitigate against short-term health effects particularly asphyxia. Carbon dioxide or helium loss in an outdoor environment would have no particular effect though carbon dioxide does provoke climate change effects; the quantities involved are very limited, however.

12.7.13 There may be potential mechanical effects and risk of harm to occupational groups due to a sudden blast of pressurised gas.

Ignition of hazardous materials

12.7.14 Kerosene the only flammable materials likely to be used in bulk quantities at the Proposed Project.

12.7.15 Uncontrolled combustion of kerosene during delivery or launch vehicle fuelling would result in deflagration rather than explosion and then only if vapour had built up to a concentration above the lower explosive limit of 0.6% in a given volume of air.

Off-nominal Launch Scenarios

12.7.16 The resulting deflagration following ignition of propellant during a launch failure would create a short-lived initial fireball potentially extending several tens of metres from the pad, with the residual propellant rapidly burning off over several minutes.

12.7.17 Relatively little empirical data on the environmental effects of directly comparable catastrophic losses of a launch vehicle exist. Research by NASA summarising all available historic data for the accidental and planned test destruction of kerosene-propelled launch vehicles suggests that the initial overpressure wave, which approximately corresponds to the deflagration radius (fireball) decays within tens of metres of the point of ignition (Blackwood, 2015).

12.7.18 The initial deflagration radius is not therefore expected to extend beyond the boundary of the Proposed Project and the duration of any subsequent propellant burn-off would be minimal in the open air.

12.7.19 The working expectation is that the risk of ignition of peat will be low following a rocket propellant deflagration. Some of the peat substrate closest to the launch sites has been removed for use in off-spaceport peatland improvement projects. A peat fire would in any case not be allowed to persist and would be extinguished by the spaceport and municipal fire services.

12.7.20 The loss of all or part of the launch vehicle to the marine environment are considered in Chapter 10 – Marine and Transboundary Effects of this AEE Report.

Table 12.2 Events assessed

Event	Receptors	Potential Consequences	Significance	Mitigation
Failure of containment – liquid				
Kerosene	Hu, W, Hab	Soil and groundwater contamination. Runoff to watercourse or sea.	**Moderate (Significant)**	Bunded transfer (using SaxaVord Spaceport's infrastructure). Maintenance regime for storage, transfer and containment equipment as part of SaxaVord Spaceport responsibilities.
Hydrogen peroxide	Hu, W, Hab	Corrosive damage to receptors in close proximity to release.	**Moderate (Significant)**	Bunded transfer (using SaxaVord Spaceport's infrastructure)
Failure of containment – gas				
Carbon dioxide gas	Hu	Inundation of an indoor workspace could lead to asphyxia if worker egress was prevented. There may be potential mechanical effects and risk of harm to occupational groups due to a sudden blast of pressurised gas.	Minor	External storage by SaxaVord Spaceport's design
Helium gas	Hu	Inundation of an indoor workspace could lead to asphyxia if worker egress was prevented though dispersion will be quicker than nitrogen.	Minor	None required – inert.
Ignition of bulk quantities				
Kerosene	Hu, W	Initial blast could affect human and wildlife receptors within the site boundary, with off-site effects less likely. Residual fires could cause a short-term episode of high air pollutant concentrations near the blast site and immediate downwind locations.	**Major (Significant)**	Bulk storage off-site by SaxaVord Spaceport's design. Fire risk assessment of potential operating envelope by Saxavord Spaceport to inform safe working practices around flammable materials.

Event	Receptors	Potential Consequences	Significance	Mitigation
Aeronautical events				
Rocket crash – ground strike	Hu, W, Hab	Damage to receptors through impact and loss of propellant containment, potential ignition of propellant vapour and flammable substrate (peat).	**Major (Significant)**	CAA license requirements for launch management (Skyrora). All launch trajectories are to the north and have minimal land overflight (Skyrora). Areas around launch pad are not peat rich and some peat has been removed.
Rocket crash – water strike	W, Hab	Damage to receptors through impact and loss of propellant containment.	**Minor (Not Significant)**	Marine environment (Chapter 10) concludes this is not significant. Propellant load will be partially combusted.

* Key to receptor abbreviations: Hu(man), W(ildlife), Hab(itat).

12.8 Additional Mitigation

12.8.1 Other than where fluid containment and transfer arrangements are required to limit releases to the environment (noted in Table 12.2 and included within the design as standard mitigation), there are not considered to be further significant environmental risks which require additional mitigation measures. No additional mitigation measures beyond the measures identified in Section 9.6 are considered necessary.

12.8.2 Inherent safe operating practices are required under CAA licensing requirements. The prevention and mitigation of other accidents and disasters without significant environmental effects will be managed through parallel risk and hazard management processes under CAA licensing i.e., the Skyrora XL Launch Operations Safety Case.

12.9 Residual Effects

12.9.1 Residual effects are not relevant to the discussion of significant environmental effects of major accidents and disasters as the effectiveness of the proposed mitigation cannot be absolutely guaranteed as these are low-frequency random events.

12.10 Cumulative Assessment

12.10.1 Cumulative effects can be either inter-project or intra-project effects.

12.10.2 Intra-project risks on site will be managed in accordance with CAA licensing requirements and mitigated by use of Exclusion Zones. There are no intra-project cumulative effects that have the potential to result in significant effects and so no intra-project cumulative assessment is required.

12.10.3 Inter-project cumulative effects are those where an environmental topic/receptor is affected by impacts from more than one project at the same time and the impacts act together. Due to the location of the Proposed Project on the north coast of Unst, the most northerly of the Shetland Islands, it is considered that there are no potential inter-project cumulative effects as there are no other existing or proposed developments nearby of relevance. Shetland Islands Council was contacted during the planning application stage of the Proposed Project and confirmed that there are no committed development or infrastructure projects on the Island which should be considered in the assessment.

12.11 Summary

12.11.1 This chapter considers the potential for activities at the Proposed Project to cause major accidents or be affected by natural disasters, in both cases, focussing on where harm to the environment as a consequence could reasonably occur. The assessment is quantitative for the context of an AEE Report and does not examine the probabilities of major accident events and disasters occurring.

12.11.2 A list of potential events was drawn up based on the Proposed Project activities.

12.11.3 Natural disasters including flooding and tectonic activity are considered highly unlikely given the location of the Proposed Project. Extreme weather effects have been addressed in the Climate Change Chapter 9 of this AEE Report and it is considered that the proposed infrastructure design provides sufficient resilience to the effects of extreme weather events over the design life of the Proposed Project.

12.11.4 Accident events were subcategorised into failure of containment of propellant, diesel fuel and hazardous materials, ignition and off-nominal launch scenarios. The effects on generic on-site human and wildlife receptors and off-site designated habitat sites were considered for each of these events.

12.11.5 Failures of containment were generally considered to be minor or moderate significance and largely restricted to the areas immediately within the vicinity of the release point, given the quantities in use and the rapid expected evaporation and/or dispersion of the majority of bulk liquids and gases used. Mitigation will be through adherence to the Applicant's own and SaxaVord Spaceport management procedures, robust containment and restrictions on the quantities stored at the Proposed Project site.

12.11.6 Again, noting the environmental context, ignition events are considered to be major with potential for significant effects inasmuch as damage to health or loss of life to human and wildlife receptors would be possible if in close proximity to the event. In the unlikely event that ignition of kerosene occurred, the initial blast radius would be relatively small (likely within the spaceport boundary) and the subsequent blaze limited in duration by the quantities stored and used. Mitigation will be through the restriction of ignition sources from flammable materials through standard operating practices. Uncontrolled ignition events during launches are assumed to be managed through the LV design process and integrity checks.

Off-nominal launch scenarios are considered to be of major significance should a ground strike take place, with potential for severe damage to human, wildlife and habitat receptors from impact and subsequent ignition of remaining propellant. Mitigation is inherent to the remote, northerly location of the Proposed Project and exclusively northward launch trajectories to be used. Water strikes were considered of minor significance as wildlife and marine habitat receptors could potentially be impacted and are discussed in the Marine Effects Chapter of this AEE Report.

12.12 References

Blackwood, e. a. (2015). *An Empirical Non-TNT Approach to Launch Vehicle Explosion Modelling.* AIAA Aerospace Meeting Special Session. Retrieved from NASA Spaceflight YouTube channel: https://www.youtube.com/watch?v=7RPyDPpmDAk

British Geological Survey. (2020). *Historic earthquake data around Shetland*. Retrieved from http://www.earthquakes.bgs.ac.uk/cgibin/get_events?lat1=&lat2=&lon1=&lon2=&lat0=60.74&lon0=0.905&radius=50&date1=1000-01-01&date2=2020-07-24&dep1=&dep2=&mag1=&mag2=&nsta1=&nsta2=&output=csv

Firefly Aerospace. (2019). *Twitter post made 9 September 2019*. Retrieved from https://twitter.com/firefly_space/status/1171068824138862593?lang=en

Health and Safety Executive. (2005). *EH40/2005 Workplace Exposure Limits*. Retrieved from https://www.hse.gov.uk/pubns/books/eh40.htm

Health and Safety Laboratory. (2018). *Safety at Spaceports.*

IEMA. (2020). *Major Accidents and Disasters in EIA - A Primer.*

Iridium. (2020). *Hydrazine – Toxic for Humans But Satellites Love It*. Retrieved from https://www.iridium.com/blog/2017/06/20/hydrazine-toxic-for-humans-but-satellites-love-it/

Scottish Government. (2017). *The Town and Country Planning (Environmental Impact Assessment) Regulations 2017*. Retrieved from https://www.legislation.gov.uk/ssi/2017/102/contents/made

Scottish Government. (2017). *The Town and Country Planning (Hazardous Substances) (Scotland) Regulations 2017*. Retrieved from https://www.legislation.gov.uk/ssi/2015/181/contents/made

UK Government. (1974). *The Health and Safety at Work Act 1974*. Retrieved from https://www.legislation.gov.uk/ukpga/1974/37/contents

UK Government. (1999). *The Management of Health and Safety at Work Regulations 1999*. Retrieved from https://www.legislation.gov.uk/uksi/1999/3242/contents/made

UK Government. (2002). *The Control of Substances Hazardous to Health Regulations 2002.* Retrieved from https://www.legislation.gov.uk/uksi/2002/2677/contents/made

UK Government. (2015). *The Control of Major Accident Hazards Regulations 2015*. Retrieved from https://www.legislation.gov.uk/uksi/2015/483/contents/made

UK Government. (2018). *The Space Industry Act 2018*. Retrieved from https://www.legislation.gov.uk/ukpga/2018/5/contents/enacted/data.htm

Chapter 13 Summary of Environmental Effects

13. Summary of Environmental Effects

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13. Summary of Environmental Effects

13.1 Introduction

13.1.1 The Summary of Environmental Effects provides a summary of effects of the Proposed Project, mitigation measures and the residual effects anticipated after mitigation measures have been applied.

13.2 Summary of Environmental Effects

13.2.1 Pre-mitigation and residual environmental effects are summarised in Table 13.1. The table provides a concise reference to each of the pre-mitigation and residual environmental effects identified in the technical sections of the AEE Report (with the exception of the Ornithology, Ecology and Landscape and Visual Assessments), as well as a cross reference to the relevant mitigation measures identified.

13.2.2 Table 13.2 below provides a concise reference to each of the residual environmental effects identified to receptors in the Ornithology and Ecology Assessments of the AEE Report.

13.2.3 Table 13.3 below provides a concise reference to each of the residual environmental effects identified to receptors in the Landscape and Visual Assessment of the AEE Report.

Table 13.1 Summary of Pre-mitigation and Residual Environmental Effects

Description of Effect	Pre-mitigation Effect			Mitigation Measure(s)	Residual Effect		
	Magnitude	Beneficial/ Adverse	Significance		Magnitude	Beneficial/ Adverse	Significance
Population and Human Health							
Total Economic Impact from operation of the Proposed Project in Unst of £2.6 million GVA and 74 jobs	Major	Beneficial	Significant beneficial effect	n/a	Major	Beneficial	Significant beneficial effect
Total Economic Impact from operation of the Proposed Project in the Shetland Islands of £4.0 million GVA and 112 jobs	Minor	Beneficial	Beneficial effect	n/a	Minor	Beneficial	Beneficial effect
Total Economic Impact from operation of the Proposed Project in Scotland of £5.0 million GVA and 136 jobs	Negligible	n/a	No likely significant effect	n/a	Negligible	n/a	No likely significant effect
Air Quality							
Effects at sensitive ecological and human receptors from operational phase traffic emissions	Negligible	n/a	No likely significant effect	None proposed	Negligible	n/a	No likely significant effect
Effects at sensitive human receptors from operational phase rocket launch event emissions	Negligible	n/a	No likely significant effect	None proposed	Negligible	n/a	No likely significant effect
Noise							
Non-launch noise from fixed and mobile plant	Minor	Adverse	No likely significant effect	Commitment to meeting derived noise limits at NSRs and appropriate specification of plant	Minor	Adverse	No likely significant effect
Noise and vibration from engine test and launches	Minor	Adverse	No likely significant effect	Clear communication and engagement with the local community, on the Proposed Project.	Minor	Adverse	No likely significant effect
Road traffic noise	Negligible	Adverse	No likely significant effect	None proposed	Negligible	Adverse	No likely significant effect
Vibration from engine test and launches	Minor	Adverse	No likely significant effect	None proposed	Minor	Adverse	No likely significant effect
Climate Change							
GHG emissions arising from operation.	Moderate	Adverse	Potential significant effect	Commit to procuring goods and services locally, where feasible.	Minor	Adverse	No likely significant effect
Damage to launch vehicle, pay load and lightning tower and delay of launches due to high wind speeds.	Moderate	Adverse	Potential significant effect	Suspend launch activities in high winds.	Minor	Adverse	No likely significant effect
Suspension of ferry routes and flights due to high wind speeds will limit access to the Proposed Project for launch cycle personnel and goods.	Minor	Adverse	No likely significant effect	Materials and site personnel should be sourced in Shetland or as close to the Proposed Project as possible.	Negligible	Adverse	No likely significant effect
Heavy precipitation resulting in flooding and erosion of access roads and limiting access for launch cycle vehicles.	Moderate	Adverse	Potential significant effect	Implement drainage system; ditches cut by spaceport operator in the flatter areas to aid drainage into natural streams.	Minor	Adverse	No likely significant effect
High temperatures causing site personnel welfare impacts such as heat stress	Minor	Adverse	No likely significant effect	Implement health and safety procedures e.g., provision of appropriate PPE.	Negligible	Adverse	No likely significant effect

Description of Effect	Pre-mitigation Effect			Mitigation Measure(s)	Residual Effect		
	Magnitude	Beneficial/ Adverse	Significance		Magnitude	Beneficial/ Adverse	Significance
Water ingress causing failure of electrical equipment (e.g., generators and deluge pumps)	Minor	Adverse	No likely significant effect	Implement drainage system; ditches cut in the flatter areas of the Proposed Project to aid drainage into natural streams.	Negligible	Adverse	No likely significant effect
High temperatures causing site personnel welfare impacts such as heat stress	Minor	Adverse	No likely significant effect	Implement health and safety procedures e.g., provision of appropriate PPE.	Negligible	Adverse	No likely significant effect
Overheating of equipment and potential fire due to high temperatures.	Minor	Adverse	No likely significant effect	Install deluge pumps.	Negligible	Adverse	No likely significant effect
Marine and Transboundary Effects							
Effects on Sea Ice, Water, and Sediment Quality, and Ecological Receptors from Fuel Spillage.	Minor	Adverse	No likely significant effect	None proposed	Minor	Adverse	No likely significant effect
Effects on Sea Ice, Water, and Sediment Quality, and Ecological Receptors from Metal Corrosion and Toxic Contamination.	Minor	Adverse	No likely significant effect	None proposed	Minor	Adverse	No likely significant effect
Effects on Sea Ice, Water, and Sediment Quality, and Ecological Receptors from Debris and Microplastics (Including Ingestion).	Minor	Adverse	No likely significant effect	None proposed	Minor	Adverse	No likely significant effect
Smothering of Marine Organisms, Habitat Alteration (Including Reef Effects) and Habitat Loss via Deposition of Material on the Seabed or Sea Ice.	Minor	Adverse	No likely significant effect	None proposed	Minor	Adverse	No likely significant effect
Direct Strike.	Negligible	n/a	No likely significant effect	None proposed	Negligible	n/a	No likely significant effect
Acoustic Disturbance (including Underwater Noise) from the Impact of the Jettisoned Objects Hitting the Sea Surface or Sea Ice.	Negligible	n/a	No likely significant effect	None proposed	Negligible	n/a	No likely significant effect
Thermal Effects of Jettisoned Objects.	Negligible	n/a	No likely significant effect	None proposed	Negligible	n/a	No likely significant effect
Visual Disturbance.	Negligible	n/a	No likely significant effect	None proposed	Negligible	n/a	No likely significant effect
Displacement of Fish.	Negligible	n/a	No likely significant effect	None proposed	Negligible	n/a	No likely significant effect
Damage to Human Infrastructure (Subsea Cables/Pipelines).	Minor	Adverse	No likely significant effect	None proposed	Minor	Adverse	No likely significant effect
Interference with Military Exercise Areas	Negligible	n/a	No likely significant effect	None proposed	Negligible	n/a	No likely significant effect
Impacts to Vessel Navigation Including Floating Debris, Changes to Topography and Re-routing of Vessel Traffic.	Negligible	n/a	No likely significant effect	None proposed	Negligible	n/a	No likely significant effect
Damage to Marine Archaeology/Shipwrecks.	Minor	Adverse	No likely significant effect	None proposed	Minor	Adverse	No likely significant effect
Interference with Marine and Coastal Tourism Activities/Industry.	Screened out/ Negligible	n/a	No likely significant effect	None proposed	Screened out/ Negligible	n/a	No likely significant effect

Description of Effect	Pre-mitigation Effect			Mitigation Measure(s)	Residual Effect		
	Magnitude	Beneficial/ Adverse	Significance		Magnitude	Beneficial/ Adverse	Significance
Accidents							
This subject has not been assessed in a manner comparable with other environmental aspects as it considers scenarios which are both theoretical and extreme rather than reasonably expected occurrences. Only the accidents and disaster scenarios considered likely to cause major adverse effects were considered, as is inherent to the scope of the chapter. The pre-mitigation effects are generally major, adverse and significant . Residual effects may remain similarly significant but this would be predicated on the combined failure of design, operational and physical mitigation measures.							

Table 13.2 Summary of Residual Environmental Effects – Ornithology and Ecology

Description of Effect/Receptor	Significance of Pre-mitigation Effect			Mitigation Measure	Significance of Residual Effect		
	Magnitude	Beneficial/ Adverse	Significance		Magnitude	Beneficial/ Adverse	Significance
Ornithology							
Black Guillemot	Negligible	Adverse	Not significant	Implementation of a Breeding Birds Protection Plan to be informed by, and updated annually through, targeted breeding bird surveys. Implementation of the Habitat Management Plan to: ➢ Enhance habitats for species of importance present on, or linked to, the study area. ➢ Restore important habitats and associated species. ➢ Peatland restoration.	Negligible	Adverse	Not significant
Common Guillemot	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Puffin	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Razorbill	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Shag	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Kittiwake	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Fulmer	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Merlin	No effect	n/a	Not significant		No effect	N/A	Not significant
Ringed Plover	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Golden Plover	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Dunlin	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Curlew	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Arctic Tern	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Arctic Skua	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Great skua	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Confidential species	Minor	Adverse	Potentially significant		Negligible	Adverse	Not significant
Ecology							
Designated sites	Negligible	Adverse	Not Significant	Embedded mitigation includes: ➢ Construction of ten artificial holts/shelters in suitable locations across the top of Lamba Ness to provide additional resting places away from the coast.	Negligible	n/a	Not Significant
Semi-natural habitats	Negligible	Adverse	Not Significant		Negligible	n/a	Not Significant
Otter	Negligible-minor	Adverse	Not Significant		Negligible	n/a	Not Significant

Description of Effect/Receptor	Significance of Pre-mitigation Effect			Mitigation Measure	Significance of Residual Effect		
	Magnitude	Beneficial/ Adverse	Significance		Magnitude	Beneficial/ Adverse	Significance
				➢ Retention of an important otter underpass. ➢ Enforced low vehicle speed limits (10 mph) would greatly reduce the likelihood of otter injury or death caused by vehicle traffic. ➢ Implementation of the Habitat Management Plan			

Table 13.3 Summary of Residual Environmental Effects - Landscape, Seascape and Visual

The following table sets out a summary of the assessment of the effects on landscape and visual resources arising from operation of the Proposed Project. The effects can be thought of as 'residual' effects because they take into account embedded mitigation measures included in the design and construction stages of the Proposed Project.

Receptor	**Significance of Residual Effect**	
	Magnitude and significance of predicted effect	**Beneficial/Adverse**
Direct Landscape Effects on the Landscape Resource		
Proposed Project Site	Major/Moderate, Significant effects on the fabric of the application sites in and around the immediate vicinity of the Proposed Project.	Beneficial
Effects on Landscape, Coastal, and Seascape Character Areas		
349 Major Uplands	Locally Major/Moderate, Locally Significant Elsewhere Moderate / Minor, Not Significant	Adverse
350 Peatland and Moorland	Locally Moderate, Not Significant Elsewhere Minor, Not Significant	Adverse
352 Inland Valleys	Minor, Not Significant	Adverse
353 Farmed and Settled Lowlands and Coast	Major/Moderate, Significant	Adverse
354 Farmed and Settled Voes and Sounds	Locally Moderate, Not Significant Elsewhere Minor, Not Significant	Adverse
355 Coastal Edge	Major/Moderate (Lamba Ness), Significant Major/Moderate (Blue Jibs), Significant Elsewhere Moderate/Minor, Not Significant	Adverse
CCA 16, East Unst	Major/Moderate (Lamba Ness), Significant Major/Moderate (Blue Jibs), Significant Elsewhere Minor, Not Significant	Adverse
CCA 20, Skaw	Locally Moderate, Not Significant Elsewhere Minor, Not Significant	Adverse
Seascape Character Type 13 D: Islands, Sounds and Voes	Locally Major/Moderate, Significant Elsewhere Moderate/Minor, Not Significant	Adverse

Implications for Designated Landscapes		
Shetland NSA – Hermaness Sub-unit	The sub-unit of the NSA includes parts of LCT 349 Major Uplands, LCT 355 Coastal Edge, LCT 354 Farmed and Settled Voes and Sounds, CCA 19 Hermaness, and CCA 13 Burrafirth. The assessment of effects on LCTs and CCAs finds no significant effects on these areas within the area of the NSA.	The special landscape qualities of the Hermaness sub-area of the Shetland NSA will not be at risk or compromised by the Proposed Project and the overall integrity and objectives of the Shetland NSA will be maintained.
Haroldswick and Skaw, Local Landscape Area	The LLA includes parts of LCT 349 Major Uplands, LCT 350 Peatland and Moorland, LCT 353 Farmed and Settled Lowlands and Coast, LCT 354 Farmed and Settled Voes and Sounds, and LCT 355 Coastal Edge, all of which experience areas of visual influence of the Proposed Project. The assessment of effects on LCTs found locally significant effects on each of the LCTs (excluding LCT 350) within the area of the LLA.	The key characteristics and integrity of the LLA will be locally altered by the Proposed Project across the headland between Inner Skaw and Lamba Ness, with a reduction in the scenic qualities of the LLA.
Effects on Settlements		
Booths/ Houlanbrindy	Major/Moderate, Significant	Adverse
Norwick/ Kirkaton	Major/Moderate, Significant	Adverse
Valsgarth/ Saxa Vord	Major/Moderate, Significant	Adverse
Haroldswick	No effect	No effect
Ungirsta/ Stove	No effect	No effect
Effects on Route Corridors		
A968/National Cycle Route 1 (600m section of the route, east of Little Hoeg)	Moderate/Minor to Motorists and Moderate to Cyclists, Not Significant	Adverse
B9086 (1.2 km section of the route west of Haroldswick)	Moderate/Minor to Motorists and Moderate to Cyclists, Not Significant	Adverse
B9087 (1.2 km section of the route west between Saxa Vord/ Valsgarth and Norwick)	Moderate to Motorists, Not Significant Major/Moderate to Cyclists, Significant	Adverse
Effects on Viewpoints		
1.1 - Bluejibs above the Wick of Skaw	Major – Walkers, Visitors and Residents, Significant	Adverse
1.2 - The Haa, Wick of Skaw	Major – Walkers, Visitors and Residents, Significant	Adverse
1.3 - The Garths, Lamba Ness	Major - Walkers, Visitors and Cyclists, Significant Major/Moderate - Road Users, Significant	Adverse
1.4 - Car park at The Taing, Norwick	Major - Walkers, Visitors and Residents, Significant	Adverse
1.5 - The cemetery, Norwick	Major/Moderate - Walkers, Visitors and Residents, Significant	Adverse
1.6 - B9087 Norwick	Major/Moderate – Residents and Cyclists, Significant Moderate - Road Users, Not Significant	Adverse
1.7 - Hill of Clibberswick	Major/Moderate - Walkers, Significant	Adverse
1.8 - Headland to the north of Saxa Vord radar station	Minor (experienced as a temporary effect during launches) - Walkers, Not Significant	Adverse
1.9 - A968 beneath Little Hoeg	Moderate/Minor – Cyclists and Road Users, Not Significant	Adverse
1.10 - Hermaness Hill	None, Not Significant	No effects

13.3 Significant Residual Effects

13.3.1 Post mitigation, the remaining significant residual effects are:

- Likely significant beneficial effect: Population and Human Health - Total economic impact from operation of the Proposed Project in Unst of £2.6 million GVA and 74 jobs and in the wider Shetland Islands of £4.0 million GVA and 112 jobs.
- Likely significant adverse effect: Various Landscape and Seascape assessment locations.

13.3.2 Of these, only the likely adverse effects need be considered further.

13.3.3 The likely significant landscape effects are all inherently associated with the infrastructure arequired for the construction and operation of SaxaVord Spaceport and carry over into AEE for operation of the Proposed Project only by nature of the continued operation of that development. LVIA significant residual effects (and potential alternatives) have been assessed by Shetland Islands Council and the relevant statutory consultees (including HES, NatureScot and SEPA) during the planning application stage of the SaxaVord Spaceport and the Spaceport found to be suitable with the development plans and mitigation measures outlined within the SaxaVord Spaceport AEE V3 (1 August 2022).

13.3.4 As this AEE is concerned with the operational phase of the Proposed Project only, it is considered that the significant effects identified have been appropriately dealt with through the planning process and subsequent planning conditions and need not be considered further within the AEE. As such the findings of this AEE are that there are no significant operational effects of concern from the Proposed Project.

13.4 Monitoring

13.4.1 No monitoring of the significant landscape effects was required as part of the planning permission for the SaxaVord Spaceport and therefore no monitoring is required to be imposed on the Applicant.

13.5 Conclusion

13.5.1 The conclusion of this AEE is that there are no significant operational effects of concern from the Proposed Project and that the proposed activities will comply with statutory requirements and environmental policy objectives. As described in each of the technical chapters, this takes into consideration international, national and local legislation and objectives.

Volume III AEE Drawings

Chapter 1 Drawing 1.1 Statutory Environmental Designations

N

Hermaness

Hermaness, Saxa Vord and Valla Field SPA

Saxa Vord SSSI

Hermaness, Saxa Vord and Valla Field

Hermaness NNR & SSSI

Skaw, radar station - SM

Inner Skaw, houses and field system, Unst - SM

Skaw, radar station - SM

Norwick SSSI

Burgar Stack, broch 225m NE of Stackhoull - SM

St John's Church, remains of, Norwick, Unst - SM

Norwick Meadow SSSI

Petester, abandoned township 530m N of Lee of Petester

Cross Kirk

Crussa Field and the Heogs SSSI

Spoull, Norse settlement 80m WNW of, Unst

Gardie, house and field system 650m N of Little Heog, Unst

Soterberg, settlement and field system, Unst

Crussa Field,cairns

Little Heog, cairn, 605m NW of Hagdale

Muckle Heog,two chambered cairns,Baltasound

Keen of Hamar SSSI

Valla Field SSSI

Gue, house to S of, Baliasta, Unst

Hermaness, Saxa Vord and Valla Field

Hamar,Norse settlement ENE of,Baltasound

B9086

B9087

Hill Ness

Saxa Vord

Ward of Norwick

Ness of Queyhoose

Haroldswick

Hill of Clibberswick

Hill of Woodwick

Houlina Gruna

Keen of Hamar

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KEY

- Proposed Project
- Site of Special Scientific Interest
- Special Protection Area
- Important Bird Area
- National Nature Reserve
- National Scenic Area
- Scheduled Monument
- A-Listed
- B-Listed
- C-Listed

0 0.8 1.6 km

Scale 1:45,000 @ A3

SKYRORA

Skyrora SaxaVord
Assessment of Environmental Effects

Drawing 1.1
Statutory Environmental Designations

Date:	Drawn by:	Checked by:	Version:
25/03/2024	ER	RF	V2

Project Number: 4879

Chapter 2 Drawing 2.1 Study Areas within the EZI

-60000 -50000 -40000

-3320000 -3330000 -3340000



KEY

- Environmental Zone of Influence
- Ornithology - 4km buffer
- Ornithology - 3km buffer
- Ornithology - 2km buffer
- Ornithology - 1km buffer
- Ornithology - 0.5km buffer
- Ecology – Habitat Study Area
- Noise – Study Area
- Ornithology – Study Area
- LVIA – Study Area
- Saxavord Project Site Boundary
- Ecology – Otter Study Area
- Air Quality - Study Area

0 2,500 5,000 m

Scale 1:106,339 @ A3

SKYRORA

Skyrora
Assessment of Environmental Effects

Drawing 2.1

Study Areas within the EZI

Date:	Drawn by:	Checked by:	Version:
10/19/2023	AN	IW	Draft/V1

N

Project Number: 3148

Service Layer Credits: World Ocean Base: OceanWise, Esri, Garmin, NaturalVue
World Ocean Base: Esri, GEBCO, Garmin
World Ocean Base: OceanWise, Esri, GEBCO, Garmin, NaturalVue

Chapter 3 Drawing 3.1 Proposed Project Location



KEY

Proposed Project Boundary



Coordinate System: British National Grid
Projection: Transverse Mercator

Service Layer Credits: Contains OS data © Crown Copyright and database right 2020

0 100 200 400 600 800 1,000 m

1:20,000

ITPENERGISED

SKYRORA

Skyrora SaxaVord
Assessment of Environmental Effects

Drawing 3.1
Site Location

Date:	Drawn by:	Review:	Version:
23/05/2022	ER	RF	V1

Project Number: 4879

Document Path: F:\GIS\Clients\S\Skyrora\4879 Skyrora Saxa Vord AEE\04 MXD\Drawing 3.1 - Site Locations.mxd

Chapter 3 Drawing 3.2 Proposed Launch Site Layout



KEY

Propoased Project Boundary

Coordinate System: British National Grid
Projection: Transverse Mercator

Service Layer Credits: Contains OS data © Crown Copyright and database right 2020; Historic Environment Scotland and Ordnance Survey data ©

0 62.5 125 250 375 500 m

1:12,000

ITPENERGISED

SKYRORA

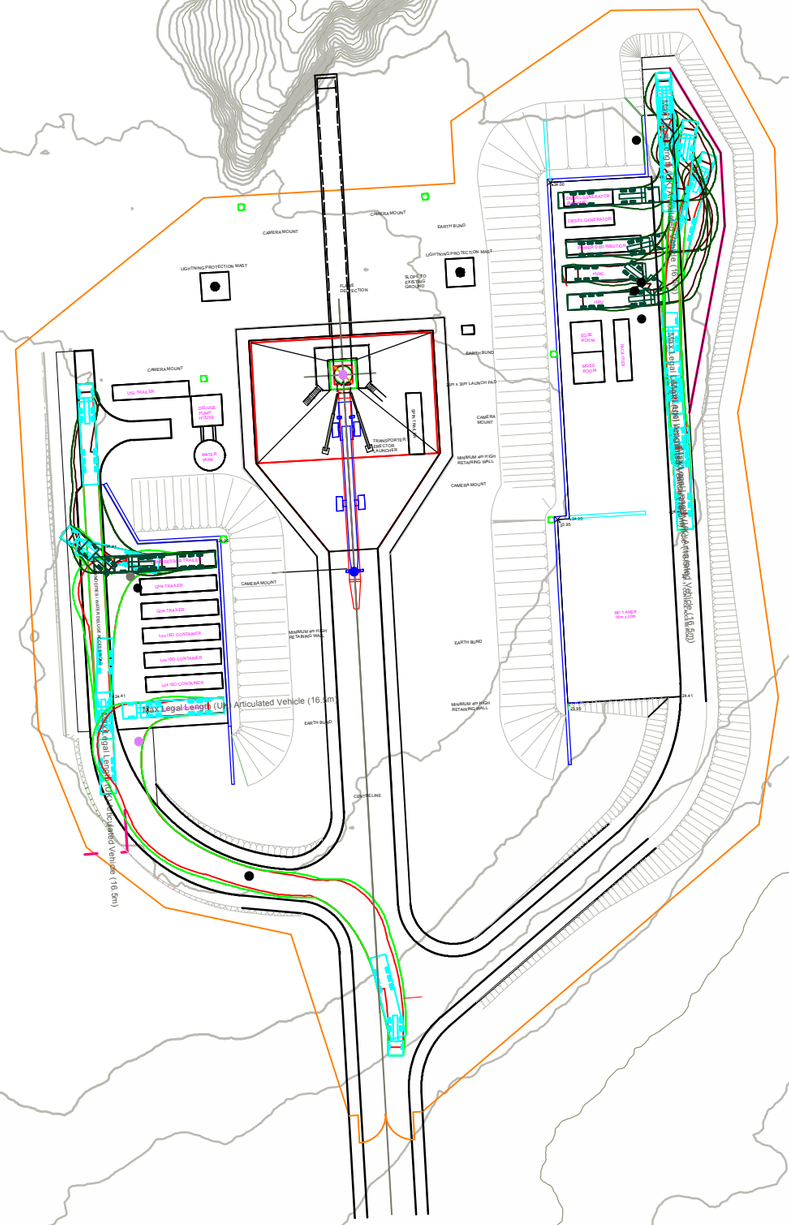
Skyrora SaxaVord
Assessment of Environmental Effects

Figure 3.2
Proposed Launch Site Layout

Date:	Lead:	Review:	Version:
24/05/2022	ER	RF	V1

Chapter 3 Drawing 3.3 Launch Pad 1 Layout

N



Drawing was provided to ITPEnergised by AECOM

0 20 40 m

Scale 1:1,000 @ A3

SKYRORA

Skyrora SaxaVord
Assessment of Environmental Effects

Drawing 3.3

Launch Pad 1 Layout

Date:	Drawn by:	Checked by:	Version:
24/05/2022	ER	RF	V1

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Project Number: 4879

Chapter 3 Drawing 3.4 Launch Pad 2 Layout

N

Drawing was provided to ITPEnergised by AECOM

0 20 40 m

Scale 1:1,000 @ A3

SKYRORA

Skyrora SaxaVord
Assessment of Environmental Effects

Drawing 3.4

Launch Pad 2 Layout

Date:	Drawn by:	Checked by:	Version:
24/05/2022	ER	RF	V1

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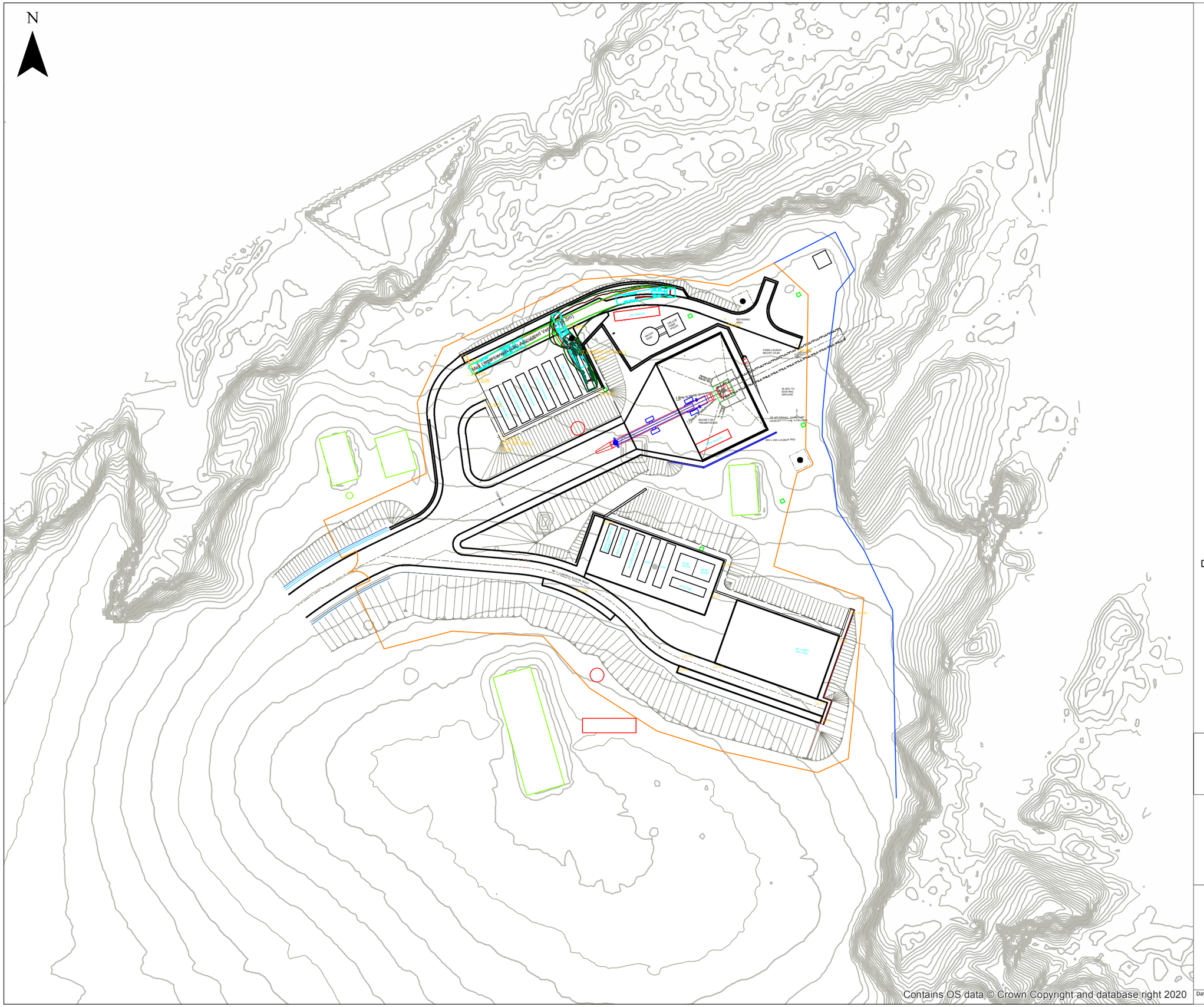
Project Number: 4879

Chapter 3 Drawing 3.5 Launch Pad 3 Layout

N



Drawing was provided to ITPEnergised by AECOM

0 20 40 m

Scale 1:1,000 @ A3

SKYRORA

Skyrora SaxaVord
Assessment of Environmental Effects

Drawing 3.5

Launch Pad 3 Layout

Date:	Drawn by:	Checked by:	Version:
24/05/2022	ER	RF	V1

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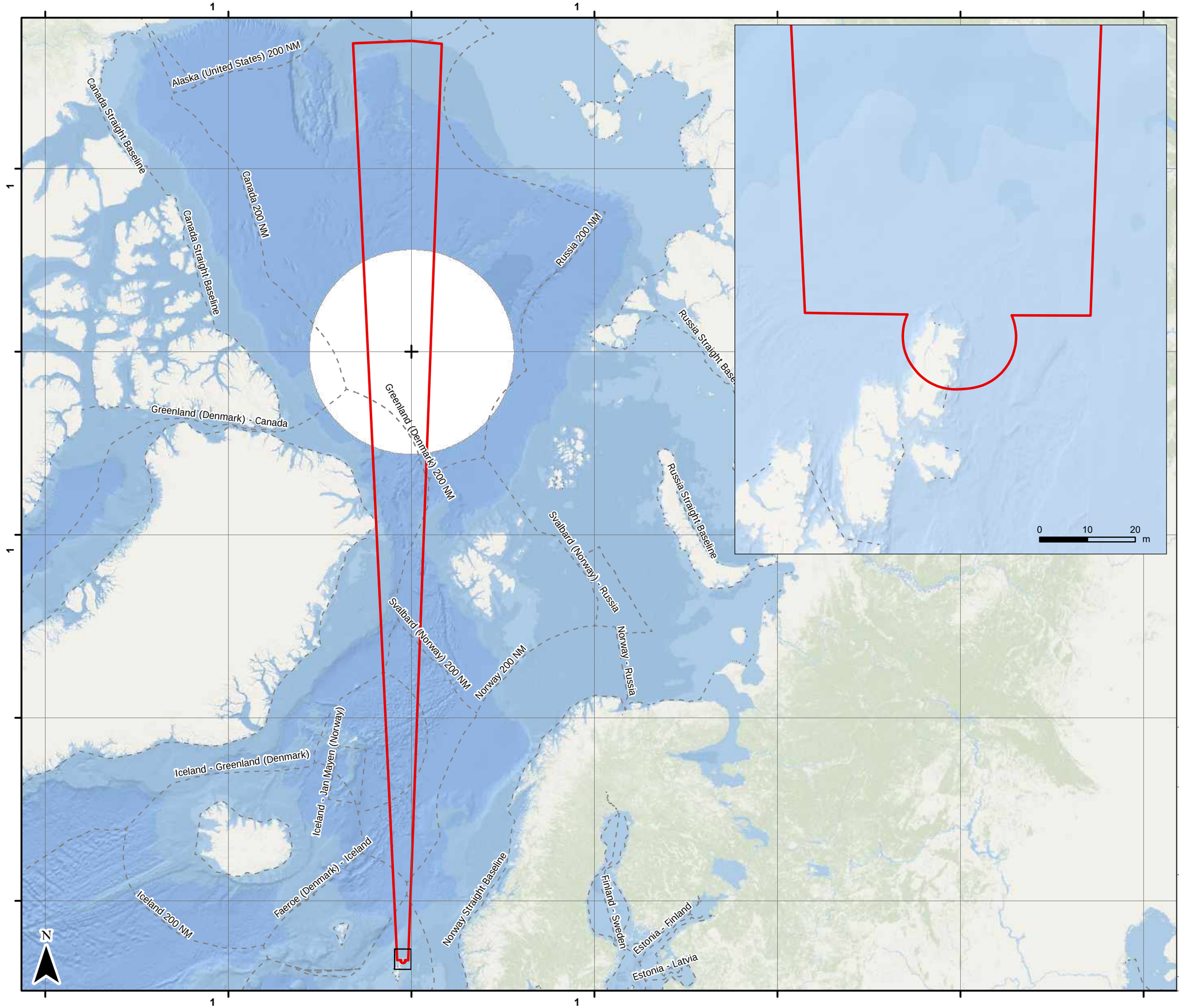
Project Number: 4879

Chapter 3 Drawing 3.6 Environmental Zone of Influence



KEY

- Environmental Zone of Influence
- EEZ boundaries

0 500 1 000 m

Scale 1:19,189,005 @ A3

SKYRORA

Skyrora
Assessment of Environmental EÃects

Drawing 3.6

Environmental Zone of In f uence

Date:	Drawn by:	Checked by:	Version:
10/12/2023	AN	IW	DraÃ/V1

Project Number: 3148

Service Layer Credits: World Ocean Base: OceanWise, Esri, Garmin, NaturalVue
World Ocean Base: OceanWise, Esri, GEBCO, Garmin, NaturalVue

Chapter 4 -

Chapter 5 Drawing 5.1 Ornithology Study Area



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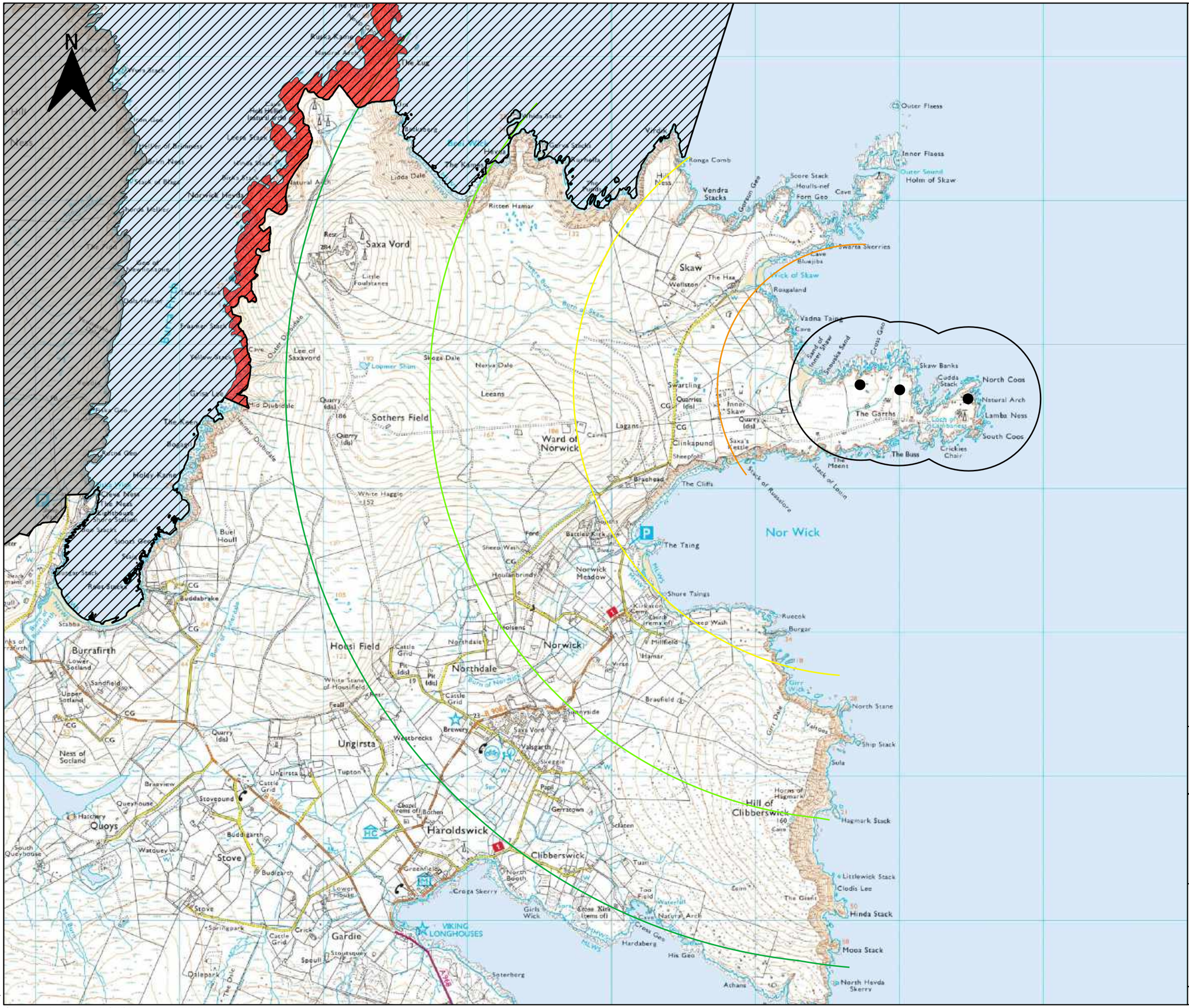
Chapter 5 Drawing 5.2 Designated Sites



KEY

- Hermaness, Saxa Vord and Valla Field SPA
- Hermaness SSSI
- Saxa Vord SSSI
- Proposed Project Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

SKYRORA

Skyrora SaxaVord
Assessment of Environmental Effects

Drawing 5.2
Designated sites within ornithological Study Area

Date:	Drawn by:	Checked by:	Version:
May 2022	K.M.	P.C.	Rev. 6

Project Number: 3148

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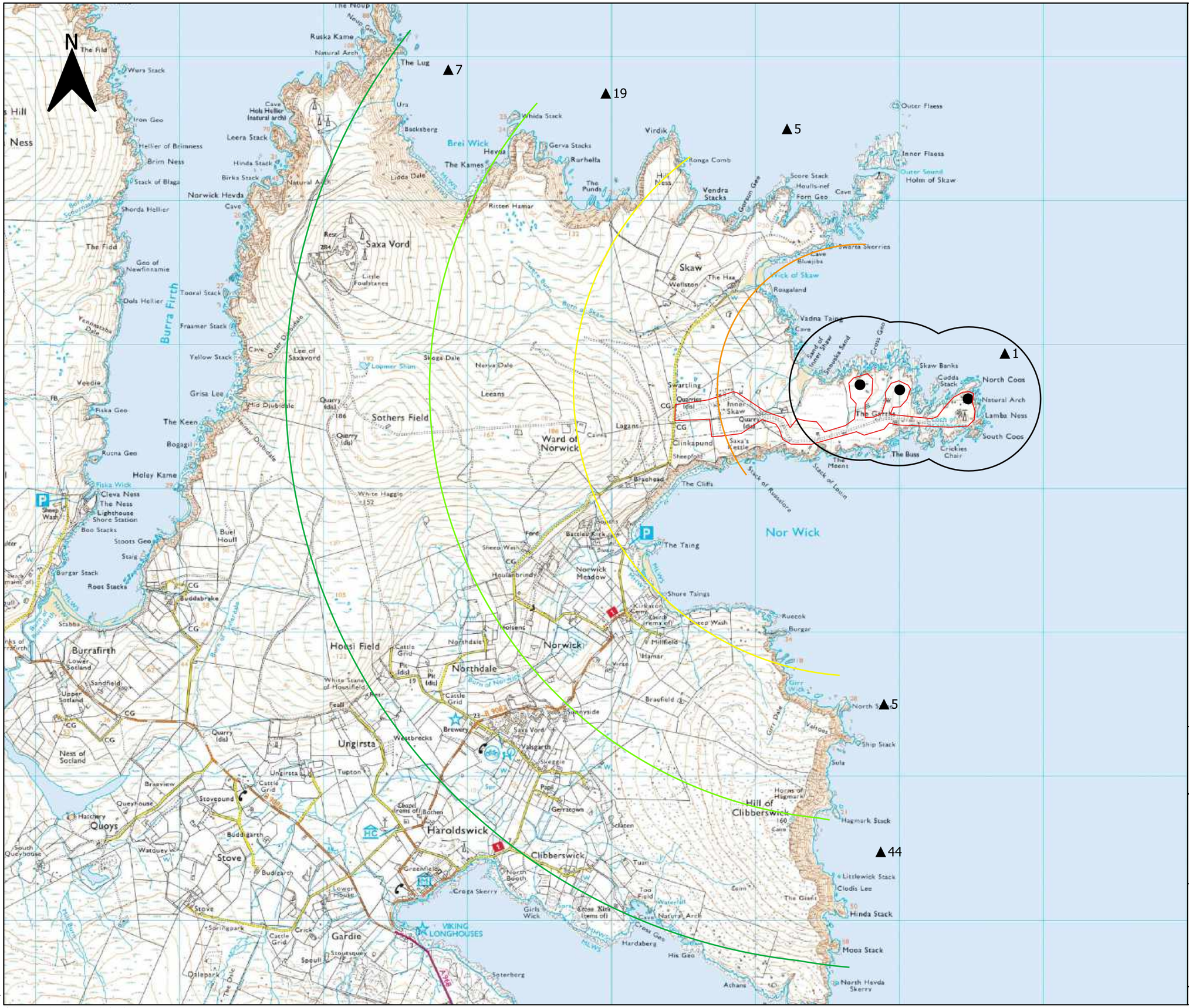
Chapter 5 Drawing 5.3 Breeding Black Guillemot within Study Area


N
2018 = 8, 2019 = 13
2018 = 11, 2019 = 10
2018 = 15, 2019 = 12
2018 = 2, 2019 = 6
2018 = 14, 2019 = 13
2018 = 6, 2019 = 6
2018 = 12, 2019 = 13
2018 = 14, 2019 = 16
2018 = 2, 2019 = 19
Saxa Vord
Sothers Field
Ward of Norwick
Nor Wick
Norwick
Northdale
Haroldswick
Clibberswick
Ungirsta
Gardie
Burra Firth
Skaw
Vendra Stacks
Hill of Clibberswick
Brei Wick
The Kames
Norwick Hevda
Ness of Sodland
Burrafirth
Quoys
Stove
Holey Kame
Ruska Kame
Leera Stack
Fraamer Stack
Yellow Stack
Grisa Lee
The Keen
Bogagil
Veedie
The Fidd
Shorda Hellier
Brim Ness
Hellier of Brimness
Iron Geo
Wurs Stack
The Fild
Ness
Hill
The Lug
Backsberg
Lidda Dale
Ritten Hamar
Gerva Stacks
Rurhella
The Punds
Virdik
Hevda
Ronga Comb
Hill Ness
Gorseton Geo
Inner Flaess
Outer Flaess
Holm of Skaw
Form Geo
Houlls-nef
Swarta Skerries
Bluejibs
Roagaland
The Hea
Wellston
Vadna Taing
Cross Geo
Skaw Banks
Cudda Stack
North Coos
South Coos
Lamba Ness
Natural Arch
The Garths
Inner Skaw
Swartling
Quarries (dis)
Clinkapund
Sheepfolds
Saxa's Kettle
Lagans
Cairns
Leeans
Nerva Dale
Skoga Dale
Loomer Shun
Burn of Skaw
Jamie Burn
Outer Dibdale
Inner Dibdale
Lee of Saxavord
Little Foulstanes
Mid Djubidale
Quarry (dis)
Fiska Geo
Rucna Geo
Fiska Wick
Cleva Ness
The Ness
Lighthouse
Shore Station
Boo Stacks
Stoots Geo
Staig
Burgar Stack
Root Stacks
Buddabrake
Scabba
Burn of Burrafirth
Burn of Voesgarth
Burn of Norwick
Burn of Gardie
Sandfield
Upper Sotland
Lower Sotland
Ness of Sodland
Braeview
Queyhouse
South Queyhouse
Watquey
Stovepund
Buddigarth
Springpark
Dalepark
Crick
Spoull
Stoutsquoy
Housi Field
White Stane of Housifield
Feall
Cattle Grid
Pit (dis)
Brewery
Westbrecks
Tupton
Papil
Gerratown
Sclaten
Tuan
Greenfield
Croga Skerry
Girls Wick
Cross Xira (rems of)
Natural Arch
Hardaberg
Hix Geo
Soterberg
Achans
North Booth
Brachead
The Cliffs
Ford
Bastles Kirk
Houlanbrindy
Norwick Meadow
Sheep Wash
The Taing
Shore Taings
Kirkaton Cairn
Ruecook
Burgar
Millfield
Hamar
Verse
Braefield
Sunnyside
Saxa Vord
Valsgarth
Sweggie
Brewery
North Stane
Girr Wick
Girr Dale
Valfoss
Ship Stane
Sula
Horns of Hagmark
Hagmark Stack
Littlewick Stack
Clodis Lee
The Grant
Hinda Stack
Mooa Stack
North Hevda Skerry
Waterfall
Natural Arch
Cairn
Resr
Loch of Russatore
Stack of Lousin
Hinda Stack
Birka Stack
Natural Arch
Cave
Hols Heller (natural archi
Norwick Hevda Cave
Shorda Hellier
Tooral Stack
Dols Hellier
Yennaspira Dale
Geo of Newfinnamie
Veedie
Fiska Geo
Rucna Geo
Holey Kame
Fiska Wick
Cleva Ness
The Ness
Lighthouse
Shore Station
Boo Stacks
Stoots Geo
Staig
Burgar Stack
Root Stacks
Buddabrake
Scabba
Burrafirth
Lower Sotland
Sandfield
Upper Sotland
Ness of Sodland
Braeview
Queyhouse
Quoys
Harchery
South Queyhouse
Watquey
Stovepund
Buddigarth
Stove
Springpark
Dalepark
Crick
Spoull
Stoutsquoy
Gardie
Housi Field
White Stane of Housifield
Feall
Cattle Grid
Pit (dis)
Brewery
Westbrecks
Ungirsta
Tupton
Papil
Gerratown
Sclaten
Haroldswick
Clibberswick

Chapter 5 Drawing 5.4 Breeding Shag within Study Area


N
▲7
▲19
▲5
▲1
▲5
▲44
Ruska Kame
Natural Arch
The Lug
Wurs Stack
Iron Geo
Hellier of Brimness
Brim Ness
Stack of Blaga
Shorda Hellier
The Fidd
Geo of Newfinnamie
Dols Hellier
Fraamer Stack
Yellow Stack
Veedie
Fiska Geo
The Keen
Bogagil
Rucna Geo
Holey Kame
Fiska Wick
Cleva Ness
The Ness Lighthouse
Shore Station
Boo Stacks
Stoots Geo
Staig
Burgar Stack
Root Stacks
Scabba
Burrafirth
Lower Sotland
Upper Sotland
Sandfield
Ness of Sotland
Quoys
Queyhouse
Braeview
Harchery
Watquey
Stove
Leera Stack
Hinda Stack
Birka Stack
Norwick Hevda
Shorda Hellier
Saxa Vord
Little Foulstanes
Burra Firth
Lee of Saxavord
Outer Dibdale
Mid Dibdale
Inner Dibdale
Sothers Field
Quarry (dis)
Grisa Lee
Loomer Shim
Skoga Dale
Norva Dale
Leeans
Ward of Norwick
Cairns
Lagans
Clinkapund
Sheepfolds
Saxa's Kettle
Swartling
Quarries (dis)
Inner Skaw
Quarry (dis)
CG
The Cliffs
Brachead
Nor Wick
The Taing
Norwick Meadow
Houlanbrindy
Holsens
Shore Taings
Ruecook
Burgar
Millfield
Hamar
Norwick
Northdale
Housi Field
Cattle Grid
Pit (dis)
Burn of Northdale
White Stane of Housifield
Feall
Sunnyside
Brewery
Saxa Vord
Valsgarth
Sweggie
Papil
Gerratown
Sclaten
Tuan
Too Field
Waterfall
Natural Arch
Cross Geo
Hardaberg
Hik Geo
Achans
North Hevda Skerry
Ungirsta
Westbrecks
Tupton
Cattle Grid
Stovepound
Buddigarth
Budgarth
Lower House
Springpark
Crick
Gardie
Stoutsquoy
Spoull
Dalepark
The Dale
A968
Soterberg
VIKING LONGHOUSES
Haroldswick
Clibberswick
North Booth
Croga Skerry
Girls Wick
Cross Kirk (rems of)
Greenfield
Hill of Clibberswick
Horns of Hagmark
Hagmark Stack
Littlewick Stack
Clodis Lee
The Grant
Hinda Stack
Mooa Stack
North Hevda Skerry
Ship Stack
Sula
Girr Wick
Girr Dale
Valfoss
North Sk
Ruga
Ness
Hill
Hellier of Brimness
Brim Ness
Stack of Blaga
Norwick Hevda
Shorda Hellier
The Fidd
Geo of Newfinnamie
Dols Hellier
Fraamer Stack
Yellow Stack
Veedie
Fiska Geo
The Keen
Bogagil
Rucna Geo
Holey Kame
Fiska Wick
Cleva Ness
The Ness Lighthouse
Shore Station
Boo Stacks
Stoots Geo
Staig
Burgar Stack
Root Stacks
Scabba
Burrafirth
Lower Sotland
Upper Sotland
Sandfield
Ness of Sotland
Quoys
Queyhouse
Braeview
Harchery
Watquey
Stove
Leera Stack
Hinda Stack
Birka Stack
Norwick Hevda

Chapter 5 Drawing 5.5 Breeding Fulmar within Study Area


N
962
1695
485
40
430
700
980
950
745
Saxa Vord
Burra Firth
Nor Wick
Skaw
Sothers Field
Ward of Norwick
Norwick
Northdale
Haroldswick
Clibberswick
Hill of Clibberswick
Ungirsta
Stove
Gardie
Burrafirth
Quoys
Ness of Sculsta
Housi Field
Skaw Banks
North Coos
South Coos
Natural Arch
Lamb Hole
Cudda Stack
The Garth
The Buss
Crickies Chair
Inner Skaw
Swartling
Clinkapund
Lagans
Leeans
Virdik
Gerva Stacks
Rurhella
Ronga Comb
Vendra Stacks
Inner Flaess
Outer Flaess
Holm of Skaw
Outer Sound
Swarta Skerries
Ruska Kame
The Lug
Brei Wick
The Kames
Ritten Hamar
Norwick Meadow
Shore Tangs
Ruecook
Burgar
North Stane
Ship Stack
Sula
Hagmark Stack
Littlewick Stack
Clodis Lee
Hinda Stack
Mooa Stack
North Hevda Skerry
Brachead
The Cliffs
The Taing
Cleva Ness
The Ness Lighthouse
Holey Kame
Fiska Wick
Burgar Stack
Root Stacks
Boo Stacks
Stoots Geo
Buel Houll
Norwick Hevda
Shorda Hellier
The Fidd
Geo of Newfinnamie
Dols Hellier
Fraamer Stack
Yellow Stack
Veedie
Grisa Lee
The Keen
Bogagil
Rucna Geo
Fiska Geo
Tooral Stack
Yennaszoba Dale
Lee of Saxavord
Outer Dibdale
Inner Dibdale
Mid Dibdale
Skoga Dale
Norva Dale
Loomer Shim
Burn of Skaw
Burn of Norwick
Burn of Burrafirth
Burn of Voe
Girt Dale
Girt Wick
Cross Geo
Gorseton Geo
Form Geo
Houlls-nef
Hill Ness
The Punds
Lidda Dale
Backsberg
Hevda
Leera Stack
Hinda Stack
Birka Stack
Natural Arch
Cave
Iron Geo
Hellier of Brimness
Brim Ness
Stack of Blaga
Wurs Stack
The Fild
The Noup
Noup Geo
Ura
Vhida Stack
Bluejibs
Roagaland
Wellston
The Hea
Vadna Taing
Sand of Inner Skaw
Snowiks Sand
Cross Geo
Quarry (dis)
Cairns
Sheepfolds
Saxa's Kettle
The Meent
Stack of Russatore
Stack of Lobsin
Ford
Sheep Wash
Houlanbrindy
Holsens
Millfield
Hamar
Braefield
Sunnyside
Saxa Vord
Valsgarth
Sweggie
Papil
Gerratown
Sclaten
Tuan
Too Field
Waterfall
Natural Arch
Cross Geo
Hardaberg
Hix Geo
Achans
Soterberg
Girls Wick
Cross Xara (rems of)
Croga Skerry
North Booth
Greenfield
Lower House
Springpark
Crick
Cattle Grid
Spoull
Stoutsquoy
Dalepark
The Dale
Buddabrake
Buddagarth
Budgarth
Stovepound
Watquey
Queyhouse
South Queyhouse
Braeview
Harchery
Sandfield
Upper Sotland
Lower Sotland
Scabba
Sheep Wash
Ungirsta
Tupton
Westbrecks
Brewery
Feall
White Stane of Housifield
Northdale
Pit (dis)
Quarry (dis)
Cairn
Ford
Bouters
Bactles Kirk
Kirkaton Cairn
Cairn (rems of)
Deuzel (rems of)
Bothen
Greenfield
Sheep Wash
Ness
Lighthouse
Shore Station
Sheep Wash
Ness
Hill
Ness
Sheep Wash
Ness
Hill
Ness
Sheep Wash
Ness
Hill
Ness

Chapter 5 Drawing 5.6 Breeding Gulls within Study Area

3 Great black-backed gull, 3 Herring gull

3 Great black-backed gull, 2 Herring gull

2 Great black-backed gull

50 Kittiwake

5 Kittiwake

KEY

- Nesting gulls (boat surveys)
- Mixed inland gull colony

Lesser black-backed gull
2018 - 12 pairs
2019 - 10 pairs

Herring gull
2018 - 10 pairs
2019 - 16 pairs

Common gull
2018 - 22 pairs
2019 - 30 pairs

- Black-headed gull colony
  2018 - 11 pairs
  2019 - 13 pairs
- Proposed Project Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

SKYRORA

Skyrora SaxaVord
Assessment of Environmental Effects

Drawing 5.6
Breeding gulls within the Study Area

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Chapter 5 Drawing 5.7 Breeding Common Guillemot within Study Area


N
20
27
53
Saxa Vord
Burra Firth
Nor Wick
Brei Wick
Skaw
Vendra Stacks
Ward of Norwick
Sothers Field
Norwick
Northdale
Haroldswick
Clibberswick
Hill of Clibberswick
Ungirsta
Gardie
Burrafirth
Stove
Quoys
Ness of Sosland
Holey Kame
Ruska Kame
The Lug
Hevda
The Kames
Virdik
Ronga Comb
Inner Flaess
Outer Flaess
Holm of Skaw
Swarta Skerries
Vadna Taing
Skaw Banks
North Coos
South Coos
Natural Arch
Lamba Ness
The Garths
The Buss
Crickies Chair
Lagans
Swartling
Clinkapund
Brachead
The Cliffs
The Taing
Norwick Meadow
Shore Taings
Ruecook
Burgar
North Stane
Ship Stack
Hagmark Stack
Littlewick Stack
Clodis Lee
Hinda Stack
Mooa Stack
North Hevda Skerry
Achans
Saterberg
Hardaberg
Hik Geo
Cross Geo
Gorseton Geo
Score Stack
Houlls-nef
Form Geo
Cave
Bluejibs
Wick of Skaw
Roagaland
The Hea
Wellston
Inner Skaw
Quarry (dis)
Quarries (dis)
Cairns
Sheepfolds
Saxa's Kettle
Stack of Russatore
Stack or Louin
Ricten Hamar
Gerva Stacks
Rurhella
The Punds
Hill Ness
Whida Stack
Backsberg
Leera Stack
Hinda Stack
Birka Stack
Norwick Hevda
Cave
Lidda Dale
Natural Arch
Cave
Hols Heller (natural arch)
Ura
Iron Geo
Hellier of Brimness
Brim Ness
Stack of Blaga
Shorda Hellier
The Fidd
Geo of Newfinnamie
Dols Hellier
Tooral Stack
Fraamer Stack
Yellow Stack
Cave
Outer Dibdale
Lee of Saxavord
Yennaszoba Dale
Veedie
Fiska Geo
The Keen
Bogagil
Rucna Geo
Fiska Wick
Cleva Ness
The Ness
Lighthouse
Shore Station
Boo Stacks
Stoots Geo
Staig
Burgar Stack
Root Stacks
Buddabrake
Scabba
Sandfield
Upper Sotland
Lower Sotland
Queyhouse
Braeview
Watquey
Stovepund
Buddigarth
Budgarth
Lower House
Springpark
Crick
Cattle Grid
Spoull
Stoutsquoy
Dalepark
The Dale
Buel Houll
Mid Dibdale
Inner Dibdale
Quarry (dis)
Grisa Lee
Loomer Shim
Skoga Dale
Nerva Dale
Leeans
Cairns
Ford
Sheep Wash
Houlanbrindy
Holsens
Northdale
Cattle Grid
Pit (dis)
White Stane of Housifield
Feall
Brewery
Sunnyside
Saxa Vord
Valsgarth
Sweggie
Papil
Gerratown
Sclaten
Tupton
Westbrecks
Ungirsta
Cattle Grid
Quarry (dis)
Housi Field
Burn of Norwick
Burn of Sotland
Burn of Ireland
Girt Dale
Girt Wick
Braefield
Hamar
Millfield
Kirkaton Cemetery
Cemetery (remains of)
Sheep Wash
Ford
Boulders
Bactles Kirk
Sluice
Tuan
Too Field
Waterfall
Natural Arch
Cross Geo
Girls Wick
Cross Kirk (remains of)
Croga Skerry
North Booth
Greenfield
Lower House
Springpark
Crick
Cattle Grid
Spoull
Stoutsquoy
Dalepark
VIKING LONGHOUSES
A968
Cairn
Cairns
Cairn
Cairn
Cairn

Chapter 5 Drawing 5.8 Breeding Razorbill within Study Area

N

2

2

11

KEY

- Razorbill individuals
- Proposed Project Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

SKYRORA

Skyrora SaxaVord
Assessment of Environmental Effects

Drawing 5.8
Breeding razorbill within the Study Area

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Chapter 5 Drawing 5.9 Breeding Puffins within Study Area

N

57

19

25

2

6

4

10

KEY

- Puffin individuals
- Proposed Project Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

SKYRORA

Skyrora SaxaVord
Assessment of Environmental Effects

Drawing 5.9
Breeding puffin within the Study Area

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Chapter 5 Drawing 5.10 Breeding Ringed Plover within Study Area

N

KEY

Ringed plover territory centre

- 2018
- 2019
- Proposed Project Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

SKYRORA

Skyrora SaxaVord
Assessment of Environmental Effects

Drawing 5.10
Breeding ringed plover within the Study Area

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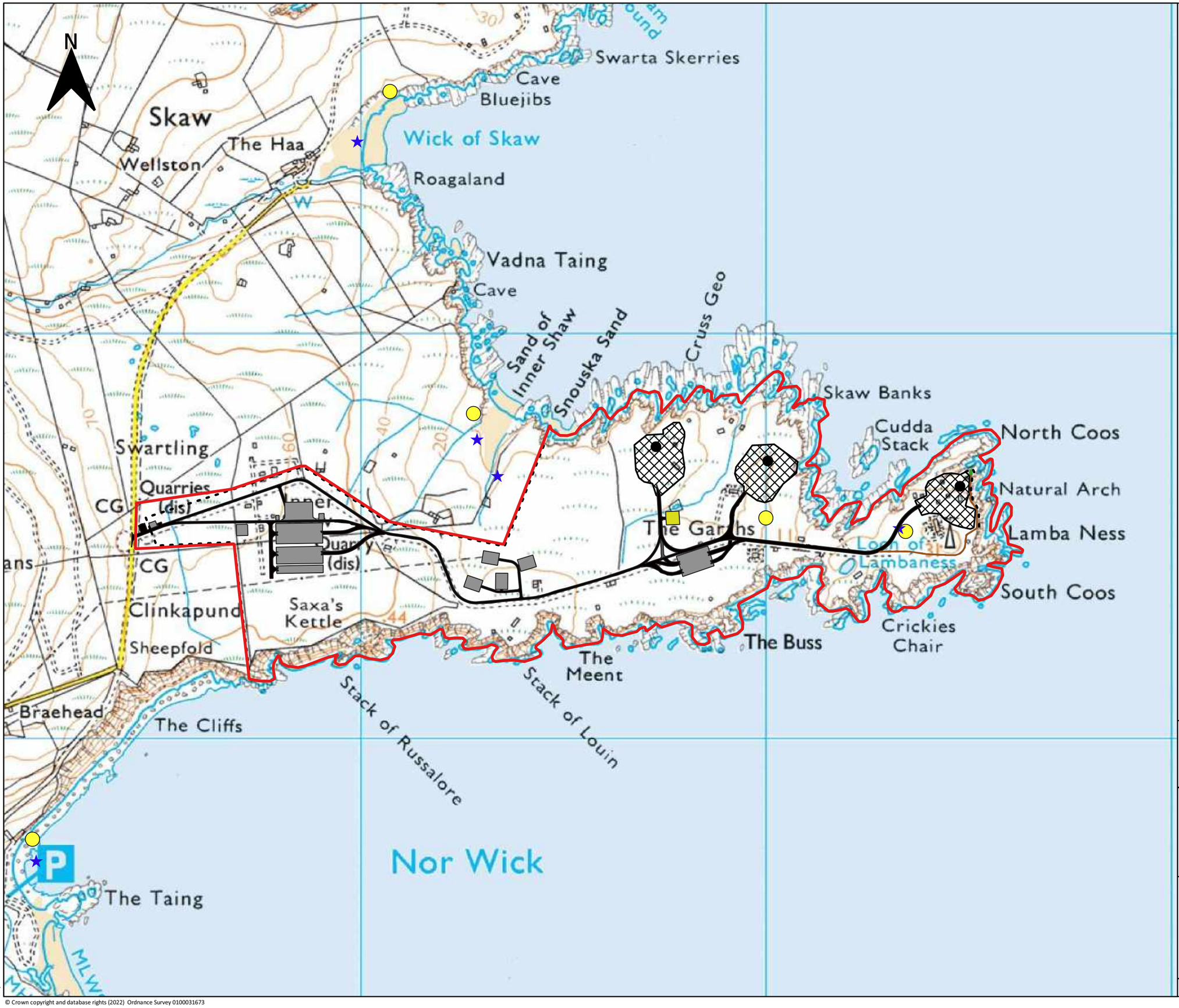
Chapter 5 Drawing 5.11 Breeding Ringed Plover within the Proposed Project Boundary



KEY

Ringed plover territory centre

- 2018
- 2019

Spaceport design layout

- Infrastructure/building
- Fenced launch pad area
- Road
- Construction compound
- Temporary construction compound
- Track to wildlife hide
- Wildlife hide
- Launch pad
- Fence
- Proposed Project Site Boundary

0 200 400 m

Scale 1:15,000 @ A3

SKYRORA

Skyrora SaxaVord
Assessment of Environmental Effects

Drawing 5.11
Breeding ringed plover within the Proposed Project Boundary

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Chapter 5 Drawing 5.12 Breeding Golden Plover within Study Area

KEY

Golden plover territory centre

- 2018
- 2019
- Proposed Project Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

SKYRORA

Skyrora SaxaVord
Assessment of Environmental Effectst

Drawing 5.12
Breeding golden plover within the Study Area

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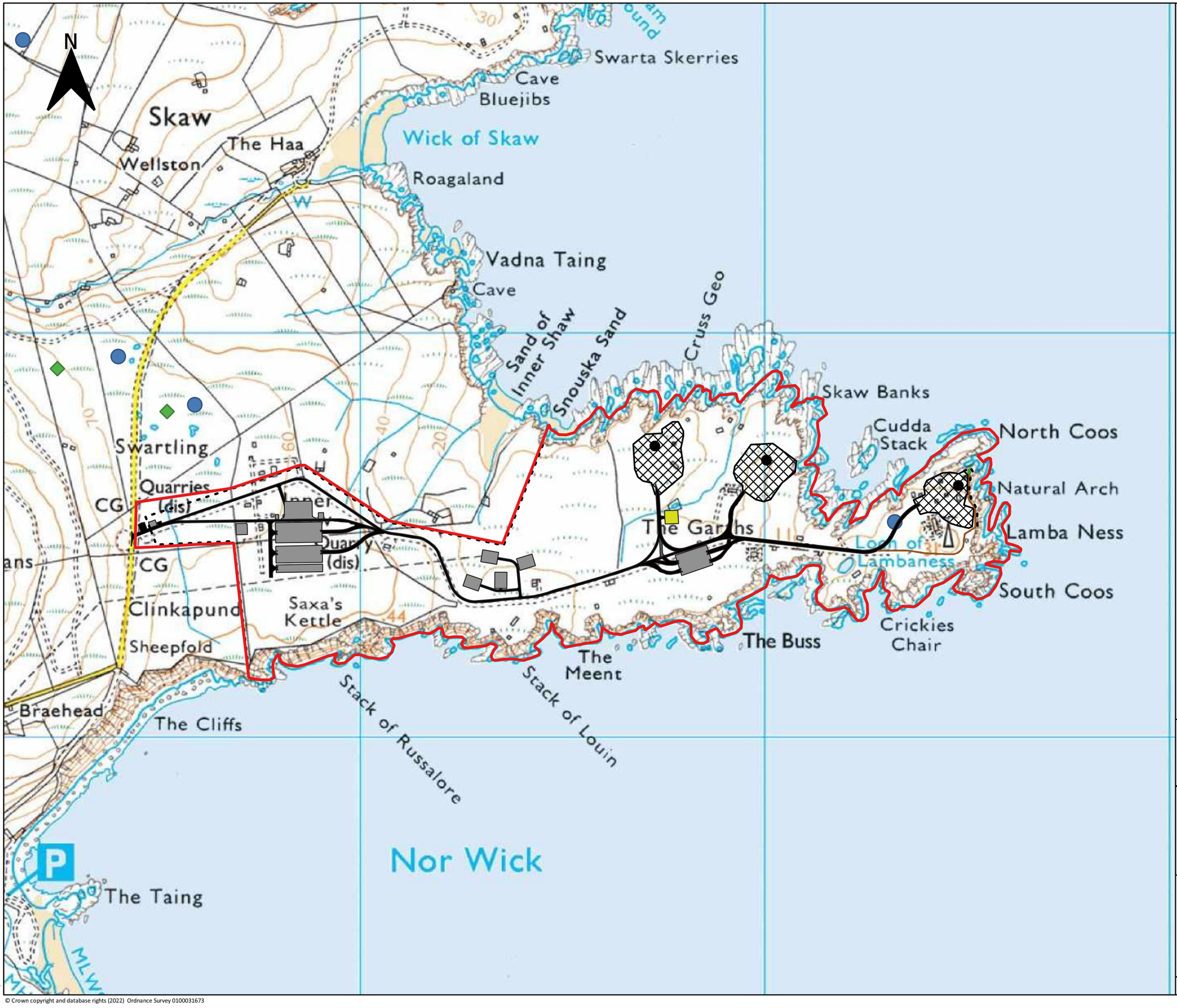
Chapter 5 Drawing 5.13 Breeding Golden Plover within Proposed Project Boundary



KEY

Golden plover territory centre

- 2018
- 2019

Spaceport design layout

- Infrastructure/building
- Fenced launch pad area
- Road
- Construction compound
- Temporary construction compound
- Track to wildlife hide
- Wildlife hide
- Launch pad
- Fence
- Proposed Project Site Boundary

0 200 400 m

Scale 1:15,000 @ A3

SKYRORA

Skyrora SaxaVord
Assessment of Environmental Effects

Drawing 5.13
Breeding golden plover within the Proposed Project Boundary

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Chapter 5 Drawing 5.14 Breeding Curlew within Study Area

KEY

Curlew territory centre

- 2018
- 2019
- Proposed Project Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

SKYRORA

Skyrora SaxaVord
Assessment of Environmental Effects

Drawing 5.14
Breeding curlew within the Study Area

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Chapter 5 Drawing 5.15 Breeding Curlew within Proposed Project Boundary

N

Skaw
The Haa
Wellston
Wick of Skaw
Roagaland
Vadna Taing
Cave
Swarta Skerries
Cave
Bluejibs
Sand of Inner Shaw
Snouska Sand
Cruss Geo
Skaw Banks
Cudda Stack
North Coos
Natural Arch
Lamba Ness
South Coos
Loch of Lambaness
The Garths
Crickies Chair
The Buss
The Meent
Stack of Louin
Stack of Russalore
Swartling Quarries
CG
(dis)
CG
Clinkapund
Saxa's Kettle
Sheepfold
Braehead
The Cliffs
The Taing
Nor Wick
P
MLW

KEY

Curlew territory centre

- 2019
- 2018

Spaceport design layout

- Infrastructure/building
- Fenced launch pad area
- Road
- Construction compound
- Temporary construction compound
- Track to wildlife hide
- Wildlife hide
- Launch pad
- Fence
- Proposed Project Site Boundary

0 200 400 m

Scale 1:15,000 @ A3

SKYRORA

Skyrora SaxaVord
Assessment of Environmental Effects

Drawing 5.15
Breeding curlew within the Proposed Project Boundary

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Chapter 5 Drawing 5.16 Breeding Dunlin within Study Area



KEY

- Dunlin territory centre
- Proposed Project Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

SKYRORA

Skyrora SaxaVord
Assessment of Environmental Effects

Drawing 5.16
Breeding dunlin within the Study Area

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Chapter 5 Drawing 5.17 Breeding Dunlin within Proposed Project Boundary

N

Skaw
The Haa
Wellston
Wick of Skaw
Roagaland
Swarta Skerries
Cave
Bluejibs
Vadna Taing
Cave
Sand of Inner Shaw
Snouska Sand
Cruss Geo
Skaw Banks
Cudda Stack
North Coos
Natural Arch
Lamba Ness
Loch of Lambaness
South Coos
Crickies Chair
The Buss
The Meent
The Garths
2018 & 2019
Swartling
Quarries
CG
(dis)
Inner Quarry (dis)
CG
Clinkapund
Saxa's Kettle
Sheepfold
2019
Braehead
The Cliffs
Stack of Russalore
Stack of Louin
Nor Wick
The Taing
P
MLW

KEY

- Dunlin territory centre

Spaceport design layout

- Infrastructure/building
- Fenced launch pad area
- Road
- Construction compound
- Temporary construction compound
- Track to wildlife hide
- Wildlife hide
- Launch pad
- Fence
- Proposed Project Site Boundary

0 200 400 m

Scale 1:15,000 @ A3

SKYRORA

Skyrora SaxaVord
Assessment of Environmental Effects

Drawing 5.17
Breeding dunlin within the Proposed Project Boundary

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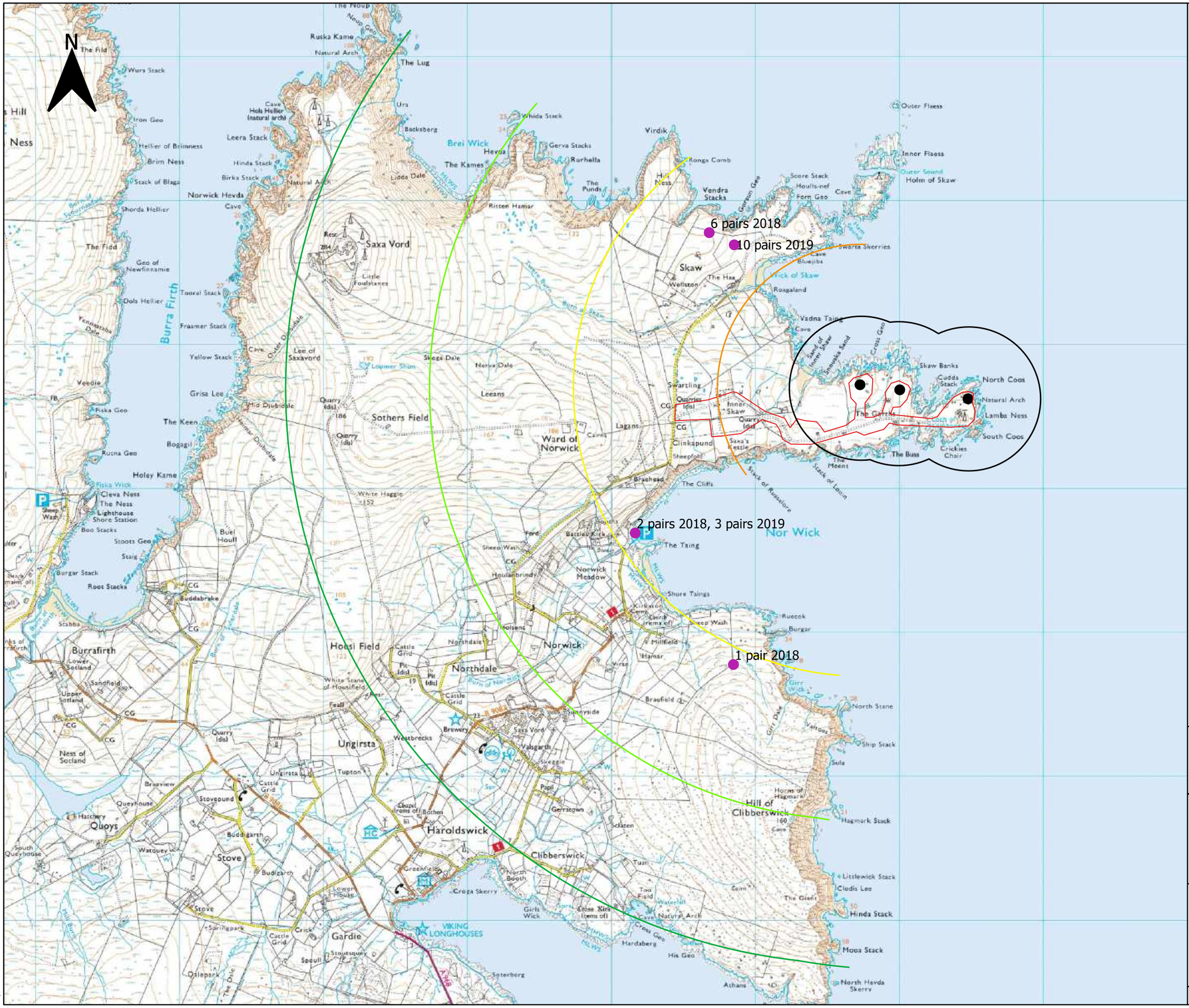
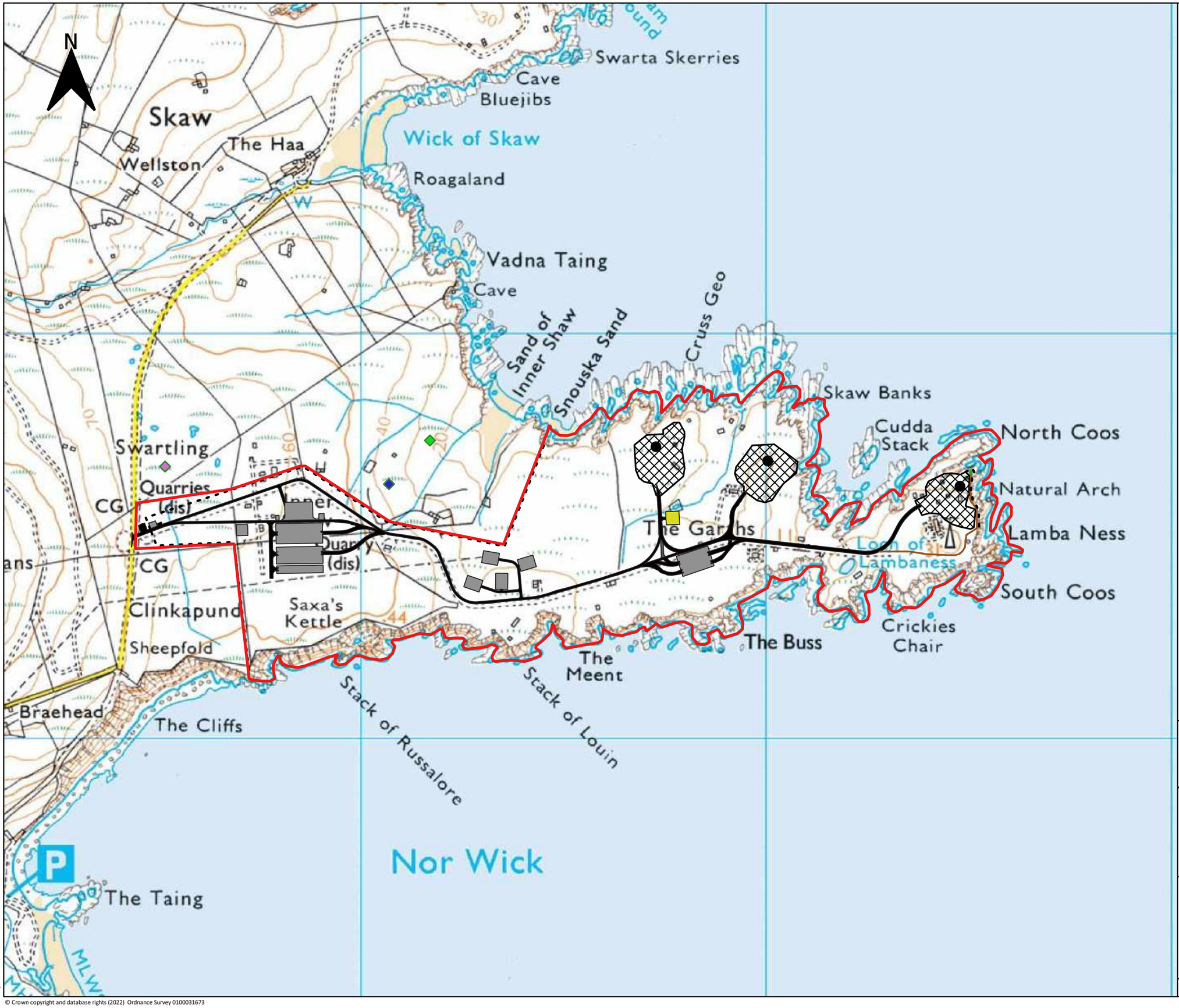
Chapter 5 Drawing 5.18 Breeding Arctic Tern within Study Area


N
6 pairs 2018
10 pairs 2019
2 pairs 2018, 3 pairs 2019
1 pair 2018
Saxa Vord
Skaw
Burra Firth
Brei Wick
Nor Wick
Sothers Field
Ward of Norwick
Norwick
Northdale
Ungirsta
Haroldswick
Clibberswick
Hill of Clibberswick
Stove
Gardie
Burrafirth
Housi Field
Leeans
Lagans
Virdik
Vendra Stacks
Ruska Kame
The Lug
Leera Stack
Norwick Hevda
Shorda Hellier
The Fidd
Yellow Stack
Fraamer Stack
Grisa Lee
The Keen
Bogagil
Holey Kame
Cleva Ness
The Ness Lighthouse
Burgar Stack
Root Stacks
Buddabrake
Ness of Sodland
Quoys
Stove
Gardie
Croga Skerry
VIKING LONGHOUSES
Girls Wick
Hardaberg
Hix Geo
Achans
North Hevda Skerry
Mooa Stack
Hinda Stack
Littlewick Stack
Clodis Lee
Hagmark Stack
North Stane
Ship Stack
Sula
Valsgarth
Northdale
Norwick Meadow
Houlanbrindy
Shure Taings
Ruecook
Burgar
Millfield
Braefield
Sunnyside
Brewery
Papil
Gerratown
Sclaten
Tuan
Too Field
Natural Arch
Cross Geo
Brachead
The Cliffs
Ward of Norwick
Cairns
Clinkapund
Sheepfolds
Saxa's Kettle
Inner Skaw
Quarries
Swartling
Wellston
The Hxa
Roagaland
Vadna Taing
Cave
Skaw Banks
Cudda Stack
North Coos
Natural Arch
Lamba Ness
South Coos
Crickies Chair
The Buss
The Meent
The Garths
Swarta Skerries
Bluejibs
Wick of Skaw
Inner Flaess
Outer Flaess
Outer Sound
Holm of Skaw
Score Stack
Houlls-nef
Forn Geo
Ronga Comb
Hill Ness
Gorseton Geo
Ritten Hamar
The Kames
Hevda
Gerva Stacks
Rurhella
The Punds
Lidda Dale
Backsberg
Ura
Whida Stack
Natural Arch
Birka Stack
Hinda Stack
Brim Ness
Hellier of Brimness
Iron Geo
Wurs Stack
The Fild
Ness
Hill
Cave
Hols Heller (natural archi
Natural Arch
The Noup
Noup Geo
Cave
Tooral Stack
Dols Hellier
Geo of Newfinnamie
Yennaspira Dale
Veedie
Fiska Geo
Rucna Geo
Fiska Wick
Sheep Wash
Boo Stacks
Stoots Geo
Staig
Buel Houll
Scabba
Burn of Burrafirth
Lower Sodland
Sandfield
Upper Sodland
Queyhouse
Braeview
Harchery
South Queyhouse
Watquey
Buddigarth
Stovepund
Ungirsta
Tupton
Cattle Grid
Quarry (dis)
Westbrecks
Feall
White Stane of Housifield
Pit (dis)
Cattle Grid
Northdale
Burn of Northdale
Sheep Wash
Holsens
Kirkaton Cairn
Cairn (rems of)
Norwick
Hamar
Verse
Girt Wick
Girt Dale
Valfroos
Horns of Hagmark
Hagmark Stack
Hinda Stack
Mooa Stack
North Hevda Skerry
Littlewick Stack
Clodis Lee
The Grant
Natural Arch
Too Field
Tuan
Sclaten
Gerratown
Papil
Sunnyside
Braefield
Millfield
Ruecook
Burgar
Shure Taings
Norwick Meadow
Houlanbrindy
Sheep Wash
Ford
Bostick
Bactles Kirk
The Taing
Nor Wick
Cairn (rems of)
Dwarfie Stane
Saxa Vord
Valsgarth
Sweggie
Brewery
Cattle Grid
Pit (dis)
Northdale
Burn of Northdale
Cattle Grid
Feall
White Stane of Housifield
Westbrecks
Ungirsta
Tupton
Cattle Grid
Quarry (dis)
Stovepund
Queyhouse
Braeview
Harchery
Quoys
South Queyhouse
Watquey
Buddigarth
Stove
Budgarth
Lower House
Springpark
Crick
Cattle Grid
Stoutsquoy
Spoull
Dalepark
The Dale
A968
Soterberg
Croga Skerry
Girls Wick
Cross Xara (rems of)
Natural Arch
Cross Geo
Hardaberg
Hix Geo
Achans
North Hevda Skerry
Mooa Stack
Hinda Stack
Littlewick Stack
Clodis Lee
The Grant
Hagmark Stack
Horns of Hagmark
Hill of Clibberswick
Sclaten
Gerratown
Papil
Sunnyside
Braefield
Millfield
Ruecook
Burgar
Shure Taings
Norwick Meadow
Houlanbrindy
Sheep Wash
Ford
Bostick
Bactles Kirk
The Taing
Nor Wick
Brachead
The Cliffs
Ward of Norwick
Cairns
Clinkapund
Sheepfolds
Saxa's Kettle
Inner Skaw
Quarries
Swartling
Wellston
The Hxa
Roagaland
Vadna Taing
Cave
Skaw Banks
Cudda Stack
North Coos
Natural Arch
Lamba Ness
South Coos
Crickies Chair
The Buss
The Meent
The Garths
Swarta Skerries
Bluejibs
Wick of Skaw
Inner Flaess
Outer Flaess
Outer Sound
Holm of Skaw
Score Stack
Houlls-nef
Forn Geo
Cave
Ronga Comb
Hill Ness
Gorseton Geo
Ritten Hamar
The Kames
Hevda
Gerva Stacks
Rurhella
The Punds
Lidda Dale
Backsberg
Ura
Whida Stack
Natural Arch
Birka Stack
Hinda Stack
Brim Ness
Hellier of Brimness
Iron Geo
Wurs Stack
The Fild
Ness
Hill
Cave
Hols Heller (natural archi
Natural Arch
The Noup
Noup Geo
Cave
Tooral Stack
Dols Hellier
Geo of Newfinnamie
Yennaspira Dale
Veedie
Fiska Geo
Rucna Geo
Fiska Wick
Sheep Wash
Boo Stacks
Stoots Geo
Staig
Buel Houll
Scabba
Burn of Burrafirth
Lower Sodland
Sandfield
Upper Sodland
Queyhouse
Braeview
Harchery
South Queyhouse
Watquey
Buddigarth
Stovepund
Ungirsta
Tupton
Cattle Grid
Quarry (dis)
Westbrecks
Feall
White Stane of Housifield
Pit (dis)
Cattle Grid
Northdale
Burn of Northdale
Sheep Wash
Holsens
Kirkaton Cairn
Cairn (rems of)
Norwick
Hamar
Verse
Girt Wick
Girt Dale
Valfroos
Horns of Hagmark
Hagmark Stack
Hinda Stack
Mooa Stack
North Hevda Skerry
Littlewick Stack
Clodis Lee
The Grant
Natural Arch
Too Field
Tuan

Chapter 5 Drawing 5.19 Breeding Arctic Skua within Study Area


N
Saxa Vord
Burra Firth
Nor Wick
Ward of Norwick
Sothers Field
Norwick
Northdale
Ungirsta
Haroldswick
Clibberswick
Hill of Clibberswick
Skaw
Vendra Stacks
Virdik
Brei Wick
The Kames
Ruska Kame
The Lug
Norwick Hevda
Leera Stack
Hinda Stack
Birka Stack
Natural Arch
Lidda Dale
Heva
Gerva Stacks
Rurhella
The Punds
Ritten Hamar
Ronga Comb
Hill Ness
Score Stack
Houlls-nef
Form Geo
Cave
Outer Flaess
Inner Flaess
Outer Sound
Holm of Skaw
Swarta Skerries
Bluejibs
Wick of Skaw
The Hxa
Wellston
Roagaland
Vadna Taing
Sand of Inner Skaw
Snowdrift Sand
Cross Geo
Skaw Banks
Cudda Stack
North Coos
Natural Arch
Lamba Ness
South Coos
Crickies Chair
The Buss
The Meent
The Garths
Inner Skaw
Quarries (dis)
Swartling
CG
Clinkapund
Sheepfolds
Saxa's Kettle
Lagans
Cairns
Brachead
The Cliffs
Stack of Russatore
Stack or Louin
Leeans
Skoga Dale
Norva Dale
Loomer Shim
Burn of Skaw
Junce Burn
Resr
Little Foulstanes
Tooral Stack
Fraamer Stack
Yellow Stack
Lee of Saxavord
Outer Dibdale
Inner Dibdale
Yennaszoba Dale
Dols Hellier
The Fidd
Geo of Newfinnamie
Shorda Hellier
Stack of Blaga
Brim Ness
Hellier of Brimness
Iron Geo
Wurs Stack
The Fild
Ness
Hill
Veedie
Grisa Lee
Mid Djubidale
The Keen
Bogagil
Rucna Geo
Holey Kame
Fiska Geo
Fiska Wick
Cleva Ness
The Ness Lighthouse
Shore Station
Boo Stacks
Stoots Geo
Staig
Burgar Stack
Root Stacks
Buddabrake
Scabba
Burrafirth
Lower Sotland
Upper Sotland
Sandfield
Ness of Sotland
Quarry (dis)
Braeview
Queyhouse
Stovepund
Harchery
Quoys
South Queyhouse
Watquey
Stove
Buddigarth
Springpark
Crick
Cattle Grid
Gardie
Stoutsquoy
Spoull
Dalepark
The Dale
Burn of Gardie
Burn of Norwick
Burn of Burrafirth
Housi Field
Cattle Grid
Pit (dis)
White Stane of Housifield
Feall
Brewery
Westbrecks
Tupton
Papil
Gerratown
Sclaten
Tuan
Too Field
Waterfall
Natural Arch
Cross Geo
Hardaberg
Hix Geo
Achans
Soterberg
Croga Skerry
Girls Wick
Cross Xara (rems of)
North Booth
Greenfield
Clodis Lee
The Grant
Littlewick Stack
Hinda Stack
Mooa Stack
North Hevda Skerry
Hagmark Stack
Horns of Hagmark
Ship Stack
Sula
North Stane
Girr Wick
Girr Dale
Valfoss
Braefield
Sunnyside
Saxa Vord
Valsgarth
Sweggie
Millfield
Hamar
Virse
Kirkaton Cairn
Ruecook
Burgar
Norwick Meadow
Houlanbrindy
Holsens
Shore Taings
The Taing
Bastles Kirk
Boosies
Sheep Wash
Sheep Wash
Lower House
Viking Longhouses
Burn of Norwick
Burn of Burrafirth
Burn of Gardie
Burn of Norwick
Burn of Skaw

Chapter 5 Drawing 5.20 Breeding Arctic Skua within Proposed Project Boundary



KEY

Arctic skua territory centre

- 1 pair 2018 and 19 2 pair 2020
- 2018
- 2018 & 2019
- 2019
- 2020

Spaceport design layout

- Infrastructure/building
- Fenced launch pad area
- Road
- Construction compound
- Temporary construction compound
- Track to wildlife hide
- Wildlife hide
- Launch pad
- Fence
- Proposed Project Site Boundary

0 200 400 m

Scale 1:15,000 @ A3

SKYRORA

Skyrora SaxaVord
Assessment of Environmental Effects

Drawing 5.20
Breeding arctic skua within the Proposed Project Boundary

Date:	Drawn by:	Checked by:	Version:
May 2022	K.M.	P.C.	Rev. 6

Project Number: 3148

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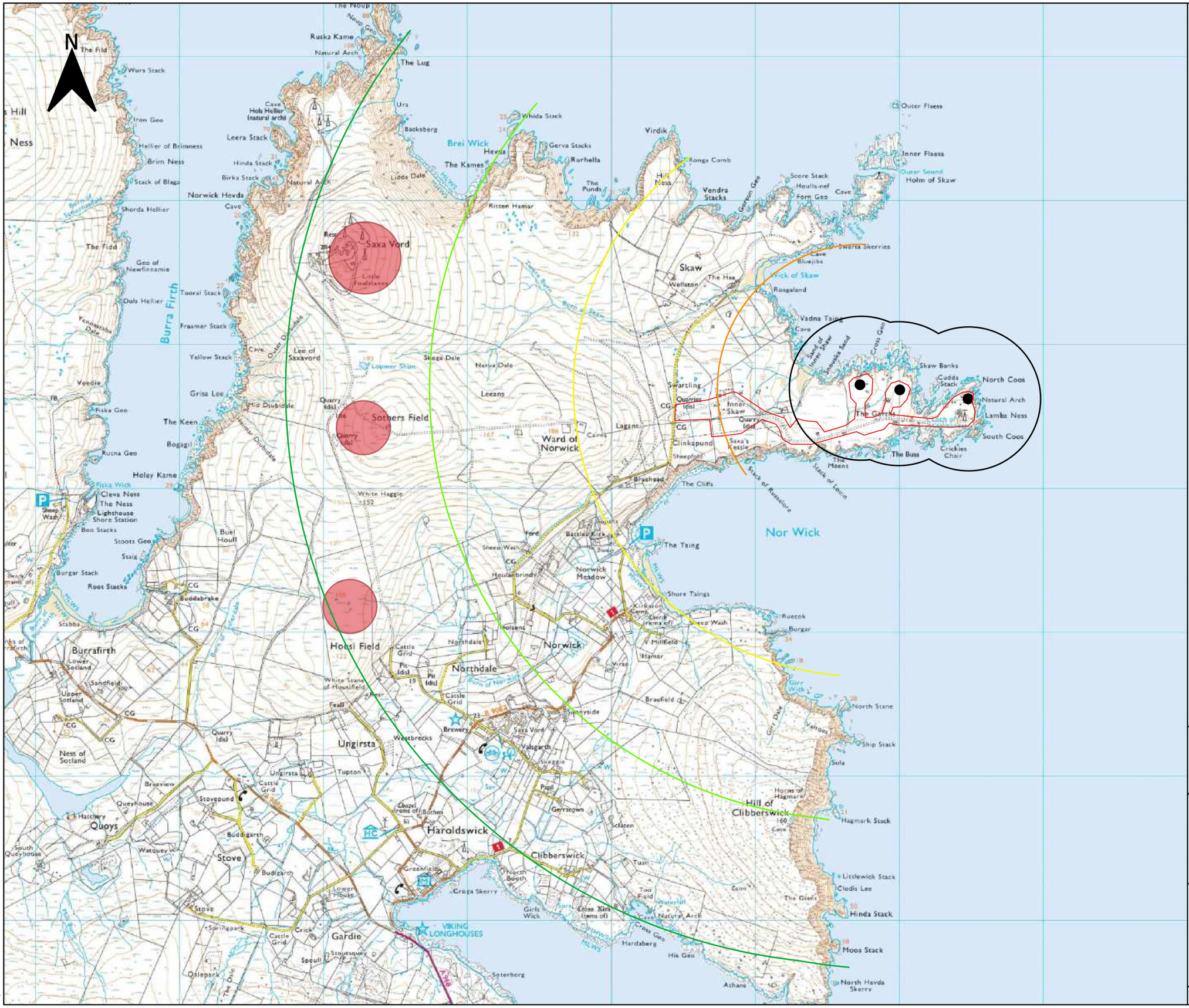
Chapter 5 Drawing 5.21 Breeding Great Skua within Study Area



KEY

- Main great skua breeding areas
- Proposed Project Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

SKYRORA

Skyrora SaxaVord
Assessment of Environmental Effects

Drawing 5.21
Breeding great skua within the Study Area

Date:	Drawn by:	Checked by:	Version:
May 2022	K.M.	P.C.	Rev. 7

Project Number: 3148

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Chapter 6 Drawing 6.1 Ecology Study Area

N

Skaw
The Haa
Wellston
Wick of Skaw
Roagaland
Swarta Skerries
Cave
Bluejibs
Ham Sound
Vadna Taing
Cave
Sand of Inner Shaw
Snouska Sand
Cruss Geo
Skaw Banks
Cudda Stack
North Coos
Natural Arch
Lamba Ness
South Coos
Crickies Chair
The Buss
The Meent
Swartling
Quarries
CG
Lagans
Cairns
CG
Clinkapund
Saxa's Kettle
Sheepfold
Braehead
The Cliffs
Stack of Russalore
Stack of Louin
Nor Wick
Booths
tles Kirk
Stones
The Taing
Norwick Meadow
MHWS
MLWS
Shure Taings

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KEY

- Proposed Project Boundary
- Launch Pad
- Fence
- Fenced Launch Pad Area
- Building/Infrastructure
- Road
- Habitat Study Area, 250m buffer
- Otter Study Area, 500m buffer

0 250 500 m

Scale 1:10,000 @ A3

SKYRORA

Skyrora SaxaVord
Assessment of Environmental Effects

Drawing 6.1

Study Area

Date:	Drawn by:	Checked by:	Version:
20/05/2022	KM	RF	Draft/V1

Project Number: 3148

Chapter 6 Drawing 6.2 Designated Sites

N

Hermaness SSSI

Hermaness, Saxa Vord and Valla Field SPA

Saxa Vord SSSI

Hermaness, Saxa Vord and Valla Field SPA

Hermaness NNR & SSSI

Norwick SSSI

Norwick Meadow SSSI

Burrafirth

Haroldswick

Crussa Field and the Heogs SSSI

Keen of Hamar SSSI

Valla Field SSSI

Hermaness, Saxa Vord and Valla Field SPA

Baltasound

Balta SSSI

Hill of Colvadare and Sobul SSSI

Valla Field SSSI

Fetlar to Haroldswick MPA

Hermaness, Saxa Vord and Valla Field SPA

Breckon SSSI

A968

Midbrake

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KEY

- Proposed Project
- 10km Buffer
- Site of Special Scientific Interest (SSSI)
- Special Protection Area (SPA)
- Marine Protected Area (MPA)
- Special Areas of Conservation (SAC)

0 2 4 km

Scale 1:80,000 @ A3

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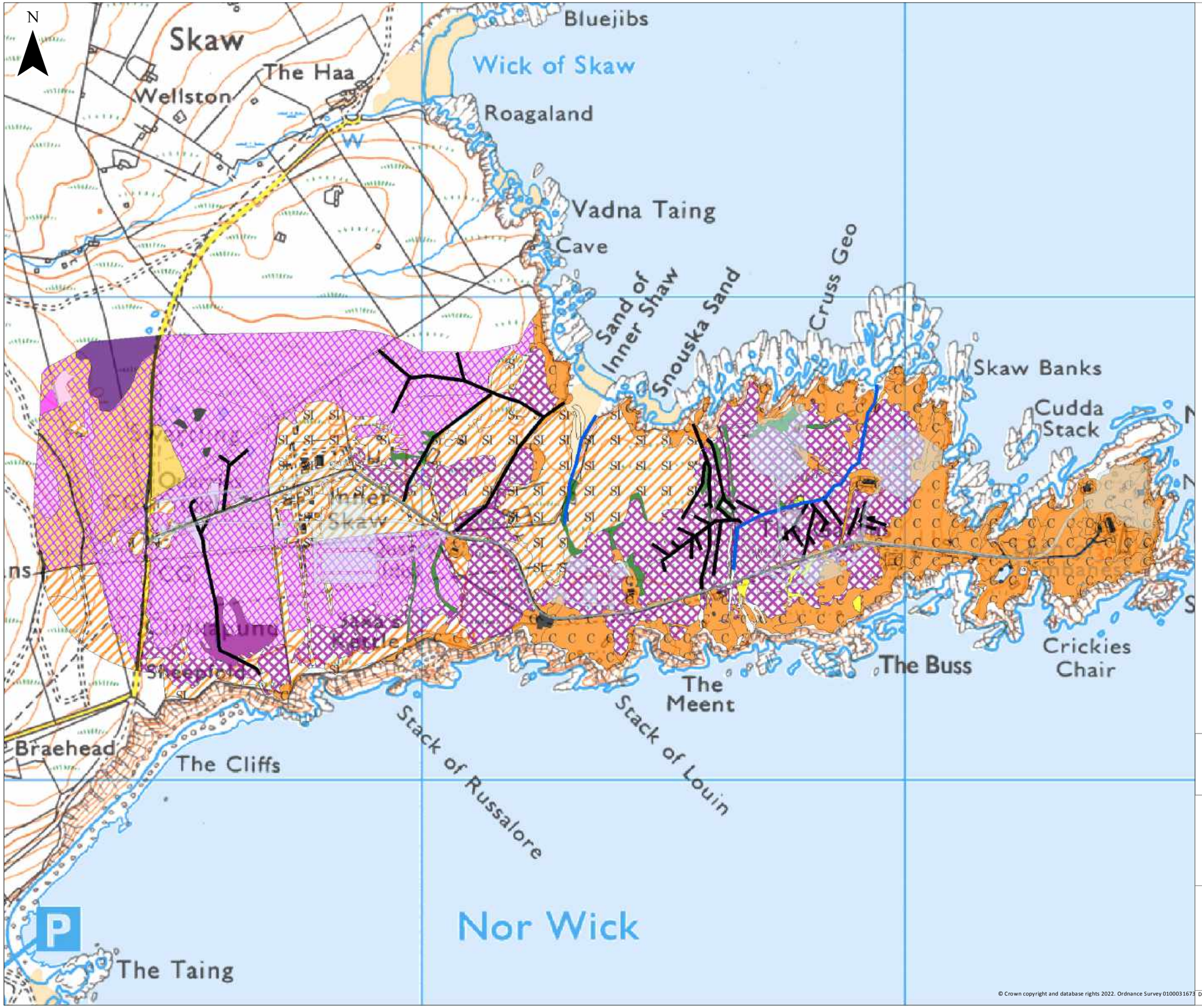
Assessment of Environmental Effects

Drawing 6.2
Designated Sites

Date:	Drawn by:	Checked by:	Version:
25/03/2024	ER	RF	V2

Project Number: 4879

Chapter 6 Drawing 6.3 Phase 1 Habitat Study Area



- Infrastucture
- Drain
- Watercourse
- Unimproved acid grassland
- Semi-improved acid grassland
- Neutral grassland
- Blanket bog
- Wet modified bog
- Wet modified bog/wet heath
- Blanket bog/bare peat
- Wet modified bog/wet heath/bare peat
- Wet modified bog/wet heath/acid flush
- Dry dwarf shrub heath
- Fen
- Acid flush
- Wet modified bog/wet heath/dry heath
- Bare peat
- Marginal vegetaion
- Standing water
- Saltmarsh
- Sand dunes
- Coastal grassland
- Buildings and roads
- Bare ground

0 200 400 m

Scale 1:7,500 @ A3

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Assessment of Environmental Effects

Drawing 6.3

Phase 1 Habitats

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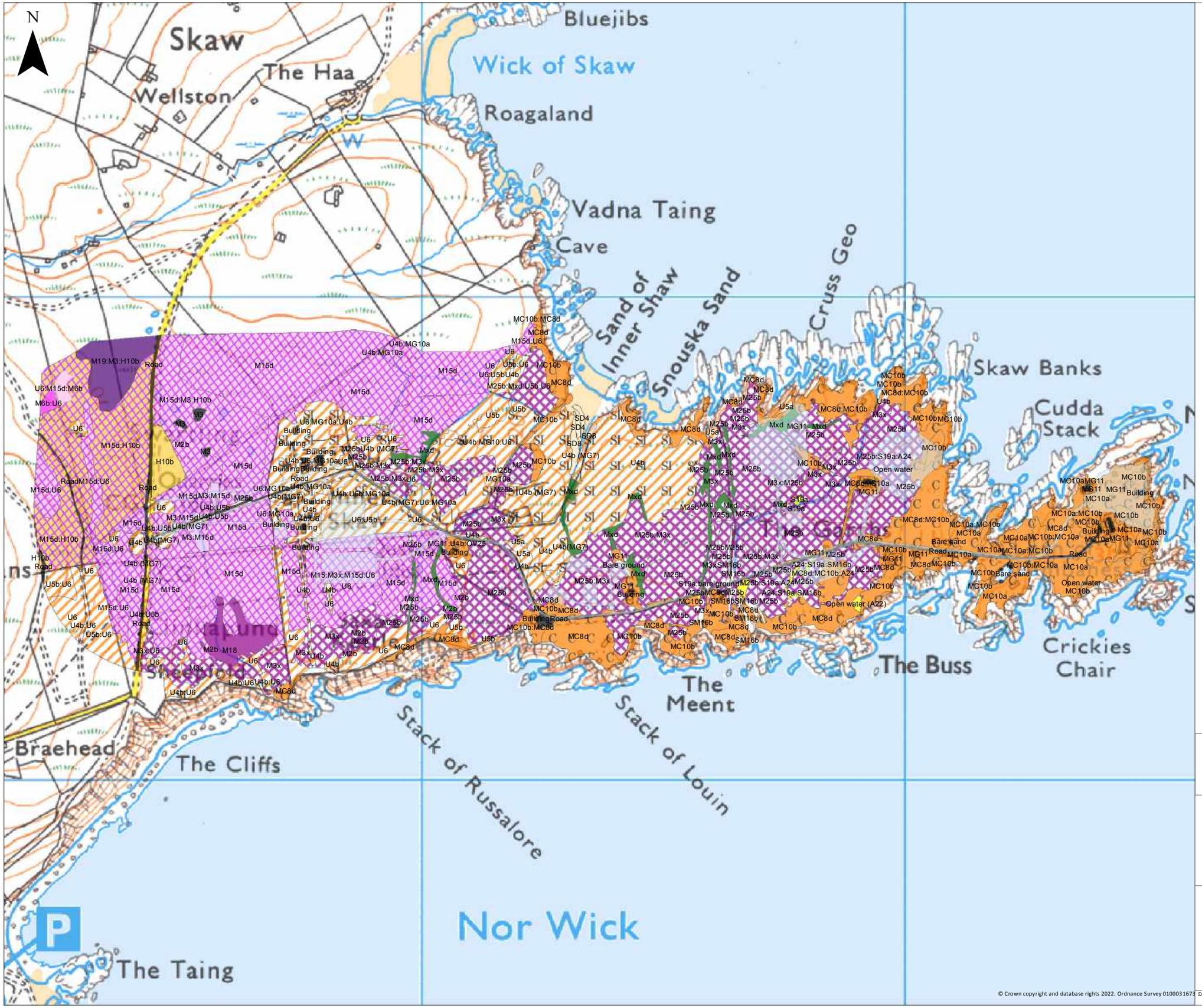
Date:	Drawn by:	Checked by:	Version:
20/05/2022	KM	RF	Draft/V1

Project Number: 3148

Chapter 6 Drawing 6.4 NVC Habitat Study Area



Scale 1:7,500 @ A3

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Assessment of Environmental Effects

Drawing 6.4

NVC

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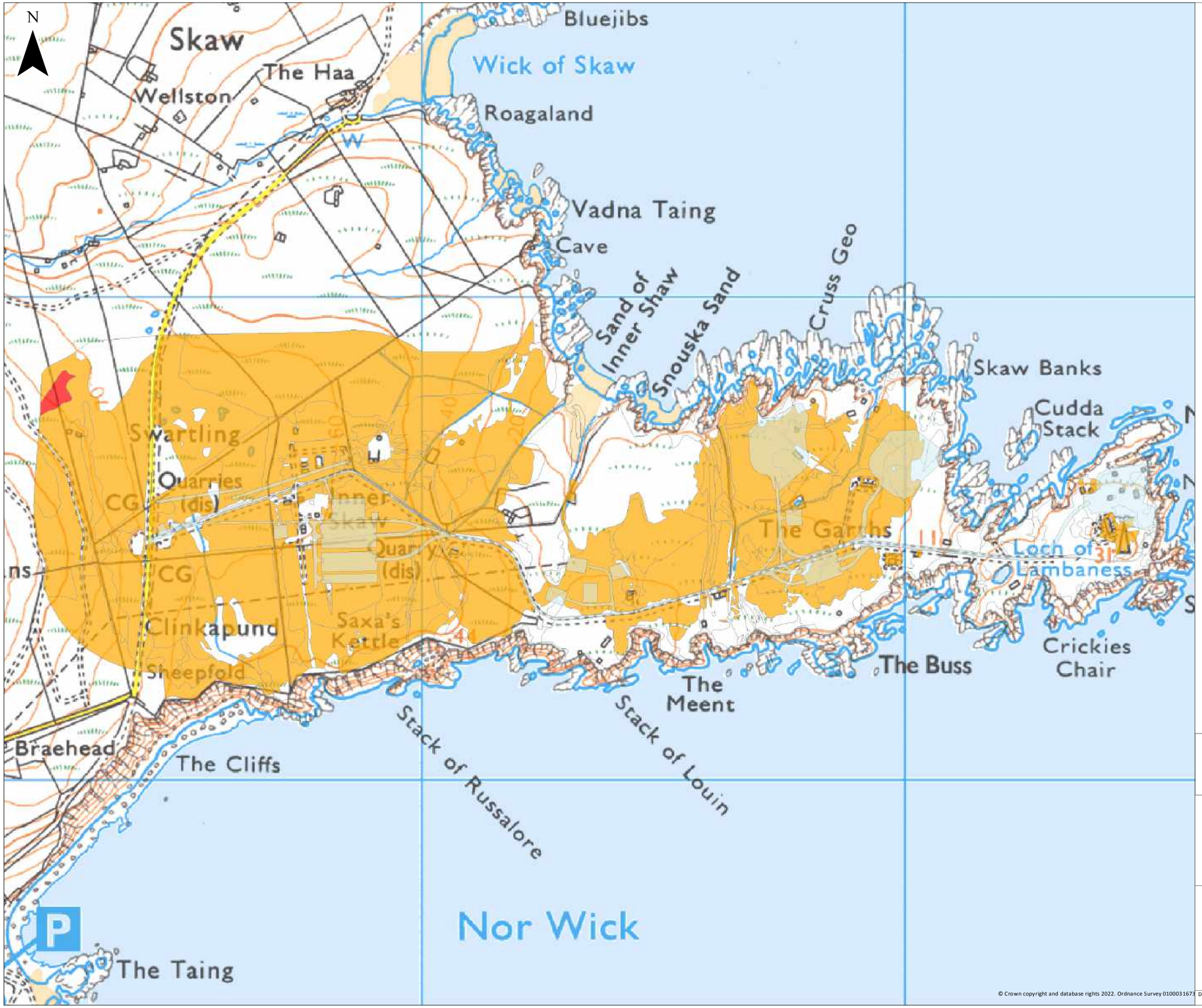
Date:	Drawn by:	Checked by:	Version:
20/05/2022	KM	RF	Draft/V1

Project Number: 3148

Chapter 6 Drawing 6.5 Potential Ground Water Dependant Terrestrial Ecosystems



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Project Number: 3148

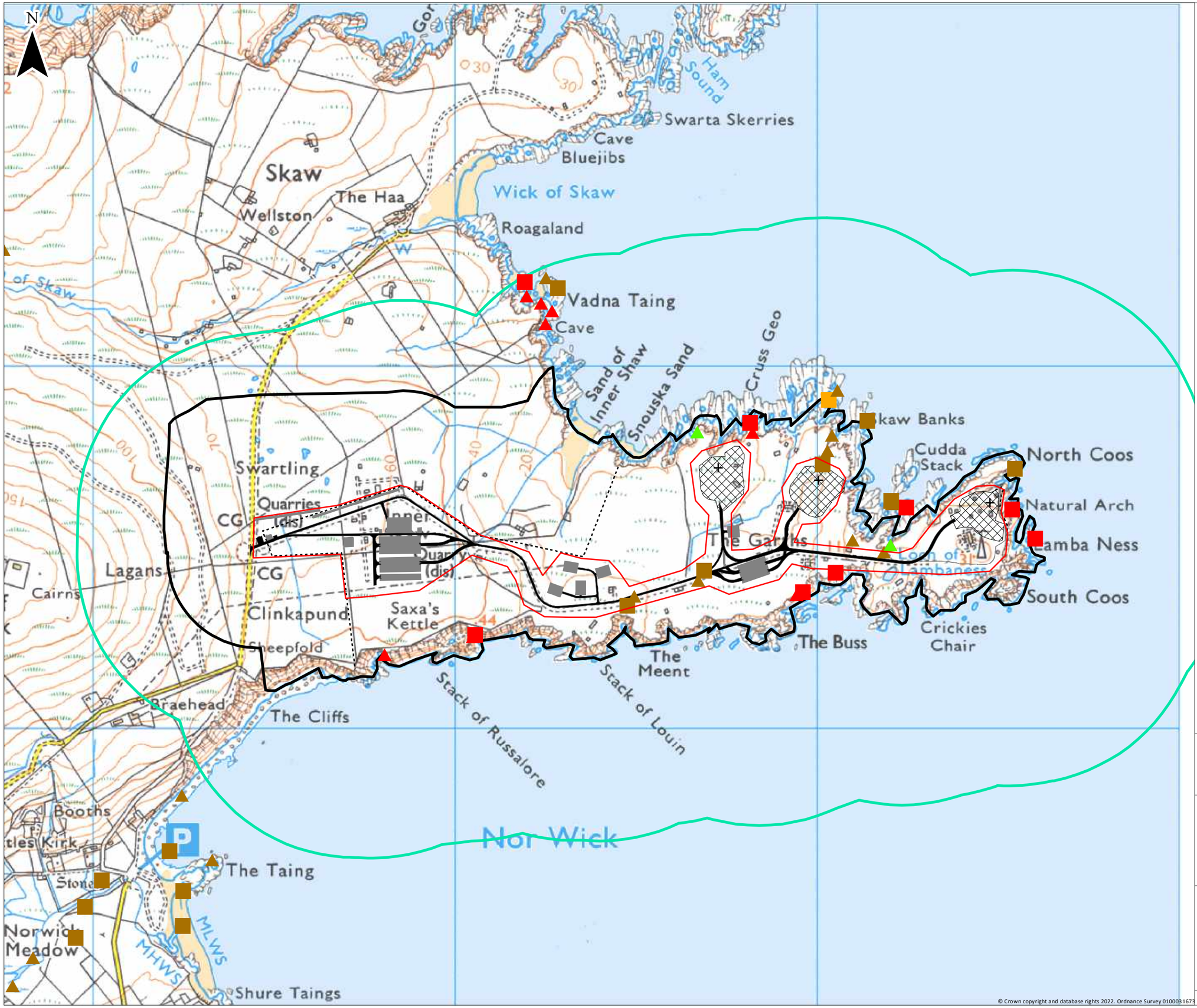
Skyrora SaxaVord
Assessment of Environmental Effects

Drawing 6.5

Potential GWDTE

Date:	Drawn by:	Checked by:	Version:
20/05/2022	KM	RF	Draft/V1

Chapter 6 Drawing 6.6 Otter Signs 2018



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Project Number: 3148

KEY

- Holts, spring 2018
- Spraints and prints, spring 2018
- Run, spring 2018
- Holt, autumn 2018
- Lay up, autumn 2018
- Spraints and prints, autumn 2018
- Proposed Project Boundary
- Launch Pad
- Fence
- Fenced Launch Pad Area
- Building/Infrastructure
- Road
- Habitat Study Area, 250m buffer
- Otter Study Area, 500m buffer

0 250 500 m

Scale 1:10,000 @ A3

SKYRORA

Skyrora SaxaVord
Assessment of Environmental Effects

Drawing 6.6

Otter Signs

Date:	Drawn by:	Checked by:	Version:
20/05/2022	KM	RF	Draft/V1

Chapter 6 Drawing 6.7 Otter signs 2020

N

Skaw
The Haa
Wellston
Wick of Skaw
Roagaland
Swarta Skerries
Cave
Bluejibs
Ham Sound
Vadna Taing
Cave
Sand of Inner Shaw
Snouska Sand
Cruss Geo
Skaw Banks
Cudda Stack
North Coos
Natural Arch
Lamba Ness
South Coos
Crickies Chair
The Buss
The Meent
Stack of Louin
Stack of Russalore
Swartling
Quarries
CG
Lagans
Cairns
CG
Clinkapund
Saxa's Kettle
Sheepfold
Braehead
The Cliffs
Booths
tles Kirk
Stones
Norwick Meadow
The Taing
MLWS
MHWS
Shure Taings
Nor Wick

KEY

- Holt
- Lay up
- Spraints and prints
- Run
- Proposed Project Boundary
- Launch Pad
- Fence
- Fenced Launch Pad Area
- Building/Infrastructure
- Road
- Habitat Study Area, 250m buffer
- Otter Study Area, 500m buffer

0 250 500 m

Scale 1:10,000 @ A3

SKYRORA

Skyrora SaxaVord
Assessment of Environmental Effects

Drawing 6.7

Otter Signs

Date:	Drawn by:	Checked by:	Version:
20/05/2022	KM	RF	Draft/V1

Project Number: 3148

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Chapter 7 Drawing 7.1 Modelled Roads and Receptors

464000.000000

465000.000000

1214000.000000

N

Norwick

Norwick Meadows SSSI

B9087

Northdale

Burn of Norwick

Norwick Residential

A968

Saxa Vord Residential

BRAKEFIELD CRESCENT

PW

TAFTENS

A968

KEY

- Modelled Receptors
- Modelled Roads



Coordinate System: British National Grid
Projection: Transverse Mercator

Service Layer Credits: Contains OS data © Crown Copyright and database right 2020

0 20 40 80 120 160 200 m

1:4,000

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Skyrora Launch Operator Licence
Assessment of Environmental Effects

Drawing 7.1
Modelled Roads and Receptors

Date:	Drawn by:	Review:	Version:
23/05/2022	AD	RF	V1

Chapter 7 Drawing 7.2 Launchpads, Buildings and Receptor Locations

465000 000000
466000 000000
467000 000000
468000 000000
1216000 000000
1215000 000000

N

Skaw

Burn of Skaw

Lamba Ness

Nor Wick

Norwick

Key

- Proposed Project Boundary
- R1 Banks Cottage
- Launch Pad 1
- Launch Pad 2
- Launch Pad 3

Coordinate System: British National Grid
Projection: Transverse Mercator

Service Layer Credits: Contains OS data © Crown Copyright and database right 2020

0 60 120 240 360 480 600 m

1:10,000

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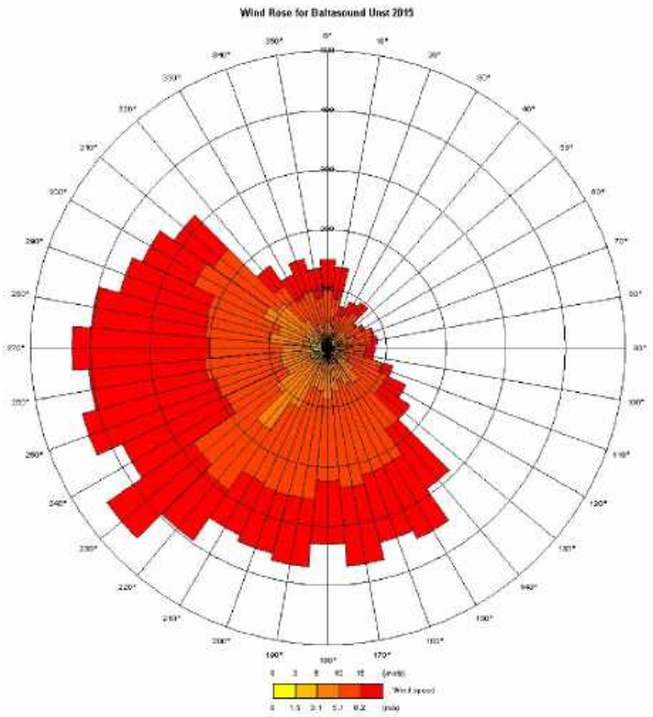
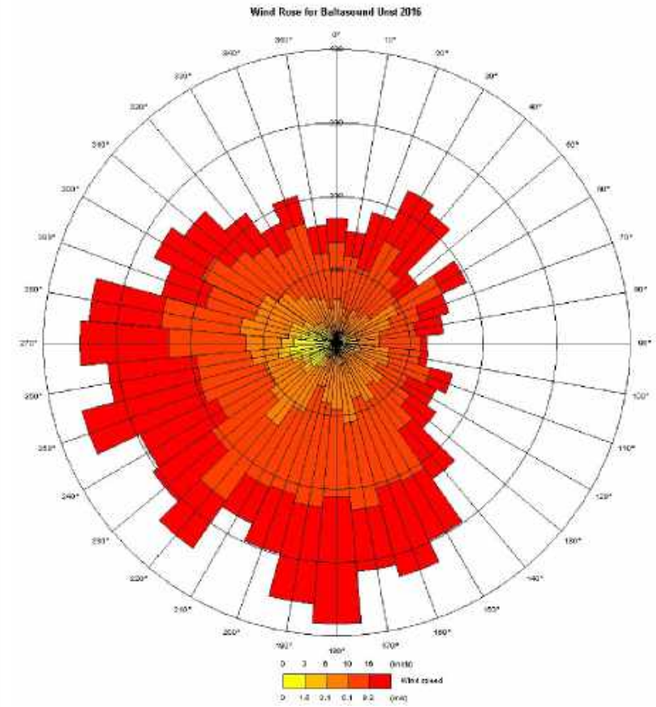
Assessment of Environmental Effects

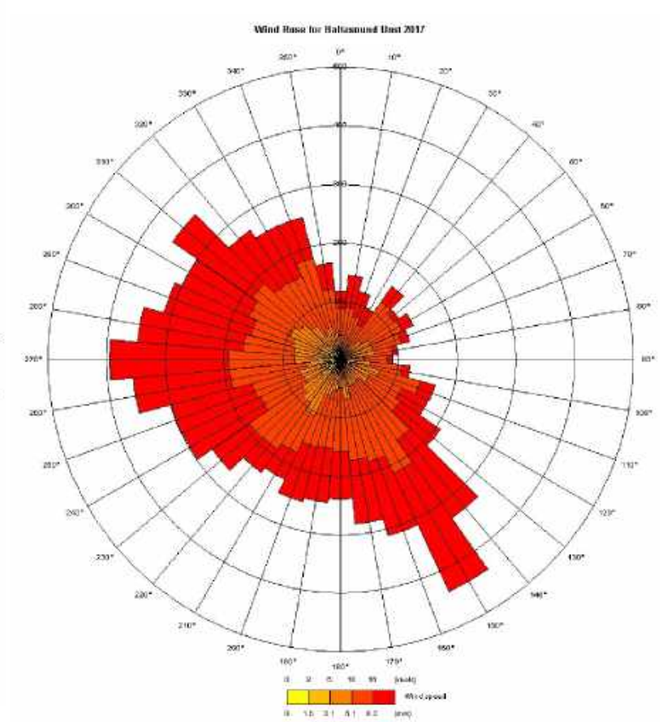
Drawing 7.2
Launchpads, Buildings and Receptor Locations

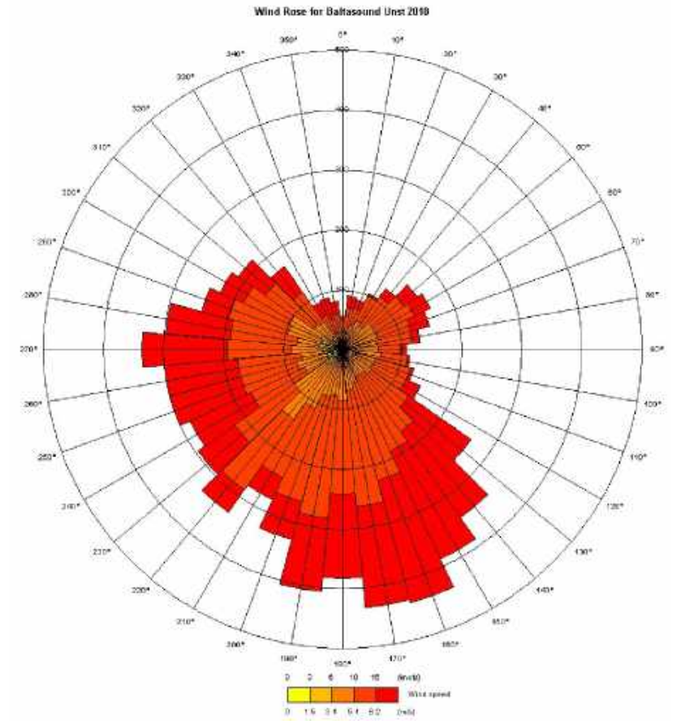
Date:	Drawn by:	Review:	Version:
24/05/2022	AD	RF	V1

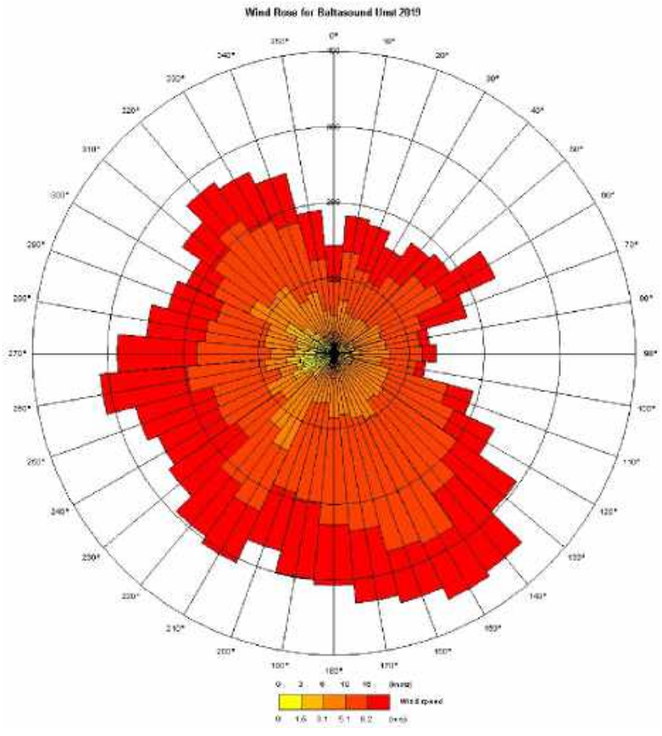
Chapter 7 Drawing 7.3 Wind Roses 2015-2019











SKYRORA

Skyrora Launch Operator Licence
Assessment of Environmental Effects

Figure 7.3
Baltasound, Unst
Hourly Meteorological Data 2015 - 2019

Date:	Drawn by:	Checked by:	Version:
23/05/2022	ER	RF	V1

Project Number: 4879

Chapter 7 Drawing 7.4 5 Minutes after Launch

464000 000000 465000 000000 466000 000000 467000 000000

1216000 000000 1215000 000000 1214000 000000

N

Skaw

Burn of Skaw

Nerva Dale

Ward of Norwick

186

Lamba Ness

R1 Banks Cottage

Nor Wick

Mucklepund

Norwick

Northdale

Burn of Norwick

Girr Wick

KEY

- Proposed Project Boundary
- R1 Banks Cottage
- Residential Properties
- Launch Pad 1
- Launch Pad 2
- Launch Pad 3

5 minutes after release
mg/m³

- 0.05
- 0.05 - 0.06
- 0.06 - 0.07
- 0.07 - 0.08
- 0.08 - 0.09
- 0.09 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5

Coordinate System: British National Grid
Projection: Transverse Mercator

Service Layer Credits: Contains OS data © Crown Copyright and database right 2020

0 70 140 280 420 560 700 m

1:12,000

ITPENERGISED

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Assessment of Environmental Effects

Drawing 7.4
Concentration of CO_2 5 Minutes After Launch

Date:	Drawn by:	Review:	Version:
24/05/2022	AD	RF	V1

Chapter 7 Drawing 7.5 10 Minutes after Launch

464000 000000
465000 000000
466000 000000
467000 000000
1216000 000000
1215000 000000
1214000 000000

N

Skaw
Burn of Skaw
Nerva Dale
Ward of Norwick
186
Lamba Ness
R1 Banks Cottage
Nor Wick
Mucklepund
Norwick
Northdale
Burn of Norwick
Girr Wick

KEY

- Proposed Project Boundary
- R1 Banks Cottage
- Residential Properties
- Launch Pad 1
- Launch Pad 2
- Launch Pad 3

10 minutes after release
mg/m³

- 0.05
- 0.05 - 0.06
- 0.06 - 0.07
- 0.07 - 0.08
- 0.08 - 0.09
- 0.09 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5

Coordinate System: British National Grid
Projection: Transverse Mercator

Service Layer Credits: Contains OS data © Crown Copyright and database right 2020

0 70 140 280 420 560 700 m

1:12,000

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Skyrora Launch Operator Licence
Assessment of Environmental Effects

Drawing 7.5
Concentration of CO_2 10 Minutes After Launch

Date:	Drawn by:	Review:	Version:
24/05/2022	AD	RF	V1

Chapter 7 Drawing 7.6 20 Minutes after Launch

464000 000000
465000 000000
466000 000000
467000 000000
1216000 000000
1215000 000000
1214000 000000

N

Skaw
Burn of Skaw
Nerva Dale
Ward of Norwick
186
Lamba Ness
R1 Banks Cottage
Nor Wick
Mucklepund
Norwick
Northdale
Burn of Norwick
Girr Wick

KEY

- Proposed Project Boundary
- R1 Banks Cottage
- Residential Properties
- Launch Pad 1
- Launch Pad 2
- Launch Pad 3

20 minutes after release
mg/m³

- 0.05
- 0.05 - 0.06
- 0.06 - 0.07
- 0.07 - 0.08
- 0.08 - 0.09
- 0.09 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5

Coordinate System: British National Grid
Projection: Transverse Mercator

Service Layer Credits: Contains OS data © Crown Copyright and database right 2020

0 70 140 280 420 560 700 m

1:12,000

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SKYRORA

Skyrora Launch Operator Licence
Assessment of Environmental Effects

Drawing 7.6
Concentration of CO_2 20 Minutes After Launch

Date:	Drawn by:	Review:	Version:
24/05/2022	AD	RF	V1

Chapter 7 Drawing 7.7 30 Minutes after Launch



KEY

- Proposed Project Boundary
- R1 Banks Cottage
- Residential Properties
- Launch Pad 1
- Launch Pad 2
- Launch Pad 3

30 minutes after release
mg/m³

- 0.05
- 0.05 - 0.06
- 0.06 - 0.07
- 0.07 - 0.08
- 0.08 - 0.09
- 0.09 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5

Coordinate System: British National Grid
Projection: Transverse Mercator

Service Layer Credits: Contains OS data © Crown Copyright and database right 2020

0 70 140 280 420 560 700 m

1:12,000

ITPENERGISED

SKYRORA

Skyrora Launch Operator Licence
Assessment of Environmental Effects

Drawing 7.7
Concentration of CO_2 30 Minutes After Launch

Date:	Drawn by:	Review:	Version:
24/05/2022	AD	RF	V1

Chapter 7 Drawing 7.8 40 Minutes after Launch



KEY

- Proposed Project Boundary
- R1 Banks Cottage
- Residential Properties
- Launch Pad 1
- Launch Pad 2
- Launch Pad 3

40 minutes after release
mg/m³

- 0.05
- 0.05 - 0.06
- 0.06 - 0.07
- 0.07 - 0.08
- 0.08 - 0.09
- 0.09 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5

Coordinate System: British National Grid
Projection: Transverse Mercator

Service Layer Credits: Contains OS data © Crown Copyright and database right 2020

0 70 140 280 420 560 700 m

1:12,000

ITPENERGISED

SKYRORA

Skyrora Launch Operator Licence
Assessment of Environmental Effects

Drawing 7.8
Concentration of CO_2 40 Minutes After Launch

Date:	Drawn by:	Review:	Version:
24/05/2022	AD	RF	V1

Chapter 7 Drawing 7.9 50 Minutes after Launch

464000 000000
465000 000000
466000 000000
467000 000000
1216000 000000
1215000 000000
1214000 000000

N

Skaw
Burn of Skaw
Nerva Dale
Ward of Norwick
186
Lamba Ness
R1 Banks Cottage
Nor Wick
Mucklepund
Norwick
Northdale
Burn of Norwick
Girr Wick

KEY

- Proposed Project Boundary
- R1 Banks Cottage
- Residential Properties
- Launch Pad 1
- Launch Pad 2
- Launch Pad 3

50 minutes after release
mg/m³

- 0.05
- 0.05 - 0.06
- 0.06 - 0.07
- 0.07 - 0.08
- 0.08 - 0.09
- 0.09 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5

Coordinate System: British National Grid
Projection: Transverse Mercator

Service Layer Credits: Contains OS data © Crown Copyright and database right 2020

0 70 140 280 420 560 700 m

1:12,000

ITPENERGISED

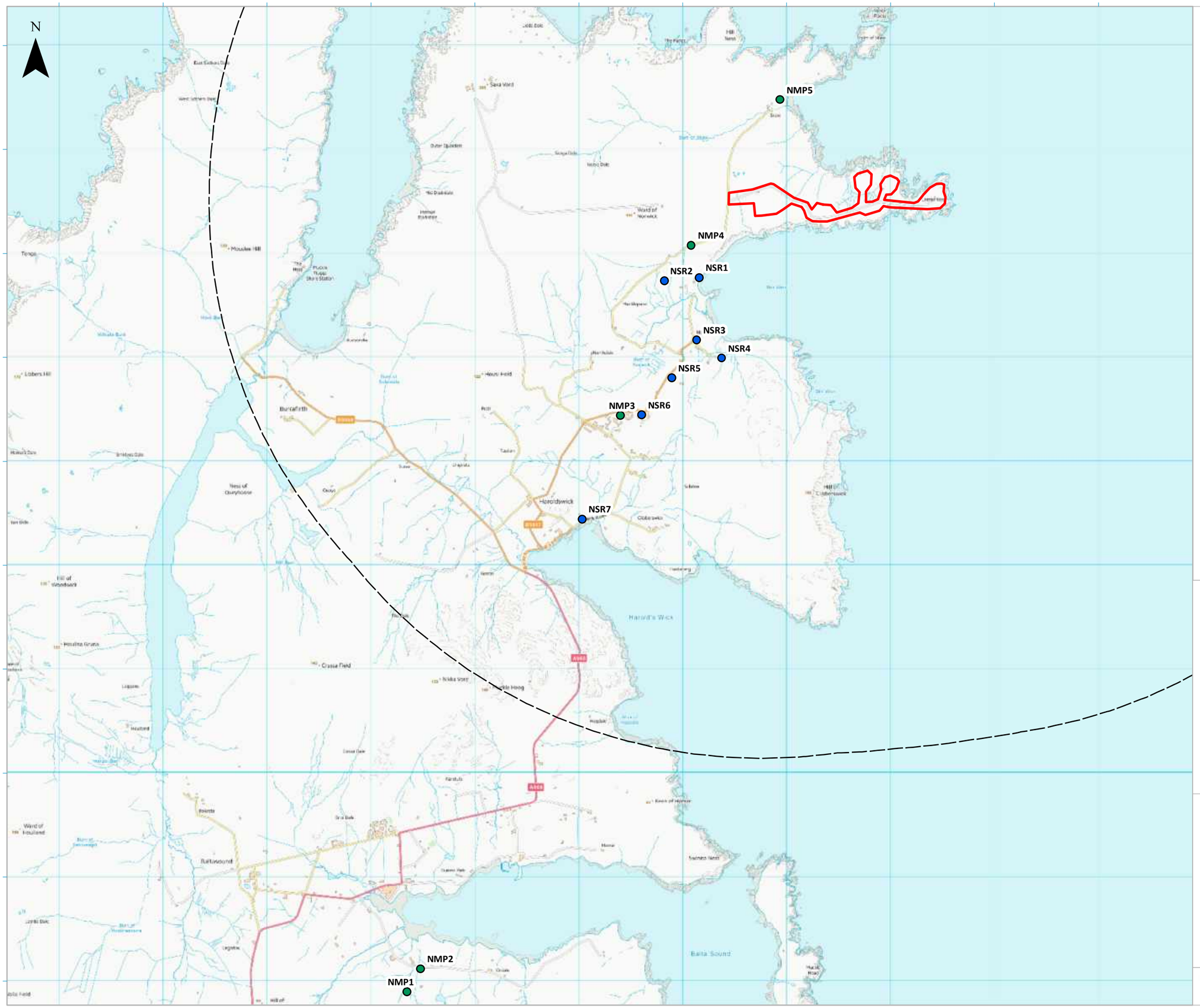
SKYRORA

Skyrora Launch Operator Licence
Assessment of Environmental Effects

Drawing 7.9
Concentration of CO_2 50 Minutes After Launch

Date:	Drawn by:	Review:	Version:
24/05/2022	AD	RF	V1

Chapter 8 Drawing 8.1 Study Area and Noise Sensitive Receptors



KEY

- Proposed Project Boundary
- NMPs
- NSRs
- 5km Study Area



Coordinate System: British National Grid
Projection: Transverse Mercator

Service Layer Credits: Contains OS data © Crown Copyright and database right 2020

0 0.15 0.3 0.6 0.9 1.2 1.5
Kilometres

1:35,000

ITPENERGISED

SKYRORA

Skyrora Launch Operator Licence
Assessment of Environmental Effects

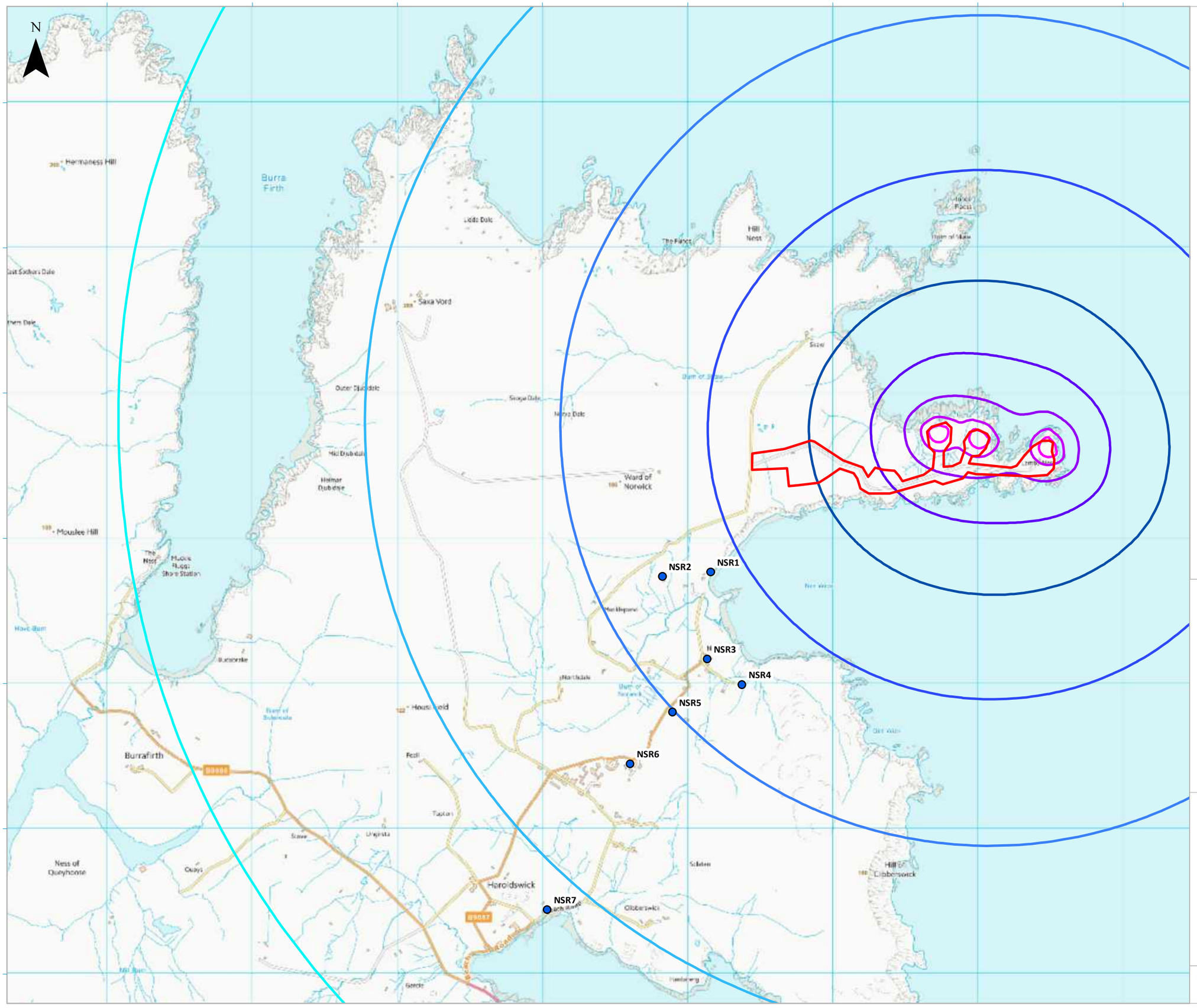
Drawing 8.1
Study Area and NSRs

Date:	Drawn by:	Review:	Version:
06/05/2022	ES	SW	V1

Project Number: 4879

Document Path: F:\GIS\Clients\S\Skyrora\4879 Skyrora Saxa Vord AEE\04 MXD\4879 - Drawing 8.1 - Study Areas and NSRs.mxd

Chapter 8 Drawing 8.2 Lden Noise Contours



Coordinate System: British National Grid
Projection: Transverse Mercator

Service Layer Credits: Contains OS data © Crown Copyright and database right 2020

0 0.1 0.2 0.4 0.6 0.8 1
Kilometres

1:25,000

ITPENERGISED

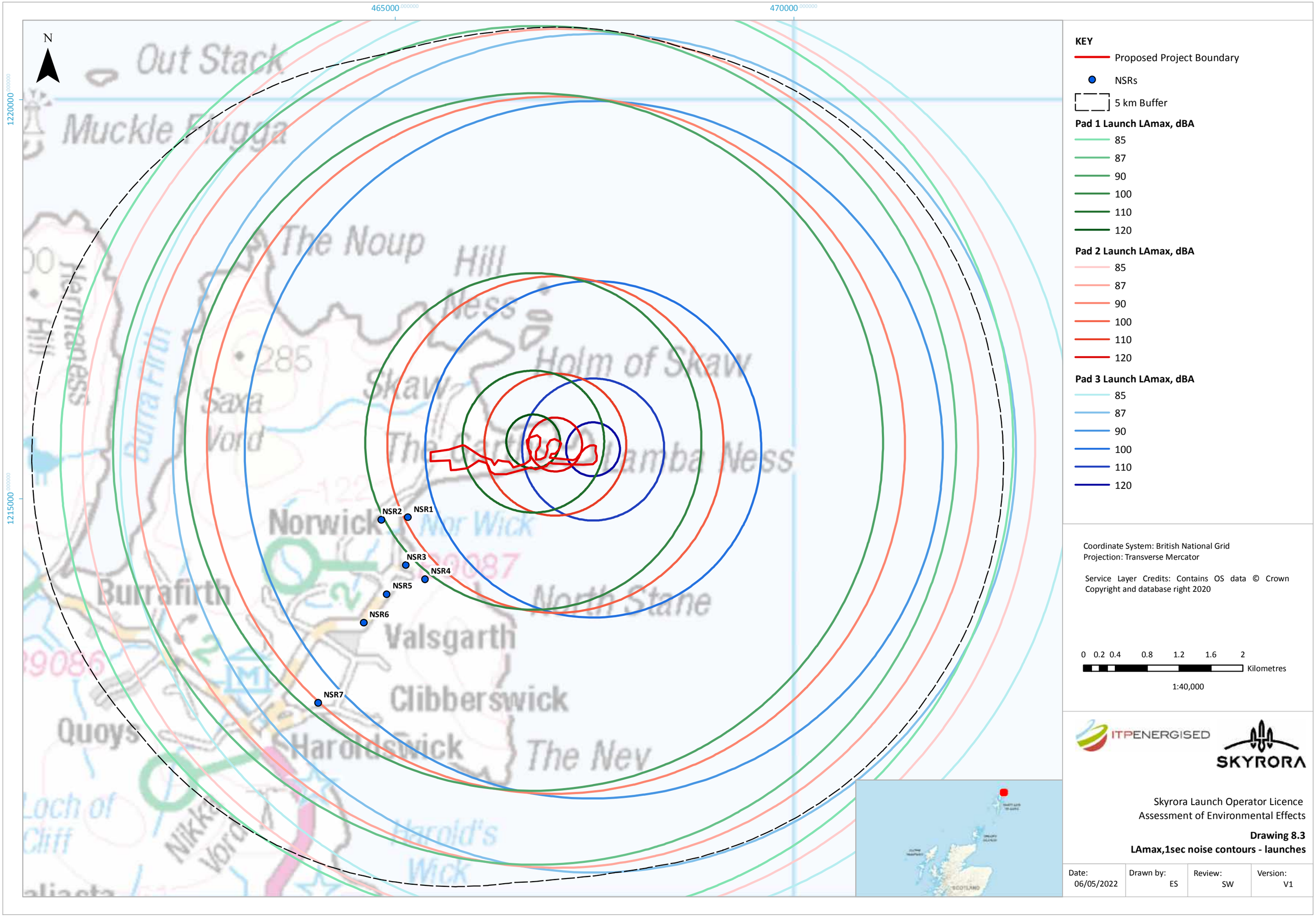
SKYRORA

Skyrora Launch Operator Licence
Assessment of Environmental Effects

Drawing 8.2
Lden noise contours

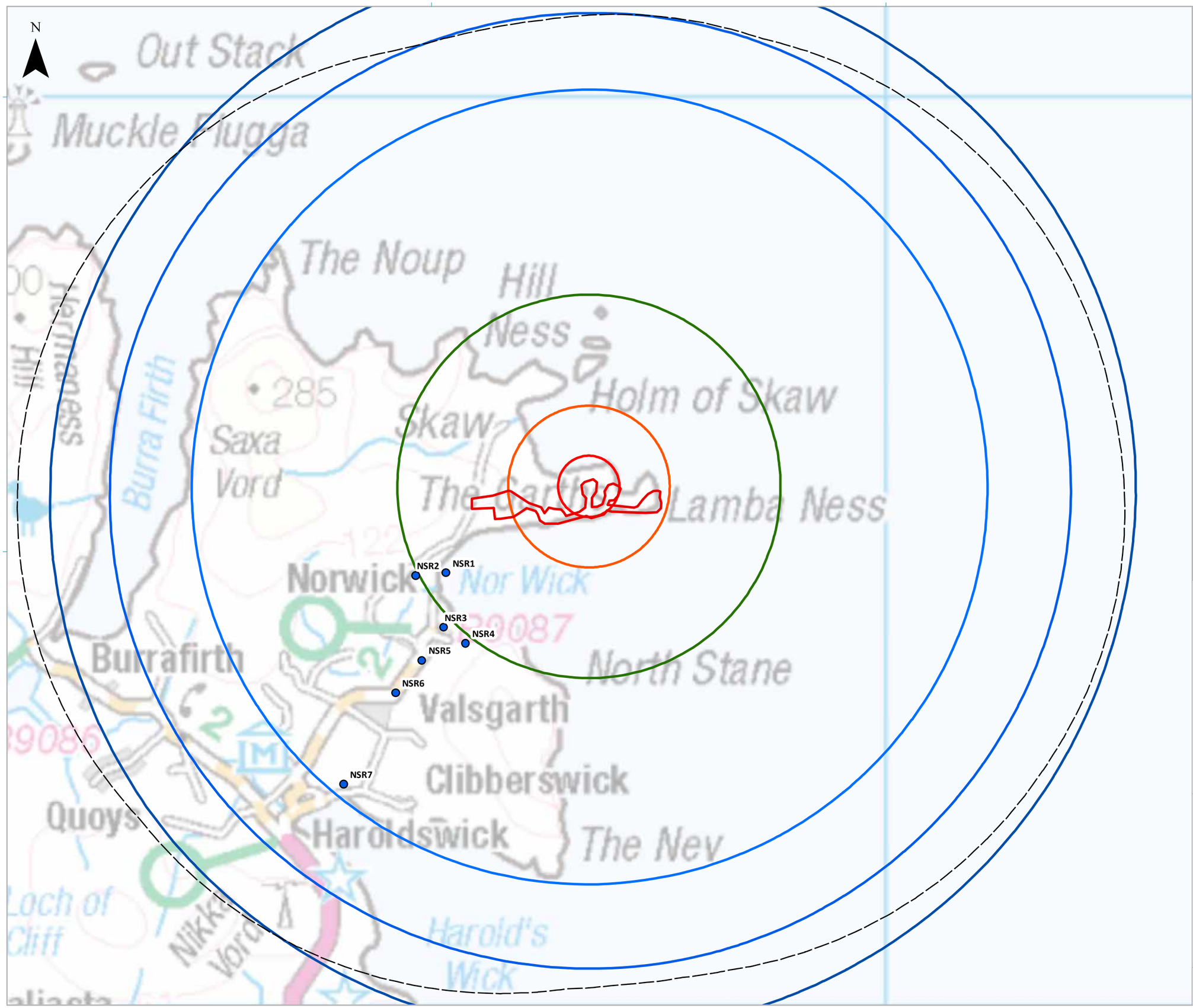
Date:	Drawn by:	Review:	Version:
06/05/2022	ES	SW	V1

Chapter 8 Drawing 8.3 LAmax, 1sec Noise Contours - Launches

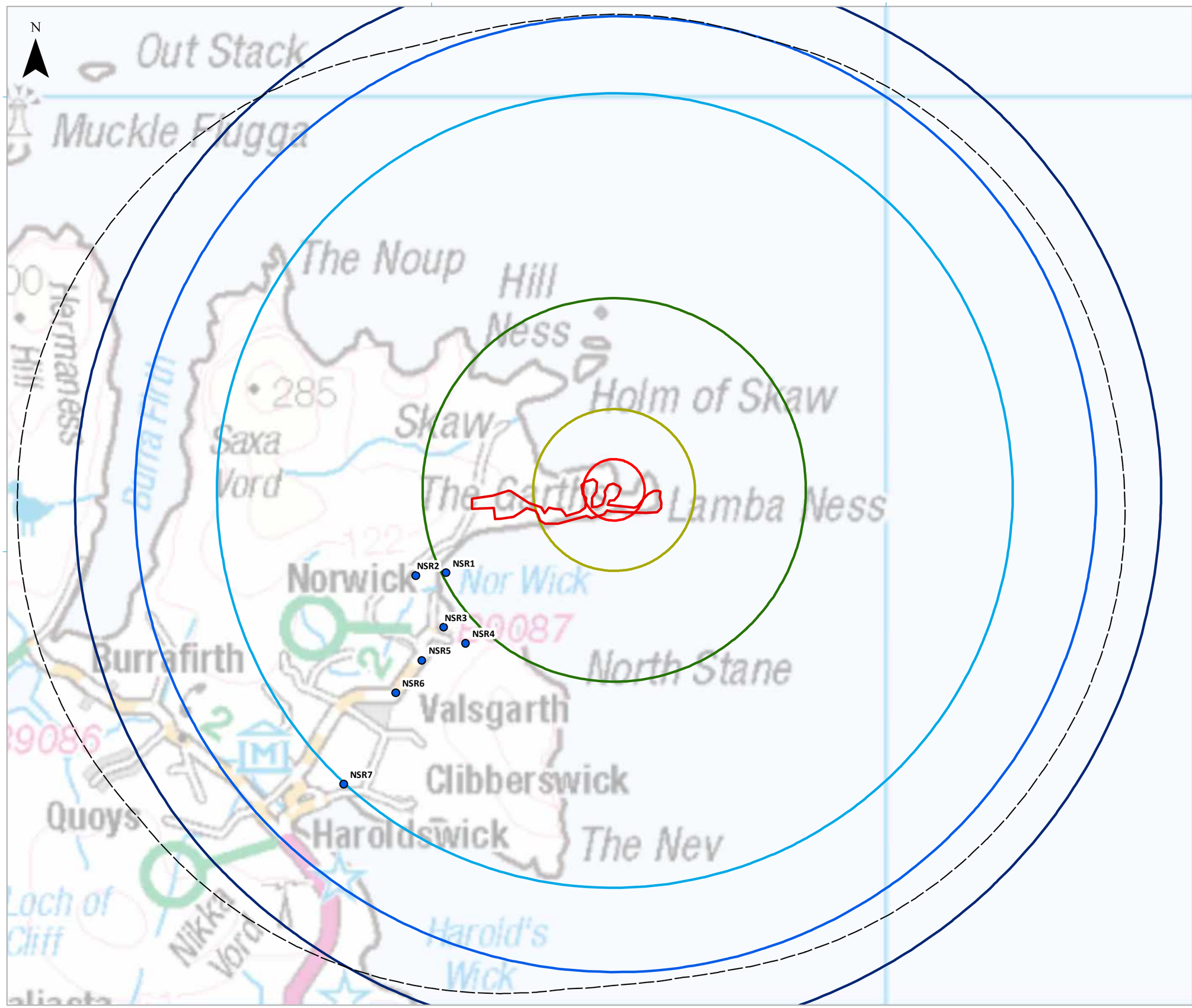


465000
470000
1220000
1215000
N
Out Stack
Muckle Flugga
The Noup
Hill Ness
Holm of Skaw
Skaw
Saxa Vord
Burra Firth
Hermaness
Norwick
Nor Wick
Burrafirth
North Stane
Valsgarth
Clibberswick
Quoys
Haroldswick
The Nev
Loch of Cliff
Harold's Wick
NSR1
NSR2
NSR3
NSR4
NSR5
NSR6
NSR7
KEY
Proposed Project Boundary
NSRs
5 km Buffer
Pad 1 Launch LAmax, dBA
85
87
90
100
110
120
Pad 2 Launch LAmax, dBA
85
87
90
100
110
120
Pad 3 Launch LAmax, dBA
85
87
90
100
110
120
Coordinate System: British National Grid
Projection: Transverse Mercator
Service Layer Credits: Contains OS data © Crown Copyright and database right 2020
0 0.2 0.4 0.8 1.2 1.6 2
Kilometres
1:40,000
ITPENERGISED
SKYRORA
Skyrora Launch Operator Licence
Assessment of Environmental Effects
Drawing 8.3
LAmax,1sec noise contours - launches
Date: 06/05/2022
Drawn by: ES
Review: SW
Version: V1

Chapter 8 Drawing 8.3a LAmax, 1sec Noise Contours - Pad 1


465000
470000
1220000
1215000
N
Out Stack
Muckle Flugga
The Noup
Hill
Ness
Holm of Skaw
Skaw
285
Saxa
Vord
Burra Firth
Lamba Ness
NSR1
NSR2
NSR3
NSR4
NSR5
NSR6
NSR7
Norwick
Nor Wick
Burrafirth
North Stane
Valsgarth
Clibberswick
Quoys
Haroldswick
The Ney
Harold's
Wick
Loch of
Cliff
KEY
Proposed Project Boundary
NSRs
5 km Buffer
Pad 1 Launch LAmax, dBA
85
87
90
100
110
120
SCOTLAND
Coordinate System: British National Grid
Projection: Transverse Mercator
Service Layer Credits: Contains OS data © Crown Copyright and database right 2020
0 0.2 0.4 0.8 1.2 1.6 2
Kilometres
1:40,000
ITPENERGISED
SKYRORA
Skyrora Launch Operator Licence
Assessment of Environmental Effects
Drawing 8.3a (Pad 1)
LAmax,1sec noise contours launches
Date: 06/05/2022
Drawn by: ES
Review: SW
Version: V1

Chapter 8 Drawing 8.3b LAmax, 1sec Noise Contours - Pad 2



KEY

- Proposed Project Boundary
- NSRs
- 5 km Buffer

Pad 2 Launch LAmax,dBA

- 85
- 87
- 90
- 100
- 110
- 120



Coordinate System: British National Grid
Projection: Transverse Mercator

Service Layer Credits: Contains OS data © Crown Copyright and database right 2020

0 0.2 0.4 0.8 1.2 1.6 2
Kilometres

1:40,000

ITPENERGISED

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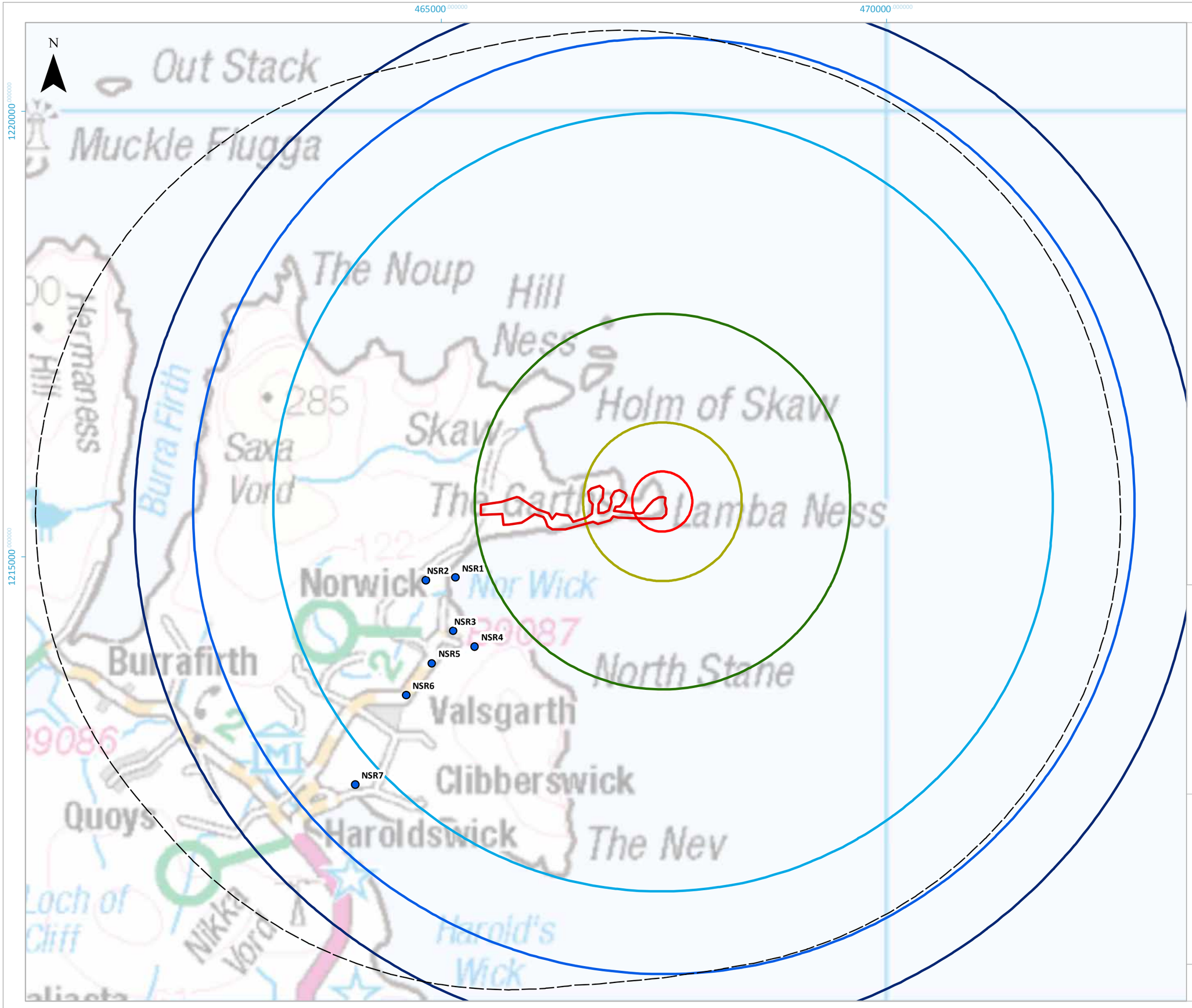
Assessment of Environmental Effects

Drawing 8.3b (Pad 2)
LAmax,1sec noise contours - launches

Date:	Drawn by:	Review:	Version:
06/05/2022	ES	SW	V1

Chapter 8 Drawing 8.3c LAmax, 1sec Noise Contours - Pad 3



KEY

- Proposed Project Boundary
- NSRs
- 5 km Buffer

Pad 3 Launch LAmax, dBA

- 85
- 87
- 90
- 100
- 110
- 120



Coordinate System: British National Grid
Projection: Transverse Mercator

Service Layer Credits: Contains OS data © Crown Copyright and database right 2020

0 0.2 0.4 0.8 1.2 1.6 2 Kilometres

1:40,000

ITPENERGISED

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Assessment of Environmental Effects

Drawing 8.0c (Pad 3)
LAmax,1sec noise contours - launches

Date:	Drawn by:	Review:	Version:
06/05/2022	ES	SW	V1

Chapter 8 Drawing 8.4 Predicted Unweighted Lmax noise contours for Launch Events

464000 465000 466000 467000 468000 469000 470000

1218000 1217000 1216000 1215000 1214000 1213000

N

NSR1
NSR2
NSR3
NSR4
NSR5
NSR6

KEY

Proposed Project Boundary

NSRs

Pad 1 Launch Lmax, dBA

111

120

Pad 2 Launch Lmax, dBA

111

120

Pad 3 Launch Lmax, dBA

111

120



Coordinate System: British National Grid
Projection: Transverse Mercator

Service Layer Credits: Contains OS data © Crown Copyright and database right 2020

0 0.1 0.2 0.4 0.6 0.8 1
Kilometres

1:20,000

ITPENERGISED

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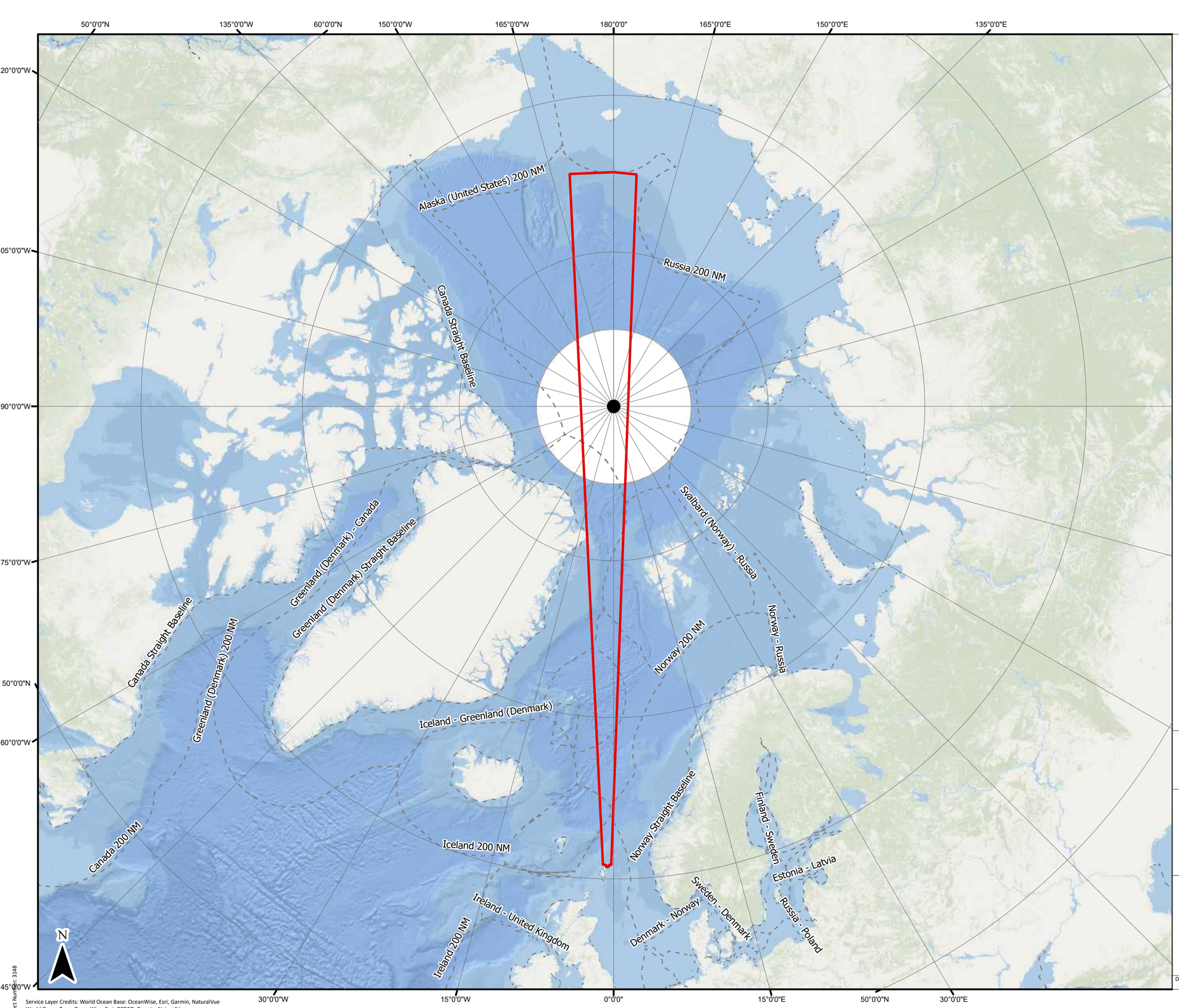
Assessment of Environmental Effects
Drawing 8.4
Predicted Unweighted Lmax Noise Contours for launch events

Date:	Drawn by:	Review:	Version:
06/05/2022	ES	SW	V1

Chapter 9 -

Chapter 10 Drawing 10.1 Environmental Zone of Influence



KEY

- Environmental Zone of Influence
- EEZ boundaries

0 650 1,300 km

Scale **1:25,000,000 @ A3**

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Assessment of Environmental Effects

Drawing 10.1

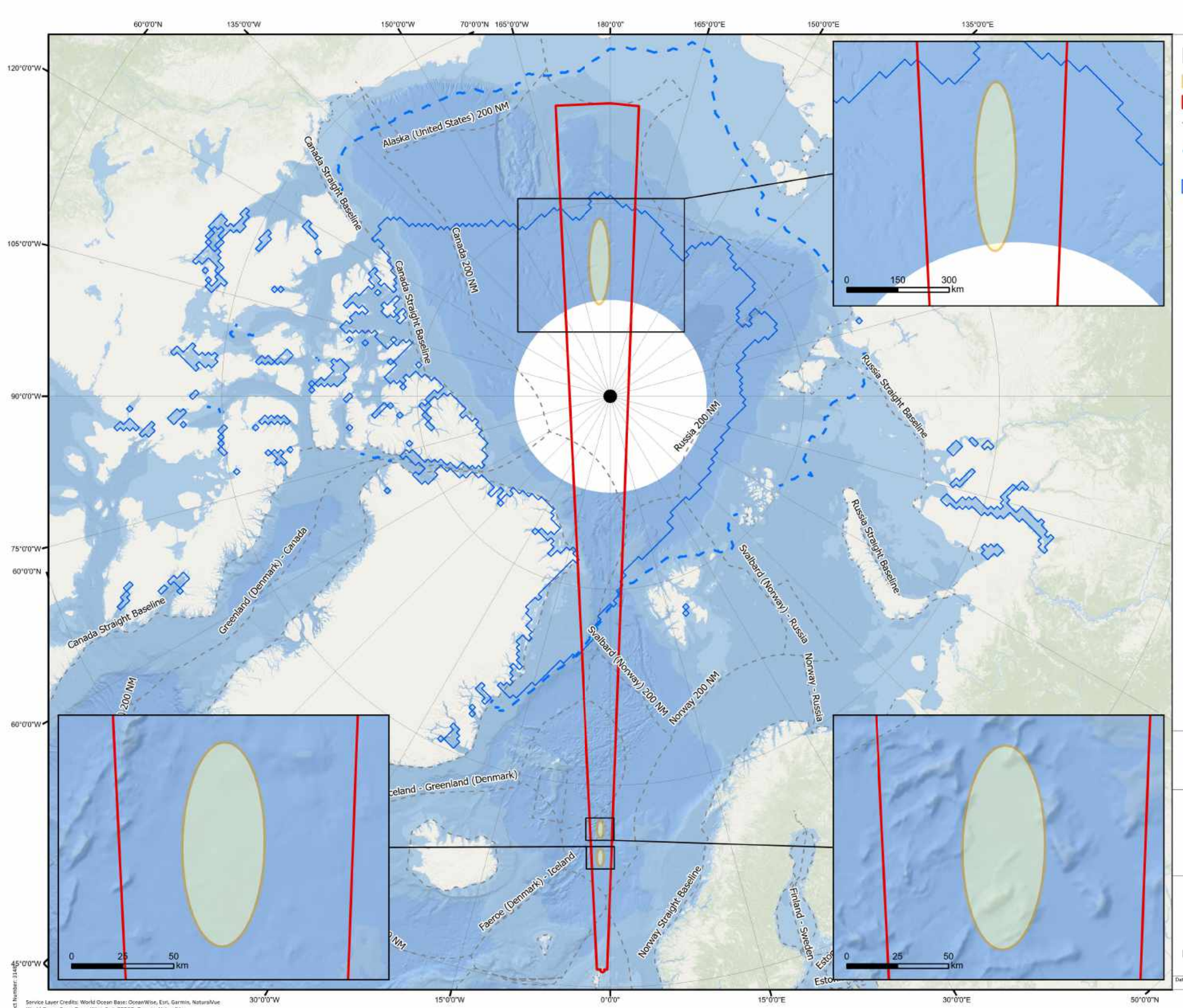
Environmental Zone of Influence

Date:	Drawn by:	Checked by:	Version:
3/27/2024	AN	IW	Draft/V1

Project Number: 3148

Service Layer Credits: World Ocean Base: OceanWise, Esri, Garmin, NaturalVue
World Ocean Base: OceanWise, Esri, GEBCO, Garmin, NaturalVue
World Ocean Base: Esri, GEBCO, Garmin, NaturalVue

Chapter 10 Drawing 10.2 Representative Impact Points



KEY

- Impact Zone
- Environmental Zone of Influence
- EEZ boundaries
- Median September Ice Cover (1981-2010)
- Lowest Recorded Ice Cover (12th September 2012)

N

0 520 1,040 km

Scale 1:20,000,000 @ A3

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Assessment of Environmental Effects

Drawing 10.2

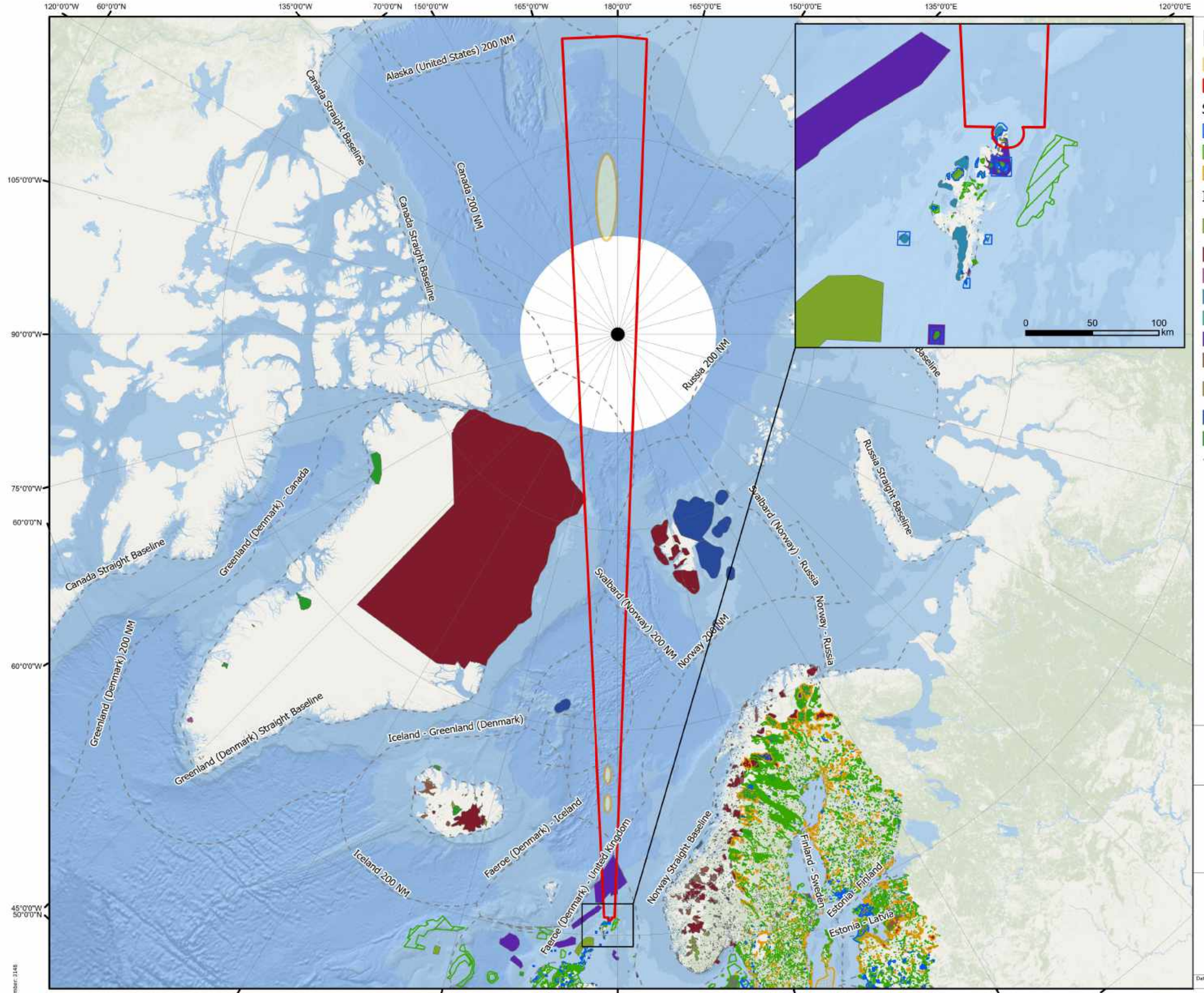
Representative Impact Points - Environmental Zone of Influence

Date:	Drawn by:	Checked by:	Version:
3/27/2024	AN	IW	Draft/V1

Project Number: 3148

Service Layer Credits: World Ocean Base: OceanWise, Esri, Garmin, NaturalVue
World Ocean Base: OceanWise, Esri, GEBCO, Garmin, NaturalVue
World Ocean Base: Esri, GEBCO, Garmin, NaturalVue

Chapter 10 Drawing 10.3 Marine Protected Areas



KEY

- Impact Zone
- Environmental Zone of Influence

SITETYPE

- SPA
- SCI
- SPA and SCI

IUCN description

- Habitat/Species Management Area
- National Park
- Natural Monument or Feature
- Not applicable
- Not assigned
- Not reported
- Protected Landscape/ Seascape
- Protected area with sustainable use of natural resources
- Strict Nature Reserve
- Wilderness Area
- EEZ boundaries

N

0 520 1,040 km

Scale 1:20,000,000 @ A3

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Assessment of Environmental Effects

Drawing 10.3

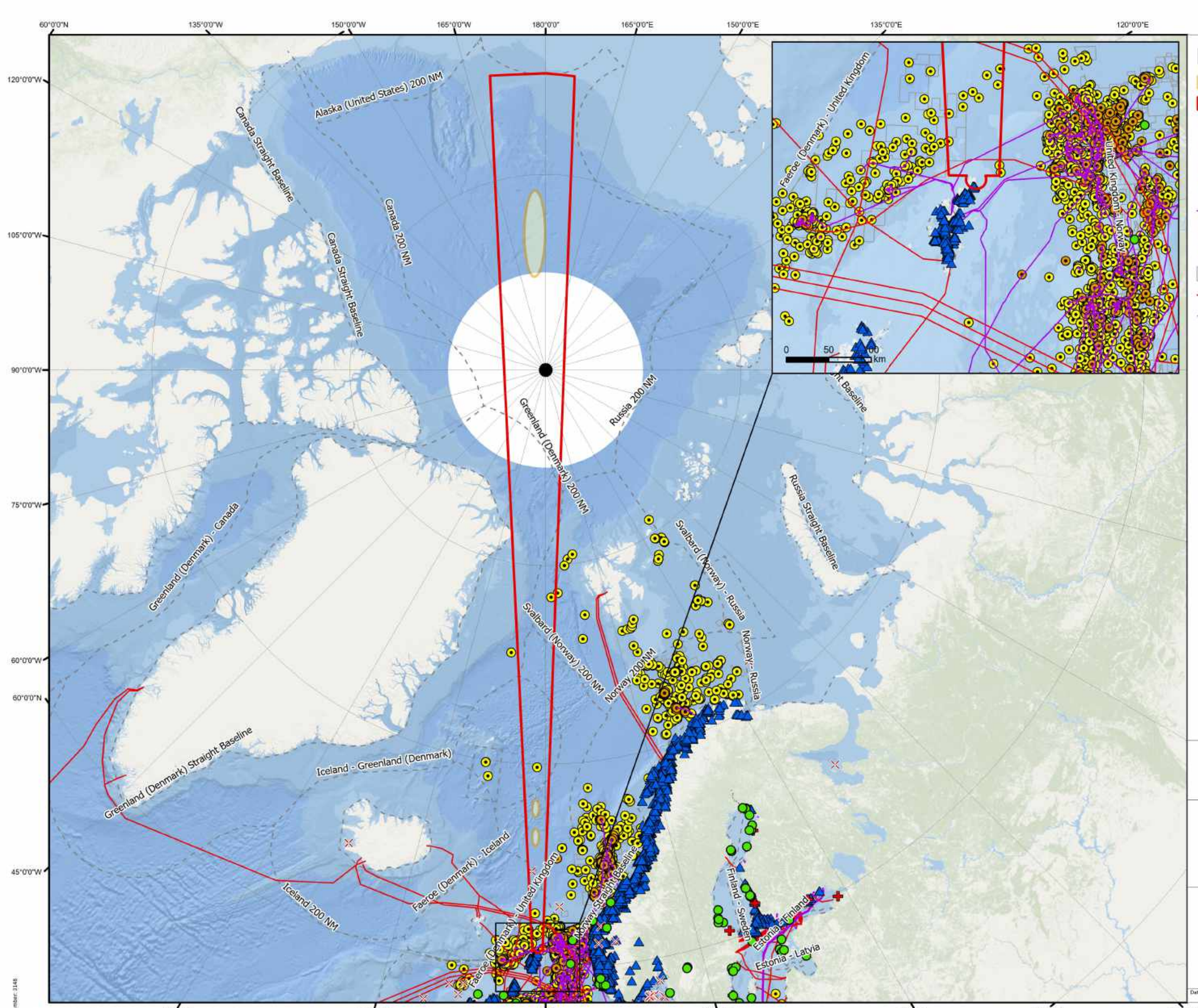
Marine Protected Areas - Environmental Zone of Influence

Date: 3/27/2024	Drawn by: AN	Checked by: IW	Version: Draft/V1

Project Number: 3148

Service Layer Credits: World Ocean Base: OceanWise, Esri, GEBCO, Garmin, NaturalVue
World Ocean Base: Esri, GEBCO, Garmin, NaturalVue

Chapter 10 Drawing 10.4 Other Marine Users



KEY

- Impact Zone
- Environmental Zone of Influence
- Wind Farms
- Waste Disposal sites
- Nuclear Power plants
- Aquaculture sites
- Pipelines
- Offshore Installations
- Boreholes
- Hydrocarbon licences
- Cables
- EEZ boundaries

N

0 520 1,040 km

Scale 1:20,000,000 @ A3

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Assessment of Environmental Effects

Drawing 10.4

Other Marine Users - Environmental Zone of Influence

Date:	Drawn by:	Checked by:	Version:
3/27/2024	AN	IW	Draft/V1

Project Number: 3148

Service Layer Credits: World Ocean Base: OceanWise, Esri, GEBCO, Garmin, NaturalVue
World Ocean Base: Esri, GEBCO, Garmin, NaturalVue

Chapter 10 Drawing 10.5 Current and Potential Use of Marine Environment

60°0'0"N 135°0'0"W 150°0'0"W 165°0'0"W 180°0'0" 165°0'0"E 150°0'0"E 135°0'0"E 120°0'0"E

120°0'0"W 105°0'0"W 90°0'0"W 75°0'0"W 60°0'0"W 45°0'0"W 30°0'0"W 15°0'0"W 0°0'0" 15°0'0"E 30°0'0"E 50°0'0"N 45°0'0"E

Alaska (United States) 200 NM
Canada Straight Baseline
Canada 200 NM
Canada Straight Baseline
Russia Straight Baseline
Russia 200 NM
Greenland (Denmark) 200 NM
Svalbard (Norway) 200 NM
Russia Straight Baseline
Norway 200 NM
Greenland (Denmark)
Greenland (Denmark) Straight Baseline
Iceland - Greenland (Denmark)
Faeroe (Denmark) - Iceland
Iceland 200 NM
Faeroe (Denmark) - United Kingdom
Norway Straight Baseline
United Kingdom - Norway
0 50 100 km

KEY

- Impact Zone
- Environmental Zone of Influence
- Open dredge spoil disposal site
- Disused dredge spoil disposal site
- Closed dredge spoil disposal site
- Tidal lease sites
- Tidal draft plan option
- Offshore Wind Energy draft plan options
- Wave draft plan options

Sand and Gravel resources

- Construction aggregate - Coarse
- Construction aggregate - Fine (Coarse Sand)
- Construction aggregate - Fine (Fine Sand)
- Fill aggregate
- EEZ boundaries

N

0 520 1,040 km

Scale 1:20,000,000 @ A3

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Assessment of Environmental Effects

Drawing 10.5

Current and Potential Use of Marine Environment - Environmental Zone of Influence

Date:	Drawn by:	Checked by:	Version:
3/27/2024	AN	IW	Draft/V1

Project Number: 3148

Service Layer Credits: World Ocean Base: OceanWise, Esri, Garmin, NaturalVue
World Ocean Base: OceanWise, Esri, GEBCO, Garmin, NaturalVue
World Ocean Base: Esri, GEBCO, Garmin, NaturalVue

Chapter 10 Drawing 10.6 Oil, Gas and Telecoms Infrastructure

Chapter 11 Drawing 11.1.1 Study Area

N

KEY

Proposed Project Boundary

Environmental Zone of Influence (5km, 10km, 15km)

0 1 2 5 km

Scale 1:125,000 @ A3

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Assessment of Environmental Effects

Drawing 11.1.1

Environmental Zone of Influence

Date:	Drawn by:	Checked by:	Version:
May 2022	HEPLA	PD	V1

Project Number: 3148

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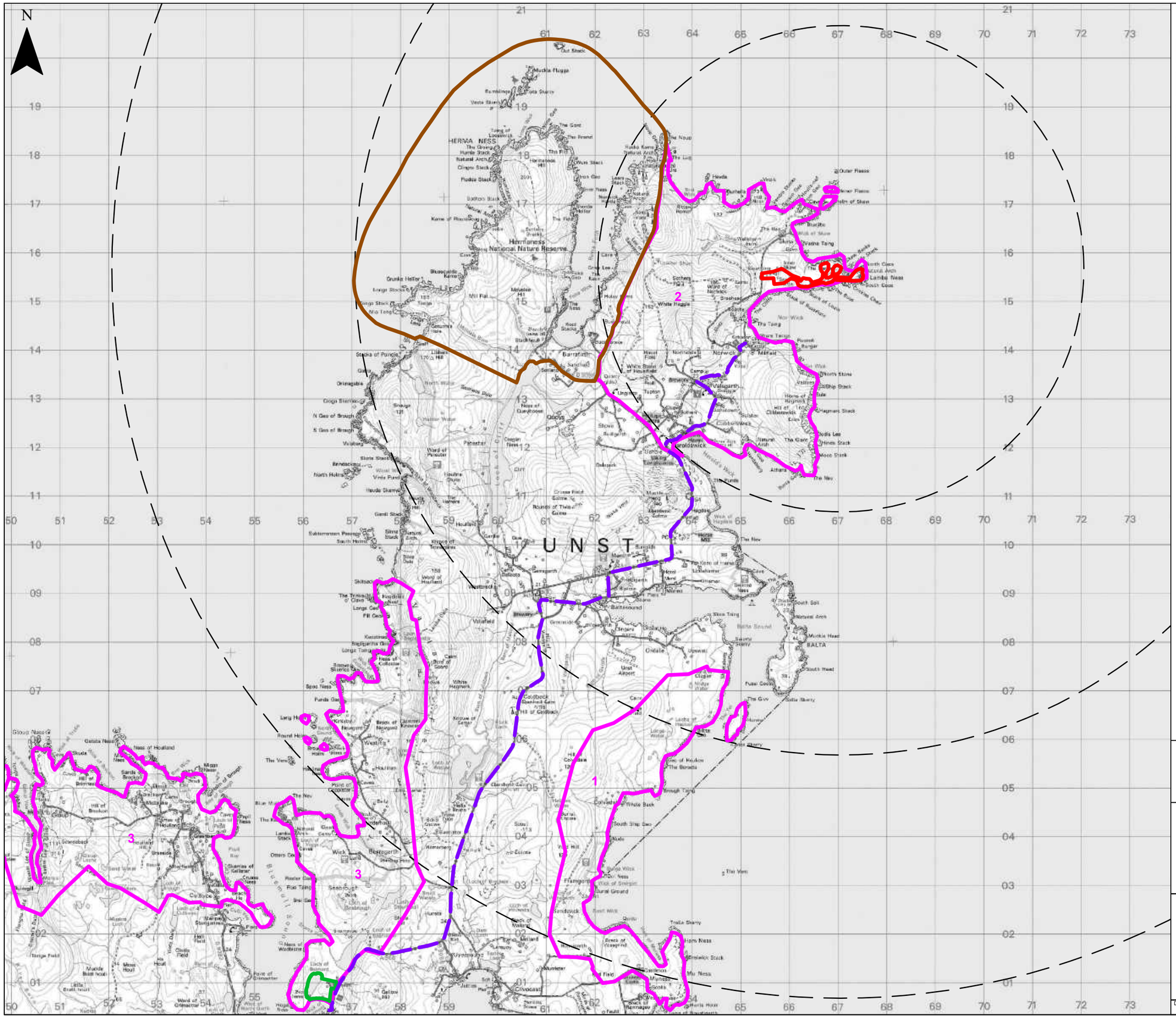
Chapter 11 Drawing 11.1.2 Landscape Designations



KEY

- Proposed Project Boundary
- Environmental Zone of Influence (5km, 10km, 15km)
- Gardens and Designed Landscapes (Belmont House)
- National Scenic Areas (Herma Ness)
- National Cycle Route 1
- Local Landscape Areas

1. Colvadale and Muness, Unst
2. Haroldswick and Skaw
3. Gloup Voe and Bluemull Sound

0 1 2 3 km

Scale 1:75,000 @ A3

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Skyrora
Assessment of Environmental Effects

Drawing 11.1.2
Landscape Designations Plan (and National Cycle Network Routes)

Date:	Drawn by:	Checked by:	Version:
May 2022	HEPLA	PD	V1

Project Number: 3148

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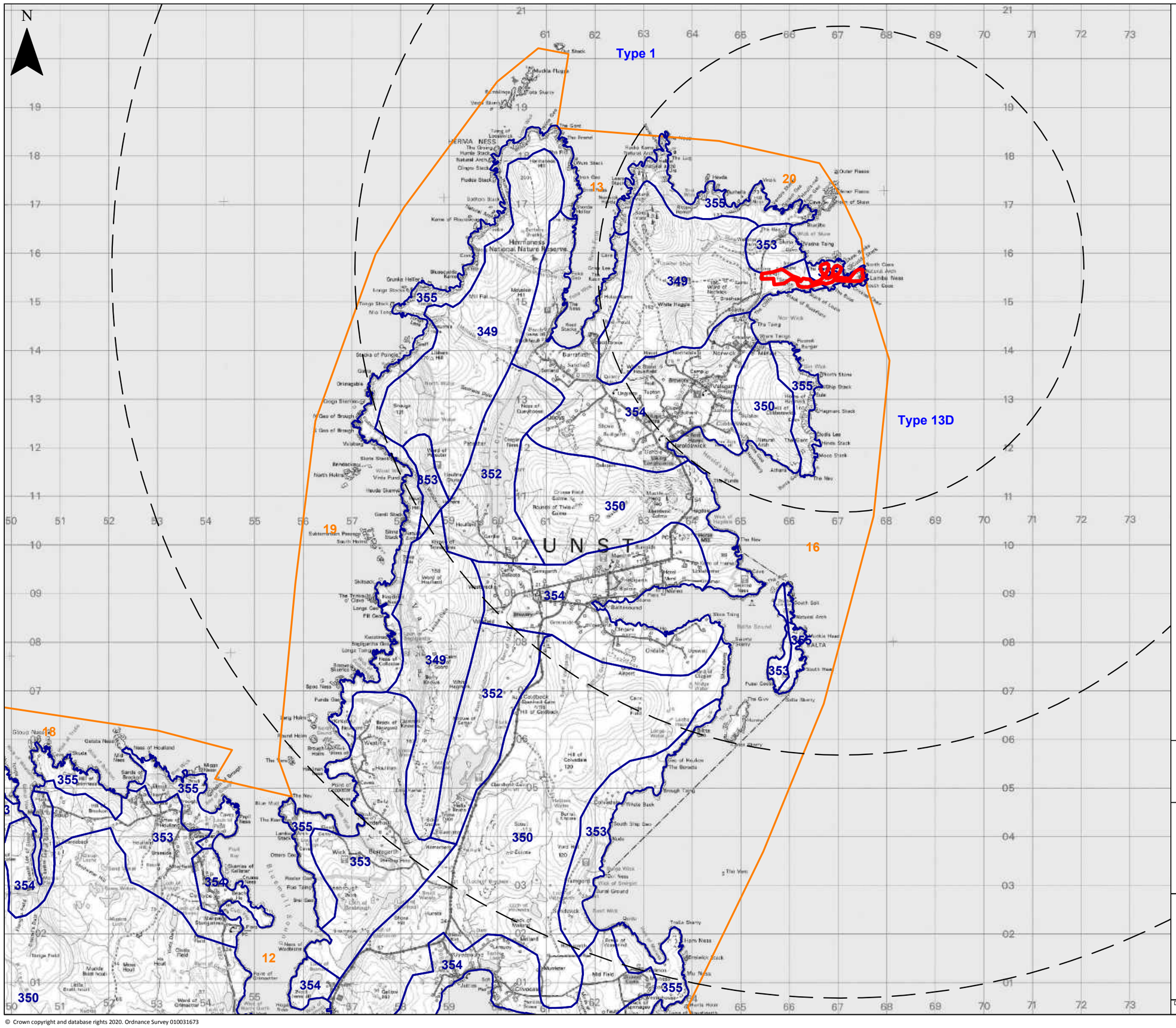
Chapter 11 Drawing 11.1.3 LCAs



KEY

Proposed Project Boundary

Environmental Zone of Influence
(5km, 10km, 15km)

Landscape Character Areas

349. Major Uplands
350. Peatland and Moorland
352. Inland Valleys
353. Farmed and Settled Lowlands and Coast
354. Farmed and Settled Voes and Sounds
355. Coastal Edge

Coastal Character Areas

12. Bluemull Sound
13. Burrafirth
16. East Unst
18. Gloup-Breckon
19. Hermaness
20. Skaw

Type — Seascape Character Areas

1. Remote High Cliffs
13D. Islands, Sounds and Voes

0 1 2 3 km

Scale 1:75,000 @ A3

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Assessment of Environmental Effects

Drawing 11.1.3

Landscape Character /Coastal / Seascape Character Areas

Date:	Drawn by:	Checked by:	Version:
May 2022	HEPLA	PD	V1

Project Number: 3148

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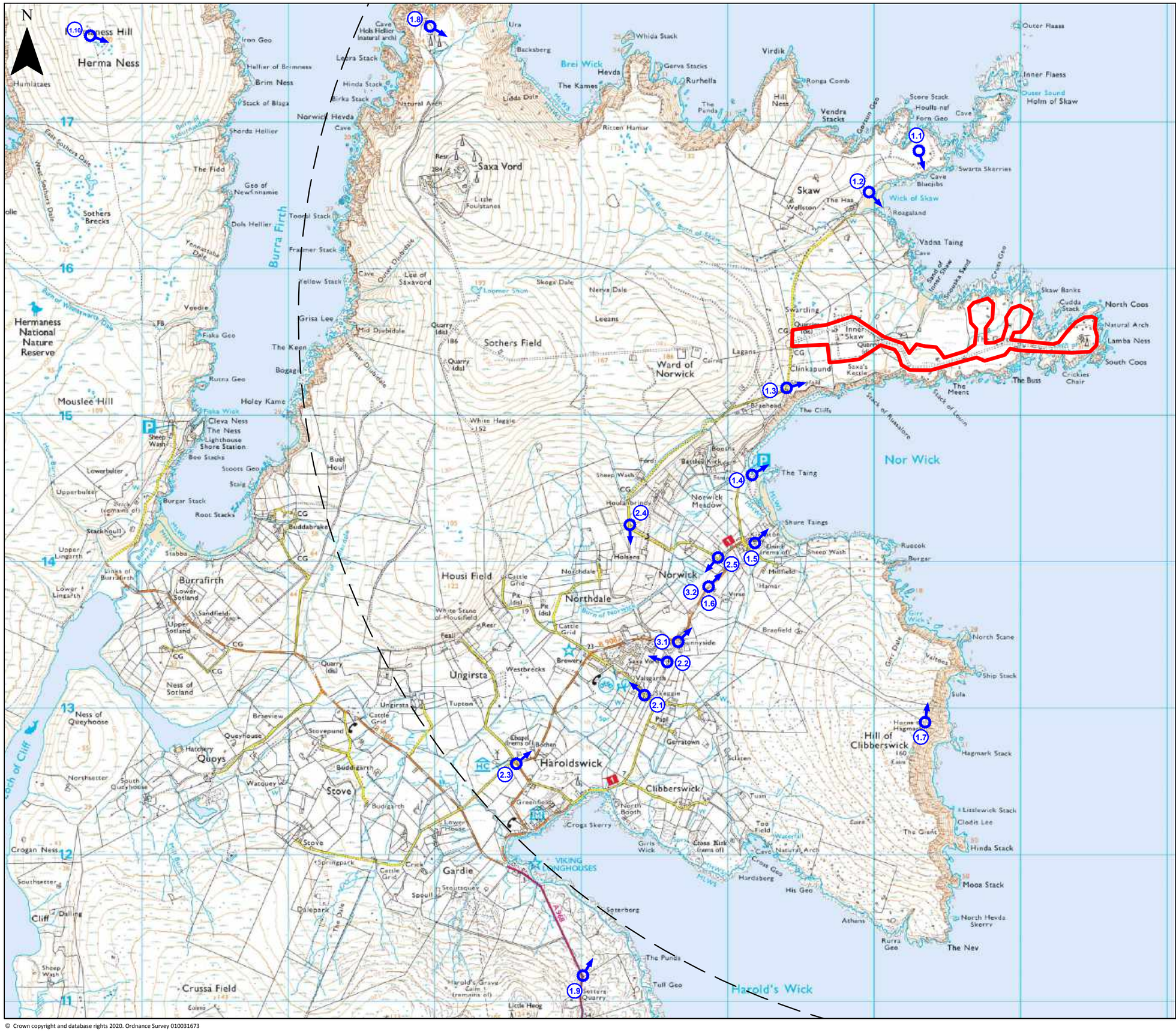
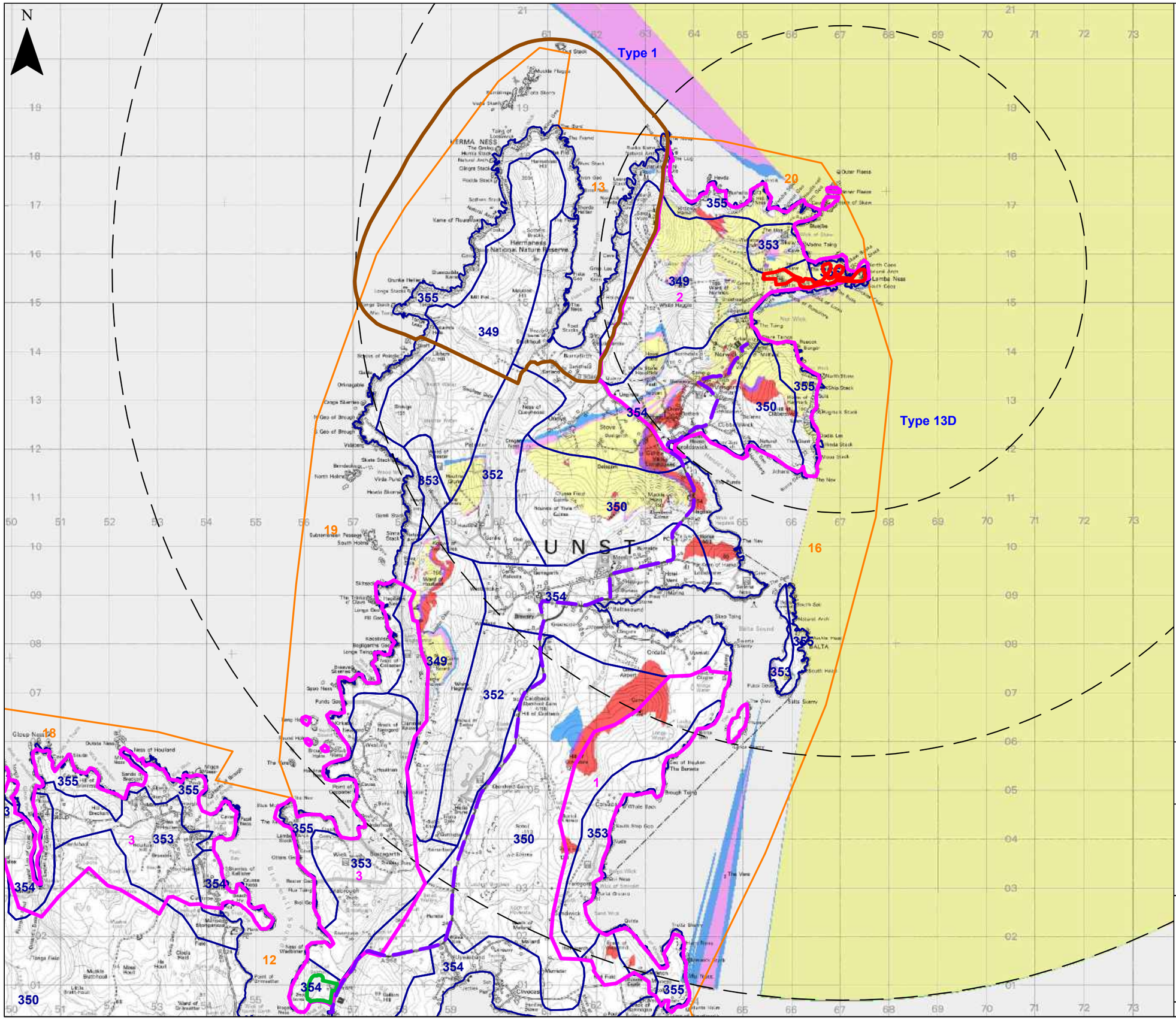
Chapter 11 Drawing 11.1.4 Viewpoint Location Plan


N
1.10
Herma Ness
Hermaness National Nature Reserve
Mouslee Hill
1.8
Saxa Vord
Resr
Norwick
Hevda
Brei Wick
The Kames
Whida Stack
Gerva Stacks
Rurhella
Virdik
Ronga Comb
Hill Ness
Vendra Stacks
Outer Flaess
Inner Flaess
Outer Sound
Holm of Skaw
Score Stack
Houlls-naf
Fern Geo
Cave
1.1
Swarta Skarries
Cave Bluejibs
1.2
Skaw
The Haa
Wick of Skaw
Roagaland
Vadna Taing
Cave
Burra Firth
Burn of Sodomadale
Burn of Sotherdale
East Sothers Dale
West Sothers Dale
Sothers Brecks
The Fidd
Geo of Newfinnamie
Shorda Hellier
Toorel Stack
Dols Hellier
Framer Stack
Yellow Stack
Cave
Outer Disibidale
Lee of Saxavord
Veedie
FB
Fiska Geo
Grisa Lee
Mid Disibidale
The Keen
Bogagir
Ruina Geo
Holey Kame
Fiska Wick
Cleva Ness
The Ness
Lighthouse
Shore Station
Boo Stacks
Stoots Geo
Scaig
Lowerbutter
Upperbutter
Burgar Stack
Root Stacks
Buddabrake
CG
Stackhoull
Upper Lingarth
Lower Lingarth
Stabba
Ruins of Burrafirth
Burrafirth
Lower Sotland
Upper Sotland
Sandfield
Ness of Sotland
Ness of Queyhoose
Queyhoose
Briseview
Hatchery
Quoys
Northsetter
South Queyhoose
Watquey
Stove
Crogan Ness
Southsetter
Cliff
Dalling
Sheep Wash
Crussa Field
Cairns
Sothers Field
Skoga Dale
Nerva Dale
Leeans
Loomer Shun
Quarry (dis)
Ward of Norwick
Cairns
Lagans
Swarling
Inner Skaw
Clinkapund
Saxa's Kettle
Braehead
The Cliffs
The Meent
The Buss
Crickies Chair
Skaw Banks
Cudda Stack
North Coos
Natural Arch
Lamba Ness
South Coos
Stack of Riunasiore
Stack of Leiorn
Nor Wick
1.3
1.4
The Taing
Norwick Meadow
Houlanbrindy
2.4
Holsens
Shure Taings
Ruscok
Burgar
Millfield
Hamar
Virse
1.5
2.5
3.2
1.6
Housi Field
Cattle Grid
Pit (dis)
Northdale
White Stone of Housifield
Reer
Feal
Burn of Norwick
Braefield
3.1
Sunnyside
2.2
Brewery
Westbrecks
Ungirsta
Tupton
Valsgarth
Skeggin
2.1
Papil
Gerratown
Sclaten
Haroldswick
2.3
Chapel (rems of)
Bochen
HC
Greenfield
Lower House
Croga Skerry
Clibberswick
North Booth
Tuan
Too Field
Waterfall
Cave
Natural Arch
Girls Wick
Cross Kirk (rems of)
Cross Geo
Hardaberg
His Geo
Athans
Rurra Geo
The Nev
Hill of Clibberswick
1.7
Hagmark Stack
North Scane
Valtoss
Ship Stack
Sula
Lisslewick Stack
Clodis Lee
The Grens
Hinda Stack
Mooa Stack
North Hevda Skerry
Gardie
VIKING LONGHOUSES
Spoull
Stroutsquoy
Dalepark
The Dale
Sloag
Setterborg
A968
The Punds
Tull Geo
Harold's Grave Cairn (remains of)
Little Heog
Setters Quarry
1.9
Harold's Wick
Burn of Sotherdale
Burn of Skaw
Burn of Norwick
Burn of Cliff
Hose Burn
Mill Burn
Burn of Stabba
Burn of Burrafirth
Burn of Newfinnamie
Burn of Sodomad

Chapter 11 Drawing 11.2.1a ZTV Launch



KEY

Proposed Project Boundary

Environmental Zone of Influence (5km, 10km, 15km)

Landscape Character Areas

349. Major Uplands
350. Peatland and Moorland
352. Inland Valleys
353. Farmed and Settled Lowlands and Coast
354. Farmed and Settled Voes and Sounds
355. Coastal Edge

Coastal Character Areas

12. Bluemull Sound
13. Burrafirth
16. East Unst
18. Gloup-Breckon
19. Hermaness
20. Skaw

Type Seascape Character Areas

1. Remote High Cliffs
13D. Islands, Sounds and Voes

Landscape Designations

Gardens and Designed Landscapes (Belmont House)

National Scenic Areas (Herma Ness)

National Cycle Route 1

Local Landscape Areas

1. Colvadale and Muness, Unst
2. Haroldswick and Skaw
3. Gloup Voe and Bluemull Sound

Visibility of Site

Visibility of baseline built form only

Visibility of lightning masts only

Combined visibility of baseline built form and lightning masts

Combined visibility of lightning masts and rocket launch sites

Combined visibility of baseline built form, lightning masts and rocket launch sites

NOTES: Calculated using Earth's curvature (radius 6360km) and atmospheric refraction coefficient of 0.075.

Terrain data is derived from OS Terrain 5 gridded height data.

ZTV calculation does not take into account any surface features such as trees and buildings.

Lightning mast height - 46m / Rocket height - 36m

ZTV view height - 2m

ZTV calculation resolution - 20m

0 1 2 3 km

Scale 1:75,000 @ A3

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Assessment of Environmental Effects

Drawing 11.2.1a

Zone of Theoretical Visibility: Launch Site Infrastructure including rockets and erected lightning masts

Date:	Drawn by:	Checked by:	Version:
May 2022	HEPLA	PD	V1

Project Number: 3148

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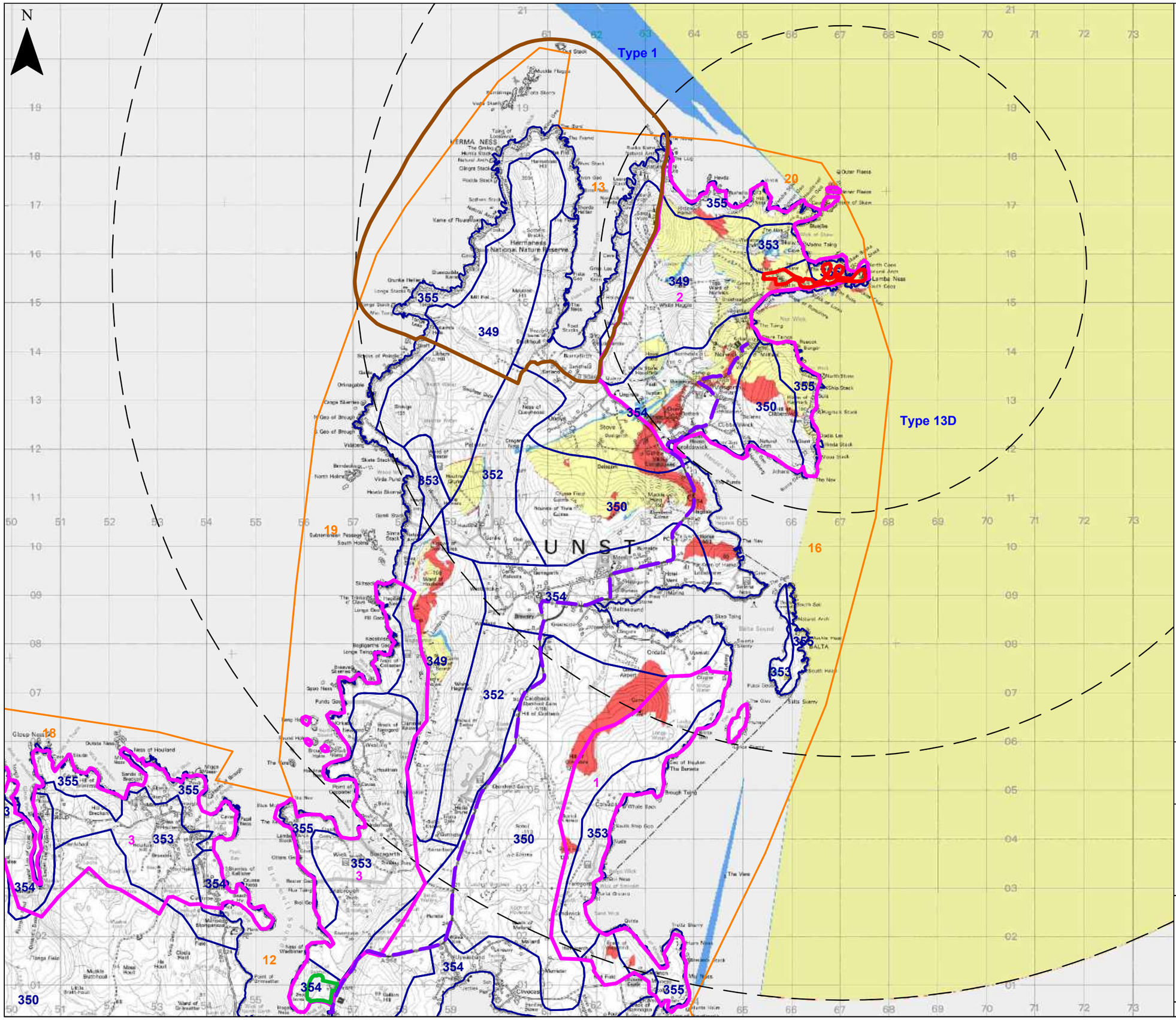
Chapter 11 Drawing 11.2.1b ZTV Masts



KEY

Proposed Project Boundary

Environmental Zone of Influence (5km, 10km, 15km)

Landscape Character Areas

349. Major Uplands
350. Peatland and Moorland
352. Inland Valleys
353. Farmed and Settled Lowlands and Coast
354. Farmed and Settled Voes and Sounds
355. Coastal Edge

Coastal Character Areas

12. Bluemull Sound
13. Burrafirth
16. East Unst
18. Gloup-Breckon
19. Hermaness
20. Skaw

Type Seascape Character Areas

1. Remote High Cliffs
13D. Islands, Sounds and Voes

Landscape Designations

Gardens and Designed Landscapes (Belmont House)

National Scenic Areas (Herma Ness)

National Cycle Route 1

Local Landscape Areas

1. Colvadale and Muness, Unst
2. Haroldswick and Skaw
3. Gloup Voe and Bluemull Sound

Visibility of Site

Visibility of baseline built form

Visibility of lightning masts (retracted)

Combined visibility of baseline built form and lightning masts (retracted)

NOTES: Calculated using Earth's curvature (radius 6360km) and atmospheric refraction coefficient of 0.075.

Terrain data is derived from OS Terrain 5 gridded height data.

ZTV calculation does not take into account any surface features such as trees and buildings.

Lightning mast height (retracted) - 25m

ZTV view height - 2m

ZTV calculation resolution - 20m

0 1 2 3 km

Scale 1:75,000 @ A3

SKYRORA

Skyrora

Assessment of Environmental Effects

Drawing 11.2.1b

Zone of Theoretical Visibility: Launch Site Infrastructure (without rockets / lightning masts retracted)

Date:	Drawn by:	Checked by:	Version:
May 2022	HEPLA	PD	V1

Project Number: 3148

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Chapter 11 Drawing 11.3.1.1 VP1 – 1 Montage



Viewpoint 1.1 - Existing View (90°)



Viewpoint 1.1 - Predicted Photomontage View (90°)

Viewpoint 1.1 Information:
Bluejibs above the Wick of Skaw

Grid Reference:	466309, 1216806
Bearing to Site:	140°
Distance to Site:	1.1km
Camera Make:	Canon EOS 5D Mk II
Camera Lens:	50mm
Date:	27/07/2020
Time:	13:14

Viewing Instructions:
View flat at a comfortable arms length

SKYRORA

Skyrora
Assessment of Environmental Effects

Drawing 11.3.1.1
Viewpoint 1.1
Bluejibs above the Wick of Skaw

Date:	Drawn by:	Checked by:	Version:
May 2022	HEPLA	PD	V1

Project Number: 5168

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Chapter 11 Drawing 11.3.1.2 VP1 – 2 Montage



Viewpoint 1.2 - Existing View (90°)



Viewpoint 1.2 - Predicted Photomontage View (90°)

Viewpoint 1.2 Information:
The Haa, Wick of Skaw

Grid Reference:	465968, 1216524
Bearing to Site:	125°
Distance to Site:	860m
Camera Make:	Canon EOS 5D Mk II
Camera Lens:	50mm
Date:	27/07/2020
Time:	12:53

Viewing Instructions:
View flat at a comfortable arms length

SKYRORA

Skyrora
Assessment of Environmental Effects

Drawing 11.3.1.2
Viewpoint 1.2
The Haa, Wick of Skaw

Date:	Drawn by:	Checked by:	Version:
May 2022	HEPLA	PD	V1

Print Number: 5168

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Chapter 11 Drawing 11.3.1.3 VP1 – 3 Montage



Viewpoint 1.3 - Existing View (90°)



Viewpoint 1.3 - Predicted Photomontage View (90°)

Viewpoint 1.3 Information:
The Garths, Lamba Ness

Grid Reference:	465405, 1215187
Bearing to Site:	80°
Distance to Site:	320m
Camera Make:	Canon EOS 5D Mk II
Camera Lens:	50mm
Date:	27/07/2020
Time:	11:45

Viewing Instructions:
View flat at a comfortable arms length

SKYRORA

Skyrora
Assessment of Environmental Effects

Drawing 11.3.1.3
Viewpoint 1.3
The Garths, Lamba Ness

Date:	Drawn by:	Checked by:	Version:
May 2022	HEPLA	PD	V1

Project Number: 5168

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Chapter 11 Drawing 11.3.1.4 VP1 – 4 Montage



Viewpoint 1.4 - Existing View (90°)



Viewpoint 1.4 - Predicted Photomontage View (90°)

Viewpoint 1.4 Information:
Car Park at the Taing, Norwick

Grid Reference:	465172, 121459
Bearing to Site:	60°
Distance to Site:	800m
Camera Make:	Canon EOS 5D Mk II
Camera Lens:	50mm
Date:	27/07/2020
Time:	11:15

Viewing Instructions:
View flat at a comfortable arms length

SKYRORA

Skyrora
Assessment of Environmental Effects

Drawing 11.3.1.4
Viewpoint 1.4
Car Park at the Taing, Norwick

Date:	Drawn by:	Checked by:	Version:
May 2022	HEPLA	PD	V1

Project Number: 5148

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Chapter 11 Drawing 11.3.1.5 VP1 – 5 Montage



Viewpoint 1.5 - Existing View (90°)



Viewpoint 1.5 - Predicted Photowireframe View (90°)

Viewpoint 1.5 Information:
The Cemetery, Norwick

Grid Reference:	465188, 1214128
Bearing to Site:	45°
Distance to Site:	1.2km
Camera Make:	Canon EOS 5D Mk II
Camera Lens:	50mm
Date:	27/07/2020
Time:	10:56

Viewing Instructions:
View flat at a comfortable arms length

SKYRORA

Skyrora
Assessment of Environmental Effects

Drawing 11.3.1.5
Viewpoint 1.5
The Cemetery, Norwick

Date:	Drawn by:	Checked by:	Version:
May 2022	HEPLA	PD	V1

Project Number: 5168

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Chapter 11 Drawing 11.3.1.6 VP1 – 6 Montage





Viewpoint 1.6 Information:
B9087 Norwick

Grid Reference:	464872, 1213830
Bearing to Site:	45°
Distance to Site:	1.6km
Camera Make:	Canon EOS 5D Mk II
Camera Lens:	50mm
Date:	27/07/2020
Time:	10:29

Viewing Instructions:
View flat at a comfortable arms length

SKYRORA

Skyrora
Assessment of Environmental Effects

Drawing 11.3.1.6

Viewpoint 1.6
B9087 Norwick

Date:	Drawn by:	Checked by:	Version:
May 2022	HEPLA	PD	V1

Project Number: 5148

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Chapter 11 Drawing 11.3.1.7 VP1 – 7 Montage



Viewpoint 1.7 - Existing View (90°)



Viewpoint 1.7 - Predicted Photomontage View (90°)

Viewpoint 1.7 Information:
Hill of Clibberswick

Grid Reference:	466351, 1212904
Bearing to Site:	10°
Distance to Site:	2.4km
Camera Make:	Canon EOS 5D Mk II
Camera Lens:	50mm
Date:	27/07/2020
Time:	15:22

Viewing Instructions:
View flat at a comfortable arms length

SKYRORA

Skyrora
Assessment of Environmental Effects

Drawing 11.3.1.7
Viewpoint 1.7
Hill of Clibberswick

Date:	Drawn by:	Checked by:	Version:
May 2022	HEPLA	PD	V1

Project Number: 5168

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Chapter 11 Drawing 11.3.1.8 VP1 – 8 Montage



Viewpoint 1.8 - Existing View (90°)



Viewpoint 1.8 - Predicted Photomontage View (90°)

Viewpoint 1.8 Information:
Headland to the north of Saxa Vord radar station

Grid Reference:	462970, 1217656
Bearing to Site:	110°
Distance to Site:	3.3km
Camera Make:	Canon EOS 5D Mk II
Camera Lens:	50mm
Date:	03/08/2020
Time:	19:09

Viewing Instructions:
View flat at a comfortable arms length

SKYRORA

Skyrora
Assessment of Environmental Effects

Drawing 11.3.1.8

Viewpoint 1.8 - Headland to the north of Saxa Vord radar station

Date:	Drawn by:	Checked by:	Version:
May 2022	HEPLA	PD	V1

Project Number: 5168

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Chapter 11 Drawing 11.3.1.9 VP1 – 9 Montage





Viewpoint 1.9 Information:
Lay by on A968 above Harold's Wick

Grid Reference:	464014, 1211174
Bearing to Site:	15°
Distance to Site:	4.4km
Camera Make:	Canon EOS 5D Mk II
Camera Lens:	50mm
Date:	13/10/2020
Time:	10:50

Viewing Instructions:
View flat at a comfortable arms length

SKYRORA

Skyrora
Assessment of Environmental Effects

Drawing 11.3.1.9
Viewpoint 1.9
Lay by on A968 above Harold's Wick

Date:	Drawn by:	Checked by:	Version:
May 2022	HEPLA	PD	V1

Project Number: 5168

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Chapter 11 Drawing 11.3.1.10 VP1 – 10 Montage



Viewpoint 1.10 - Existing View (90°)



Viewpoint 1.10 - Predicted Photowireframe View (90°)

Viewpoint 1.10 Information:
Hermaness Hill

Grid Reference:	460648, 1217592
Bearing to Site:	105°
Distance to Site:	5.2km
Camera Make:	Canon EOS 5D Mk II
Camera Lens:	50mm
Date:	01/08/2020
Time:	18:53

Viewing Instructions:
View flat at a comfortable arms length

SKYRORA

Skyrora
Assessment of Environmental Effects

Drawing 11.3.1.10

Viewpoint 1.10
Hermaness Hill

Date:	Drawn by:	Checked by:	Version:
May 2022	HEPLA	PD	V1

Project Number: 5168

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Chapter 11 Drawing 11.4.1 NT1 Montage



Viewpoint 3.1 - Existing View (90°)



Viewpoint 3.1 - Predicted Photomontage View (90°)

Viewpoint 3.1 Information:
Skulhus - Dusk

Grid Reference:	464664, 1213453
Bearing to Site:	25°
Distance to Site:	2.0km
Camera Make:	Canon EOS 5D Mk II
Camera Lens:	50mm
Date:	03/08/2020
Time:	23:10

Viewing Instructions:
View flat at a comfortable arms length

SKYRORA

Skyrora
Assessment of Environmental Effects

Drawing 11.4.1

Viewpoint 3.1
Skulhus - Dusk

Date:	Drawn by:	Checked by:	Version:
May 2022	HEPLA	PD	V1

Project Number: 5148

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Chapter 11 Drawing 11.4.2 NT2 Montage



Viewpoint 3.2 - Existing View (90°)



Viewpoint 3.2 - Predicted Photomontage View (90°)

Viewpoint 3.2 Information:
Virse - Dusk

Grid Reference:	464872, 1213830
Bearing to Site:	45°
Distance to Site:	1.6km
Camera Make:	Canon EOS 5D Mk II
Camera Lens:	50mm
Date:	03/08/2020
Time:	22:40

Viewing Instructions:
View flat at a comfortable arms length

SKYRORA

Skyrora
Assessment of Environmental Effects

Drawing 11.4.2

Viewpoint 3.2
Virse - Dusk

Date:	Drawn by:	Checked by:	Version:
May 2022	HEPLA	PD	V1

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Chapter 12 -

Chapter 13 -

Volume IV AEE Technical Appendices

Appendix 1.1 CVs

CURRICULUM VITAE **GRAEME BLACKETT**

QUALIFICATIONS: BA Hons Economics, University of Strathclyde
Member Institute for Economic Development
Member Economic Development Association Scotland

CAREER SUMMARY:

2002-	Director, BiGGAR Economics
2000-2001	Senior Consultant, Deloitte
1998-1999	Consultant, Deloitte
1993-1998	Consultant, Segal Quince Wicksteed Limited
1991-1992	Parliamentary Researcher and Freelance Consultant

Graeme Blackett co-founded BiGGAR Economics in 2002. He was previously manager of Deloitte's economic consulting practice in Scotland and Northern Ireland and a consultant with SQW Limited. Graeme is an economist with over 25 years of experience in economic development. Graeme has also been a member of the Advisory Board of the leading think tank Reform Scotland and economic advisor to the Sustainable Growth Commission, established by the First Minister of Scotland to advise on improving Scotland's economic performance.

Selected Project Experience

- study of the potential socio-economic benefits to Iceland of developing an onshore wind energy sector and a review of international evidence on any implications for the tourism, on behalf of Landsvirkjun;
- assessment of the socio-economic impacts of the proposed wind farm on the island of Yell, on behalf of Element Power and Energy Isles;
- socio-economic assessment of the Seagreen Offshore wind farm development in the outer Firth of Forth;
- expert witness on socio-economic and tourism issues at the Scottish Land Court hearing into the proposed Viking Energy wind farm on Shetland;
- baseline economic and exchequer impacts of the North Sea oil and gas sector and scenario analysis to assess potential future economic and exchequer impacts as part of an assessment of the case for public sector support for R&D for the UK oil and gas sector;
- economic impact assessment of the University of the Highlands and Islands and its academic partners, including Shetland College and NAFC Marine Centre;
- economic impact assessment of the European research-intensive universities, based on analysis of the 23 members of the League of European Research Universities (LERU);
- assessment of the contribution to the economy of France made by the 18 members of the association of French research-intensive universities (CURIF);
- assessment of the economic contribution of the Swiss Federal Institutes of Technology (ETH) Domain institutions;

- cost-benefit analysis model and report for a Major Project Application by the University to find funding for the Scottish Centre for Regenerative Medicine;
- economic impact assessment of Aberdeen Innovation Hub, which aims to facilitate innovation and collaboration in the three key sectors: life sciences, food and drink and oil and gas;
- socio-economic impact assessment of a major hospital investment programme in Edinburgh for the National Health Service in Lothian;
- modelling future trends in the Scottish life sciences cluster for Scottish Enterprise, based on analysis of global trends and Scottish competitiveness in key sub-sectors;
- assessment of the economic impact of the Malthus Uniteam workers accommodation facility in Shetland;
- economic impact assessment, followed by and socio-economic assessment, of the proposed Nigg Bay development at Aberdeen Harbour;
- economic impact assessment of the proposed Carters yard student accommodation development in Stirling;
- economic appraisal, stress testing and business planning for the national Innovation Centre for Ageing in Newcastle;
- economic impact assessment for the proposed Edinburgh Park South development in the west of Edinburgh
- economic appraisal and impact assessment of the proposed mixed-use development St Andrews West in Fife;
- economic impact study of Peterborough United Football Club, including its current impact on the town and region and potential future economic impacts;
- economic and well-being impact assessment for Buccleuch, covering its four estates and Buccleuch Property;
- economic impact assessment of Scottish Government consultation on proposals to introduce a charge on single use plastic bags.

CURRICULUM VITAE

Dr Peter J Cosgrove

Name: Dr Peter J Cosgrove, FCIEEM
Date of Birth: 19 June 1969
Profession: Environmental Scientist
Specialisation: Ecologist, Fellow of the Chartered Institute of Ecology and Environmental Management (FCIEEM)

Recent Career Summary:

2011–present day	Director of Ecology with Alba Ecology.
2009-2011	Principal Ecologist with Alba Ecology.
2005–2009	Principal Ecologist with EnviroCentre.
1998-2009	Freshwater Ecologist, Independent Ecological Consultant.
2004-2005	Ecology and Landscape Advisor, Cairngorms National Park Authority, UK.
1998-2003	Cairngorms Biodiversity Officer, Cairngorms Partnership, Cairngorms National Park Authority, UK.
1998	Wildlife Crime Investigations Officer, RSPB.
1995-1998	Ecological Research Fellow, Aberdeen University.

Education:

1991-1995	PhD. Zoology, University of Aberdeen, UK.
1987-1991	BSc. (Hons) 2[1] Environmental Studies, University of Hertfordshire, UK.

Profile:

Peter is a highly skilled ecologist with over twenty years experience in wildlife and habitat research, land-use management, conservation planning and policy development and environmental assessments. He has managed many large projects and budgets from conception through to completion and has a strong proven track record of delivery in both the public and private sector, producing over 150 peer-reviewed scientific papers, commissioned reports and books (Appendix 1). In particular, Peter specialises in bringing consensus to difficult conservation issues through innovative approaches to partnership working, negotiation and conflict resolution. In the last decade Peter has focussed his efforts on freshwater pearl mussels, invasive species, species reintroduction, environmental impact assessment, ecological clerks of work, forestry management and renewable energy developments.

Peter's work has concentrated primarily in six areas: (1) Peter co-ordinated the development and implementation of over 100 action plans with partners, for a quarter of the UK's most threatened habitats and species; (2) Peter provided advice and guidance on conservation, planning and development control issues in designated and non-designated areas and has a thorough working knowledge of national and international designation issues, especially Natura 2000 sites and carrying out Appropriate Assessments; (3) Delivery of ecological elements of EIAs, the production of Environmental Statements, Ecological Clerks of Work and negotiation with statutory authorities and private sector; (4) Peter has specialised in invasive species issues in Ireland, the UK and internationally; (5) Communication of often complex biodiversity/conservation information and messages effectively to different audiences; and (6) Peter is recognised as an international authority on the survey and conservation of the endangered freshwater pearl mussel and its aquatic habitat.

Relevant Experience:

- *Freshwater pearl mussel advisor*

Over 100 commissioned pieces of work for the public and private sector on aquatic casework issues for development control, surveying and conservation management of this endangered species. During the last decade this has included Site Condition Monitoring for all of Scotland's SACs and SSSIs where *M.*

margaritifera is a feature. Recently advisory work has included developing, testing and publishing standard deepwater survey methods for the species, advising on the removal of a fish counter on an SAC and a feasibility study for improving fish passage on another two pearl mussel SAC rivers and producing leaflet and on-line guidance on freshwater pearl mussels for developers operating in rivers in Scotland. Since 2000, Peter has been on special 'call-off' contract for the provision of expert advice on freshwater pearl mussels to the Scottish Natural Heritage and Forestry and Land Scotland and has recently concentrated on developing and implementing a project entitled the '*Restoration of freshwater pearl mussels in selected Scottish rivers*'. During 2013-2015 Peter completed SNH's 2nd national freshwater pearl mussel survey across Scotland and has recently published the findings. In 2020, Peter wrote CIEEM's COVID-19 freshwater pearl mussel survey guidance.

- *Invasive species*

Provision of expert advice leading to the development and implementation of this best-practice cross-border invasive species programme in Northern Ireland and the Republic of Ireland.

- *Ecological project co-ordination*

Project co-ordination and logistical management of large scale development projects, including the management of Ecological Clerks of Work teams across Scotland. For example, completed the delivery of biodiversity/habitat management plans for two large developments near Glasgow. The first for a 900 housing unit application and the second for a new road. The work involved updating old ES's and negotiating detailed and costed timetabled action plans for delivery of the mitigation measures outlined in the ES and also the concerns raised by the regulators (primarily local authorities and the statutory nature conservation agency). In 2012, Peter successfully completed delivery of ECoW support for the Trump Golf Development on Menie Estate, Aberdeenshire. Peter is currently providing ECoW support on several large scale projects in northern Scotland, ranging from wind farms, housing developments, a whisky distillery and bridge repair works.

- *Biodiversity Action Plan work, habitats and species*

A thorough working knowledge of most of Scotland's terrestrial and aquatic protected species and habitats, the experts who work on them and the UK BAP process. Development of standardised ecological survey methodologies and conflict resolution strategies for 'problematical' high-profile species. Development of project briefs, securing funding, management and implementation of many practical biodiversity projects in the north of Scotland. In 2020 Peter co-authored, with Alba Ecology a feasibility study for reintroducing cranes into the Cairngorms National Park.

- *Provision of expert advice on national and European conservation designations*

Provision of expert advice to competent authorities (e.g. Cairngorms National Park Authority, The Crown Estate, Irish Sea Fisheries Board and SNH) on conservation designation issues in relation development control. Peter has completed ca. 50 Appropriate Assessments for competent authorities. Peter has also provided expert witness testimony at Public Local Inquiries in Scotland (e.g. Achany Wind Farm, Caplich Wind Farm, Coul Links Golf Course).

- *Delivery of ecological elements of renewable energy EIA and ES*

In the last decade Peter has successfully completed the delivery of ten large onshore wind farm ES's (range in size from 36-103 turbines) and many small-medium sized wind farms.

Examples of recent commissioned work:

- Principal ecological/ornithological advisor on 2 on-shore wind farm, Peel Energy.
- Principal ecological/ornithological advisor on 3 on-shore wind farm, ABO Wind.
- Principal ecological advisor on-shore wind farm, WKN AG.
- Principal ecological advisor on 5 on-shore wind farms, SSE Renewables.
- Freshwater pearl mussel guidance for numerous clients operating in and around rivers.
- Site Condition Monitoring for all Scottish freshwater pearl mussel SACs, SNH and led surveys of all of Scotland's known pearl mussel rivers as part of the SNH 2nd national survey for the species.

- Developed, co-ordinated and implemented the first successful Scottish reintroduction for the globally threatened freshwater pearl mussel, SNH.
- Co-ordination and production of 44 Appropriate Assessments for aquaculture operations in Scottish Natura 2000 sites, Crown Estate.
- Development of Irish Screening Protocol for Aquaculture operations in Natura 2000 sites, Irish Sea Fisheries Board.
- Ecological Clerk of Works co-ordinator for Menie Estate, Trump International Golf Links Scotland.
- Expert ornithological witness, on-shore windfarm, N Scotland, Scottish and Southern Energy.
- Ecological advisor and ECoW co-ordinator for new road, Kirkintilloch Initiative.
- Project manager writing and reviewing the Highland Biodiversity Action Plan, Highland Council.
- As Biodiversity Officer and Ecology and Landscape Advisor in the Cairngorms National Park, provided advice and guidance on conservation and casework issues to the Cairngorms National Park Board as well as writing policies for the development of the National Park Plan, the Local Plan and writing and producing the Cairngorms Biodiversity Planning Guidance Note.
- Co-ordinated the production, development and implementation of 26 Habitat and 100 Species Action Plans in the Cairngorms on behalf of stakeholder and partner organisations. This covered collaborative biodiversity work on a quarter of the UK's most threatened species.
- Developed, co-ordinated and contributed to seven projects on non-native species: (1) Strategic water vole and American Mink plan for Cairngorms, (2) Developed and implemented Cairngorms non-native fish programme, (3) Investigated impact of non-native Mandarin ducks on native Goldeneyes in Scotland, (4) Seabird conservation and rat eradication, Eynhallow Island, Orkney, (5) Research into non-native *Ranunculus* on freshwater pearl mussels and salmon, (6) Invasive Species in Ireland, (7) UK Overseas Territories invasive species prevention.

Other qualifications:

Full, clean driving licence (Lantra 4 wheel-drive off-road trained). Fully licensed freshwater pearl mussel surveyor. Construction Skills Certification Scheme/ROLO H&S Trained: Professionally Qualified Person (Reg No: 13290751; Expires: April 2025). Fellow of Chartered Institute of Ecology and Environmental Management. Winner of the RSPB's 2014 Nature of Scotland Species Champion Award. Winner of the 2018 Neil Findlay Trophy, Scottish Forestry sectors awards. At the 2018 Chartered Institute of Ecology and Environmental Management (CIEEM) Awards, Peter and Alba Ecology were Highly Commended in the Best Practice Award for Knowledge Sharing.

Computer skills:

Peter is a skilled user of PC desktop systems; using standard packages such as Windows Excel, Word, Powerpoint etc. Peter is proficient in desktop publishing and has edited and published numerous bulletins, newsletters, reports and press releases.

Media and presentation skills:

Peter is highly experienced with all forms of contemporary media, having appeared on dozens of TV and radio programmes, as well as broadsheet and blog media. Peter is a well respected public speaker and lectures in Great Britain, Ireland and internationally on a variety of conservation topics.

Personal interests and hobbies:

Hill walking and camping, ornithology, fishing, cycling, cricket, football, public speaking, wildlife guiding.

References available on request

Appendix 1: **SCIENTIFIC WRITING**

PEER REVIEWED SCIENTIFIC PUBLICATIONS:

- **Cosgrove, P.** 2019. Black Redstart breeding in the Cairngorms. Scottish Birds 39:3-7.

- **Cosgrove, P.**, Kortland, K., Shields, D., Potter, R., Murray, J. and Cosgrove, C. 2017. Response of incubating golden and white-tailed eagles to forest road traffic: results of a pilot study. Scottish Birds 37: 14-25.

- **Cosgrove, P.,** McInnes, N., Dolby, S., Gunn, D., Shields, D., Cosgrove, C. and Kortland, K. 2017. Forest management and freshwater pearl mussels: a practitioners' perspective from the north of Scotland. Scottish Forestry 71: 14-21.

- Massey, K., **Cosgrove, P.**, Massey, F., Jackson, D. and Chapman, M. 2016. Habitat characteristics of breeding Eurasian Whimbrel *Numenius phaeopus* on Mainland Shetland, Scotland, UK. Bird Study 63: 500-508.

- **Cosgrove, P**., Watt, J., Hastie, L., Sime, I., Shields, D., Cosgrove, C., Brown, L. Isherwood, I. and Bao, M. 2016. The status of the freshwater pearl mussel *Margaritifera margaritifera* (L.) in Scotland: extent of change since 1990s, threats and management implications. Biodiversity and Conservation 25: 2093-2112.

- **Cosgrove, P.** 2016. Do adult Golden Eagles teach their offspring to hunt? Scottish Birds 36:10-11.

- **Cosgrove, P.,** Shields, D., Cosgrove, C., Farquhar, J., Jarrett, D., Jancke, S., Mitchell, A. and R Moggach. 2014. *Population size, structure and distribution of an unexploited freshwater pearl mussel* Margaritifera margaritifera (L.) *population in Scotland*. Journal of Conchology 41: 1-12.

- **Cosgrove, P.**, Doyle, P., Cosgrove, R., Goff, R., Veen, J. and Manneh, L. 2013. *Tanji River Bird Reserve, The Gambia – a globally important breeding site for Royal Tern* Thalasseus maximus. Bulletin of the African Bird Club 1: 27-30.

- **Cosgrove, P.**, Hastie, L, Watt, J., Sime, I. and Boon, P. 2012. *Scotland's freshwater pearl mussels: the challenge of climate change*. In: River Conservation and Management. Wiley-Blackwell.

- **Cosgrove, P.**, Hastie, L. and Sime, I. 2012. Wildlife Crime and Scottish Freshwater Pearl Mussels. British Wildlife 24: 10-13.

- Jahn, O., **Cosgrove, P.**, Cosgrove, C., Muses Cevallos, T. And Santander Garcia, T. 2010. *First record of Brown Pelican* Pelecanus occidentalis *from the Ecuadorian Highlands*. Cotinga 32: 108.

- **Cosgrove, P.** 2008. *Grenada Dove* Leptotila wellsi *response to non-native ground predators.* Cotinga 30: 72-73.

- Laughton, R., **Cosgrove, P.J.**, Hastie, L.C. and Sime, I. 2008. *Effects of aquatic weed removal on freshwater pearl mussels and juvenile salmonids in the River Spey, Scotland*. Aquatic Conservation: Freshwater and Marine Ecosystems 18: 44-54.

- **Cosgrove, P.**, Hastie, L. and Sime, I. 2007. *Recorded natural predation of freshwater pearl mussels* M. margaritifera (L.) *in Scotland.* Journal of Conchology 39: 469-472.

- **Cosgrove, P.J.** and Harvey, P.V. 2005. *The rediscovery of freshwater pearl mussels* Margaritifera margaritifera (L.) *in Shetland*. Shetland Naturalist 2:2 pp 57-64.

- **Cosgrove, P.** and Harvey, P. 2003. *An unusual freshwater pearl mussel* Margaritifera margaritifera (L.) *population in Scotland.* Journal of Conchology 38: 139-146.

- **Cosgrove, P.J.**, Butler, J.R.A. and Laughton, R.L. 2004. *Canoe and walking surveys of wintering Goosanders, Red-breasted Mergansers, Great Cormorants and Common Goldeneyes on the River Spey*, 1994-2003. Scottish Birds 24:2 pp1-10.

- **Cosgrove, P.** 2003. *Mandarin ducks in northern Scotland and the potential consequences for breeding Goldeneye*. Scottish Birds 24:1 pp 1-10.

- **Cosgrove, P.** and McGregor, R. 2003. Short note: *Unusual behaviour of Common Redshanks and Common Starlings towards dead Common Redshank.* Scottish Birds 24:1 pp 40.

- Hastie, L.C., **Cosgrove, P.J.**, Ellis, N. and Gaywood, M.R. 2003. *The threat of climate change to freshwater pearl mussel populations.* Ambio 32: 40-46.

- Hastie, L.C. and **Cosgrove, P.J.** 2002. *Intensive searching for mussels in a fast-flowing river: an estimation of sampling bias*. Journal of Conchology 37: 309-316.

- Anderson, A. and **Cosgrove, P.** 2002. *The Fulmar*. In: The Migration Atlas: movements of the birds of Britain and Ireland. Ed: Marchant, J.H. *et al.* BTO. *Poyser publishing.*

- Young, M.R., **Cosgrove, P.J.**, Hastie, L.C. and Henninger, B. 2001. *A standardised method for assessing the status of freshwater mussels in clear, shallow rivers*. Journal of Molluscan Studies 67: 395-396.

- **Cosgrove, P.J.** and Hastie, L.C. 2001. *Conservation of threatened pearl mussel populations: river management, mussel translocation and conflict resolution*. Biological Conservation 99:183-190.

- Young, M.R., **Cosgrove, P.J.** and Hastie, L.C. 2001. *The extent of, and causes for, the decline of a highly threatened najad:* Margaritifera margaritifera. In: Ecology and Evolutionary Biology of the Freshwater Mussels Unionoidea. Eds Bauer, G and Wachtler, K Springer-Verlag, Heidelburg, Germany. Ecological Studies 145:337-357.

- Hastie, L. and **Cosgrove, P.** 2001. *The decline of migratory* Salmonid *stocks: a new threat to pearl mussels in Scotland*. Freshwater Forum 15: 85-96.

- **Cosgrove, P.** and Oswald, J. 2001. *Capercaillie captures in snares*. Scottish Birds 22: 40-42.

- **Cosgrove, P.J.**, Young, M.R., Hastie, L, C., Gaywood, M. and Boon, P.J. 2000*. The status of the freshwater pearl mussel* Margaritifera margaritifera *Linn. in Scotland*. Aquatic Conservation: Freshwater and Marine Ecosystems 10:197-208.

- Hastie, L.C., Young, M.R., Boon, P.J. **Cosgrove, P.J.** and Henninger, B. 2000. *Sizes, densities and age structures of Scottish* Margaritifera margaritifera *(L.) populations*. Aquatic Conservation: Marine and Freshwater Ecosystems 10:229-247.

- **(Cosgrove, P.)** Dick, D. and Stronach, A. 1999. *The use, abuse and misuse of crow cage traps in Scotland*. Scottish Birds 20:1 pp 6-13.

- Watson, A., Marquiss, M. and **Cosgrove, P.J.** 1998. *North-east Scottish counts of Goldeneye, Goosander, Red-breasted Merganser and Cormorant in 1944-50 compared with 1988-97*. Scottish Birds 19:5 pp 249-258.

- **Cosgrove, P.J.** 1997. Short note: *Long-tailed Duck eating eel*. British Birds 90:9 pp 357*.*

- **Cosgrove, P.J.** 1997. *A winter survey of sawbill ducks and Cormorants on the River Deveron, north-east Scotland.* Scottish Birds 19:2 pp 93-100.

- **Cosgrove, P.J.** 1996. *A winter survey of Goldeneyes on the River Deveron, north-east Scotland*. Scottish Birds 18:4 pp 242-246.

COMMISSIONED CONTRACT REPORTS:

- Alba Ecology, 2020. Cairngorms Crane Project: Feasibility Study for Crane Reintroduction. A commissioned report by Scotland: The Big Picture and the Cairngorms National Park Authority.
- **Cosgrove, P.**, Shields, D., Anderson, D. and Massey, K. 2020. Understanding the impact of the 2018 drought on key freshwater pearl mussel populations in Scotland. SNH Research Report.
- **Cosgrove, P.** and Shields, D. 2020. Borgie Forest Freshwater Pearl Mussel Forest Management plan Update. Forestry and Land Scotland Commissioned Report.
- Alba Ecology, 2020. Protected Terrestrial Mammal Survey Report - 40 unit housing development Alvie Estate, Kincraig. Cairngorm Residential LLP Commissioned Report.
- Alba Ecology, 2020. Cambus Bird Survey Report. Diageo Commissioned Report.
- **Cosgrove, P.** and Massey, K. 2020. River Spey, Boat O'Brig freshwater pearl mussel translocation, 2020. Network Rail Commissioned Report.
- Massey, K. and **Cosgrove, P.** 2020. Freshwater pearl mussel survey of the Abhainn Bheag an Tunns, Argyll, 2020. Scottish Woodlands Commissioned Report.
- **Cosgrove, P.** and Massey, K. 2019. Freshwater Pearl Mussel Survey, Clashnessie Burn. Scottish Water Commissioned Report.
- Alba Ecology, 2019. Lairg Wind Farm Environmental Statement. Energie Kontor Commissioned Report.
- Alba Ecology, 2019. Lerwick, Mossy Hill Wind Farm Environmental Statement. Peel Energy Commissioned Report.
- Alba Ecology. 2019. Protected Terrestrial Mammal, Woodant and Rare Plant Survey Report for Proposed Glenmore Footpath. FLS Commissioned Report.
- **Cosgrove, P.,** Anderson, D., Shields, D. and Massey, K. 2019. Freshwater pearl mussel survey of Forestry and Land Scotland Badenoch and Strathspey Watercourses. Forest and Land Scotland Commissioned Report.
- Alba Ecology 2019. Project Novus, Grantown on Spey Distillery Environmental Statement. Speymalt Whisky Distributors Limited Commissioned Report.
- Alba Ecology, 2019. Reptile Survey Report and Species Protection Plan: Dulnain Bridge 2019. JHO Architects Commissioned Report.
- **Cosgrove, P.,** Shields, D., Anderson, D. and Massey, K. 2019. Boat O'Brig Freshwater Pearl Mussel Survey, River Spey, 2019. Network Rail Commissioned Report.
- Alba Ecology, 2019. Protected Terrestrial Mammal Survey Report for a Proposed Housing Development, Cromdale.
- Alba Ecology, 2019. Protected Terrestrial Mammal Survey Report for Proposed Development Lynstock Crescent, Nethy Bridge. M.C. Hastie, Chartered Quantity Surveyors Commissioned Report.
- Alba Ecology, 2019. Breeding Bird Survey Report for a Proposed Housing Development, Cromdale.
- **Cosgrove, P.** 2019. River Meig Freshwater Pearl Mussel Survey, 2019. Galbraith Commissioned Report.
- **Cosgrove, P.** and Massey, K. 2019. 2019 Freshwater Pearl Mussel Survey, Aberlour. Aberlour Distillery Commissioned Report.

- **Cosgrove, P.,** Massey, K. and Shields, D. 2018. Coul Links Environmental Statement. Coul Links Ltd. Commissioned Report.
- **Cosgrove, P.** and Shields, D. 2018. Kercock, River Tay Freshwater Pearl Mussel Survey, 2018. Glenprosen Estate Commissioned Report.
- **Cosgrove, P.** and Anderson, D. 2018. Dunkeld, River Tay Freshwater Pearl Mussel Survey, 2018. Commissioned Report.
- **Cosgrove, P.** 2018. River Fiddich Abstraction, Otter Survey 2018. Mott MacDonald Commissioned Report.
- Alba Ecology, 2018. Liberty BA Lochaber: Allow Wheel Plant Breeding Bird Protection Plan 2018. Commissioned Report.
- **Cosgrove, P.** 2018. AWPR SWD 02 CSO Freshwater Pearl Mussel Survey. Scottish Water Commissioned Report.
- **Cosgrove, P.** and Massey, K. 2018. Blarghour Wind Farm Environmental Statement. Coriolis Energy Commissioned Report.
- Shields, D., Cosgrove, C. and **Cosgrove, P**. 2018. An evaluation of Forestry Management for Freshwater Pearl Mussel in Borgie Forest Watercourses. FCS Commissioned Report.
- **Cosgrove,** P and Anderson, D. 2018. Technical Note: Freshwater pearl mussels and water quality – a literature review. CH2M Commissioned Report.
- **Cosgrove, P**. 2017. Balmenach Distillery Otter Survey 2017. Balmenach Distillery Commissioned Report.
- **Cosgrove, P**. 2017. Lochaber Smelter Protected Terrestrial Mammal Survey. Commissioned Report.
- **Cosgrove, P**. 2017. Inverallan Church 2017 Red Squirrel Survey. Seafield Estate Commissioned Report.
- **Cosgrove, P**. 2017. Grantown East protected terrestrial mammal survey 2017. Commissioned Report.
- **Cosgrove, P**. and Potter, R. 2017. Loch Lussa 2015-2017 Goose Study. FCS Commissioned Report.
- **Cosgrove, P**. and Shields, D. 2017 Freshwater pearl mussel survey of the Conon Bridge Railway Bridge, Highland. JBA Commissioned Report.
- **Cosgrove, P**. 2017. Burn of Inverton freshwater pearl mussel survey, 2017. CNPA Commissioned Report.
- **Cosgrove, P**. and Shields, D. 2016. Freshwater pearl mussel survey deep-water survey of the River Spey Kingussie A9 crossing. CH2M Fairhurst JV Commissioned Report.
- **Cosgrove, P**. 2016. Beachen Court Otter Species Protection Plan. RS McLeod Ltd. Commissioned Report.
- **Cosgrove**, P.J., Hastie, L.C. and Watt, J. 2016. Surveys of high risk freshwater pearl mussel populations. Scottish Natural Heritage Commissioned Report.
- **Cosgrove, P.J.** and Massey, K. 2016. *Beaw Field Wind Farm Environmental Statement*. Peel Energy Ltd Commissioned Report.
- **Cosgrove, P.** and Shields, D. 2016. *Freshwater pearl mussel survey of the Conon Bridge Railway Bridge, Highland*. JBA Commissioned Report.
- Shields, D. and **Cosgrove, P.** 2016. *Freshwater pearl mussel and otter survey of the River Dee at Ballater Bridge, Aberdeenshire*. Aberdeenshire Council Commissioned Report.

- Shields, D. and **Cosgrove, P**. 2016. *Freshwater pearl mussel and otter survey of the River Dee at Aboyne Bridge, Aberdeenshire*. Aberdeenshire Council Commissioned Report.

- **Cosgrove, P**. and Shields, D. 2016. *Freshwater pearl mussel and otter survey of the River Dee at Old Brig O' Dee, Aberdeenshire*. Historic Environment Scotland Commissioned Report.

- Shields, D. and **Cosgrove, P**. 2016. *Freshwater pearl mussel habitat suitability assessment and survey of the Water of Dye at the proposed Glendye Wind Farm*. Land Use Consultants Commissioned Report.

- Watt, J., Hastie, L.C., and **Cosgrove, P.J.** 2016. *Monitoring the success of freshwater pearl mussel reintroductions*. SNH Commissioned Report.

- **Cosgrove, P**., and Shields, D. 2016. *Freshwater pearl mussel survey of the Culrain Burn, Highland*. FCS Commissioned Report.

- **Cosgrove, P.** 2015, 2016, 2017, 2018 and 2019. *Glenfalloch Estate breeding bird and butterfly survey report*. Glenfalloch Estate Annual Commissioned Reports.

- **Cosgrove, P.** and Shields, D. 2015. *Freshwater pearl mussel survey of the River Truim and River Spey, A9 Dualling – Glen Garry to Dalraddy*. CH2M Fairhurst JV Commissioned Report.

- Watt, J, **Cosgrove, P.J** and Hastie, L.C. 2015. *A national freshwater pearl mussel (Margaritifera margaritifera, L.) survey of Scotland*. SNH Commissioned Report.

- **Cosgrove, P**. and Cosgrove, C. 2014. *Carron freshwater pearl mussel survey*. Chivas Bothers Ltd Commissioned Report.
- **Cosgrove, P.** and Massey, K. 2014. *Woodlands Wind Farm Environmental Statement*. ABO Wind Commissioned Report.

- **Cosgrove, P.** and Massey, K. 2014. *Hartwood Wind Farm Environmental Statement*. ABO Wind Commissioned Report.

- **Cosgrove, P**. Shields, D. and Cosgrove, C. 2013. *Freshwater pearl mussel survey of Borgie Forest watercourses*. A Forestry Commission Scotland Commissioned Report.

- Shields, D. **Cosgrove, P.** and Jarrett, D. 2013. *Freshwater pearl mussel survey of selected watercourses in the River Moriston catchment*. A Forestry Commission Scotland Commissioned Report.

- Shields, D and **Cosgrove, P.** 2013. *Freshwater pearl mussel survey of watercourse at the proposed Balnacoil Windfarm, Highland*. Vento Ludens Commissioned Report.

- Bingham, C. and **Cosgrove, P.** 2013. *Drumoak Phase 1 and Protected Mammal Survey Report*. Stewart Milne Homes Commissioned Report.

- **Cosgrove, P.** 2012. *Shetland 2012 Freshwater pearl mussel survey*. SNH Commissioned Report.

- **Cosgrove, P.** and Shields, D. 2012. *Freshwater pearl mussel survey and assessment of selected water bodies at the A'Chruach Windfarm, Argyll*. Terence O'Rourke Commissioned Report.

- **Cosgrove, P.** and Shields, D. 2012. *Freshwater pearl mussel survey of additional watercourses at the Muaitheabhal Windfarm, Eisgein Estate, Lewis*. Beinn Mhor Power Commissioned Report.

- **Cosgrove, P.** and Shields, D. 2012. *Farr micro hydro freshwater pearl mussel survey*. Green Highland Renewables Commissioned Report.

- **Cosgrove, P.** 2012. *Freshwater pearl mussel survey for the Beauly to Kintore Reconductoring Project*. Scottish Hydro Electric Transmission Ltd Commissioned Report.

- Bingham, C., Shields, D. and **Cosgrove, P.** 2012. *Glenmore Forest Formica exsecta survey report*. Forestry Commission Scotland Commissioned Report.

- **Cosgrove, P.** 2012. *Environmental Statement Ornithology Chapter, Stronelairg Wind Farm*. SSE Renewables Commissioned Report.
- **Cosgrove, P.** 2012. *Environmental Statement Ecology Chapter, Stronelairg Wind Farm*. SSE Renewables Commissioned Report.
- **Cosgrove, P.** 2012. *Environmental Statement Ecology Chapter, Bhlaraidh Wind Farm*. SSE Renewables Commissioned Report.
- **Cosgrove, P.** 2012. *Environmental Statement Ornithology Chapter, Bhlaraidh Wind Farm*. SSE Renewables Commissioned Report.
- **Cosgrove, P.** 2012. *Environmental Statement Ecology Chapter, Glencassley Wind Farm*. SSE Renewables Commissioned Report.
- **Cosgrove, P.** 2012. *Environmental Statement Ornithology Chapter, Glencassley Wind Farm*. SSE Renewables Commissioned Report.
- **Cosgrove, P.** 2012. *Burn of Whilk crossbill survey*. WYG Environment Planning Transport Ltd Commissioned Report.
- Shields, D and **Cosgrove, P.** 2012. *Phase 1 Habitat Survey Report, Corhulloch Farm, Dumfries and Galloway*. RES Commissioned report.
- McGregor, R and **Cosgrove, P.** 2012. *Auchenlosh Otter and Badger Survey*. A2 Environmental Commissioned Report.
- **Cosgrove, P.** 2012. *Inverailort Protected Mammal Survey*. Flichity Estates Partnership Commissioned Report.
- Shields, D and **Cosgrove, P.** 2011. *Freshwater pearl mussel survey of Gruinard River, Wester Ross*. Gruinard Estate Commissioned Report.
- **Cosgrove, P.** 2011. *Freshwater pearl mussel survey of watercourses at the proposed Dalnessie Wind Farm*. SSE Renewables Commissioned Report.
- **Cosgrove, P.** 2011. *Freshwater pearl mussel survey of additional watercourses at the Muaitheabhal Windfarm, Eisgein Estate, Lewis*. Beinn Mhor Power Commissioned Report.
- **Cosgrove, P.** 2011. *Environmental Statement Ecology Chapter, Sallachy Wind Farm*. WKN AG Commissioned Report.
- **Cosgrove, P.** 2011. *Environmental Statement Ornithology Chapter, Sallachy Wind Farm*. WKN AG Commissioned Report.
- **Cosgrove, P.** 2011. *Foyers Red Squirrel Survey*. SSE Generation Limited Commissioned Report.
- **Cosgrove, P.** 2011. *Freshwater pearl mussel survey of the Beauly-Dounreay Phase 2 Reinforcement Project: Cambusmore substation*. Scottish Hydro Electric Transmission Limited Commissioned Report.
- **Cosgrove, P.** 2011. *Freshwater pearl mussel survey of watercourses at the proposed Allt Duine wind farm, Kincraig.* RWE Npower Renewables Commissioned Report.
- (**Cosgrove, P.**). 2010. *Freshwater pearl mussel guidance for professionals working in and around Scottish rivers*. SNH Commissioned Leaflet and On-line guidance.
- Hastie, L.C., Watt, J. and **Cosgrove, P.J**. 2010. *Restoration of freshwater pearl mussels in selected Scottish rivers – Phase 2A – pilot study on reintroduction*. SNH Commissioned Report.
- (Webley, J., Dale, K. and **Cosgrove, P.**). 2009. *Glen Lyon Hydro Grid Connection freshwater pearl mussel survey*. EnviroCentre Commissioned Report for Ash design+assessment.

- **Cosgrove, P.** and Mitchell, A. 2009. *Freshwater pearl mussel survey of additional selected water bodies at the Muaitheabhal windfarm, Eisgein Estate, Isle of Lewis*. Land Use Consultants Commissioned Report.

- **Cosgrove, P.** and Watt, J. 2009. *Freshwater pearl mussel and fish habitat survey of Coire Fearna proposed hydro-electric scheme, Glenmoirdart, Lochaber*. TradeLink Solutions Ltd Commissioned Report.

- **Cosgrove, P.** 2009*. Site Condition Monitoring of freshwater pearl mussels in the River Ba, Rannoch Moor Special Area of Conservation.* SNH Commissioned Report.

- **Cosgrove, P.** and Farquhar, J. 2009*. Freshwater pearl mussel survey of the River Moriston, Highland*. SSE Commissioned Report.

- **Cosgrove, P.** and Mitchell, A. 2009*. Site Condition Monitoring of freshwater pearl mussels in the Foinavon Special Area of Conservation.* SNH Commissioned Report.

- **Cosgrove, P.** and Farquhar, J. 2009*. Site Condition Monitoring of freshwater pearl mussels in the North Harris Special Area of Conservation.* SNH Commissioned Report.

- Hastie, L. and **Cosgrove, P.** 2009. *Site Condition Monitoring of freshwater pearl mussels in the River Oykel Special Area of Conservation.* SNH Commissioned Report.

- (**Cosgrove, P.**) 2009. *Deepwater freshwater pearl mussel survey of the River Tay, Perth*. EnviroCentre Commissioned Report for Atkins.

- **Cosgrove, P.** on behalf of EnviroCentre. 2008. *Freshwater pearl mussel survey of selected water bodies at the proposed Viking Wind Farm, Shetland*. SSE Commissioned report.

- **Cosgrove, P.J.** and Hastie, L.C. 2008. *Site Condition Monitoring of freshwater pearl mussels in the Abhainn Clais an Eas and Allt a' Mhuilinn Special Area of Conservation*. SNH Commissioned Report.

- Hastie, L.C and **Cosgrove, P.J.** 2008. *Site Condition Monitoring of freshwater pearl mussels in the Loch Stack Site of Special Scientific Interest*. SNH Commissioned Report.

- **Cosgrove, P.J.** and Hastie, L.C. 2008. *Site Condition Monitoring of freshwater pearl mussels in the Ardvar and Loch a' Mhuilinn Woodlands Special Area of Conservation*. SNH Commissioned Report.

- **Cosgrove, P.J.** and Hastie, L.C. and Mitchell, A. 2008. *Site Condition Monitoring of freshwater pearl mussels in the Inverpolly Special Area of Conservation*. SNH Commissioned Report.

- **Cosgrove, P.** and Farquhar, J. 2008. *Freshwater pearl mussel survey of the River Spey, at Kingussie*. Scottish Water Solutions Commissioned report.

- **Cosgrove, P.** and Mitchell, A. 2008. *Freshwater pearl mussel survey of the Abhainn Shlatach and Allt na h-aire at a proposed hydro-electric scheme, Glenfinnan, Lochaber*. Tradelink Solutions Ltd Commissioned Report.

- **Cosgrove, P.** 2008. *Freshwater pearl mussel survey of a proposed bridge crossing, Kilbraur, Gordonbush, Sutherland*. SSE Commissioned Report.

- **Cosgrove, P.** 2008. *Freshwater pearl mussel survey of selected waterbodies at the proposed Pairc Wind Farm, Isle of Lewis*. SSE Commissioned Report.

- **Cosgrove, P.** and Mitchell, A. 2008. *Freshwater pearl mussel survey of selected water bodies at proposed hydro-electric schemes, Kinlochmoidart, Lochaber*. Tradelink Solutions Ltd Commissioned Report.

- **Cosgrove, P.** 2008. *Freshwater pearl mussel survey of the Glenforslan River and River Moidart at a proposed hydro-electric scheme, Kinlochmoidart, Lochaber*. Tradelink Solutions Ltd Commissioned Report.

- **Cosgrove, P.** 2008. *Freshwater pearl mussel survey of selected water bodies at the proposed Pairc wind farm, Isle of Lewis*. SSE Commissioned report.

- **Cosgrove, P.** and Farquhar, J. 2008. *Southwest Scotland Project freshwater pearl mussel survey*. Land Use Consultants Commissioned Report.

- **Cosgrove, P.** and Farquhar, J. 2008. *Freshwater pearl mussel survey of the Ullapool River and Rhidorroch River, NW Scotland*. Rhidorroch Estate Commissioned Report.

- **Cosgrove, P.**, Hastie, L., MacDougal, K. and Kelly, A. 2007. *Development of a remote, deep-water survey method for freshwater pearl mussels*. SNH Commissioned Report No 263 (ROAME No. F06AC606).

- (**Cosgrove, P.** and MacDougal, K.) EnviroCentre. 2007. *Feasibility study for improving fish passage in two rivers: Mingarry Burn and Allt Grigadale*. SNH Commissioned Report No 250 (ROAME No. R06AC611).

- **Cosgrove, P.** and Farquhar, J. 2007. *Freshwater pearl mussel survey of selected water bodies in the Kinlochbervie Water Resource Zone, NW Scotland*. Mott MacDonald Commissioned Report.

- **Cosgrove, P.** and Farquhar, J. 2007. *Freshwater pearl mussel survey of selected water bodies in the Lochdornoch Water Resource Zone, River Evelix*. Mott MacDonald Commissioned Report.

- **Cosgrove, P.** and Hastie, L. 2007. *Freshwater pearl mussel survey of selected water bodies at the Muaitheabhal Windfarm, Eisgein Estate, Isle of Lewis*. Land Use Consultants Commissioned Report.

- **Cosgrove, P.** and Farquhar, J. 2007. *Freshwater pearl mussel survey of the River Spey at Aviemore and Allt na Criche at Lynwilg*. Scottish Water Solutions Commissioned Report.

- **Cosgrove, P.** and Hastie, L. 2007. *Freshwater pearl mussel survey of the River Spey at Grantown on Spey*. Scottish Water Solutions Commissioned Report.

- **Cosgrove, P.** and Farquhar, J. 2007*. Freshwater pearl mussel survey and assessment of selected water bodies at the A'Chruach Windfarm, Minard, Argyll*. Terence O'Rourke Commissioned Report.

- **Cosgrove, P.J.** and Hastie, L.C. 2007. *Freshwater pearl mussel survey of the River Spey, South Bank, at Carron, Aberlour, Moray. Part I.* Diageo Commissioned Report.

- **Cosgrove, P.J.** and Hastie, L.C. 2007. *Freshwater pearl mussel survey of the River Spey, South Bank, at Carron, Aberlour, Moray. Part II*. Diageo Commissioned Report.

- Hastie, L. and **Cosgrove, P.J.** 2007. *Freshwater pearl mussel survey of the River Spey at Arndilly, Moray*. Smiths Gore Commissioned Report.

- Hastie, L.C. and **Cosgrove, P.J.** 2007. *Freshwater pearl mussel survey of the Coladoir River, Isle of Mull*. SNH Commissioned Report.

- **Cosgrove, P.J.** and Jackson, S.J. 2007. *Freshwater pearl mussel survey of the River Cree, Dumfries*. SNH Commissioned Report.

- **Cosgrove, P.J.** and Jackson, S.J. 2007. *Freshwater pearl mussel survey of the Palnure Burn, Dumfries*. SNH Commissioned Report.

- **Cosgrove, P.J.** 2007. *Freshwater pearl mussel survey of the River Bellart, at Dervaig, Isle of Mull*. SNH Commissioned Report.

- ERA/**Cosgrove and Hastie Associates**. 2007. *Restoration of freshwater pearl mussel in selected Scottish rivers Phase I(A): candidate rivers for restoration*. SNH Commissioned Report.

- (**Cosgrove, P.**) EnviroCentre. 2007. *The KLR Biodiversity/Habitat Management Plan*. EnviroCentre Commissioned Report for The Kirkintilloch Initiative.

- (**Cosgrove, P.**) EnviroCentre. 2006. *Irish Screening Protocol for Aquaculture*. EnviroCentre Commissioned Report for The Irish Sea Fisheries Board.

- (**Cosgrove, P.**) EnviroCentre. 2006. *Woodilee Biodiversity/Habitat Management Plan*. EnviroCentre Commissioned Report for Cala Homes.

- (**Cosgrove, P.** and McMullan, R.) EnviroCentre. 2006. *Aquaculture Appropriate Assessments of the implications for the conservation interests of Scottish Natura 2000 sites*. EnviroCentre Commissioned Report for The Crown Estate.

- **Cosgrove, P.** and Hastie, L. 2006. *Freshwater pearl mussel survey of the River Dee at Waterside, Aberdeen.* Dee District Salmon Fishery Board Commissioned Report.

- **Cosgrove, P.** and Hastie, L. 2006. *Freshwater pearl mussel survey of the River Dee, South bank, at Dee Street Bridge, Banchory, Aberdeenshire.* The Banchory Fishings Commissioned Report.

- (**Cosgrove, P.**) 2005. Biodiversity Planning Guidance Note for the Householder. Cairngorms National Park Authority.

- **Cosgrove, P.** 2005. *Freshwater pearl mussel survey of the River Dee at Dee Street Bridge, Banchory, Aberdeenshire.* Byzak Commissioned Report.

- **Cosgrove, P.** and Farquhar, J. 2005. *Conservation of Atlantic Salmon in Scotland LIFE project: freshwater pearl mussel survey.* Dee District Salmon Fishery Board Commissioned Report.

- **Cosgrove, P.** and Moggach, A. 2005. *Freshwater pearl mussel survey of the River Spey at Dipple, Fochabers*. Mott MacDonald Ltd Commissioned Report.

- **Cosgrove, P.** and Farquhar, J. 2005. *Freshwater pearl mussel survey of the Maldie Burn and Abhainn a' Ghlinne Dhuibh, Glendhu, Sutherland.* ASH Commissioned Report.

- **Cosgrove, P.** and Farquhar, J. 2005. *Freshwater pearl mussel survey* of the Kilmartin River and Rivers Snizort and Ord. SNH Commissioned Report.

- **Cosgrove, P.**, Moggach, A. and Hastie, L. 2004. *Freshwater pearl mussel survey for the Rothes Flood alleviation scheme*. Posford Haskoning Ltd, Royal Haskoning Commissioned Report.

- **Cosgrove, P.J.**, Moggach, A. and Farquhar, J.E. 2004. *Freshwater pearl mussel survey of the Inverpolly candidate Special Area of Conservation.* SNH Commissioned Report.

- **Cosgrove, P.J.** and Moggach, A. 2004. *Freshwater pearl mussel survey of the Ardvar and Loch a'Mhuilinn woodlands candidate Special Area of Conservation.* SNH Commissioned Report.

- **Cosgrove, P.J.** and Moggach, A. 2004. *Freshwater pearl mussel survey of the Glen Beasdale candidate Special Area of Conservation.* SNH Commissioned Report.

- **Cosgrove, P.J.** 2004. *Freshwater pearl mussel survey of the Loch Stack Site of Special Scientific Interest.* SNH Commissioned Report.

- **Cosgrove, P.J.** 2003. *Freshwater pearl mussel survey of the Stanley Mills Weir, River Tay*. RWE Innogy Commissioned Report.

- Hastie, L.C., **Cosgrove, P.J.**, Farquhar, J.E. and Socrates, A. 2003. *Freshwater pearl mussel survey of the Rivers Naver-Mallart Special Area of Conservation.* SNH Commissioned Report.

- Hastie, L.C., **Cosgrove, P.J.**, Farquhar, J.E. and Socrates, A. 2003. *Freshwater pearl mussel survey of the River Oykel candidate Special Area of Conservation.* SNH Commissioned Report.

- Hastie, L.C. and **Cosgrove, P.J.** 2003. *Freshwater pearl mussel survey of the River Moriston candidate Special Area of Conservation.* SNH Commissioned Report.

- Hastie, L.C. and **Cosgrove, P.J.** 2003. *Freshwater pearl mussel survey of the River Tay system candidate Special Area of Conservation.* SNH Commissioned Report.

- **Cosgrove, P.J.**, Hastie, L.C. and Farquhar, J.E. 2003. *Freshwater pearl mussel survey of River Dee candidate Special Area of Conservation.* SNH Commissioned Report.

- **Cosgrove, P.**, Hastie, L. and. Watt, J. 2003. *Freshwater pearl mussel and otter survey and environmental assessment of proposed pipe construction and operations at Invercannie water treatment works, Banchory, River Dee, Aberdeenshire*. Scottish Water Commissioned Report.

- **Cosgrove, P.** and Farquhar, J. 2003. *Freshwater pearl mussel survey around proposed bank repair works on the Lummels Pool, at Aboyne Fishings, River Dee, Aberdeenshire*. Aboyne Water Fishings Commissioned Report.

- Laughton, R, **Cosgrove, P.J.** and Hastie, L.C. 2003. *The effect of Ranunculus removal on juvenile salmonids and Freshwater pearl mussels in the River Spey*. SNH Commissioned Report.

- **Cosgrove, P.** 2002. Freshwater pearl mussel survey for the A830 Arisaig to Loch Nan Uamh Road Development. SNH Commissioned Report.

- **Cosgrove, P.J.** and Hastie, L.C. 2002. *Freshwater pearl mussel survey of the Ahainn Dubh at Inverbain, Shieldaig, Highland.* Innogy Commissioned Report.

- Hastie, L.C. and **Cosgrove, P.J.** 2002. *Freshwater pearl mussel survey at Strachan, Water of Feuch, Aberdeenshire.* Scottish Water Commissioned Report.

- **Cosgrove, P.J**. and Hastie, L.C. 2002. *Freshwater pearl mussel survey and environmental assessment of a proposed outfall modification, Fochabers, River Spey, Morayshire.* Scottish Water Commissioned Report.

- **Cosgrove, P.J.** and Hastie, L.C. 2002. *Freshwater pearl mussel monitoring survey 2002 following river engineering work at Carron and Laggan fishings, River Spey, Morayshire.* SNH Commissioned Report.

- **Cosgrove, P.J.** and Hastie, L.C. 2002. *Freshwater pearl mussel survey of the River Tarff, Fort Augustus, Highland.* ASH Commissioned Report.

- **Cosgrove, P.**, Farquhar, J., Watt, J. and Birkeland, K. 2002. *Freshwater pearl mussel survey of the Ahainn na Coinnich, Highland.* ASH Commissioned Report.

- **Cosgrove, P.J.** 2002. *Freshwater pearl mussel survey of selected burns in Shetland*. Shetland Biological Records Centre Commissioned Report.

- Hastie, L.C. and **Cosgrove, P.J.** 2002. *Freshwater pearl mussel survey of the Douglas Water, Argyll.* Environmental Resources Management Commissioned Report.

- **Cosgrove, P**. and McKnight, A. 2001. *The Cairngorms Upland Grain Project*. A joint Cairngorms Local Biodiversity Action Plan and Cairngorms Farming and Wildlife Advisory Group report.

- **Cosgrove, P.** and Farquhar, J. 2001. *Freshwater pearl mussel survey of the River Moriston, Inchmore Fish Farm, Highland.* Marine Harvest Commissioned Report.

- Hastie, L.C. and **Cosgrove, P.J.** and Young, M.R. 2001. *Freshwater pearl mussel survey and environmental assessment at Aberlour and Craigellachie, River Spey Morayshire.* North of Scotland Water Authority (NoSWA) Commissioned Report.

- **Cosgrove, P.J.** 2001. *Freshwater pearl mussel survey of Stanley Mill race, adjacent to the River Tay, Perthshire.* Innogy Commissioned Report.

- **Cosgrove, P.J.**, Hastie, L.C. and Young, M.R. 2001. *Freshwater pearl mussel monitoring survey following river engineering work on the River Connon, Highland.* NoSWA Commissioned Report.

- **Cosgrove, P.J.** and Hastie, L.C. 2001. *Freshwater pearl mussel monitoring survey following river engineering work at the Carron and Laggan Fishings, River Spey, Moray*. SNH Commissioned Report.

- **Cosgrove, P.J.**, Hastie, L.C. and Farquhar, J.E. 2001. *Freshwater pearl mussel and river habitat survey of candidate Special Areas of Conservation: River Evelix, Badnaban Burn and Clashnessie Burn*. SNH Commissioned Report.

- **Cosgrove, P.J.**, Hastie, L.C. and Young, M.R. 2001. *National survey of the Freshwater pearl mussel – Phase II*. *Deepwater survey methodology*. SNH Commissioned Report.

- **Cosgrove, P.J.**, Hastie, L.C. and Young, M.R. 2000. *National survey of the Freshwater pearl mussel – Phase II*. SNH Commissioned Report.

- Hastie, L.C. and **Cosgrove, P.J.** 2000. *Environmental Impact Assessment of proposed river engineering works in the middle reaches of the River Spey*. SNH Commissioned Report.

- Hastie, L.C. and **Cosgrove, P.J.** 2000. *Freshwater pearl mussel survey of the River Dee near Lower Dess Mill, Kincardinshire O'Neil*. Morgan Fisheries Consultancy Commissioned Report.

- **Cosgrove, P.J.** and Hastie, L.C. 2000. *Freshwater pearl mussel* Margaritifera margaritifera *survey of the River X (confidential), Knoydart*. SNH Commissioned Report.

- **Cosgrove, P.J**. and Hastie, L.C. 2000. *Freshwater pearl mussel* Margaritifera margaritifera *survey of the Ardnamurchan burns.* SNH Commissioned Report.

- **Cosgrove, P.J.** 1999. *Beauly Firth Birds: a review report*. Hartley Anderson Ltd Commissioned Report.

- **Cosgrove, P.J.** and Farquhar, J.E. 1999. *Distribution and conservation status of the freshwater pearl mussel* Margaritifera margaritifera *in Lewis and Harris*. SNH Commissioned Report.

- **Cosgrove, P.J.** 1999. *Survey of the proposed River Moidart SAC for the presence of Freshwater Pearl Mussels* Margaritifera margaritifera. SNH Commissioned Report.

- **Cosgrove, P.J.** Young, M.R. and Hastie, L.C. 1999. *River Conon Freshwater Pearl Mussel monitoring programme*. NoSWA Commissioned Report.

- **Cosgrove, P.J.** 1999. *Survey of the proposed River Kerry SAC for the presence of Freshwater Pearl Mussels* Margaritifera margaritifera. SNH Commissioned Report.

- **Cosgrove, P.J.** Young, M.R. and Hastie, L.C. 1999. *The River Conon Freshwater Pearl Mussel translocation programme*. NoSWA Commissioned Report.

- **Cosgrove, P.J.** 1998. *Blackdog Environmentally Friendly Housing Environmental survey*. Aberdeenshire Council Commissioned Report.

- **Cosgrove, P.J.** and Young, M.R. 1998. *Survey of the River Conon for the presence of Freshwater Pearl Mussels (*Margaritifera margaritifera *Linn.)*. NoSWA Commissioned Report.

- **Cosgrove, P.J.** and Young, M.R. 1998. *Freshwater pearl mussel survey of the River Spey: Phase 1*. SNH Commissioned Report.

- **Cosgrove, P.J.** 1998. *Freshwater pearl mussel survey of the River Clunie*: Dee Salmon Fishery Board Commissioned Report.

- Cooksley, S.L. and **Cosgrove, P.J.** 1998. *Monitoring wood-ants in native pine woodland during regeneration*. SNH Commissioned Report.

- **Cosgrove, P.J.** and Young, M.R. 1998. *The status of the freshwater pearl mussel* Margaritifera margaritifera *in Scotland*. SNH Commissioned Report.

- Rae, S. and **Cosgrove, P.** 1997. *Botanical survey of upland areas around Loch Seaforth, North Harris: Phase II South Eisken.* SNH Commissioned Report.

- **Cosgrove, P.J.** 1997. *Distribution survey of Freshwater Pearl* Mussels Margaritifera margaritifera*: Observation records by Vice Counties in Scotland*. SNH Commissioned Report.

- Patterson, I.J., Kantolla, P.S., Oldfield, S. and **Cosgrove, P.J.** 1997. *Nesting distribution and nesting success of Eiders on Forvie National Nature Reserve*. SNH Commissioned Report.

- Patterson, I.J. and **Cosgrove, P.J.** 1997. *The Eider population of Forvie National Nature Reserve*. SNH Commissioned Report.

- Patterson, I.J. and **Cosgrove, P.J.** 1997. *Waders and waterfowl on the Ythan estuary 1996/97*. SNH Commissioned Report.

- Patterson, I.J. and **Cosgrove, P.J.** 1997. *Monitoring of a goose management scheme for the Strathbeg area.* SNH Commissioned Report.

- **Cosgrove, P.J.** 1997. *North Sea Bird Club Annual Report 1995/1996*, Aberdeen University.

- Lambin, X., Telfer, S., **Cosgrove, P.** and Alexander, G. 1996. *Survey of Water voles and American mink on the Rivers Don and Ythan*. SNH Commissioned Report.

- Patterson, I.J., **Cosgrove, P.J.** and Doyle, P. 1996. *Water quality and input of nutrients in winter by roosting birds at the Winter Loch, St Fergus, winter 1995/6*. St Fergus Dunes Management Committee Commissioned Report.

- **Cosgrove, P.J.** 1996. *Survey of piscivorous birds on the R. Deveron*. SNH Commissioned Report.

- **Cosgrove, P.** and Turner, R. 1995. *A review of the UK Government's commitments and responses to the Rio and Helsinki Biodiversity Forest Principles*, RSPB Commissioned Report.

- **Cosgrove, P.J.** and Doyle, P.A.T. 1995. *North Sea Bird Club Annual Report 1993/1994*, Aberdeen University.

- Harley, D. and **Cosgrove, P.** 1990. *Compendium of timber statistics*. RSPB Commissioned Report.

- **Cosgrove, P.**, Gordon, C., Bainbridge, I. and Turner, R. 1990. *Forestry consultations in England and Wales. A survey of County Councils and National Parks*. RSPB Commissioned Report.

POPULAR/MAINSTREAM WRITING:

- **Cosgrove, P.,** Shields, D. and Cosgrove, C. 2014. *Mollusc of the Glen*. British Wildlife 26:18-19.

- **Cosgrove, P.** Guest blog: *Tactics of the raptor haters*. Standing up for Nature. http://markavery.info/2014/11/12/guest-blog-peter-cosgrove

- **Cosgrove, P.**, Hastie, L. and Sime, I. 2012. *Wildlife crime and Scottish freshwater pearl mussels*. British Wildlife 24:1 pp 10-13.

- **Cosgrove, P.**, Amphlett, A., Elliott, A., Ellis, C., Emmett, E., Prescott, T. and Watson Featherstone, A. 2005*. Aspen: Britain's missing link with the boreal forest*. British Wildlife 17:2 pp 107-115.

- **Cosgrove, P.** and Field, B. 2005. *Home and Away: São Tomé and Principe, Gulf of Guinea Islands*. Birding World 18 (2) 81-82.

- **Cosgrove, P.** 2003. *Trends and change in Scottish freshwater pearl mussel populations*. Recorder News, Biological Recording in Scotland: 50, pp 8-9.

- *The Cairngorms Local Biodiversity Action Plan*. 2002. **Eds. Cosgrove, P.** and the Cairngorms Local Biodiversity Action Plan Steering Group. The Cairngorms Partnership.

- *The Biodiversity and management of Aspen woodlands.* 2002. **Eds. Cosgrove, P.** and Amphlett, A. The Cairngorms Partnership.

- **Cosgrove, P.** 2001. *Devils' island: illegal bird killing in Cyprus*. Birdwatch 106: pp 22-24.
- **Cosgrove, P.** 2001. *Bird killing in Cyprus*. Scottish Bird News 61: pp 4.
- **Cosgrove, P.**, Hastie, L. and Young, M. 2000. *Freshwater pearl mussels in peril*. British Wildlife 11:5 pp 340-347.
- **Cosgrove, P.** 1999. *Rat colonisation of Eynhallow, Orkney*. Orkney Field Club Bulletin 1999.
- **(Cosgrove, P).** 1999. *Caught in a trap: wildlife crime in Scotland*. The Angry Corrie: 41 pp 8.
- **Cosgrove, P.** 1999. *Red-flanked Bluetail at Newburgh*, North-east Scotland 1998. Birding Scotland 2:1 pp 36-38.
- Evans L.G.R. and **Cosgrove P.J.** 1997. *Turtle identification and sightings in British Waters*. Rare Birds 3:6 pp 268-269.
- Evans L.G.R. and **Cosgrove P.J.** 1997. *A Red-billed Starling in the North Sea- escape or vagrant?* Rare Birds 3:6 pp 270.
- **Cosgrove P.J.** 1997. *Fish-eating birds: a review*. Scottish Bird News: 44.
- **Cosgrove, P.J.** 1995-1998. Editor of 'The Fulmar: Bulletin of the North Sea Bird Club' Nos. 73-84.
- Jardine, D., **Cosgrove, P.**, Holmes, M. and Bankier, S. 1994. *Recoveries and controls from Siskins caught in Northumbria*. Northumbrian Birds 1993.

CURRICULUM VITAE
Dr Kate Massey, MCIEEM

Name:	Dr Kate Massey, MCIEEM
Profession:	Environmental Scientist
Specialisation:	Botanist and ecologist
Contact email:	kate@albaecology.co.uk
Mobile:	07827 275893

RECENT CAREER SUMMARY

2015–present day	Principle Ecologist and Botanist with Alba Ecology.
2012 -2015	Senior Ecologist, Alba Ecology.
2010 -2012	Ecologist, Alba Ecology.
2008-2009	Post-doc Researcher, University of Aberdeen.
2007-2008	Biodiversity Officer, Environment Agency

EDUCATION

2003-2007	PhD. Biology and Environmental Science, University of Sussex.
2002-2003	MSc. Ecology, University of Aberdeen.
1998-2001	BSc. (Hons) Environmental Geoscience, University of Bristol.

PROFILE

Kate is a highly experienced ecologist with over fifteen years working in ecological research and habitat assessment. She is a particularly skilled botanist and respected habitat surveyor. She has contributed to and led on many large projects and has a strong proven track record of delivery in both the public and private sector, producing over 100 peer-reviewed scientific papers and commissioned reports.

Kate's main roles as a Principle Ecologist within Alba Ecology is carrying out habitats assessments for a range of projects and providing ecological advice particularly in relation to plants and habitats. Kate leads all the botanical based work such as Phase 1 Habitat, National Vegetation Classification (NVC), Groundwater Dependant Terrestrial Ecosystem (GWDTE) and floristic surveys for protected plants. In the last 10 years, she has successfully worked on numerous projects in the north of Scotland, and has got the vegetation and habitat element of ES's accepted on Mossy Hill Wind farm, Bhlaraidh Wind Farm, Stronelairg Wind Farm, Glencassley Wind Farm and Sallachy Wind Farm with others currently going through the planning/consents process (e.g. Coul Links Golf Course). Kate has written the Ecology ES chapters for Mossy Hill Wind Farm, Beaw Field Wind Farm and many that are currently actively in the planning process. Kate has experience of attending Public Inquiry as part of the planning process.

Kate is interested in invasive species management and led a recent successful efforts to remove non-native American Skunk Cabbage from a tributary of the River Spey Special Area of Conservation. Kate has surveyed for a range of non-native invasive species and has produced management plans to form the bases of irradiation programs.

RELEVANT EXPERIENCE

Habitats and Vegetation

Kate has carried out numerous Phase 1 Habitat, NVC and GWDTEs surveys in a wide range of habitats and vegetation types including uplands, montane area, sand dunes and grasslands. Kate co-ordinates the projects, carries out field work, writes the associated reports figure. Recent projects include the Distillery near Craggan, Mossy Hill Wind farm, Lairg Wind farm, Coul Links Golf Course, Viking Wind Farm, Bhlaraidh Wind Farm, Stronelairg Wind Farm, Glencassley Wind Farm and Sallachy Wind Farm, plus numerous smaller scale projects (single turbines, housing developments etc).

Ecological project co-ordination

Kate has led on the production of the Ecology elements of Environmental Statements for a number of large scale projects, including chapter writing, technical appendix writing and figure production. Recent projects include the Distillery near Craggan, Lairg Wind Farm, Coul Links Golf Course, Mossy Hill Wind Farm, Beaw Field Wind Farm with many still going through the planning process.

Kate also co-ordinates all habitat and vegetation projects, including managing field workers, writing report, meeting deadlines and providing advice.

Peatland Restoration

A particular strength is Kate's work on large-scale peatland restoration projects in relation to wind farm developments and the Forestry Commission land in the north and west of Scotland. This work has featured strongly in Habitat Management Plans we have developed for many of our recent clients.

GIS, Data Handling and Statistical Analysis

Kate is also our GIS specialist and statistics advisor. She is highly skilled in dealing with complex data sets. She has provided the Collision Risk Assessments (CRA) for numerous wind farm sites including Lairg Wind Farm, Blarghour Wind Farm and Mossy Hill Wind Farm. Kate performs analysis on our ecological data when required, such as modelling bird population dynamics using VORTEX.

Kate is proficient in using ArcGIS and QGIS. Her work involves creating, drawing and editing ecological data such as habitat polygons and flightlines as well as producing the maps and figures for ES submissions. Kate has a good working knowledge of statistical and data presentation packages such as Minitab, VORTEX and Simgmplot.

Species Surveys

Kate is experienced in undertaking surveys for a range of rare and/or protected species such as botanical surveys for rare species, freshwater pearl mussels, otters, water voles, red squirrels and badger. Kate has undertaken freshwater pearl mussel surveys in a range of rivers, including survey several Special Areas of Conservation (SACs) designated for freshwater pearl mussels.

RELEVANT SKILLS

Vascular Plants

- Excellent plant identification skills for plants found in grasslands, sand dunes and salt marshes and upland habitats including heaths, mires, flushes and montane habitats.

Non-native Invasive Species

- Excellent identification skills for non-native invasive plant species. Provides surveys for a range of non-native invasive species and produced management plans to form the bases of irradiation programs.

Non Vascular Plants

- Good bryophyte identification skills (attended bryophyte identification course, Royal Botanic Gardens, Edinburgh, and *Sphagnum* identification course).

Habitats and communities

- Highly experienced (>15 years) in Phase 1 Habitat and NVC surveying.
- Experienced (~10 years) in assessing potential groundwater dependant terrestrial ecosystems.

Mammals

- Experienced in following standard guidance and standard survey techniques for a range of mammal surveys and identifying mammal field signs for a range of species (e.g. water voles, otters, badgers, pine marten and red squirrel).

Freshwater Pearl Mussels

- Experienced in identification and following standard survey techniques at a range of rivers including several SAC designated for Freshwater pearl mussels.

Computer Skills

- Highly skilled user of PC desktop systems; using standard packages such as Windows Excel, Word, Powerpoint etc. Also skilled in GIS software using both ArcGIS and QGIS and statistical packages such as Minitab, VORTEX and Sigmaplot.

Presentation skills

- Presented scientific research at several conferences such as the British Ecological Society annual conference. Regularly presents information at project team meetings.
- Run a series of seminars at universities on a range of ecological subjects.

OTHER QUALIFICATIONS

Full driving licence. Member of Chartered Institute of Ecology and Environmental Management. Current First Aid Certificate. Safe Space Certificate.

PERSONAL INTERESTS AND HOBBIES

Hill walking. Mountain biking. Naturalist. Kate also volunteers through Girl-guiding as both a Brownies and Guide Unit Leader running weekly meetings, camps, holidays and activities for young girls and teenagers.

PUBLICATIONS

Massey, K., Cosgrove, P**.**, Massey, F., Jackson, D. and Chapman, M. 2016. Habitat characteristics of breeding Eurasian Whimbrel *Numenius phaeopus* on Mainland Shetland, Scotland, UK. *Bird Study* **63**: 500-508.

Massey, F.P. **Massey, K**., Ennos, A.R. and Hartley, S.E. 2009. Impacts of silica-based defences in grasses in the feeding preference of sheep. *Basic and Applied Ecology,* **10:** 622-630.

Massey, F.P., **Massey, K**., Press, M.C. and Hartley, S.E. 2006. Neighbourhood composition determines growth architecture and herbivory in tropical rain forest tree seedlings. *Journal of Ecology*. **94**: 646-655.

COMMISSIONED REPORTS

Cosgrove, P., **Massey, K.** Anderson, D., Shields, D. 2020. Cairngorms Crane Project: Feasibility Study for Crane Reintroduction. A commissioned report by Scotland: The Big Picture and the Cairngorms National Park Authority.

Massey, K. and Cosgrove, P. 2019. *Protected Terrestrial Mammal, Woodant and Rare Plant Survey Report for Proposed Glenmore Footpath*. Commissioned Report.

Massey, K. and Cosgrove, P. 2020. Freshwater pearl mussel survey of the Abhainn Bheag an Tunns, Argyll, 2020. Scottish Woodlands Commissioned Report.

Cosgrove, P., Shields, D., Anderson, D. and **Massey, K**. 2020. Understanding the impact of the 2018 drought on key freshwater pearl mussel populations in Scotland. SNH Research Report.

Cosgrove, P. and **Massey, K.** 2020. River Spey, Boat O'Brig freshwater pearl mussel translocation, 2020. Network Rail Commissioned Report.

Massey. K. and Shields. D. 2019. *Lairg II Wind Farm Ecology Environmental Statement*. Commissioned Report.

Massey, K. 2019. *Nethybridge Housing Phase 1 Habitat, NVC and GWDTE report*. Commissioned Report.

Massey. K. and Anderson. D. 2019. *Lairg II Wind Farm Ornithology Environmental Statement.* Commissioned Report.

Massey. K. and Anderson. D. 2019. *Lairg II Wind Farm Lairg Collision Risk Assessment. ES Technical Appendix.* Commissioned Report.

Massey. K. 2019. *Lairg II Wind Farm Natural Heritage Information Desk Study. ES Technical Appendix.* Commissioned Report.

Massey, K. and Cosgrove, P. 2019. *Lairg II Outline Habitat Management Plan. ES Technical Appendix.* Commissioned Report.

Massey. K. 2019. *Dunnottar Park, Stonehaven Invasive, Non-native Species Management Plan.* Commissioned Report.

Massey. K. 2019. *Dunnottar Park, Stonehaven Invasive, Non-native Species Survey Report*. Commissioned Report.

Cosgrove, P., Anderson, D., Shields, D. & **Massey, K**. 2019. *Freshwater Pearl Mussel Survey of Forestry and Land Scotland Badenoch and Strathspey Watercourses*. Forest and Land Scotland Commissioned Report.

Cosgrove, P., Anderson, D., Shields, D. and **Massey, K**. 2019. *Boat O'Brig Freshwater Pearl Mussel Survey, River Spey, 2019. C*ommissioned Report.

Cosgrove, P. and **Massey, K**. 2019. Freshwater Pearl Mussel Survey, Clashnessie Burn. Scottish Water Commissioned Report.

Massey. K. 2019. *Cromdale Housing Phase 1 Habitat, NVC and GWDTE report.* Commissioned Report.

Massey. K. 2019. *Distillery at Craggan Natural Heritage Desk Study Report*; ES Technical Appendix. Commissioned Report.

Cosgrove, P and **Massey, K.** 2019. *Distillery at Craggan Outline Habitat Management Plan*. ES Technical Appendix. Commissioned Report.

Massey, K and Cosgrove, P. 2019. *Distillery at Craggan Enviromental Statement - Ecology*. Commissioned Report.

Massey, K. 2019. *Phase 1 Habitat Survey and Groundwater Dependent Terrestrial Ecosystems Report for the proposed distillery at Craggan North of the A95 at Grantown on Spey.* ES Technical Appendix. Commissioned Report.

Massey. K and Shields, D. 2018. *Distillery at Craggan Phase 1 Habitat, NVC GWDTE Survey Report*. ES Technical Appendix. Commissioned Report.

Shields, D and **Massey, K.** 2018. *Lairg II Wind Farm Phase 1 Habitat, NVC and GWDTE report. ES Technical Appendix.* Commissioned Report.

Massey. K and Anderson. D. 2018. *Blarghour Wind Farm Collision Risk Assessment report*. ES Technical Appendix. Commissioned Report.

Massey, K. and Cosgrove, P. 2018. *Blarghour Wind Farm Environmental Statement - Ecology*. Commissioned Report.

Cosgrove, P. and **Massey, K.** 2018. *Blarghour Wind Farm Outline Habitat Management Plan*. ES Technical Appendix. Commissioned Report.

Massey, K., Anderson, D and Cosgrove, P. 2018. *Mossy Hill Bird Technical Report*. ES Technical Appendix. *Commissioned Report*.

Massey. K. 2018. *Mossy Hill Wind Farm Phase 1 Habitat, NVC and GWDTE report*. ES Technical Appendix. Commissioned Report.

Massey, K. and Cosgrove, P. 2018. *Mossy Hill Wind Farm Natural Heritage Desk Study*. ES. ES. Technical Appendix. Commissioned Report.

Massey. K. 2018. *Mossy Hill Wind Farm Collision Risk Assessment report*. ES Technical Appendix. Commissioned Report.

Massey, K. and Cosgrove, P. 2018. *Mossy Hill Wind Farm Environmental Statement*. *Commissioned Report*.

Cosgrove, P and **Massey, K**. 2018. *Mossy Hill Wind Farm Outline Habitat Management Plan.* ES Technical Appendix. Commissioned Report.

Massey, K. 2018. *Phase 1 Habitat Survey of LH Stainless, Towiemore*. Commissioned Report.

Massey, K. 2018. *River Fiddich Abstraction, Non-native Invasive Plant Species Survey 2018*. Commissioned Report.

Massey, K. 2018. *Collision Risk Model for Strathbeg Wind Farm*. Commissioned Report.

Shields, D. and **Massey, K**. 2018. Freshwater Pearl Mussel Survey of the River Dee by Ballater Bridge, Aberdeenshire. Aberdeenshire Council Commissioned Report.

Massey. K. 2017. *Blarghour Wind Farm Phase 1 Habitat, NVC and GWDTE report*. ES Technical Appendix. Commissioned Report.

Massey, K. and Cosgrove, P. 2017. *Lochaber Smelter Environmental Statement – Ecology Chapter*. Commissioned Report.

Massey, K and Cosgrove, P. 2017. *Phase 1 Habitat, Protected Terrestrial Mammal and Bat Roost Potential Surveys at Jacobite Cruises, Loch Ness*. Commissioned Report.

Shields, D. and **Massey, K**. 2017. *Phase 1 Habitat Survey of North Chesthill Hill Track*. Commissioned Report.

Massey, K, Shields, D, Potter, R and McMullen, A. 2017. *National Vegetation Classification Survey and Groundwater Dependant Terrestrial Ecosystem Report for Ourack Wind Farm*. Commissioned Report.

Massey, K. 2017. *Phase 1 Habitat, Protected Terrestrial Mammal and Bat Roost Potential Surveys at Proposed Car Park Extensions at Inverness Airport*. Commissioned Report.

Potter, R. and **Massey, K**. 2017. *National Vegetation Classification Survey Report for Camore.* Commissioned Report.

Massey, K. 2017. *Updated Phase 1 Habitat and Non-native Invasive Plant Species Survey of Carron Den, Stonehaven*. Commissioned Report.

Massey, K and Potter, R. 2016. *Phase 1 Habitat, NVC and GWDTE report for Coul Links*. Commissioned Report.

Massey, K. 2016**.** *Aerial Comparisons of Habitats at Coul Links between 1988, 2009 and 2016*. Commissioned Report.

Shields, D and **Massey K**. 2016. *Fonseca's Seed-fly Botanophila fonsecai Survey Report for Coul Links, Sutherland*. Commissioned Report.

Massey, K. and Cosgrove, P. 2016. *Coul Links Golf Course Environmental Statement – Ecology Chapter.* Commissioned Report.

Cosgrove, P. and **Massey, K**. 2016. *Beaw Field Wind Farm Environmental Statement – Ecology Chapter*. Peel Energy Ltd. Commissioned Report.

Massey. K. and Shields. D. 2016. *Beaw Field Wind Farm Phase 1, NVC and GWDTE report*. Commissioned Report.

Massey. K., Cosgrove, P. and Shields. D. 2016. *Beaw Field Wind Otter survey report*. Commissioned Report.

Massey, K. 2016. *Red-throated diver population modelling for Beaw Field Wind Farm*. Commissioned Report.

Potter, R. and **Massey, K**. 2016. *Phase 1 Habitat Survey Report for Brodie Castle.* Commissioned Report.

Massey. K. and Cosgrove. 2016. *Peatland Hag restoration at Glen Affric*. Commissioned Report.

Shields, D. and **Massey, K**. 2016. *Phase 1 Habitat Survey Report for Culcairn, Evanton, Ross and Cromarty*. Commissioned Report.

Shields, D and **Massey, K.** 2016. *Freshwater pearl mussel survey of the River Dee at Ballater Bridge, Aberdeenshire*. Commissioned Report.

Shields, D and **Massey, K**. 2015. *National Vegetation Classification Survey and Groundwater Dependant Terrestrial Ecosystem Report for a Wind Farm by Bettyhill*. Commissioned Report.

Massey, K. 2015. *Phase 1 Habitat and National Vegetation Classification Survey Report for Grantown-on-Spey Caravan Site*. Commissioned Report.

Shields, D and **Massey, K.** 2014. *Phase 1 Habitat and NVC Survey Report for Kergord access track, North Mainland, Shetland*. Commissioned Report.

Massey, K. 2014. *Preliminary National Vegetation Classification Report for the Proposed Access Track for Pogbie Wind Farm where it crosses the Linn Dean Scottish Wildlife Trust Reserve*. Commissioned Report.

Shields, D and **Massey, K.** 2014. *Protected Terrestrial Mammal Survey Report for Pogbie Wind Farm, East Lothian*. Commissioned Report.

Massey, K. 2014*. Amenity Grassland Project – Grass Species Identification Report*. Commissioned Report.

Shields, D and **Massey, K**. 2014. *Phase 1 Habitat, National Vegetation Classification and Groundwater Dependent Terrestrial Ecosystems Report for Loch Dubh, Lairg, Sutherland*. Commissioned Report.

Massey, K, and Cosgrove, P. 2014. Woodlands Ecological Environmental Statement Chapter. Commissioned Report.

Massey, K. 2014. *Natural Heritage Information Desk Study of Woodlands*, Easter Ross. ES Technical Appendix. Commissioned Report.

Cosgrove, P. and **Massey, K.** 2014. *Hartwood Wind Farm Environmental Statement.* ABO Wind Commissioned Report.

Massey, K. and Cosgrove, P. 2014. *Hartwood Wind Farm Outline Habitat Management Plan*. ABO Wind Commissioned Report.

Massey, K and Shields, D. 2014. *Breachen Court, Grantown on Spey Phase 1 Habitat & NVC Survey Report.* Commissioned Report.

Massey, K. 2014. *Phase 1 Habitat Survey and NVC Report, Branny, Invermark.* Commissioned Report.

Massey, K. 2014. *Phase 1 Habitat Survey and NVC Report, Dalbreck, Invermark*. Commissioned Report.

Massey, K. 2014. *Phase 1 Habitat Survey and NVC Report, Inchmundie,* Invermark. Commissioned Report.

Massey, K. 2014. *Otter and Water Vole Survey for Glenmore, Argyll.* Forestry Commission. Commissioned Report.

Massey, K. 2014. *Phase 1 Habitat and Protected Terrestrial Mammal Survey of Texas Instruments, Larkfield Industrial Estate, Greenock*. Commissioned Report.

Massey, K. 2014. *Natural Heritage Information Desk Study of Texas Instruments, Larkfield Industrial Estate, Greenock*. Commissioned Report.

Massey, K. 2014. *Phase 1 Habitat Survey and National Vegetation Classification Survey Report for Castle Fraser, Aberdeenshire*. Commissioned Report.

Massey, K. 2014. *Natural Heritage Information Desk Study of Corrybrough, Tomatin, Highland Region*. Commissioned Report.

Massey, K. 2014. *Phase 1 Habitat and Non-native Invasive Plant Species Survey of Carron Den, Stonehaven*. Commissioned Report.

Massey, K. 2014. Phase 1 Habitat Survey of Sillyflatt Farm, Inverbervie. Commissioned Report.

Massey, K., Massey, F.P. and Cosgrove, P. 2014. *Peatland Restoration Plan for North Nesting Pilot Study Area*. Commissioned Report.

Massey, K. 2013. *Woodlands Phase 1 and National Vegetation Classification Report*. ES Technical Appendix. Commissioned Report.

Massey, K. 2013. *Phase 1 Habitat Survey Report for Stemster, Caithness*. Commissioned Report.

Massey, K, 2012, *Stronelairg Phase 1 and National Vegetation Classification Report.* Commissioned report.

Cosgrove, P. and **Massey, K**. 2012. *Stronelairg Windfarm Environmental Statement – Ecology Chapter.* Commissioned Report.

Massey, K. 2012. *Bhlaraidh Phase 1 and National Vegetation Classification Report*. ES Technical Appendix. Commissioned Report.

Massey. K. 2012. *Phase 1 Habitat Survey and National Vegetation Classification Report – Levishie Wind Farm*. ES Technical Appendix. Commissioned Report.

Massey, K. 2012. *Balnacoil Natural Heritage Desk Study*. ES Technical Appendix. Commissioned Report.

Massey, K. 2012. *Balnacoil Phase 1 Habitat and NVC Survey Report. ES Technical Appendix*. Commissioned Report.

Massey, K. 2012. *Phase 1 Habitat and NVC Survey Report for Glencassley*. ES Technical Appendix Commissioned Report.

Massey, K, Massey, F.P. and Cosgrove. 2011. *A study to characterise breeding whimbrel habitat on Mainland Shetland: Field seasons 2010 and 2011*. Commissioned report.

Cosgrove, P. Doyle, P. and **Massey, K**. 2011. *Levishie Natural Heritage Desk Study*. ES Technical Appendix. Commissioned Report.

Massey, K., Wilson-Parr, R., Doyle, P. and Cosgrove, P. 2011. *Post-construction monitoring of birds at Slieve Rushen wind farm, Fermanagh: year 3 (2010)*. Commissioned Report.

Massey, K. 2011. *Earlswell Phase 1 Habitat Survey*. Commissioned Report.

Doyle, P. and **Massey, K**. 2011. *Earlswell Natural Heritage Desk Study*. Commissioned Report.

Massey, K., Massey, F.P. and Cosgrove, P. 2011. *A study to characterise breeding whimbrel habitat on Mainland Shetland: Field seasons 2010 and 2011*. Commissioned Report.

Massey, K. 2010. Phase 1 Ecological Survey of an Area Prior To Commercial Development in Portlethen, Aberdeenshire. Commissioned Report.

Massey, K. 2010. *Sallachy Phase 1 Habitat Survey and National Vegetation Classification Survey*. Commissioned Report.

Massey, K. 2010. *Sallachy Natural Heritage Desk Study*. Commissioned Report.

References available on request

Simon Waddell

Associate - Noise

Qualifications and Professional Memberships

- Environmental Geoscience BSc Hons.
- Acoustics and Noise Control PG Diploma
- Certification of Competence in Environmental Noise Measurement
- Member of Institute of Acoustics (MIOA)

Career Summary

Simon Waddell, BSc, MIOA is an experienced environmental consultant, with over 12 years of experience in environmental noise. A technical specialist in environmental noise, but with an appreciation of other environmental disciplines, Simon has extensive experience of noise assessment in accordance with various planning and permitting requirements across the UK, particularly in relation to power generation, energy storage, infrastructure, residential, industrial and waste-related developments.

Simon also has extensive international ESIA experience to both local and international standards, including IFC/World Bank. Experience includes the specification, commissioning and analysis of baseline monitoring campaigns and development of noise source inventories and computational models to international standards to determine potential environmental effects.

Selected Project Experience

UK Noise – Rockets and space

- SaxaVord Spaceport, EIA. Noise assessment of proposed spaceport on Unst, Shetland. Undertook baseline noise survey, predicted construction phase noise levels, liaised with rocket and aircraft noise specialist, interpreted predictions provided by specialist in the context of UK guidance, reported on findings. Spaceport planning application consented.
- SaxaVord Spaceport, AEE. Noise assessment of proposed spaceport on Unst, Shetland. Consulted with CAA, interpreted predictions provided by aircraft and rocket noise specialist in the context of new UK AEE guidance, reported on findings.
- Midlothian, Scotland. Noise assessment in support of proposed rocket engine testing facility. Baseline noise survey, agreement of approach with Environmental Health, prediction of operational noise levels, evaluation against agreed criteria.
- Midlothian, Scotland. Noise compliance monitoring to discharge planning conditions of rocket engine testing facility. Measurement of off-site noise levels at receptor locations, reported on findings. Planning condition discharged by Environmental Health.
- Cockenzie, East Lothian, Scotland. Noise and assessment as part of planning application for operation of proposed rocket engine testing facility within former power station coal storage area. Consulted with Environmental Health, undertook baseline noise survey, predicted operational noise levels via noise modelling, evaluated in accordance with BS4142 and appropriate guidance, attended community consultation events, specified appropriate mitigation, reported on findings.

- Port of Rosyth, Fife, Scotland. Measured noise levels during test firing of a rocket engine. Post-processed measured data to determine sound power level of test and characterise noise emissions associated with testing activities.

UK Noise – Land development

- Giants on the Quayside (Whey Aye Wheel), Newcastle-upon-Tyne, UK. Noise and vibration assessment of proposed observation wheel and associated entertainment facilities as part of EIA. Input to Scoping and consultation with Environmental Health, specified and oversaw baseline noise survey, analysed baseline data, predicted construction noise and vibration levels at sensitive receptors, predicted operational noise levels due to operation of wheel and associated facilities and from changes road traffic flows. Evaluated noise and vibration impact in accordance with BS5228, BS4142 and CRTN, specified appropriate mitigation, reported on findings.
- Whitekirk, East Lothian, UK. Assessment in support of EIA of proposed redevelopment of golf course to holiday lodges. Input to Scoping and consultation with Environmental Health, baseline noise survey, analysis of baseline data, review of baseline and projected traffic flow data, modelling of post development traffic noise in accordance with CRTN. Evaluated noise levels against BS8233 target noise levels, determined noise impacts in accordance with PAN1/2011, specified appropriate outline mitigation, reported on findings.
- Thistle Street NW Lane, Edinburgh, UK. Noise assessment of proposed hotel development within existing commercial building. Constructed detailed noise model of building, including proposed air handling plant, predicted noise levels at windows of neighbouring buildings, evaluation of plant noise against Noise Rating (NR) curves. Specified appropriate mitigation and reported on findings.

UK Noise – Manufacturing and waste

- Lochaber/Fort William, Highlands, Scotland. Noise assessment of proposed aluminum billet plant within Lochaber smelter complex. Consulted with SEPA, undertook baseline noise survey, predicted construction phase and operational phase noise levels. Evaluated predicted levels in accordance with BS5228 and BS4142, specified appropriate mitigation and reported on findings as a chapter within an EIA Report.
- Hillthorn Farm, Sunderland, England. Noise and vibration assessment of proposed business park adjacent to Nissan assembly plant. Consulted with Sunderland City Council, specified baseline monitoring campaign, predicted construction phase and operational phase noise levels, including noise from road traffic. Evaluated predicted levels in accordance with BS5228 and BS4142 and against DMRB criteria, specified appropriate mitigation and reported on findings as a chapter within an EIA Report.
- South Crosland Quarries, Huddersfield, UK. Noise assessments in support of planning applications and EIAs for quarrying and restoration of worked-out quarries using inert waste. Consulted with Environmental Health, specified and oversaw baseline surveys and noise and vibration source characterisation measurements. Predicted and evaluated operational noise and vibration levels. Specified appropriate mitigation and reported on findings.
- Tennents Wellpark Brewery, Glasgow, UK. Noise assessment to meet SEPA requirement for baseline monitoring before commissioning of new anaerobic digestion plant within existing brewery complex. Oversaw baseline noise survey, technical review of noise report.
- New distillery, Highlands, UK. Noise assessment as part of EIA for proposed whisky distillery near Grantown-on-Spey. Consulted with Environmental Health, oversaw baseline noise survey, reviewed available information and developed noise model of proposed distillery complex, evaluated noise from construction and operations phases in accordance with BS5228 and BS4142 respectively, specified appropriate mitigation, reported findings for ES.
- IAMP TWO, Sunderland, UK. Noise assessment as part of EIA for large-scale multi-unit manufacturing complex. Contributed to Scoping and undertook detailed consultation with Environmental Health. Undertook baseline noise survey, predicted noise levels during construction

and operation of the facility, and due to changes in road traffic flows. Vibration assessment considering vibration from piling and from road traffic.

- IAMP ONE, Sunderland, UK. Noise assessment as part of EIA for large-scale multi-unit manufacturing complex. Contributed to Scoping and undertook detailed consultation with EHO. Undertook baseline noise survey, predicted noise levels during construction and operation of the facility, and due to changes in road traffic flows. Specified appropriate mitigation and reported findings. Proposed development was consented and is under construction.
- Ardross Distillery, Highlands, UK. Noise assessment for proposed whisky distillery. Consulted with EHO, reviewed baseline noise data provided by others, reviewed available information and developed noise model of proposed distillery, operations phases in accordance BS4142, specified appropriate mitigation and reported findings.
- Jed Forest Distillery, Scottish Borders, UK. Noise assessment as part of EIA for two proposed whisky and gin distilleries near Jedburgh. Consulted with EHO at Scottish Borders Council, undertook baseline noise survey, reviewed available information and developed noise model of proposed distillery complex, evaluated noise from construction and operations phases in accordance with BS5228 and BS4142 respectively, specified appropriate mitigation, reported findings for ES.
- Buckie Maltings, Moray, UK. Noise assessment of new grain drying shed at maltings complex. Consulted with EHO, specified plan of study for baseline noise survey, reviewed available information and developed noise model of proposed facility, evaluated noise from operations phases in accordance with BS4142 respectively, specified appropriate mitigation, reported findings.

Employment History

- 2005 – 2006 – Mason Evans Partnership – Graduate Engineer
- 2007 – 2012 – Enviros/SKM Enviros/SKM – Consultant
- 2012 – 2016 – Golder Associates – Consultant
- 2016 – Present – ITPEnergised – Principal Consultant

ANNIE DANSKIN

ASSOCIATE – AIR QUALITY

QUALIFICATIONS & PROFESSIONAL MEMBERSHIPS

- BEng (Hons) Environmental Engineering
- Member Institution of Environmental Sciences
- Member Institute of Air Quality Management
- Member of Environmental Protection Scotland Expert Advisory Group on Air Quality

CAREER SUMMARY

Annie Danskin has 21 years of experience in the field of air quality consultancy and research, managing projects for and providing introductory and advanced training courses to many local authorities, regulatory authorities (EA, SEPA, HSE), industrial operators and academic institutions. She has prepared expert witness reports for public inquiries and presented at public meetings, conferences and exhibitions on numerous occasions.

Key projects include air quality impact assessments for EIAs, planning applications and PPC and Environmental Permits; Local Air Quality Management studies for Local Authorities; odour impact assessments and management plans; and assessment of accidental and emergency releases including fires and flares at offshore installations. She is an experienced project manager and is a specialist in atmospheric dispersion modelling, particularly using the full suite of ADMS models. Annie is a member of the Institution of Environmental Sciences and the Institute of Air Quality Management.

SELECTED PROJECT EXPERIENCE

INDUSTRIAL & MANUFACTURING

- Rocket Engine Testing Facility, Cockenzie – Client: Skyrora. Preparation of a dispersion modelling study to assess the potential short-term effects for local residents of exposure to carbon monoxide emissions from jet exhaust emissions during rocket launch events at a proposed rocket engine testing facility. Used the “puff” model to calculate peak exposure concentrations during the lifetime of the release and a total concentration dose experienced at each receptor for the duration of release. Launch events were simulated for a range of meteorological conditions.
- Coffee Roasting Factory, Dundee – Client: Aimers Coffee & Tea. Preparation of a detailed dispersion modelling study of emissions of odour, dust and oxides of nitrogen from a new coffee roasting factory in Dundee. Included analysis of a range of conditions dependent on the raw coffee bean source and the darkness of roasting. Included complex topography, sensitivity to building effects, time-varying emissions profiles and a range of operating scenarios and meteorological conditions. Involved extensive consultation Dundee City Council.
- Alloy Wheel Facility, Lochaber – Client: Liberty Lochaber Aluminium Ltd. Preparation of an EIA Report Air Quality Chapter submitted with the planning application. The Air Quality Impact Assessment (AQIA) included a detailed atmospheric dispersion modelling study to assess the potential impacts of emissions from a proposed new alloy wheel facility and adjacent biofuel generators at sensitive receptors for human health and ecology. Included complex topography, building effects, time-varying emissions profiles and a range of operating scenarios and meteorological conditions. Involved extensive consultation with SEPA, SNH and The Highland Council. Assessment included a Construction Phase Dust Risk Assessment.
- Rosebank and Islay Distilleries – Client: Blyth and Blyth. Technical advisor on stack height analysis, screening of boiler emissions, odour risk assessment and odour management plan.

- Expansion of Wood Pellet Manufacturing Facility, Girvan, South Ayrshire – Client: Land Energy. Project Manager to co-ordinate delivery of air quality, noise, ecology and landscape and visual impact assessments. Included liaison with SEPA and South Ayrshire Council environmental protection officers, site visits, detailed modelling of emissions from wood pellet manufacturing process and Biomass CHP exhaust gases. Complex building configurations and local topography were included in the study.
- Ambient Dust Monitoring at Scrap Metal Facility – Client: Dalton Metals Recycling. Undertaken to check compliance with IPC Permit conditions related to emissions from activities and processes within the site and the ambient concentrations at the site boundary and neighborhood sensitive receptors. Results submitted to SEPA with a dust management plan.
- Granton Distillery, Edinburgh - Client: Halewood International. Odour impact assessment for a proposed new gin distillery adjacent to existing residential receptors. Included dispersion modelling with ADMS-5, and recommended abatement technologies appropriate for the scale of the plant. Submitted with the planning application to City of Edinburgh Council.
- Town Hall Energy Centre, Crawley – Client: Westrock. Assessment of the potential impacts on existing and proposed future residential receptors of emissions from each of two development phases of an energy centre comprising gas boilers and CHP units. Submitted to the local authority with the planning application. Included an assessment of the potential impact mitigation provided by options for low-NO_x equipment.
- Sainsbury's CHP Plant, Dundee – Client: Sainsbury's. Assessment of the site suitability and potential impacts on local air quality from a proposed CHP plant, packaged back-up plant and associated substation do demonstrate no adverse impacts. Dispersion modelling using ADMS-5 included assessment for a range of stack heights.
- Glasgow Caledonian University CHP Plant – Client: GCU. Detailed atmospheric dispersion modelling assessment to assess the impact of the variable emissions profile from the GCU CHP plant on proposed and existing residential receptors at nearby development sites. Included complex topography, building effects and emissions from adjacent roads. Undertaken in order to discharge a planning condition imposed by Glasgow City Council
- PPC Permit Application for Enviroco at Albert Quay, Aberdeen. Project manager for the compilation of environmental assessments to support an application for a permit under the Pollution Prevention and Control (Scotland) Regulations 2000 (the PPC Regulations) for a Part A installation in the Waste Management Sector, administered by Enviroco at a site at Albert Quay, Aberdeen. The site is involved in the storage of hazardous waste received from offshore North Sea facilities pending transfer to a licenced disposal site, where it is processed in line with the PPC Regulations, where these are appropriate. The project included pre-application meetings with the Scottish Environment Protection Agency and submission of the final application.
- Environmental Permit Variation Application for Enviroco, Great Yarmouth. Project manager for the compilation of environmental assessments to support an application for a permit variation under the Environmental Permitting Regulations (England and Wales) 2010 for a Part A installation in the Waste Management Sector, administered by Enviroco in Great Yarmouth. The site was undergoing extensive expansion and introducing significant improvements for pollution prevention and control. The permit variation consolidated the previous permit, waste management licence and previous exemptions that applied to the site. The project included pre-application meetings with the Environment Agency and submission of the final application.

PROPERTY & URBAN REGENERATION

- Edinburgh Park Southern Phase, Residential-Led Mixed Use Development, Edinburgh – Client: Parabola Edinburgh LLP. Technical lead on an air quality impact assessment of a residential-led mixed-use development. Included dispersion modelling with ADMS-Roads to predict the potential effects of traffic-generated pollutants on air quality at existing and proposed receptors including a large number of projected cumulative impacts from allocated development sites included in the West Edinburgh Transport Appraisal (WETA). Additional assessment of impacts was undertaken

within two nearby AQMAs. A comprehensive six-month ambient air quality monitoring survey was also undertaken at locations around the proposed development boundary, and the data used to verify the dispersion model. The study also included an odour risk assessment due to the proximity of the proposed development to a poultry farm and included several odour sampling surveys in a variety of meteorological conditions and operational scenarios at the poultry farm.

- Johnnie Walker Experience, Edinburgh – Client: DIAGEO. Air quality impact assessment of a visitor experience development including the potential effects on local air quality of development-generated traffic, combustion source emissions and kitchen extraction systems at existing and proposed receptors including within the adjacent Edinburgh Central AQMA.
- Ratho Station Residential Development, Edinburgh – Client: Taylor Wimpey East of Scotland. Technical lead for an air quality impact assessment of a residential development for multiple iterations of site layout and road traffic scenarios. The air quality assessment included dispersion modelling with ADMS-Roads to predict the potential effects of traffic-generated pollutants on air quality at existing and proposed receptors including within the adjacent Glasgow Road AQMA. Included a Construction Phase Dust Risk Assessment.
- Crofthead, Bishopbriggs – Client: Mactaggart & Mickel Homes. Preparation of a detailed dispersion modelling study and report assessing the effects of changes in traffic flow on the local road network and the impacts for air quality, particularly within the Bishopbriggs AQMA. Assessment included a Construction Phase Dust Risk Assessment and site suitability assessment for residential use.
- Bishopsgate Office Redevelopment, London – Client: Estates Office Shoreditch. Technical Lead for air quality assessment for the partial demolition and redevelopment of commercial premises to mixed office and retail use. Included the impact of traffic and energy centre emissions on existing local receptors and proposed future occupants of the building. An Air Quality Neutral Assessment in accordance with London Council's Air Quality Guidance was included. Assessment included a Construction Phase Dust Risk Assessment.
- Kenmuir, Carmyle – Client: Arm Architects. Technical lead for an air quality impact assessment of a residential masterplan development and preparation of an EIA report chapter. The air quality assessment included dispersion modelling with ADMS-Roads to predict the potential effects of traffic-generated pollutants on air quality at existing and proposed receptors. Three site access routes were assessed and advice given to the design team regarding required distance of future residences from roadsides. Assessment included a Construction Phase Dust Risk Assessment and screening of the potential impacts at the development site from nearby industrial sources.
- Corton Village Development, Ayr – Client: Manse Investment. Technical lead for an air quality impact assessment of a residential/educational/commercial masterplan development and preparation of an EIA report chapter. The air quality assessment included dispersion modelling with ADMS-Roads and ADMS 5 to predict the potential effects of traffic-generated and energy centre-generated pollutants on air quality at existing and proposed receptors. The study included a large number of projected cumulative impacts from allocated development sites the Ayr/Prestwick area. Assessment included a Construction Phase Dust Risk Assessment.
- Retail Development, Cupar – Client: London and Scottish Investments Limited. Preparation of a detailed dispersion modelling study and report assessing the effects of changes in traffic flow and Drive-Thru queueing traffic on the local road network and the impacts for air quality, particularly within the Cupar Bonnygate AQMA.
- Cammo Fields Residential Development, Maybury Road, Edinburgh – Client Cala Homes. Technical lead for an air quality impact assessment of a residential development and preparation of an EIA report chapter. The air quality assessment included dispersion modelling with ADMS-Roads to predict the potential effects of traffic-generated pollutants on air quality at existing and proposed receptors including a large number of projected cumulative impacts from allocated development sites included in the West Edinburgh Transport Appraisal (WETA). Additional assessment of impacts was undertaken within a nearby AQMA. Supplementary reports including an assessment of the potential for odour impacts from a nearby composting facility

- Commercial Development, Chapelhall, North Lanarkshire – Client: Gray Planning. Preparation of a detailed dispersion modelling study and report assessing the effects of changes in traffic flow on the local road network and the impacts for air quality, particularly within the Chapelhall AQMA. Assessment included a Construction Phase Dust Risk Assessment.
- Gilston Farm, Polmont – Client: Acies Group. Management and technical delivery of an air quality impact assessment for a mixed residential and commercial development. The air quality assessment included dispersion modelling with ADMS-Roads to predict the potential effects of traffic-generated pollutants on air quality at existing and proposed receptors. An additional odour and dust risk assessment was undertaken to determine the potential for nuisance complaints from future residents due to the proximity to existing landfill and waste management sites. Mitigation measures were recommended where appropriate, to minimise the potential for adverse residual effects being experienced by sensitive receptors during the construction and operational phases of the proposed development.
- Clyde Waterfront & Renfrew Riverside and Glasgow Airport Improvement Area City Deals Projects- Client: Renfrewshire Council (2016-present). Senior team member to undertake air quality impact assessment of both schemes individually and assess the cumulative impact of both in conjunction with development projected to be facilitated by the Proposed Development. Including advanced dispersion modelling and GIS techniques and extensive data management. Preparation of material for public exhibitions and culminating in the production of three separate Environmental Statement Chapters on Air Quality with detailed technical appendices plus contributions to Climate Change chapters.
- A720 Sheriffhall Roundabout, Edinburgh – Client: Transport Scotland (2015). Senior team member to undertake DMRB Stage 2 Options Appraisal which involved a qualitative assessment of the various options based on the proximity to a range of identified sensitive receptors and the likely implications on traffic flows. Subsequent design and management of a baseline 6-month ambient air quality monitoring survey at 8 sensitive receptor locations and a detailed Stage 3 DMRB assessment of the preferred option, requiring detailed atmospheric dispersion modelling of road traffic emissions.

OIL & GAS

- Armada Kraken FPSO Vessel – Client: PI Ltd. Technical lead for assessment required to support an application to operate the vessel under Offshore Combustion Installations (Prevention and Control of Pollution) Regulations 2001. The purpose of the assessment was to predict pollutant concentrations of key substances at the nearest platforms within the North Sea, human receptors on the vessel and the nearest inhabited landfall point. The assessment considered the atmospheric emissions from the installation during normal gas and crude oil operations of the Steam Boiler Package (SBP) and the Power Generation Module (PGM).
- Montrose Alpha Offshore Installation – Client: PI Ltd. An assessment of atmospheric emissions from the existing installation and additional sources on a new bridge linked platform (BLP) adjacent to the Montrose platform, required to support an application to vary the PPC permit for the installation.
- Brent Removal and Dismantlement – Client: Shell (UK) Ltd. Management and technical delivery of Air Quality Environmental Statement chapter for the EIA to address the potential effects of the Brent Delta topside transfer to barge, inshore transit and onshore dismantlement project on air quality in Hartlepool.
- South Stream Russia to Bulgaria Pipeline. Member of project team that assessed the air quality impact of a proposed major gas pipeline between Russia and Bulgaria. The main focus of the assessment was the impact of construction phase emissions on sensitive receptors in close proximity to the landfall sections and pipeline corridor onshore. The assessment considered emissions from shipping, construction plant and road traffic within the affected areas.
- BAT Assessment of Odour Abatement Options and Odour Management Plan for PPC Compliance at Nigg Terminal. Review of potential odour emission sources on-site including jetty operations,

ship-to-ship transfer, crude oil reception and separation, ballast tanks, API separators, settlement tanks and lagoons and recommendations for priority control. The study included a BAT assessment of options for odour control and abatement and the development of new management procedures.

ONSHORE/OFFSHORE RENEWABLES

- Peaking Power Plants – Client: Forsa Energy. Technical advisor on detailed stack height analysis and dispersion modelling assessments of peaking power plants in Dundee and Greenock including assessment of Medium Combustion Plant Directive emissions limits. One site included consideration of the potential impacts of existing nearby wind turbine wakes on the dispersion of industrial emissions from new stacks.
- Gas-Fired Peaking Power Plant, Haydock – Client: LCFG Ltd. Assessment of the potential impacts on local air quality and in particular at a nearby Air Quality Management Area, of emissions from fourteen gas-fired engines. The assessment accounted for variable hours of operation and focused on the potential to exceed short-term air quality standards at sensitive receptors. The assessment also included stack height optimisation.
- Biomass Installation at Blackcraig Castle – Client: John Noel Thompson. Preparation of an air quality assessment to assess suitability of a proposed site for a wood fired biomass system.
- Biomass CHP Plant, Wellingborough – Client: Padd Energy. Technical lead on air quality assessment undertaken as part of an application for an Environmental Permit to the Environment Agency. Includes risk assessment, dispersion modelling, BAT assessment and the development of management plans to minimise emissions to atmosphere from the operation of the plant.
- River Tay District Heating Scheme – Client: Perth and Kinross Council – An assessment of the potential effects on local air quality of emissions of oxides of nitrogen (NO_x) from the use of gas-fired top-up boilers that are part of the scheme. Included an assessment of the potential net NO_x reduction in tonnes/annum across the City as public sector properties connected to the scheme.
- Raigmore Hospital, Inverness – Client: NHS Highland. Management and delivery of an atmospheric dispersion modelling study submitted with the planning application to Highland Council for the installation of two 1.7MW wood pellet boilers at Raigmore Hospital in Inverness. The study assessed the potential environmental impact and risk to human health of emissions from the existing multi-flue stack in a number of possible power generating scenarios at the hospital.

CORPORATE ADVISORY

- Review and Assessment of Air Quality for Local Authorities. Project Manager for a series of assessments for Scottish Local Authorities required as part of the Local Air Quality Management regime implemented under the Environment Act 1995. Included collation of emissions inventories including industrial, commercial, domestic and road traffic sources across the Council areas and within hotspots and Air Quality Management Areas (AQMAs); detailed dispersion modelling studies to determine source contributions and inform Action Plans for improvement; advise on air quality monitoring campaigns and preparation of annual reports.
- Assessing the Potential Air Quality Impact from Biomass Installations in the Planning Process, Workshop – Client Moray Council. Preparation and delivery of a half-day workshop for 4 personnel from the Moray Council Department of Public Health to assist the team in the assessment of planning applications for biomass installations within the Moray region with respect to local air quality impacts. Included practical exercises interpreting data supplied with the EPUK Biomass Boiler Information Request Form provided by applicants, and the use of spreadsheet screening assessment tools. Guidance was also given on when to ask applicants for more detailed assessments and how to consider cumulative impacts with other sources.

EMPLOYMENT HISTORY

- AECOM/URS – Principal Consultant - Responsible for business development in Scotland and providing training, mentoring, technical review and specialist advice on the effects of buildings and topography on atmospheric dispersion to the air quality consultancy teams located across the UK. Delivery of AQIAs for complex industrial sites and high profile developments including effects on human health and sensitive habitats and ecosystems at offshore and onshore locations.
- TSI Scotland – Air Quality Specialist - Primarily focused on the Environmental Consultancy part of the business but also provided support in the Energy business, undertaking energy audits and assessments for the Carbon Trust and developing and delivering energy awareness training programs for private and public sector clients.
- BMT Cordah – AQIAs for EIAs, planning applications and PPC permit applications for a wide range of property developers and industrial operators including companies from the oil and gas, power producing, waste management, renewables, chemical, cement and pulp and paper industries. Providing technical support and advice to UK Local Authorities on the regulatory regime of Local Air Quality Management (LAQM) and assisting them in fulfilling their obligations to review, assess and improve local air quality. Included preparation of review and assessment reports, compilation of emissions inventories including industrial, traffic and domestic sources, screening and detailed modelling studies and the development of Air Quality Action Plans (AQAP) for improvement.
- CERC - Major involvement in the development of the ADMS range of dispersion models including code testing, development of user guide documentation and completion of validation studies. Project manager on the development and delivery of introductory and advanced customised training courses in atmospheric physics and the use of dispersion models to individuals and audiences of up to 30 including personnel from industry, local authorities and regulatory agencies. Manager of the technical support helpdesk advising over 200 clients. Development of a database system for logging and responding to queries, and providing user-feedback to the model-development team in order to ensure continuous improvements to future versions of software. Consultancy services to a wide range of industrial clients from manufacturing, power producing, petrochemical and waste management industries, providing AQIAs and stack height analysis services to demonstrate compliance with environmental permit conditions or to accompany planning applications.

MarineSpace
Making Sense of the Marine Environment™

Curriculum Vitae

Ian Reach

Principal Marine Scientist

Email: Ian.reach2@marinespace.co.uk

AREAS OF EXPERTISE

Ian has 28 years' experience as a marine ecologist and environmental auditor. Ian developed his marine ecological skills as part of JNCC's Marine Nature Conservation Review team and then in his role as Senior Marine Ecologist at Natural England. In this role Ian developed common standards monitoring, Natura 2000 marine SAC designations, and detailed knowledge of the legislative frameworks for UK waters; specialising in management advice to the marine aggregate and offshore renewables sectors. At MarineSpace, Ian has established himself as a leading marine environmental consultant delivering a range of projects. Ian can apply specialisms including marine ecology and nature conservation impact assessment, Expert Witness representation, and negotiation with Governmental and statutory bodies during licensing and HRA processes. He has a track record of HRA including plan-level, and strategic assessment for seabed user operations, allowing efficient and compliant delivery of assessments for operators and regulators alike. Ian is recognised as an international expert on *Sabellaria spinulosa* reefs and subtidal sandbank functionality and conservation.

KEY SKILLS

- Management and consenting advice of marine and coastal projects/developments;
- Strategic and Regional Environmental Assessment and Environmental Impact Assessment;
- Marine Protected Area advice/Habitats Regulations and Marine Conservation Zone Assessments;
- Production of adaptive environmental management plans, and mitigation and monitoring proposals;
- Managing compliance with permit conditions on behalf of clients;
- Strategic marine environmental research and assessment projects.

CAREER

2011 – Present:	MarineSpace Ltd, **Principal Marine Scientist**
2010 – 2011:	Natural England, **Principal Specialist Marine Ecology and Marine Operations**
2007 – 2010:	Natural England, **Senior Specialist Marine Ecology and Marine Aggregate Operations**
2006 – 2007:	Natural England, **Specialist Marine Operations – Offshore Wind**
2001 – 2006:	English Nature, **Specialist Marine Ecology and Marine Protected Area Officer**
1999 – 2001:	English Nature, **Wildlife Warden – Lundy Marine Nature Reserve**
1994 – 1997:	JNCC, **Marine Ecologist – Marine Nature Conservation Review**

QUALIFICATIONS/PROFESSIONAL AFFILIATIONS / POSITIONS

1993 BSc. (Hons) Marine Biology with Fish Biology, University of Plymouth, UK

Professional Member of the Marine Biological Association UK. Advisor to: ICES Working Group on Marine Systems; Pelagic Advisory Council; New York Energy Research and Development Authority Offshore Wind State of the Science Benthos and Birds Working Groups; U.S. Regional Wildlife Science Entity Bird and Bat, and Ecosystems Subcommittees; JNCC Offshore Wind Environmental Evidence Register Working Group.

SELECTED RECENT PROFESSIONAL EXPERIENCE

2022 - ongoing Skyrora XL LV – AEE, Syrora
Technical lead. Transboundary AEE Chapter.

2021 Astraius LV – MERA for AEE, Astraius/Prestwick Space Port
Technical lead. Transboundary MERA for AEE Chapter.

2021 Shetland Space Centre – AEE, SaxaVord
Technical lead. Transboundary AEE Chapter.

2021 Shetland Space Centre – AEE, SaxaVord
Technical lead. Review of the CAA AEE Regulations for client.

2020 - 2021 Shetland Space Centre – EIA, SaxaVord
Technical lead. Transboundary EIA Chapter.

2021 - ongoing 3 Array Assets, Ørsted
Technical lead. Environmental appraisal, HRA and MCZ Risk Assessments, Marine Licence applications for Array Cable Protection System stabilisation emergency work campaigns for 3 arrays/offshore wind farms.

2021 4 Array Assets, Ørsted
Technical lead. Environmental appraisal, HRA and MCZ Risk Assessments, Marine Licence applications for Array Cable Protection System stabilisation emergency work campaigns for 4 arrays/offshore wind farms.

2021 - ongoing Gas Pipeline Stabilisation and Decommission Programme, Perenco
Technical lead. Environmental appraisal, HRA and survey scope for all southern North Sea pipeline assets. Developing survey Sop's. Biogenic reef data interpretation and assessment. Liaison with SNCBs.

2020 - ongoing Round 4 Offshore Wind, Site Characterisation
Technical lead. Critical review of consenting risk associated with HRA issues for client.

2020 - ongoing Erebus Floating Offshore Windfarm – Environmental Statement, Blue Gem Wind
Technical Lead. HRA and EIA co-ordinator and lead assessor and QC.

2019 - ongoing Race Bank Wind Farm – Annual Monitoring Reporting, Ørsted
Technical Lead. Analysis of post-construction survey data, HRA compliance and innovative sandeel monitoring programme lead.

2019 - ongoing Lincs Wind Farm – Annex I reef habitat survey – Ørsted
Technical Lead. Analysis of acoustic data to identify Annex I *Sabellaria spinulosa* reef habitat within the wind farm array and Inner Dowsing, Race Bank and North Ridge SAC.

2019 – ongoing Morlais Tidal Array Demo – EIA, Mentor Môn
Technical lead. EIA chapters for assessment of tidal stream demonstration project. Benthic ecology, migratory fish baseline and assessment chapters. Advice concerning HRA issues.

2018 – ongoing Lincs Wind Farm, Transmission Capitol
Technical Lead. Information to identify consenting risk and inform HRA in support of export cable remediation O&M licence.

2014, 206, 2018 The Crown Estate Marine Mineral Licensing Round HRA, The Crown Estate
Technical Lead. Plan-level HRA in support of the last three marine aggregates licensing rounds.

2018 Race Bank Wind Farm – Annex I reef habitat survey – Ørsted
Technical lead. Design of subtidal drop-down video survey to identify Annex I *Sabellaria spinulosa* and cobble reef habitat along export cable route post-installation.

2018 Regional Cumulative Effect Assessments of Marine Aggregate Extraction Operations on Atlantic Herring Spawning Habitat and Sandeel Habitat, various Dredging Associations

Project Director and Technical Lead. Updated 2013 methodology to identify, map and assess herring and sandeel habitats and assessment of impacts from marine aggregate dredging for 4 strategic regions.

2017 – 2019 London Array Wind Farm, London Array Ltd
Technical Lead. HRA of cable remediation O&M licence/turbine replacement HRA / mitigation plan.

2017 – 2019 London Array Wind Farm, Blue Transmission London Array
Technical Lead. HRA in support of export cable remediation O&M licence.

2014 – 2015 Dogger Bank Creyke Beck Offshore Wind Farm Public Examination, Forewind Ltd
Expert Adviser. Benthic ecology and marine nature conservation support and HRA for Dogger Bank SCI. Support during examination, including expert witness client representation during public hearings.

2014 Atlantic Herring Spawning Habitat Strategic Assessment Workshop, European Dredging Association and International Council for the Exploration of the Sea (ICES)
Technical Expert. Led session at the ICES Working Group on Marine Systems (WGMARS) in Copenhagen, regarding innovative strategic methods of regional-scale Atlantic herring habitat classification.

2014 Race Bank Wind Farm – Annex I reef habitat survey – Centrica
Technical Expert. Design of subtidal drop-down video survey to identify and characterise Annex I *Sabellaria spinulosa* and cobble reef habitat along export cable route pre-installation.

2013 – 2014 Lincs Wind Farm, Centrica Renewables Energy Ltd / Lincs Wind Farm Ltd
Technical Expert. Developed innovative approach to HRA delivery for a 20 year O&M licence regarding HRA of jack-up rigs in a SAC. Adopted by MMO as a standard for efficient delivery of long-term O&M licenses.

SELECTED PUBLICATIONS

Contributing author to: Cook, A., K.A. Williams, E. Jenkins, J. Gulka, and J. Liner. 2021. Bird Workgroup Report for the State of the Science Workshop on Wildlife and Offshore Wind Energy 2020: Cumulative Impacts. Report to the New York State Energy Research and Development Authority (NYSERDA). Albany, NY. 37 pp. Available at https://www.nyetwg.com/2020-workgroups.

Contributing author to: Degraer, S., Z.L. Hutchison, C. LoBue, K.A. Williams, J. Gulka, and E. Jenkins. 2021. Benthos Workgroup Report for the State of the Science Workshop on Wildlife and Offshore Wind Energy 2020: Cumulative Impacts. Report to the New York State Energy Research and Development Authority (NYSERDA). Albany, NY. 45 pp. Available at http://www.nyetwg.com/2020-workgroups.

Reach I.S., 2016. *UK Aggregate Extraction and Atlantic Herring Spawning Habitat: Identification, Assessment, and Adaptive Environmental Management*. Proceedings of the ICES Annual Science Conference, Riga 2016.

Lloyd Jones D., Langman R., **Reach I.S.**, Gribble J., and Griffiths N., 2016. *Using Multibeam and Sidescan Sonar to Monitor Marine Aggregate Dredging*. In: Seafloor Mapping along Continental Shelves: Research and Techniques for Visualizing Benthic Environments. C.W. Finkl and C. Makowski (eds.), Coastal Research Library 13. Springer International Publishing, Switzerland.

Pastoors M., **Reach I.S.**, Worsøe Clausen L., Russell M., Wiseman A., Ohms V., Reedtz-Sparrevohn C., Strehlow H., Dankel D.J., and Goldsborough D., 2015. *Using a science-industry partnership to identify herring spawning locations in the North Sea*. Proceedings of the ICES Annual Science Conference, Copenhagen 2015.

Lloyd Jones D., Backstrom J., and **Reach I.S.**, 2014. *Regional Environmental Assessment of Marine Aggregate Dredging Effects: The UK Approach*. In: Environmental Management and Governance: Advances in Coastal and Marine Resources. C.W. Finkl and C. Makowski (eds.), Coastal Research Library 8. Springer International Publishing, Switzerland.

Reach I.S., Henson K., Golding T.J., Murphy K.J., Langman R.J., Coates A.S., Warner I.C., Hatton L., Wright, S., and Leake S., 2013. *Marine Aggregate Licence, Renewal and Application Areas: A Report to Inform an*

Appropriate Assessment (in combination), on the classified Red-throated Diver population of the Outer Thames Estuary Special Protection Area - Version 1.0. A Report produced for BMAPA to inform MMO.

Reach I.S., Latto P., Alexander D., Armstrong S., Backstrom J., Beagley E., Murphy K., Piper R., and Seiderer L.J., 2013. *Screening Spatial Interactions between Marine Aggregate Application Areas and Atlantic Herring Potential Spawning Areas.* A Method Statement produced for British Marine Aggregate Producers Association.

Reach I.S., Cooper W.S., Firth A.J., Langman R.J, Lloyd Jones D., Lowe S.A. and Warner I.C., 2012. *A Review of Marine Environmental Considerations associated with Concrete Gravity Base Foundations in Offshore Wind Developments*. A report for The Concrete Centre by Marine Space Limited. 160pp.

Limpenny D.S., Foster-Smith R.L., Edwards T.M., Hendrick V.J., Diesing M., Eggleton J.D., Meadows W.J., Crutchfield Z., Pfeifer S., and **Reach I.S.**, 2010. *Best methods for identifying and evaluating Sabellaria spinulosa and cobble reef*. Aggregate Levy Sustainability Fund Project MAL0008. Joint Nature Conservation Committee, Peterborough, 134 pp. ISBN: 978-0-907545-33-0.

Morris R.K.A., **Reach I.S.**, Duffy M.J., Collins T.S., and Leafe R.N., 2004. Forum: On the loss of saltmarshes in south-east England and the relationship with *Nereis diversicolor*. *Journal of Applied Ecology*, 41: pp. 787-791.

Reach I., 2002. The occurrence of the non-native brown alga *Sargassum muticum* and red alga *Asparagopsis armata* at Lundy. *Annual Report of the Lundy Field Society*, 51, 113-115.

Gavin Bollan

Technical Director

Qualifications and Professional Memberships

- BSc (Hons.) Environmental Science
- Chartered Environmentalist (CEnv)
- Chartered Scientist (CSci)
- Member of the Institution of Environmental Sciences (MIEnvSc)
- Fellow of the Institute of Air Quality Management (FIAQM)

Career Summary

Gavin has over 25 years of experience in the environment industry, more than 20 years of which has been in consulting. He has been active in Environmental and GHG Inventories and Permitting and industrial air pollution control and management in the UK since the 1990s. He has also been a practitioner and verifier of life cycle impact assessments at product and project level since 2011.

Gavin is an analytical chemist by training, having spent four years after graduation in industry as site environmental chemist, with responsibility for measuring emissions to air and water.

His work in consultancy was initially in air quality management, in the fields of industrial emissions, ambient air quality and occupational hygiene monitoring. Gavin has produced a suite of guidance for UK regulators in the UK on gaseous and particulate monitoring techniques which called on this direct experience.

In the 2000s he developed innovative major capital project carbon footprinting and lifecycle analysis services for Atkins, with a focus on transparency and traceability in source data, emission factors and calculation methodologies. He has also worked on some of the UK's largest infrastructure projects including major highway upgrades, high speed rail and the development of the London Olympic Park.

At ITPEnergised, Gavin is Technical Director with the Advisory Services business stream with responsibilities covering industrial air pollution permitting and pollution control issues, assisting clients with their obligations under the Industrial Emissions Directive and the latest iterations of Best Available Techniques for pollution control. He brings the benefit of long experience across multiple sectors in pollution control and especially greenhouse gas management to clients promoting clean and future energy projects. Since joining ITPEnergised in 2018 he has written several Environmental Statement / EIA Report climate chapters for transportation, industrial and commercial building developments, examining climate vulnerability and resilience, generating greenhouse gas inventories for project lifecycles and working with design teams on practical and measurable ways to reduce energy usage and GHG emissions. He is ITPEnergised's principal author of Major Accident and Disaster chapters for Environmental Statements, which calls on his extensive experience of industrial process operation and control.

Selected Project Experience

Climate Change Impact Assessment and Sustainability

- Climate Change (Resilience and GHG Emissions), various, England / Scotland, 2019-2022 chapters on several project including the Saxa Vord Space Centre, the Hillthorn Farm commercial development and the Alvance Aluminium Smelter extension. Analysis of future Met Office projections and assessment of project vulnerability. Development of GHG and energy inventories for critical review and development of mitigation strategies at construction and operational stages.
- Offshore Wind supply chain carbon strategy, Inch Cape, Scotland, 2021. Development of supply chain GHG emissions evaluation strategy and internal awareness presentation.
- Carbon analysis and energy efficiency optioneering, Trans Adriatic Pipeline (TAP), Greece and Albania, 2019-2020. Detailed analysis of fixed asset operating options to reduce GHG emissions and operating costs.
- Energy Statement and Project GHG Inventory, Ras al-Khair Industrial City, Royal Commission in Jubail, Saudi Arabia, 2011-2019. Thermal power and industrial emission inventory.

Major accidents and disasters

- Environmental Statement / EIA Report chapters, England / Scotland, 2019-2022. Qualitative environmental risk chapters for several project including the Saxa Vord Space Centre, the Hillthorn Farm commercial development and the Alvance Aluminium Smelter extension.

Renewable Energy Advisory

- Confidential green hydrogen development projects, Protium Green Solutions, England / Scotland / Wales, 2020 - date. Account Manager and Adviser on project facilitation and compliance, on several prospective renewably-powered electrolytic hydrogen production installations.
- Uskmouth Power Station Conversion, Wales, Simec Atlantis Energy, 2018-2021. Client's Agent, Simec Uskmouth Power. Embedded technical adviser in client's permitting and engineering teams for a former coal fired power station conversion in Wales
- Keadby Power Station, SSE Thermal, England, 2020. Carbon intensity evaluation for GHG abatement and alternative fuel scenarios.
- Low Carbon Infrastructure Transition Plan, Scottish Government, 2019 – date. Technical evaluation of Scottish Government grant applications for low carbon technology developments including water source heat pumps, green hydrogen and wind Power to X projects.
- Solar and Wind Energy Resource Assessments, Various Clients, Scotland and England, 2020-date. Project director and critical reviewer.
- Clean Development Mechanism Prefeasibility, Fadhili Gas Plant, Saudi Aramco, 2015. Review of planned activities with potential to generate carbon credits

Lifecycle Assessment

- Energy and Carbon Assessment, Thames Tideway Tunnel, 2011 – 2012. Tasks included a full lifecycle carbon model for the construction and operation of the tunnel, an Energy Statement to London Plan requirements and an options appraisal for renewable offsetting technologies.
- Full Multiparametric LCA, Sulzer Pumps, Germany 2011-2014 Cradle-to-grave assessments and voluntary disclosure report verification for industrial pumping products and construction products. Working in the capacity of official verifier for the International Environmental Performance Declaration consortium; developed assessment methodology, audit framework and reporting protocols. Desktop audit complemented by site visits in Germany and Switzerland.

Peter Dunmow BA(Hons) DipLA MA(Hons)

Chartered Landscape Architect



Qualifications

BA (Hons) Landscape Architecture, Greenwich University, 1991

Dip LA, Landscape Architecture, Greenwich University, 1993

MA (Hons) Landscape Architecture, Greenwich University, 1996

Affiliations

Chartered Member of the Landscape Institute

Fields of Competence

Peter has twenty five years of experience in Landscape Architecture and Urban Design, managing and working on a range of projects throughout the UK and overseas. His experience covers the full range of landscape consultancy services including landscape and visual impact assessments, comprehensive planning supporting statements and public inquiry evidence for a range of developments including wind farms and other renewable developments, overhead power lines, substation projects, biomass plants, business parks, housing, roads, quarry and mineral developments. Peter has prepared a range of townscape assessment work for a variety of new retail, commercial and residential developments as well as analysis and survey for urban renewal, regeneration and design studies. In addition, Peter complements these skills with considerable experience in masterplanning, detailed site planning and contract management.

Career History

HEPLA - Hermitage Environmental Planning and Landscape Architecture Limited

Director 2015

Enviros Consulting/ SKM Enviros/ Jacobs

Landscape Technical Lead 2005 – 2015

Farningham McCreadie Partnership

Principal Landscape Architect 1999 - 2005

Chris Blandford Associates, Sussex

1994 - 1999 Landscape Architect

British Waterways, Northamptonshire

Assistant Landscape Architect 1991 - 94

Technical Skills	Management Skills
• Expert Witness	• Organisation and Motivation
• Landscape and Visual Impact Assessment	• Team Management
• Environmental Impact Assessment	• Technical Leadership
• Masterplanning	• Commercial Focus
• Urban Design	• Market Adaption
• Townscape Studies and Assessments	• Project Management
• Landscape Design and Implementation	• Contract Management

Relevant Experience

Public Inquiries

- Pencloe Wind Farm Inquiry (2017) – Provision of support Inquiry Team on landscape and visual matters including preparation of an updated cumulative landscape and visual impact assessment, input to the Inquiry Report and Precognition, cross examination strategy. Appeal allowed. (North British Wind Energy/Invenergy)
- Fallago Rig Extension Inquiry (2017) –Preparation of Inquiry Report, Precognition and acted as Landscape Expert Witness at this wind farm Inquiry, held in the Scottish Borders. Appeal decision pending. (Scottish Borders Council)
- Kentish Flats Offshore Wind Farm Extension - Preparation of submissions to the Examination In Public (Vattenfall)
- Inverness Local Plan Inquiry – Preparation of a Statement of Evidence and accompanying documents in support of an allocation for residential development, including attendance and presentation of evidence at Inquiry. (William Gray Construction)
- Shawfair Local Plan Inquiry - Preparation of a Statement of Evidence including an independent Landscape and Visual Impact Assessment of the 'South East Wedge' area of Edinburgh for presentation at a Local Plan Inquiry with specific reference to housing land allocations. (Edmonstone Developments Ltd)
- Dungannon and South Tyrone Local Plan Inquiry - Preparation of Statements of Evidence including Landscape and Visual Impact Assessments of various subject lands for presentation at a Local Plan Inquiry with specific reference to housing/business land allocations. (Dungannon and South Tyrone Borough Council)
- Shawfair Local Plan Inquiry - Preparation of a Statement of Evidence including a supporting Landscape and Visual Impact Assessment for presentation at a Local Plan Inquiry with specific reference to housing land allocations. (Bett Homes Ltd)

Planning Appeals

- Dell Wind Farm – Preparation of landscape and visual aspects of the Statement of Appeal and associated appendices. (Coriolis Energy Limited)
- Article 33 Inquiry - Campbell College, Belfast - Preparation of Statements of Evidence in support of proposed residential developments including supporting Landscape and Visual Impact Assessments and full and detailed mitigation strategies for presentation at an Article 33 Planning Inquiry. (Campbell College Board of Governors)
- London Road, Kilmarnock - Preparation of a Townscape and Visual Impact Assessment in support of the conversion of a former nursing home, forming part of a written submission to the Scottish Executive, Planning and Conservation Area Consent Appeal . (Silverdale Developments Ltd)
- St. Patrick's Church, Cowgate — Preparation of Townscape and Visual Impact Assessment in support of a hotel development in the Edinburgh Old Town Conservation Area forming part of a written submission to the Scottish Executive, Planning and Conservation Area Consent Appeal.
- Straid Road, Ballycastle – Preparation of statement of evidence and documents in support of a small residential development, including attendance and participation in an informal hearing. (Private Client)

Presentations, Consultation and Lecturing

- Delivery of lecture to the MSc / Diploma Postgraduate Course in EIA – Landscape and Visual impact Assessment in EIA, Scottish Rural College. (2020)
- All Energy Conference Paper, Aberdeen, June 2013 – 'Cumulative Assessment – Visualisation Techniques'. Peter set out a review current best practice in the use of graphics to support the cumulative assessment of wind farms.
- Renewables UK Conference Paper, Glasgow, November 2010 – 'Views from the Front: Residential Visual Amenity and Settings Assessment'. Peter set out a user friendly guide to the evolving methodologies for the presentation of robust assessments.
- Provision of EIA module lecturing to the MSc/PG Dip in Ecological Economics – Introduction to Landscape and Visual impact Assessment lecturing role with the Scottish Agricultural College. (2009-2011)
- Scottish Government Planning Advice - Enviros Consulting Ltd MacRoberts LLP were appointed by the Scottish Government to provide support and advice including landscape advice to planning authorities on the preparation of their supplementary planning guidance (SPG) for wind farms from the period between March 2008 and March 2009. Details at www.spgadvice.co.uk. (Scottish Government)
- British Wind Energy Association - Enviros Consulting Ltd were appointed by BWEA to undertake a review of Draft Supplementary Planning Guidance (SPG) Wind Energy in Northern Ireland's Landscapes, prepared on behalf of the Department of the Environment NI by Julie Martin Associates. This review was prepared to assist BWEA in drawing up a formal response to the Draft SPG. (BWEA)

Landscape and Visual Impact Assessments

A wide experience on a very wide range of assessment work including Environmental Impact Assessment, and Landscape and Visual Impact Assessment for over 20 onshore and offshore wind farms. LVIA experience includes preparation of comprehensive planning supporting statements and public Inquiry evidence for a range of developments including business parks, housing, roads, quarry and mineral developments.

Renewables Experience

- Pencloe Wind Farm, New Cumnock, East Ayrshire – review of Landscape and Visual Impact Assessment for a tip height extension, Section 36c application.
- Yell Wind Farm, Yell, Shetland - Landscape and Visual Impact Assessment for a proposed 32 turbine, Section 36 application. Engagement with Shetland Island Council and SNH at an early stage to agree parameters and sensitivities associated with the proposal. Detailed design optimisation process to achieve a careful landscape fit. Element Power Ltd / energy Isles
- Bilbo Solar Farm, Crimmond, Aberdeenshire – Landscape and Visual Impact Assessment for a proposed 44.5 Ha solar array (Green Energy International)
- Patrickston Solar Farm, Kippen, Stirlingshire– Landscape and Visual Impact Assessment for a proposed 17.4 Ha solar array (Green Energy International)
- Greystone Knowe Wind Farm – Feasibility Study for a proposed 12 turbine wind farm in the Moorfoot Hills (Coriolis Energy Limited)
- Ulzieside Wind Farm, Dumfries and Galloway – Preparation of supplementary environmental information, including a comprehensive cumulative landscape impact assessment, to refresh an existing planning application following resolution of aviation constraints. NBW Wind Energy Ltd

- Bettyhill Farm Extension, Sutherland – Preliminary feasibility and design advice followed by ongoing Landscape and Visual Impact Assessment for a proposed c.7 turbine extension. NBW Wind Energy/ Invenergy
- Turnalt Wind Farm, Argyll and Bute – Preliminary feasibility and design advice for a proposed wind farm site near Ardfern in mid Argyll. Coriolis Energy Limited
- Tidal Stream Array, Anglesey – site search for onshore cable land fall and sub station, for a proposed tidal stream array, to minimise landscape and visual effects. Anglesey Marine Energy, Morlais
- Blar Gavary Farm, near Bonar Bridge, Highlands – Baseline Landscape and Visual Impact Assessment for a proposed 10 turbine development. Eneco
- New Wind Farm Proposal, Powys – Preliminary feasibility and design advice for a non-TAN8 site in the Cambrian Mountains. Infinis
- Margree Wind Farm, Dumfries and Galloway – Preparation of supplementary environmental information to refresh an existing planning application following resolution of aviation constraints. NBW Wind Energy Ltd
- Starryshaw Wind Farm, Shotts, North Lanarkshire – Post application supplementary environmental information and consultation. Willowind
- Blairadam Wind Farm, Fife – Post application consultation. Partnership for Renewables
- Pencloe Wind Farm, New Cumnock, East Ayrshire - Landscape and Visual Impact Assessment for a proposed 19 turbine, Section 36 application. Engagement with East Ayrshire Council and SNH at an early stage to agree parameters and sensitivities associated with the proposal. Detailed design optimisation process to achieve a careful landscape fit. NBW Wind Energy Ltd
- Cummings Hill, nr. Jedburgh, Scottish Borders - Landscape and Visual Impact Assessment for a proposed 7 turbine development. Early stage submission of representations with regard to designation of Special Landscape Areas. Design optimisation process to balance production capacity and sensitive landscape receptors. Infinis
- Dell Wind Farm north of the Glendoe Hydro project, Highland - Ongoing Landscape and Visual Impact Assessment for a proposed 18 turbine wind farm, Section 36 application. Detailed design optimisation to eliminate effects on Castle Urquhart. Completion of challenging and remote site work. Coriolis
- Balunton Wind Farm near Bargrennan, Dumfries and Galloway - Ongoing Landscape and Visual Impact Assessment for a proposed 9 turbine application. The project became viable following a successful representation to the Dumfries and Galloway Interim Planning Policy for Renewables, arguing that the site was appropriate to be included as an unconstrained area of search. NBW Wind Energy Ltd.
- Kentish Flats Offshore Wind Farm Extension – Preparation of a landscape, seascape and visual impact assessment for 17 turbine extension to an existing offshore wind farm. Key tasks included seascape characterisation of the study area and advice on design optimisation. (Vattenfall)
- Blyth Offshore Demonstrator Project – Landscape Technical Lead for the now consented NaREC 15 turbine offshore test array. Key tasks include working within a ‘Rochdale envelope’ project description to identify the maximum scale of development with the least environmental harm and consultation with the MMO. (NaREC)
- Tullo Wind Farm Extension, Aberdeenshire - Landscape and Visual Impact Assessment for a proposed 5 turbine extension to an existing wind farm, near Stonehaven.
- Seagen Sea Skerries Tidal Stream Array, Anglesey – Technical review of Landscape and Visual Impact Assessment for the proposed turbine array. (MCT Ltd)

- Belmore Wind Farm – Settings assessment of Scheduled Ancient Monument sites prepared as an addendum to a EIA for a proposed wind farm in Northern Ireland. (Airtricity)
- Park Head Wind Farm – Landscape and Visual Impact Assessment for a proposed 9 turbine wind farm in Castle Morpeth District, Northumberland. (Renewable Energy Systems)
- Butterwell Wind Farm, Northumberland – Preparation of a detailed Landscape and Visual Impact Assessment for a 9no. turbine wind farm, including cumulative assessment of 7 adjacent sites. (Renewable Energy Systems)
- Tallentire Wind Farm, Cumbria –Baseline Landscape and Visual Impact Assessment for a 9no. turbine wind farm. (Renewable Energy Systems)
- Goonhilly Wind Farm – Landscape and Visual Impact Assessment for a proposed wind farm on the site of Goonhilly Downs Earth Station Site. (British Telecom/PMSS)
- Yelvertoft Wind Farm – Landscape and Visual Impact Assessment for a proposed wind farm close the M1 motorway in Northamptonshire. (Your Energy Ltd)
- Crockandun Wind Farm - Landscape and Visual Impact Assessment for a proposed wind farm on Slieve Gallion near Draperstown. (SWS Energy)
- Craignagapple Wind Farm - Landscape and Visual Impact Assessment for a proposed wind farm east of Strabane within the western extent of the Sperrin Mountains. (SWS Energy)
- Heysham Wind Turbine – Preparation of a Landscape and visual impact Assessment of a proposed large single wind turbine to the east of Heysham. (British Telecom)
- Tormywheel Wind Farm, Fauldhouse – Preparation of a comprehensive landscape strategy to provide mitigation to a proposed development of 14no. wind turbines. (PI Renewables)
- Perth and Kinross Wind Farm Policy – Preparation of representations to the Perth and Kinross Structure Plan on of behalf of the Scottish Renewables Forum as part of an objection to strategic wind farm planning policy in the region. (Scottish Renewables Forum)
- Slievekirk Wind Farm – Landscape and Visual Impact Assessment for an overhead pole mounted grid connection for a new wind farm in Northern Ireland. (Airtricity)
- Durran Mains – Feasibility and design work associated with a proposed borrow pit for a wind farm in Caithness. (DP Energy)
- Scottish Wind Farm Site Search – Support to RES in their prospecting for new Scottish Wind Farm sites. Advice focussed on a review of Landscape Character Types and their capacity for wind farm development. (RES)
- South and East of England Site Search – Services to RWE NPower in the preparation of sieve maping in GIS, followed by the identification and ranking of search areas. (RWE Npower)
- Numerous Planning Policy Representations on behalf of Wind Farm developers. (Wind Prospect, North British Wind Ltd, Infinis)
- Dunduff Quarry Wind Farm - Preparation of a landscape appraisal to inform the potential planning of a new small scale wind farm adjacent to an existing quarry development. (Patersons of Greenoakhill)
- Tesco CHP Plant Goole – Landscape and Visual Impact Assessment for a proposed Combined Heat and Power Plant at the Tesco distribution warehouse near Goole, East Riding of Yorkshire. (Tesco)
- Tesco CHP Plant Livingston – Landscape and Visual Impact Assessment for a proposed Combined Heat and Power Plant at the Tesco distribution warehouse in Livingston, West Lothian. (Tesco)

Environmental Impact Assessment

- Wavegarden, Ratho – Preparation of scoping correspondence with City of Edinburgh Council, including preliminary Zone of Theoretical Visibility plans to confirm that Landscape and Visual matters could be scoped out of the EIA process – (Tartan Leisure)
- Trengothal Radio Station, Land's End, Cornwall – Landscape and Visual Impact Assessment for a proposed large new satellite dish antenna at the Trengothal Radio Station site, including the preparation of indicative photomontages. The site is located in close proximity to sensitive Cornwall AONB. (BT/Avanti)
- Peffermill Sports Complex and Athletes Village – Landscape and Visual Impact Assessment for the proposed re-development of the Peffermill Sports Complex and associated Athletes Village, Peffermill, Edinburgh (Edinburgh University)
- Bangour Village – Landscape and Visual Impact Assessment for a residential development within the former Bangour Village Hospital site (Ambassador Group)
- Mixed Use Development Comprising Film & TV Studio Including Backlot Complex, Mixed Use Employment Uses, Straiton, Midlothian – Preparation of a comprehensive landscape and visual impact assessment for 36 Ha site to the south of Edinburgh. (Pentland Film Studios Ltd)
- Dolphingston, East Lothian – Preparation of a comprehensive landscape and visual impact assessment for a proposed new 8.72 Ha residential development to the south-west of Prestonpans. (Hallam Land)
- Orchardfield, East Linton, East Lothian – Preparation of a comprehensive landscape and visual impact assessment for a proposed new 6.32 Ha residential development, including indicative wireframe visualisations. (Stewart Milne Homes Ltd)
- Millerhill Zero Waste Facility. LVIA for a new large scale waste facility at Millerhill, Edinburgh. (Midlothian Council)
- Garreg Lwyd Hill Wind Farm, Wales - Preparation of a Landscape and Visual Impact Assessment and as part of an Environmental Impact Assessment for a new overhead power line connecting from the substation in the middle of the Proposal site at Tre-foel over a course of 39km south to just beyond Kington in Herefordshire. (RES)
- Robin House Children's Hospice, Balloch - Landscape and Visual Impact Assessment Children's Hospice Association Scotland's second children's hospice for Scotland, Robin House in Balloch near Loch Lomond, open to children with life-limiting / terminal conditions and their families. Significantly the LVIA was carried out in the context of the newly formed Loch Lomond and the Trossachs National Park. Despite the design having been commended by bodies such as The Royal Fine Arts Commission, the new Park Authority's Planning advisor recommended the project for refusal on site and policy issues. Permission was granted at committee following completion of the LVIA.
- Global Point International Business Park, Belfast – Preparation of a Landscape and Visual Impact Assessment and Concept Design Statement as part of an Environmental Impact Assessment for a new 200 acre Business Park. (Invest Northern Ireland/Pro Logis)
- Castlecourt, Belfast – Preparation of a Townscape and Visual Impact Assessment as part of an Environmental Impact Assessment for a 500,000 ft² extension to city centre shopping mall. (Westfield Shopping)
- Dunadry, Nr. Antrim – Preparation of a Landscape and Visual Impact Assessment and Concept Design Statement as part of an Environmental Impact Assessment for a new garden village settlement. (Lagan Developments)

- Mullingar Business Park, County Westmeath, Eire – Preparation of a Landscape and Visual Impact Assessment as part of an Environmental Impact Assessment for a new 70 acre business park. (IDA)
- Ballyoan, Londonderry – Preparation of a Landscape and Visual Impact Assessment and as part of an Environmental Impact Assessment for a 95 acre settlement expansion. (Various)
- 'K' Village, Kendal - Detailed townscape assessment forming part of an Environmental Impact Assessment for the redevelopment of a former shoe factory as a factory outlet centre. (Guinea Group)

Quarry Related Experience

- Willington Sand and Gravel Pit Extension, Trent Valley, Derbyshire – Landscape and Visual Impact Assessment and mitigation strategy for the proposed quarry extension. (Cemex)
- Swinton Quarter Craft Stone Quarry, Swinton, Scottish Borders – Landscape and Visual Impact Assessment and mitigation strategy for the proposed re-opening of a small stone quarry in the Scottish Borders. (Hutton Stone)
- Comrie Colliery Reclamation Scheme, Comrie Open Cast Site, Oakley, Fife – Restoration planting strategy for the re-formed earthworks associated with this former open cast coal mine.
- Borrow Pits, Burn of Whilk Wind Farm, Caithness – Quarry phasing design and mitigation strategy for the proposed re-opening of a small hard rock quarry.
- Tarfhaugh Sand Pit, West Linton, Scottish Borders – Preparation of draft quarry development proposals as part of feasibility study for the potential opening of a sand and gravel quarry on the site of a glacial kame feature near West Linton.
- Durran Mains – Feasibility and design work associated with a proposed borrow pit for a wind farm in Caithness. (DP Energy)
- East Garnock, Quarry Design and Restoration - Lead design and planning of a 120Ha quarry proposal for a site in North Ayrshire. The design proposals include progressive restoration of the 7 million tonne extraction phased over 20 years. Restoration is focussed on the creation of extensive areas of new wetland habitat and tidal lagoons. (NPL Estates)
- Levenseat Quarry Extension, Fauldhouse, West Lothian – Preparation of full and detailed Landscape and Visual Impact Assessment in support of an application for a 12Ha extension to an existing sand and gravel quarry. (WBB Minerals)
- Levenseat Quarry Re-Phasing – Preparation of a presentation to illustrate proposals for an application to vary a Planning Consent. The presentation prepared in Powerpoint included the design of the proposed quarry phasing over a 20 year period alongside an accompanying landscape mitigation strategy. (WBB Minerals)
- Edston Quarry, Peebles – Preparation of a Landscape and Visual Impact Assessment (LVIA) in support an application to re-open a small hard rock quarry. The assessment included proposals for mitigation and quarry phasing.
- Craigiehill Quarry, Edinburgh - Dormant hard rock quarry. Landscape and Visual Impact Assessment (LVIA) as part of an EIA and Restoration Strategy for a change of use from a quarry to a recycling facility. (Tarmac)
- Beltmoss Quarry, Kilsyth, North Lanarkshire - Hard rock quarry. LVIA as part of an EIA and Restoration Strategy for an extension to an existing quarry. Followed by Determination of Conditions Application in respect of Conditions appended to Planning Permission. (Patersons of Greenoakhill)

- Cruicks Quarry, Inverkeithing, Fife - Hard rock quarry making aggregates. LVIA followed by Determination of Conditions Application in respect of Conditions appended to Planning Permission. Contract Administration of initial phase of the restoration planting works. Subsequent preparation of detailed restoration proposals to support an application for quarry deepening. (Tarmac)
- Cotside Quarry, Carnoustie, Angus - Sand and gravel quarry. LVIA and Restoration Strategy as part of an Environmental Impact Assessment for an extension to the existing quarry. Followed by Determination of Conditions Application in respect of Conditions appended to subsequent Planning Permission.
- Cunmont Quarry, Dundee, Angus - Hard rock quarry LVIA as part of EIA and Restoration Strategy for an extension to an existing quarry. Followed by Determination of Conditions Application in respect of Conditions appended to Planning Permission. (Ennstone Thistle)
- Boyne Bay, Portsoy, Aberdeenshire - Limestone quarry. Preparation of a Restoration Strategy as part of an application to modernise working conditions and a Planning Application for a quarry extension. (Boyne Bay Lime Company)
- Lough Fea, Draperstown, County Antrim, Northern Ireland - Sand and gravel quarry LVIA as part of an EIA and Restoration Strategy for a new sand and gravel quarry. (FP McCann)
- Altnamuskin Quarry, County Tyrone, Northern Ireland - Sand and gravel quarry. Preparation of a Restoration Strategy as part of a Determination of Conditions Application to the Planning Permission. (Mullin and Sons)

Masterplanning

- Bangour Village Hospital, West Lothian – Preparation of the Landscape Masterplan for the conversion of the former hospital site in a housing led masterplan. Ambassador Group Ltd.
- Winning entry for the Moorside Earthworks Competition in the west of Cumbria. The earthworks will form the setting to Europe's largest nuclear new build power station site at Moorside, planned by NuGen. http://moorside.landscapeinstitute.org/
- Preparation of a Concept Master Plan of Belad Al-Husayneya, Mecca, Saudi Arabia – Preparation of a concept masterplan and early stage design principles for a new suburban extension to the Holy City of Mecca. The preliminary concept design was developed from initial masterplan baseline studies, through a series of design options, followed by the adoption a final concept masterplan. (Al Waqif Family/Khatib and Alami)
- Raith Estate, Kirkcaldy West - Preparation of Concept Masterplan and detailed supporting statement as part of representation to the FIFEPlan Local Development Plan. (Raith Estates)
- Ardeer Peninsula, North Ayrshire - Masterplan led regeneration strategy for a 100 Hectare site to deliver of a mix of suitable and sustainable end uses. A series of Masterplan options have been prepared for the heavily constrained and contaminated site which are subject to an ongoing SEA process. Enviros have coordinated Stakeholder consultation and a series of public exhibitions which have led to the selection of a preferred Masterplan option.
- Tamfourhill, Falkirk – Preparation of a Concept Masterplan to guide Falkirk Council in planning the redevelopment of contaminated lands adjacent to the Union Canal. The proposals considered the integration of the Falkirk Wheel Visitor Centre, the Antonine Wall and the redevelopment proposals beside the canal including: residential; business; and commercial boat services/canal basins. (Falkirk Council)
- Former Woodilee Hospital, Lenzie - Masterplan led regeneration of a former hospital site for a new village development at Woodilee, Lenzie. The detailed site planning of the

village was designed in accordance with the 'home zones' principle and included the formation of a market street as the core to the proposed development.

- Dunadry Garden Village, Nr. Antrim – Preparation of a Concept Master plan, as part of an Outline Planning Application, for an innovative garden village of potential regional significance. The new village proposals include a mixed use development of approx. 1500 houses arranged around a central core, including parkland, local services, community facilities and a small business park. (Lagan Developments)
- Global Point International Business Park – Preparation of a detailed Master plan, as part of an Outline Planning Application, in support of a new 200 acre business park on the edge of Belfast. The development proposals consist of 1.45millon ft2 of business floor space set within a high quality landscape that includes linear parks, formal recreational facilities, a 'village centre,' and structural woodlands. Following on from the master planning stage a design brief was developed to provide a coherent and practical framework for the future development of the business park. (Invest Northern Ireland/Pro Logis)
- Middlefield, Falkirk – Preparation of a Concept Master plan in support of a proposed mixed use Business Park at Middlefield, Falkirk. The masterplan was accompanied by a design guide for the long term sustainable development of the site. (Callendar Estate)
- Dundee Western Villages – Master planning for a new village development to the west of Dundee. The detailed site planning of the village was designed in accordance with the 'home zones' principle and included the formation of a market street as the core to the proposed development. The proposed development has received detailed planning consent. (Bett Homes)
- Collinswell Park, Burntisland – Master planning for the development of a new residential development on the site of a former Aluminium Works. The scheme is centred on a new public park which was carefully designed to accommodate flood waters from the Kirkton Burn. (Collinswell Land)
- Blair's College Aberdeen - Preparation of Concept Masterplan for the re-development of a seminary college near Banchory. The proposals include a luxury hotel and signature golf course and golf related facilities, integrated with the development of 280 residential units. (Muir Group)
- Land at East Haddington – Preparation of a Concept Masterplan for a proposed settlement expansion and golf course extension to the existing Amisfield Golf Course on lands to the east of the village of Haddington in East Lothian. (Bryant Homes)
- Longniddry, East Lothian – Preparation of a Concept Masterplan for the expansion of an existing settlement incorporating a new golf course and country Club. (Bryant Homes)

Major Infrastructure Projects

- Jubilee River (Maidenhead, Windsor and Eton Flood Alleviation Scheme) - Design and implementation of 11.5km of new river channel to alleviate flooding along the River Thames, including Environmental Management throughout the contract period. (Environment Agency)
- M25 Widening - Comprehensive scheme design for proposed Motorway widening between Junctions 12-15 including comprehensive landscape and visual impact assessments and mitigation design. (Highways Agency)
- A1M Alconbury to Peterborough - Design and implementation of highway upgrade and widening including Environmental Management throughout the contract period. (Highways Agency)

Infrastructure Projects

- EE Mobile Phone Mast Roll Out – Preparation of landscape and environmental planning services to support the implementation of emergency mast sites throughout Scotland.

- Finnieston substation, Glasgow - Preparation of detailed landscape mitigation proposals for the city centre development (Scottish Power, 2011)
- Kentish Flats Offshore Wind Farm Extension - Preparation of a landscape, seascape and visual impact assessment for 17 turbine extension to an existing offshore wind farm. The work included the assessment of the cable landfall, transition pit and options for routeing of the underground cable corridor over a 2km route from Whitstable to the onshore grid station. Support given on this NSIP through EIP process (Vattenfall ,2011).
- Proposed Substation, Swansea North - LVIA for a proposed 400kV substation near at Swansea North. The scheme has successfully been granted planning permission (National Grid plc, 2010)
- Blyth Offshore Demonstration Project - Confirmation of preferred route corridor for connection of a 1.5km underground HVDC route for the 275 kV export cables from the cable landfall and transition pit to the Blyth substation (formerly Blyth Power Station) owned by National Grid. Included extensive consultation and negotiation with Natural England (NAREC, 2011)
- Slievekirk Wind Farm - Landscape and Visual Impact Assessment for an overhead pole mounted grid connection for a new wind farm in Northern Ireland. (Airtricity, 2010)
- Garreg Lwyd Hill Wind Farm, Wales - Preparation of a Landscape and Visual Impact Assessment and as part of an Environmental Impact Assessment for a new overhead power line connecting from the substation in the middle of the Proposal site at Tre-foel over a course of 39km south to just beyond Kington in Herefordshire. (RES, 2010)

Townscape Studies and Assessments

Experience with a range of urban assessment work for a variety of new retail, commercial and residential development, covering a wide range of townscape analysis and surveys for urban renewal, regeneration and design studies.

- Iona Street – Preparation of verified visualisations to support a proposed residential development in Edinburgh (Manson Architects)
- Bonnington Road Lane – Preparation of verified visualisations to support a proposed residential development in Edinburgh (JM Architects)
- Jeffrey Street - Preparation of Townscape and Visual Impact Assessment and verified visualisations to support a proposed hotel extension development in Edinburgh (CFP Architects)
- Calton Hill, City Observatory Project – Townscape and Visual Impact Assessment for the proposed refurbishment and re-development of the City Observatory Compound. Key issues included consideration of the effects of a proposed new ‘Salon’ housing a restaurant, designed to reflect the adjacent neoclassical architecture, on the city skyline, the Edinburgh World Heritage Site and associated conservation designations.
- Royal Edinburgh Hospital (REH) Edinburgh - Townscape and Visual Assessment (TVA) for the proposed redevelopment of existing hospital complex in south Edinburgh suburbs to modernise and improve facilities, while retaining the key parkland edges and other important townscape/ landscape features and minimising effects on patients and surrounding residents. Hub South-east Scotland
- Port of Leith Redevelopment - Responsible for townscape and visual impact assessment and advice and guidance on the overall project design optimisation for the proposed redevelopment and extension of the Port of Leith, Edinburgh. Within this complex environment close to conservation areas, listed buildings and extensive areas of residential development key services included negotiation on the scope of the assessment with Statutory Consultees. 2012 – Ongoing. Scottish Enterprise / Forth Ports

- Audley Square, Mayfair – Preparation of a Townscape and Visual Impact Assessment as part of an Environmental Impact Assessment for a new hotel and apartment complex within the heart of Mayfair. The proposals for the eight storey building were developed with Foster and Partners. Architects. (Hedleigh (Mayfair) Ltd)
- Royal Shakespeare Theatre, Stratford Upon Avon – Detailed Townscape and Visual Impact Assessment forming part of an Environmental Impact Assessment for the redevelopment of the existing Royal Shakespeare Theatre. (Royal Shakespeare Company Ltd)
- Woodside Quarry, Horsforth, Leeds – Preparation of a Townscape and Visual Impact Assessment as part of an Environmental Impact Assessment for a mixed use development within the context of a former sandstone quarry within suburban Leeds. The proposals include a mix of residential and commercial uses including a small community hub centred around a high quality public realm. (Burford Group Ltd)
- Gallowgate, Newcastle Upon Tyne - Preparation of a Townscape and Visual Impact Assessment, including a night time lighting impact assessment as part of an Environmental Impact Assessment for a mixed use development on the former Tyne Brewery site. The proposals included: a hotel; offices; student halls of residence; and a residential accommodation, located within five separate buildings. (Storeys SSP/Downing)
- St. Andrews Greenbelt Study.
- South East Wedge, Edinburgh, Green Belt Study.
- Donaghadee – Preparation of a Town Strategy presenting an overview of the area's key characteristics, needs, issues and priorities, including a literature review, local survey/public consultation and report. (Ards Borough Council)
- Glengormley and Ballyclare – Town centre re-generation studies. (Newtownabbey Borough Council)
- Lee Valley Regeneration Study – Preparation of a regeneration strategy and associated environmental enhancements for the River Lee. (London Borough of Hackney)

Landscape Design and Implementation

- Nationwide House, Croft Campus, Swindon – Lead design consultant for major projects at Nationwide Building Society's Headquarters in Swindon, associated with the development of the Headquarters Campus for the Nationwide Building Society. These have included: the design and implementation of a new Decked Car Park and associated roof garden; major campus wide environmental enhancements; and, the construction of a new system of site access and circulation. All projects have included liaison with an extended project team, detailed contract management and inspection within the context of an extremely busy campus environment used by 3000 employees. (Nationwide Building Society)
- West Mill Road, Colinton, Edinburgh – Preparation of detailed hard and soft landscape proposals for a new residential development to discharge Planning Conditions, followed by the implementation of the scheme on site. (Applecross Properties Ltd)
- New Baptist Church, Moira, Northern Ireland – Preparation of detailed hard and soft landscape proposals for a new church to discharge Planning Conditions, followed by the implementation of the scheme on site.
- Eastfieldburn, Cambuslang – Preparation of detailed hard and soft landscape proposals for the restoration of a disused mine. Specifically, the proposals included the formulation of strategy to eradicate a Japanese knotweed infestation.
- 23a Northumberland St, Edinburgh – Preparation of detailed hard and soft landscape proposals associated with a domestic extension and new garden, followed by the implementation of the scheme on site.

- Cruicks Quarry, Inverkeithing – Preparation of detailed quarry restoration planting proposals to discharge Planning Conditions followed by on site implementation, contract management and inspection and ongoing maintenance.
- Altonhill, Kilmarnock – Preparation of detailed soft landscape proposals associated with a new residential development, initially to discharge Planning Conditions, followed by on site implementation, contract management and inspection and ongoing maintenance.
- Swanley Town Centre - Detailed design and implementation of town centre environmental enhancements. (Swanley Borough Council)
- Kuwait Oil Sector Complex - Preparation of detailed proposals for the design of a new flag ship development in Kuwait City. (Kuwaiti Ministry of Oil)

Urban Design

- Bells Mills, Dean Village, Edinburgh – Site planning and preparation of hard and soft landscape proposals as part of a Planning Application for 24no. apartments within 4no. 3-4 storey blocks for a vacant overgrown site adjacent to the Water of Leith. The scheme was successfully taken to appeal following a deemed refusal and is currently being worked up in detail for implementation. (Bishop Loch/BUREDI)
- Belford Lodge, Dean Village, Edinburgh – Similar scale and form of flatted apartment development for a nearby site beside the Water of Leith. The approved scheme is now also being worked up in detail for implementation. (Gregor Properties)
- Donaghadee – Preparation of a Town Strategy presenting an overview of the area's key characteristics, needs, issues and priorities, including a literature review, local survey/public consultation and report. (Ards Borough Council)
- Royal Quay, Harefield – Detailed planning application for a new residential development within the context of a Conservation Area, including hard and soft landscape proposals. (Ravenblack Developments)
- Gravesend – Detailed planning application for a new flatted apartment development overlooking the River Thames in Kent. The waterfront scheme includes the formation of a new riverside walkway focussed on a redeveloped pier and restaurant. (Ravenblack Developments)
- Ards Shopping Centre, Newtownards – Detailed hard and soft landscape design for the proposed re-development of a shopping centre. The extended development includes the creation of significant areas of formal and informal public open space, new squares, plazas and a water garden. A proposal for an extended earthwork feature forms the gateway to the development itself, Newtownards and the county of Ards and North Down. (Private Client)

Historic Garden Restoration Design

- Houghton Park - Preparation of detailed Restoration Management Plan for a Grade 1 registered park funded by English Heritage to improve the legibility of the landscape for visitors, re-create lost parkland and restore key relationships between the park and surrounding buildings. (Lord Cholmondeley)
- Regency Parks Brighton - Preparation of detailed proposals for the restoration of the existing dilapidated parks within Brighton. (Brighton and Hove Borough Council)
- Norfolk Square, Brighton - Site planning through to on site implementation for the restoration of Norfolk Square, Brighton. (Brighton and Hove Council)

Other Interests

- World travel, walking and mountaineering, climbing, ski-touring, cycling, vegetable growing, cooking, river and sea-kayaking, art.

Ruth Fain

Associate Director – Environmental Planning and Advisory

Qualifications and Professional Memberships

- MGeol (Hons) Environmental Geology
- Chartered Scientist (CSci)
- Member of the Institute of Environmental Sciences (MIEnvSc)
- Member of the Institute for Air Quality Management (MIAQM)
- NEBOSH General Certificate in Occupational Health and Safety (Distinction)

Career Summary

Ruth is a Chartered Scientist and Member of the Institute of Air Quality Management with over 18 years' experience in managing and delivering environmental impact assessment (EIA) and compliance projects, with a focus on renewable energy and industrial developments. She is an experienced client and project manager and is a specialist in development consenting.

In addition to her Project Management skills, Ruth is a technical expert in air quality and odour and is experienced in all aspects of environmental regulation and management. She utilises this operational knowledge in her EIA project management, bringing a whole project approach to the planning and design stages.

Ruth is knowledgeable in the latest UK EIA Regulations and their implementation, best available techniques, and conversant in international best practice guidance and standards for ESIAs issued by the International Finance Corporation and World Bank Group. She has experience of Development Consent Order applications and experience of working with all stakeholder groups associated with planning and consenting.

Selected Project Experience

Environmental Impact Assessment

- SaxaVord Spaceport, Unst - Assessment of Environmental Effects (AEE) and reporting to the Civil Aviation Authority as part of the Spaceport Operator License Application under the Space Act 2018. Management and reporting of AEE focusing on operation effects of launching small satellites from the three vertical launchpads on Unst.
- Shetland Space Centre - SaxaVord Spaceport, Unst - Management and reporting of EIA as part of major planning application for a vertical launch space port and associated infrastructure at Lamba Ness. Assessment over three years with particular focus on marine and transboundary effects, minimisation of impact on scheduled monuments and assessment and mitigation of effects on a diverse bird and animal population.
- Alvance British Aluminium – Billet and Casting Facility, Fort William - Management of EIA for 12,254 m2 billet casting facility. Works included multi-discipline EIA, flood risk management, draingage strategy design and peat management planning.

- Sembcorp - Combined Cycle Power Plant, Teesside. Air Quality, Noise and Greenhouse gas assessment works to support DCO variation required by design change to alternative technology.
- Legal & General - Hillthorn Business Park, Sunderland**.** Management and delivery of EIA technical input for a large industrial business park.
- Giants on the Quayside, World Wheel Company, Newcastle - Management and delivery of technical input to planning and EIA process including production of Environmental Statement for £100M urban regeneration project in Newcastle, comprising Europe's largest observation wheel and associated entertainment developments.
- International Advanced Manufacturing Park, Sunderland - Assessment and delivery of air quality input into Environmental Statement and Non-Technical Summary for Phase 1 and 2 of an advanced manufacturing park, including DCO process at phase 2.
- Forsa Energy - Air Quality Impact Assessment and delivery of air quality input into Environmental Statement and Non-Technical Summary for a proposed peaking power plant site with approximate output of 19.9 MWe and located in an area with particularly onerous council requirements.
- Distilleries – Management of development EIA for proposed distilleries including Glenmorangie, Glenrothes and a new distillery in Jedburgh. Assessment included multi-disciplinary assessment of construction and operational effects in accordance with appropriate standards.
- Mining Development, Gabon - Air quality monitoring (in-field) and EIA assessment to support a World Bank standard environmental and social impact assessment for the construction and operational phase of a mine in Gabon, Africa.
- Kosovo Motorway, Kosovo Ministry of Transport - World Bank standard environmental and social impact assessment for the construction and operational phase of the Kosovo Motorway Project. Assessment of impacts on air quality of a 102 km dual carriageway road scheme.

Associated Projects

- Locate Solar – Development and utilisation of a bespoke methodology with Lichfields for assessing site suitability for solar development.
- Confidential Client, South east England - feasibility assessment of developing ground mounted solar installations including identification of potential sites and grid and wider environmental constraints assessment.
- Project technical and development support, confidential thermal and fuel cell hydrogen installations, Protium Green Solutions, UK
- Bruichladdich – Project Hyladdie, Islay. Technical input into BEIS Green Distilleries funded feasibility study on incorporating innovative hydrogen combustion technology into an existing distillery.
- Permitting and Industrial Pollution Control
    - PPC / EP permit application, variations and surrenders - Project management and delivery of PPC/ EP permit applications, variations and surrenders for clients in the Manufacturing, Power, Oil and Gas and Waste sectors including Nestlé, Refresco, British Nuclear Group, Egdon Resources, National Oilwell Varco, AES Kilroot, Biffa, Shanks Waste Solutions, Princes, Thomas Hardy Brewery and Premier Foods. Support during negotiations with regulatory authorities, coordination of specialist studies and ongoing compliance and stakeholder engagement work.
    - Nestlé UK – Long term regulatory compliance support to various UK Sites including emissions dispersion modelling, odour impact assessment, Best Available Technique (BAT) assessment, cost benefit analysis and general EP compliance support during planning, permitting and divestiture stages of operation. Various sites across the UK. Regularly liaising between site contacts, regulators, client and external legal advisors and client commercial/PR teams regarding issues of nuisance, civil claims, EP permit breaches and transactional risk management.

- BAT Assessment - Assessment of particulate abatement plant for emissions from gas and coal fired boilers and other site process emissions for confidential manufacturing client. In addition to planning and permitting requirements, the investigation was submitted as a case study to an Environment Agency large combustion plant (LCP) BAT reference document working party.

- Air Quality and Odour Assessment and Modelling
  - Co-author: "Guidance on the Assessment of Odour for Planning", Institute of Air Quality Management.
  - Odour Dispersion Modelling, Impact and BAT Assessments – odour impact assessment, BAT assessment and cost benefit analysis for planning, permitting and due diligence stages of operation for clients in the waste and manufacturing sectors. Regularly working with client legal and commercial teams regarding issues of statutory and private nuisance and operational risk management.
  - AERMOD and ADMS dispersion modelling and assessment of emissions from various manufacturing, waste and power facilities. Site impact assessment (base case) and investigation into modelled impact of operational improvement scenarios, including varying stack designs, locations and heights and BAT assessment of various abatement technologies.

Blue Ridge Research and Consulting, LLC

Shetland Space Centre Launch Vehicle Operations Data Call

November 25, 2020

Prepared for:
Scott Hammond
Shetland Space Centre
Shetland, Scotland
Scott.Hammond@ShetlandSpaceCentre.com

Blue Ridge Research and Consulting, LLC
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Asheville, NC 28801
(p) 828-252-2209
(f) 831-603-8321
BlueRidgeResearch.com

CAGE Code:	4JAW9
TIN:	20-4555864
DUNS No.:	784-426-954
NAICS 541330:	Small Business
OCI:	None
Validity:	120 days



PROPRIETARY

1 Qualifications

The following sections provide an overview of our team as well as the qualification and experience of the key personnel related to the proposed effort.

1.1 Blue Ridge Research and Consulting, LLC

29 N Market St, Suite 700, Asheville, NC 28801
Contact: *Michael James*
Phone: *828.252.2209*
Website: *BlueRidgeResearch.com*

BRRC is an acoustical engineering consultancy focused on critical noise and vibration challenges for aerospace, aviation, and Department of Defense projects. With experience from 250+ civilian and military noise studies, BRRC's team of exceptional acoustical engineers are trusted advisors to public, private, and academic clients around the world. BRRC's expertise comprises measurement, modeling, and analysis of outdoor acoustics and sonic booms with a broad range of applications, including airports, spaceports, highways, railways, industrial plants, outdoor warning siren systems, and natural soundscapes.

BRRC's modeling capabilities enable the company to address unique conditions and impacts, and BRRC has developed specialized visualization tools to relate that information to decision makers and the public. BRRC's modeling experience ranges from military noise and sonic boom models including NoiseMap, MR_NMap, SARNAM, BNoise, PCBoom, and BoomMap to publicly available models such as AEDT and TNM. BRRC also has advanced in-house modeling capabilities with BRRC noise models such as The Launch Vehicle Acoustic Simulation Model (RUMBLE), flight safety models, and flight optimization models.

BRRC's noise source and propagation measurement experience is extensive, encompassing aircraft (subsonic and supersonic), rockets, helicopters, weapon systems, UAVs, sirens, and soundscapes. BRRC has significant experience in test plan development, pretest coordination, site selection, measurement setup, test execution, data analysis, and test documentation. BRRC personnel have provided their expertise for the development of numerous standardized testing and data analysis protocols. Our team has led the development of state-of-the-art customized measurement systems, which range in complexity from self-contained, three-channel systems to measurement arrays requiring 350+ data channels.

BRRC has the expertise to address complex environmental noise modeling and measurement challenges that require interdisciplinary teams and unique acoustical knowledge.

1.2 Related Projects

LAUNCH VEHICLE ENVIRONMENTAL NOISE STUDIES
Various Primes *Date: 2010 to Present*

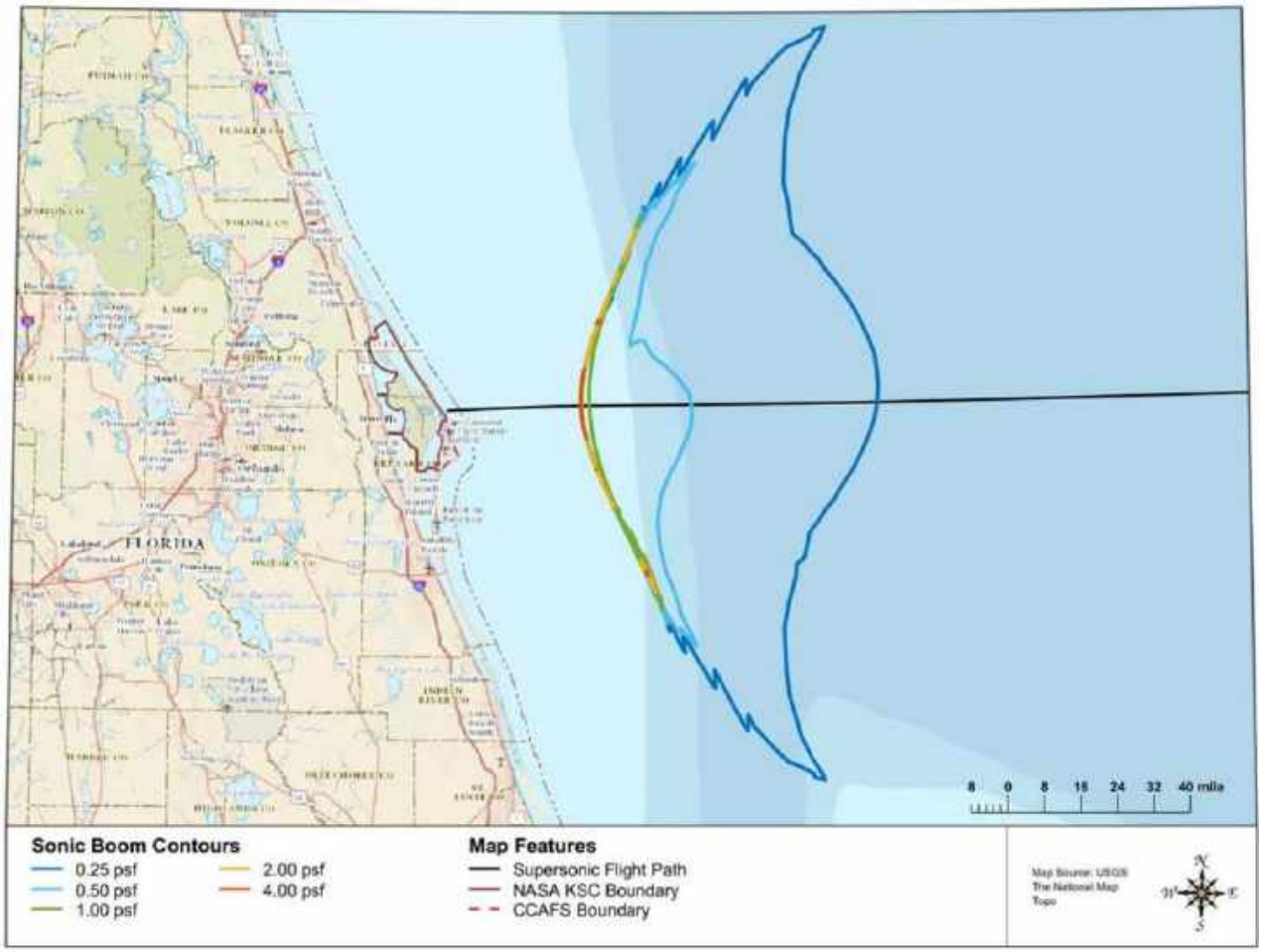
BRRC has provided noise analyses as the prime launch vehicle noise consultant in over twenty-five rocket noise environmental studies. The noise effects on the local communities and environment were evaluated based on the FAA Order 1050.1F, Environmental Impacts: Policies and Procedures, on a cumulative basis in terms of human annoyance, measured by DNL. The launch vehicle propulsion noise analyses, performed using RUMBLE, were often supplemented with single-event metrics for hearing conservation and structural damage criteria. In addition to the propulsion noise, the sonic boom analyses were performed using PCBoom, which calculates the magnitude and location of sonic boom overpressures on the ground from supersonic flight. Sonic boom impacts from launch and reentry were evaluated on a single-event basis for hearing conservation and structural damage criteria.

BRRC's commercial space launch vehicle noise study experience includes:

- EA for ABL Space Systems VAFB Launch Site (2020);
- EA for Relativity Space's Terran 1 Launch Vehicle Operations at VAFB Site B330 (2020);
- EA for Relativity Space's Terran 1 Launch Vehicle Operations at CCAFS CX-16 (2019-2020);
- EA for United Launch Alliance's Vandenberg AFB Vulcan Centaur Launch Site (2019-2020);
- EA for SpaceX's Starship Landings at LZ-4, Vandenberg AFB (2019);
- EA for Firefly's Vandenberg Orbital Launch Site (2019);
- EA for Firefly's Cape Canaveral AFS Orbital Launch Site (2019);
- EA for SpinLaunch's Kinetic Launcher System at Spaceport America (2019);
- EA for Blue Origin's Vandenberg AFB Orbital Launch Site (2019);
- EA for United Launch Alliance's Cape Canaveral AFS Vulcan Centaur Launch Site (2019);
- Space Florida's Landing Site Operators License for the Shuttle Landing Facility (2018-Present);
- EA for Canso, Nova Scotia, Canada Launch Site (2017-Present);
- EA for NASA Kennedy Space Center, LC-48 (2017);
- Space Florida's Launch Site Operators License for the Shuttle Landing Facility (2017-2018);
- EIS for Spaceport Camden (Submitted, 2016-2017);
- EA for Blue Origin Cape Canaveral AFS LC-36 Launch Site (2016);
- EA for Cecil Spaceport (Submitted, 2015-2017);
- Site-wide PEIS for expanding operations at NASA Wallops Flight Facility (2014-2016);
- EA for Hawaii Air and Space Port (Submitted, 2014-Present);
- EA for Titusville Spaceport (Submitted, 2014-Present);
- EIS for Shiloh Launch Complex (Submitted, 2013-2014);
- EA for Issuing an Experimental Permit to SpaceX for Operation of the DragonFly Vehicle at the McGregor Test Site (2013-2014);
- Preliminary Site Evaluation for Space Florida's Shiloh Launch Facility (2013);
- EIS for SpaceX Texas Launch Site (2012-2014);
- Site-wide PEIS for expanding operations at Wallops Flight Facility (2012-2013);
- EA for Midland International Airport and Space Port (2012-2014);
- PEIS for Wallops Flight Facility (2010).


EXAMPLE DNL CONTOURS
FOR A HORIZONTAL LAUNCH VEHICLE
DNL Contours
Map Features

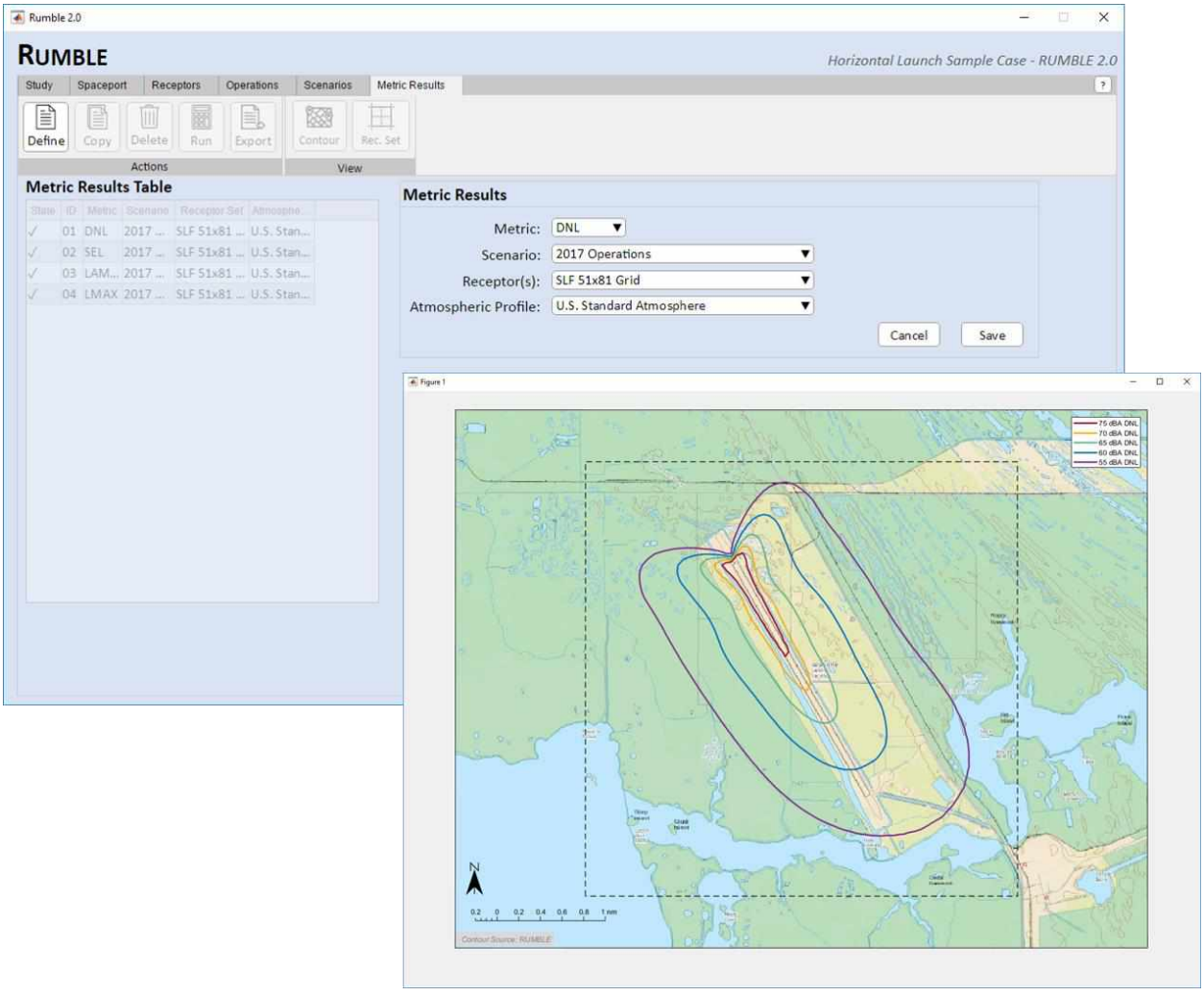

Google earth
EXAMPLE A-WEIGHTED MAXIMUM OASPL CONTOURS
FOR A VERTICAL LAUNCH VEHICLE
OASPL Contours
Map Features


FLORIDA
8 0 8 16 24 32 40 mile
Sonic Boom Contours
0.25 psf
0.50 psf
1.00 psf
2.00 psf
4.00 psf
Map Features
Supersonic Flight Path
NASA KSC Boundary
CCAFS Boundary

ACRP 02-66: COMMERCIAL SPACE VEHICLE NOISE MODEL DEVELOPMENT FOR AEDT INTEGRATION

National Academies of Science *Date: 2015 to 2017*

BRRC's Launch Vehicle Acoustic Simulation Model, RUMBLE, was selected for ACRP Project 02-66. RUMBLE provides an efficient noise prediction model that produces accurate output relevant to environmental analysis of commercial space operations and airport/space launch site facilities. The RUMBLE modeling methodology reflects the best available science and practices, and has been reviewed and accepted by FAA AEE for use in over ten commercial space studies. RUMBLE includes an updateable database of essential input parameters that compiles the available spacecraft airframe and engine data pertaining to commercial space launch operations for actively licensed launch sites and vehicles. The model's input parameters and user-interface were specifically designed to maintain a level of consistency with the AEDT modeling platform to ensure smooth future integration. A user manual and example cases will highlight the model's features and provide potential users with a better understanding of the model's operation and capabilities. This effort has resulted in improved performance and efficiency of RUMBLE with the goal of making the tool accessible to a larger community of users.



ACRP 02-81: Commercial Space Operations Noise and Sonic Boom Measurements

National Academies of Science *Date: 2017 to 2020*

BRRC conducted a measurement campaign to obtain high-fidelity rocket propulsion noise and sonic boom signatures from a diverse set of commercial space vehicle operations under Airport Cooperative Research Program (ACRP) Project 02-81. The campaign included acoustic measurements of launch operations for the SpaceX Falcon Heavy and Falcon 9, ULA Delta IV Heavy, and Northup Grumman Innovation Systems Antares 230, as well as return-to-landing operations for the Falcon Heavy side boosters. BRRC deployed custom-built multiple-channel ground recording systems at a range of locations to measure detailed time histories of the rocket propulsion noise and sonic boom signatures. BRRC compiled the results into a database of rocket propulsion noise and sonic boom measurements that will serve as model source characteristics for the purpose of facilitating community noise model development and validation. Additionally, as part of the project objectives, BRRC developed a comprehensive community noise measurement protocol for commercial space operations propulsion noise and sonic booms that is intended to standardize the methodology for acquiring future measurements.

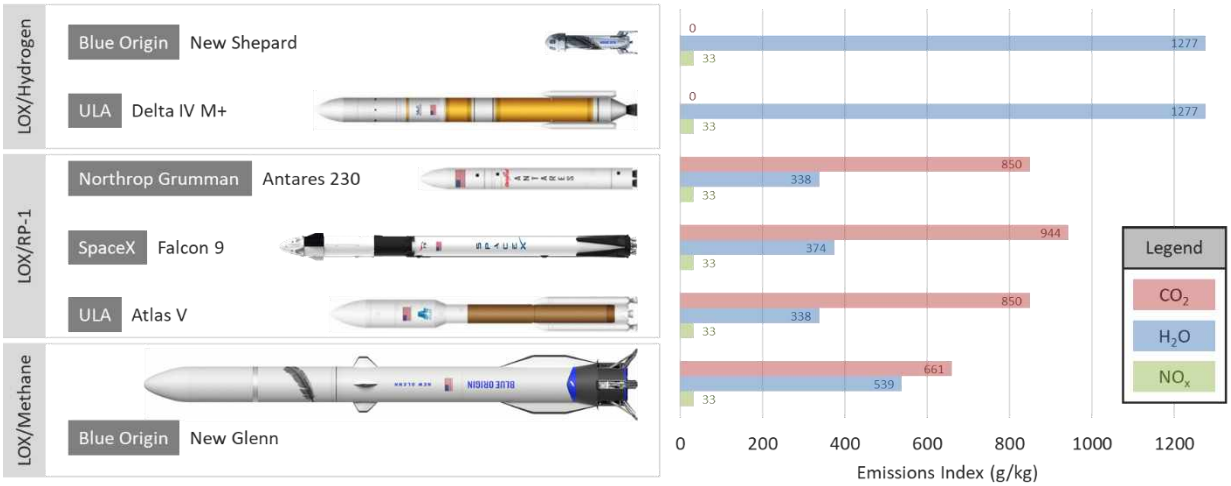




ACRP 02-85: COMMERCIAL SPACE VEHICLE EMISSIONS MODEL

National Academies of Sciences *Date: 2018 to Present*

BRRC developed a commercial space vehicle emissions model, which uses emissions indices to estimate the total quantities of the various pollutants emitted by space vehicles. A review of existing literature relevant to commercial space vehicle emissions informed the model development by identifying existing data and methodologies. The emissions model was integrated into BRRC's Launch Vehicle Acoustic Simulation Model, RUMBLE, providing the first user-friendly tool of its kind to enable practitioners to make accurate commercial space vehicle emissions and noise predictions for environmental documents. RUMBLE uses internal databases of engine performance data and emissions indices to allow users to easily estimate emissions for existing and emerging commercial space vehicles. A companion user guide describes the model's inputs and outputs as well as a technical review of the numerical codes and first-order approximations used to develop the databases and model methodology. Since AEDT is the standard model for estimating airport-related emissions, BRRC designed the commercial space vehicle emissions model with the intent to be integrated with AEDT. Additionally, BRRC prepared an integration plan, which describes the software and user interface modifications required to achieve a seamless integration of the commercial space vehicle emissions model with AEDT.



1.3 Key Personnel

Michael James, *Chief Engineer*

Mr. Michael James' areas of expertise include applied research, measurement, and analysis of atmospheric acoustics and technical management of consulting studies focused on military and community noise. Mr. James' research focus is developing innovative measurement, signal processing, and modeling techniques to characterize and map the noise emitted from complex noise sources. He has performed over 50 large-scale sound and vibration measurements for military and civilian aviation, rockets, weaponry, and blast noise to develop reference noise data and advanced propagation algorithms.

He has been the principal investigator for a diverse set of rocket environmental noise and launch load prediction studies. These studies have included propulsion and sonic boom noise analysis for static, launch and landing operations of both vertical and horizontal launch vehicles. Mr. James has been the principal investigator in the development of multiple rocket noise models including The Launch Vehicle Acoustic Simulation Model, RUMBLE. These advances have led to improvements in both near-field noise modeling used to predict vibroacoustic loading on space vehicles and far-field noise modeling to predict community impact.

Mr. James, as a member of working groups, has coauthored two American National Standards Institute standards (S12.75, S12.76) on aircraft noise source characterization. Mr. James has been instrumental in developing complete measurement systems, including portable sonic boom and noise measurement systems, an energy-based acoustic measurement system for rocket noise, a near-field acoustic holography system for jet plume characterization, and the Aero-Acoustic Research Complex for aircraft source noise characterization in White Sands, NM.

Prior to the founding of BRRC, Mr. James worked for Wyle Laboratories, where he conducted aviation research for the DoD and provided technical management for airport noise studies. His MS research at Virginia Tech's Vibration and Acoustic Laboratory included designing and testing passive and active turbofan engine noise reduction and control technologies for the NASA Langley Acoustics Research Group.

1.4 Abbreviated Curricula Vitae

MICHAEL JAMES, M.S.
Chief Engineer

PRINCIPAL DUTIES AND RESPONSIBILITIES

Conceives, directs and conducts applied research and consulting studies on high-amplitude noise sources and their effects on communities and the environment.

PROFESSIONAL EXPERIENCE

Blue Ridge Research and Consulting, Asheville, NC **2006 – Present**
Chief Engineer

- Founding member of BRRC. Responsible for developing innovative measurement, analysis, and modeling techniques to characterize and map the noise emitted from rocket engines/motors and jets (co-author of over 100 technical papers and reports).
- PI for over twenty-five rocket environmental noise studies consisting of propulsion noise and sonic boom impact analysis for projects involving a diverse collection of vertical and horizontal launches vehicles. Led the development of BRRC's Launch Vehicle Acoustic Simulation Model, RUMBLE.
- PI for three Airport Cooperative Research Program (ACRP) projects designed to develop commercial space noise (Project 02-66) and emission (Project 02-85) modeling tools, and conduct a measurement campaign to gather launch vehicle noise and sonic boom data (Project 02-81).
- Performed over fifty large-scale sound and vibration measurements for military and civilian aviation, rockets, sonic boom, weaponry, and blast noise to develop reference noise data and validate models. Extensive experience in sound and vibration measurements, data acquisition, signal processing, data analysis, and software development.
- Co-Authored two ANSI standards on "Methods for the Measurement of Noise Emissions from High Performance Military Jet Aircraft (ANSI S12.75)" and "Methods for Measurement of Supersonic Jet Noise from Uninstalled Military Aircraft Engines (ANSI S12.76 (Draft))." Provided technical expertise, including jet noise measurement procedures, signal processing, data acquisition systems, testing logistics and error / variability analysis.
- Co-PI of a NASA SBIR to develop an acoustic energy-based probe to facilitate greater understanding of the noise generation characteristics of rocket engine/motors. Performed multiple static fire measurements to evaluate the probes, producing significant advances in the characterization of the rocket acoustic source sound levels, directivity, and spatial extent.
- Co-PI of an Air Force SBIR to develop a near-field acoustic holography measurement system to characterize and map the noise emitted from jet engines. The system produced the first 3D holographic representation of the sound radiation from a military jet aircraft (F-22).

Wyle Acoustics Group, Arlington, VA **2002 – 2006**
Senior Engineer

- Researched and developed innovative measurement procedures and propagation models for the new generation of fighter aircraft with different engine geometries and thrust vectoring. Performed measurement of F/A-18E and F-22 to examine nonlinear propagation characteristics.
- Performed airport Master Plan and FAR Part 150 aviation noise studies. Developed advanced analysis and processing tools for community noise exposure, radar data, model validation, and soundscape studies.

EDUCATION

M.S., Mechanical Engineering, Virginia Tech	2003
B.S., Mechanical Engineering, Virginia Tech	2000

Appendix 2.1 Launch Vehicle Comparison

Skyrora XL Orbital Launch Vehicle

The Skyrora XL orbital Launch Vehicle is approximately 24 m long, three-stage liquid fuelled orbital launch vehicle intended to place customer payloads into sun synchronous or polar orbits.

Indicative parameters for the Skyrora XL Launch Vehicle are summarised in Table 1.

Table 1 Approximate parameters associated with Skyrora XL orbital Launch Vehicle

Parameter	Stage 1	Stage 2	Stage 3*	Payload Fairing*
Maximum height (m)	15.0	5.3	1.57	5.7
Maximum diameter (m)	2.2	2.2	1.9	2.2
Gross lift off weight (kg)	55,838			
Payload weight (kg)	Up to 315			
Dry mass (kg)	4,000	1,200	300	215
Potential elements contained within	Avionics Propellant tank 9x Helium tanks 9× engines	Avionics Propellant tank 3x Helium tank 1× engine	Avionics Propellant tank 1x engine	Fairing materials Payload adapter Payload
Indicative materials present	Lightweight carbon-fibre composite material Lithium ion batteries Aluminium tank Composite overwrapped pressure vessel High density polyethylene liner Aluminium, stainless steel, INCONEL alloy 718 engine components Copper	Lightweight carbon-fibre composite material Lithium ion batteries Aluminium tank Composite overwrapped pressure vessel Aluminium, stainless steel, INCONEL alloy 718 engine components High density polyethylene liner Copper	Lithium ion batteries Propellant tank High density polyethylene liner Aluminium, stainless steel, INCONEL alloy 718 engine components Copper	3-layer composite shell (2 halves), with honeycomb filler Carbon-fibre composite bearing layers
Propellant and other gases	High Test Peroxide (HTP) Jet A-1 Kerosene Helium Nitrogen CO_2	HTP Jet A-1 Kerosene Helium Nitrogen CO_2	HTP Jet A-1 Kerosene Helium Nitrogen CO_2	n/a

Parameter	Stage 1	Stage 2	Stage 3*	Payload Fairing*
Approximate amount of propellant left upon re-entry	485 kg HTP 195 kg Jet A-1 Kerosene	231 kg HTP 55 kg Jet A-1 Kerosene	It has been assumed that the worst-case amount of propellant to be used for launch will not exceed 57,000 kg. The amount of propellant in the Skyrora XL Launch Vehicle at launch will be precisely measured so that the minimum amount is used to meet the launch requirements. All fuel is expected to be used during the launch. However, there is the possibility that some fuel will remain upon re-entry of the stage(s). The effects of these have been assessed as a precautionary measure.	
Likely fate		Exact separation heights will vary mission-to-mission but will lie within the range outlined here. Stage 1 is jettisoned first at a height of approximately 66 km. Ignition of the Stage 2 engine occurs, followed by fairing separation and jettison at an approximate height of 113 km. At an approximate height of 233 km, Stage 2 is shut down, and Stages 2 and 3 separate. Once this has occurred Stage 3 will continue into orbital phase for payload deployment. For a typical trajectory the first ignition of Stage 3 occurs between a height of 234-474 km, followed by a coast flight. Subsequent Stage 3 ignition(s) occur(s) at a height of approximately 500 km (noting there may be a second and third ignition), followed by payload separation. It is anticipated that significant sections of the Skyrora XL Launch Vehicle and associated composite materials will burn up in the atmosphere resulting in debris components. Stage 1 will enter the marine environment intact after launch. The payload fairing, and Stage 2 will fragment whilst returning to Earth and lead to debris entering the marine environment. Stage 3 is planned to re-enter the atmosphere on a trajectory that would result in total burn up.	
Recovery	Noting the conditions of the Memoranda of Understanding currently in place between the UK Government and the Governments of The Faroe Islands and Iceland respectively, the Applicant will carry out the following activities: Prior to any launch activity, the Applicant will provide copies of any relevant Notices to Aviators or Notices to Mariners issued for the launch activity to the Government of The Faroe Islands and the Government of Iceland. • On the day of launch, the Applicant will monitor the publicly available Automatic Identification Systems (AIS) information, to ensure that no fishing activity within the territories of the Faroes Islands is placed at risk by the Applicant's activities. • Should any portion of the Skyrora XL Launch Vehicle descend into the sea within the Icelandic Exclusive Economic Zone, the Applicant will contract commercial recovery services to attempt to locate any debris			

Parameter	Stage 1	Stage 2	Stage 3*	Payload Fairing*
	and recover it. This recovery effort shall be co-ordinated with the relevant agencies of the Icelandic government to ensure that all parties are informed of the results of these efforts. Other than for components returning to earth within the Icelandic Exclusive Economic Zone there are currently no recovery operations planned to recover First or Second Stages or Fairings from the Skyrora XL Launch Vehicle.			

*Stage 3 payload adapter and payload components will not splash down, and thus will not interact with the marine environment

Skyrora Skylark L Suborbital Launch Vehicle

The Skyrora Skylark L suborbital Launch Vehicle is approximately 11.6 m long and comprises a guided suborbital Launch Vehicle powered by a single pressure fed, bi-liquid propellant engine.

Indicative parameters for the Skyrora Skylark L suborbital Launch Vehicle are summarised in Table 2.

Table 2 Approximate parameters associated with Skyrora Skylark L suborbital Launch Vehicle

Parameter	Skylark L single stage suborbital launch vehicle	Stage 2	Stage 3*	Payload Fairing*
Maximum height (m)	11.67	n/a	n/a	1.2
Maximum diameter (m)	0.80	n/a	n/a	0.75
Gross lift off weight (kg)	2,690			
Payload weight (kg)	Up to 20			
Dry mass (kg)	860	n/a	n/a	10
Potential elements contained within	Propellant tank 1 x 30 kN bi-liquid-propellant pressure fed engine	n/a	n/a	Fairing materials Payload
Indicative materials present	Aluminium composite panels Aluminium tanks Composite plastic/carbon fibre pressure vessel Aluminium, stainless steel, components Low Density Supersonic Decelerator (LDSD) including 4 x inflatable fabric structures and drogue parachute (nylon)	n/a	n/a	Composite shell Aluminium tip with honeycomb filler Carbon-fibre composite bearing layers
Propellant and other gases	High Test Peroxide (HTP) Jet A-1 Kerosene Helium	n/a	n/a	n/a
Approximate amount of propellant left upon impact	2 kg HTP 1 kg Jet A-1 Kerosene	It has been assumed that the worst-case amount of propellant / fuel to be used for launch will not exceed 1,402.5 kg. The amount of propellant in the Skyrora Skylark L Launch Vehicle at launch will be precisely measured so that the minimum amount is used to meet the launch		

Parameter	Skylark L single stage suborbital launch vehicle	Stage 2	Stage 3*	Payload Fairing*
		requirements. All fuel is expected to be used during the launch. However, there is the possibility that some fuel will remain upon impact.		
Likely fate		It is anticipated that the Skyrora Skylark L Launch Vehicle will be recovered on impact with the marine environment.		
Recovery	The Applicant anticipates recovery of Skyrora Skylark L Launch Vehicles post launch. The Skyrora Skylark L Launch Vehicles will have onboard telemetry and GPS tracker systems to transit location data to the recovery team. Following launch, a rapid response vessel (rib or similar) will be deployed from shore to the understood location of the Skyrora Skylark L Launch Vehicle to confirm location and condition, and subsequently – assuming recover if possible - a larger recovery vessel will be deployed to return the Skyrora Skylark L Launch Vehicle to shore under tow.			

Appendix 2.2 SaxaVord Spaceport AEE V3 Chapter 14 Material Assets and Cultural Heritage

14. Material Assets and Cultural Heritage

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14 Material Assets and Cultural Heritage

14.1 Introduction

14.1.1 This chapter considers the issues associated with the likely significant cultural heritage effects of the Proposed Project.

14.1.2 This chapter has been produced by AOC Archaeology Group, a Registered Organisation of the Chartered Institute for Archaeologists (CIfA). The assessment has been carried out by Victoria Oleksy and Lisa Bird of AOC Archaeology Group. Victoria Oleksy is an Assistant Director and Consultancy Sector Head with over 15 years of experience working on cultural heritage assessments. Victoria specialises in EIAs, Archaeological Impact Assessment and Conservation Management Plans and has appeared as an expert witness for planning appeals and called-in planning applications. Lisa Bird is a Project Officer with five years of experience working on a range of EIAs, desk-based assessments and large walkover survey projects.

14.1.3 This assessment has been carried out in accordance with the standards of professional conduct outlined in the CIfA *Code of Conduct* (CIfA, 2021) and *Regulations for Professional Conduct* (CIfA, 2019), as well as the CIfA *Standard and guidance for commissioning work on, or providing consultancy advice on, archaeology and the historic environment* (CIfA, 2014a); *Standard and guidance for historic environment desk- based assessment* (CIfA, 2017); field evaluations (CIfA, 2020) and other relevant guidance.

14.1.4 This assessment makes the distinction between designated heritage assets, referred to as 'designated assets', which have statutory designations (including Scheduled Monuments and Listed Buildings), and 'heritage features', which relate to non-designated assets which have no statutory designation but are protected under national and local planning policy. Individual elements within Skaw radar station (centred Site 3; hereafter RAF Skaw) and Inner Skaw (Site 2) which make up part of these larger designated assets and are statutorily protected are also referred to as 'heritage features.' Hitherto unknown buried archaeological remains are referred to as 'remains'.

14.1.5 This assessment considers the potential for effects on cultural heritage and archaeology associated with the operation of the Proposed Project. The specific objectives of the chapter are to:

- describe the cultural heritage baseline;
- describe the assessment methodology and significance criteria used in completing the effect assessment;
- assess the potential for direct effects on designated assets and non-designated heritage features and remains resulting from operation of the Proposed Project;
- assess the setting effects upon designated assets within the Site and the 1 km cultural heritage study area during the operational phase;
- identify measures that would mitigate or offset any predicted significant adverse effects; and,
- assess the significance of residual effects following the implementation of mitigation.

14.1.6 This chapter is supported by the Drawings and Appendices presented in Table 14.1. All site numbers referred to in the text and Drawings relate to designated assets and heritage features listed in the Site Gazetteer (Appendix 14.1)

Table 14.1 List of Drawings and Appendices in Volume 3 and 4 Respectively

Document Title	Document Description
Drawing 14.1	Designated Assets in the Proposed Project Site and the study area
Drawing 14.2a-c	Heritage features in the Proposed Project Site
Drawing 14.3	Heritage features in the study area of the Proposed Project
Drawing 14.4	Proposed Project Site - Extract from Ordnance Survey map, 1882
Appendix 14.1	Cultural Heritage Site Gazetteer
Appendix 14.2	Cultural Heritage Plates
Appendix 14.3	Consultation Meeting Notes
Appendix 14.4	Cultural Heritage Viewpoints
	Cultural Heritage Viewpoint Location Plan
	Cultural Heritage Viewpoint 1: Inner Skaw Scheduled Monument (Site 2)
	Cultural Heritage Viewpoint 2: RAF Skaw Interpretation Board
	Cultural Heritage Viewpoint 3: Advance Chain Home (ACH) Transmitter (Site 96)
	Cultural Heritage Viewpoint 4: Chain Home (CH) Transmitter (Site 85)
	Cultural Heritage Viewpoint 5: Gun and Crew Shelter (Site 74)
	Cultural Heritage Viewpoint 6: Track (Site 85hh) looking towards CH Transmitter (Site 85)
	Cultural Heritage Viewpoint 7: CH/S Power House (Site 93)
	Cultural Heritage Viewpoint 8: CH Receiver Block (Site 111)
Appendix 14.5	Review of Existing Structures
Appendix 14.6	Detailed Archaeological & Historical Background
Appendix 14.7	Results of Walkover Survey
Appendix 14.8	Data Structure Report: RAF Skaw, Watching Brief on Ground Investigation Works
Appendix 14.9	Draft Interpretation Strategy
Appendix 14.10	Conservation Management Plan

14.2 Legislation, Policy and Guidelines

Legislation

Space Industry Act

14.2.1 The Space Industry Act (2018) regulates all spaceflight activities carried out in the United Kingdom, and associated activities. The Act requires any person or organisation to obtain the relevant licence to:

- launch a launch vehicle from the UK;
- return a launch vehicle launched elsewhere than the UK to the UK landmass or the UK's territorial waters;

- operate a satellite from the UK;
- conduct sub-orbital activities from the UK;
- operate a spaceport in the UK; or
- provide range control services from the UK.

14.2.2 As the applicant wishes to operate a vertical spaceport (at the SaxaVord Spaceport) and provide range control services (at the Launch and Range Control Centre, LRCC) they are required to apply for a both a spaceport licence and a range control licence.

Space Industry Regulations 2021

14.2.3 The Space Industry Regulations 2021 (the Regulations) set out in more detail the requirements for each licence the Regulators Licensing rules, which specify what information the UK Civil Aviation Authority (CAA), the regulator, requires in support of an application.

Statutory Framework for Heritage

14.2.4 The statutory framework for heritage in Scotland is outlined in the Town and Country Planning (Scotland) Act 1997 (HMSO, 1997a), as amended in the Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997 (HMSO, 1997b) and the Ancient Monuments and Archaeological Areas Act 1979 (HMSO, 1979) both of which are modified by the Historic Environment (Amendment) (Scotland) Act 2011 (HMSO, 2011).

14.2.5 The Proposed Project is located within the southern portion of the Scheduled Monument of Skaw, radar station (centred Site 3; hereafter RAF Skaw). As such Scheduled Monument Consent (SMC) will be required for works within the RAF Skaw Scheduled Monument in line with the Ancient Monuments and Archaeological Areas Act 1979.

14.2.6 Historic Environment Scotland's (HES) Scheduled Monument Consents Policy (SMCP) (HES, 2019a) sets out policies applied to consent decisions with regard to proposals for work on Scheduled Monuments. The following policies are relevant to this assessment:

- *'SMCP1: When undertaking works to scheduled monuments, their significance should be maintained.*
- *SMCP3: Extensive intervention to a scheduled monument will only be allowed where:*
  - it has minimal effect on the cultural significance of the monument; or
  - it is clearly necessary to secure the long-term preservation of the monument; or
  - it will clearly generate public benefits of national importance which outweigh the impact on the nationally important cultural significance of the monument. Such public benefits could come from, for example, interventions which improve public access to a scheduled monument (where appropriate) or assist public understanding once the works are completed or provide economic benefits of national importance once completed.
- *SMCP4: Proposals for change should be carefully considered, based on good authority, sensitively designed, and properly planned and executed. The level of information provided should be in proportion to the sensitivity of the monument or feature and the level of change proposed.'*

Planning Policy

14.2.7 The implications of the Acts noted above, with regard to government planning policy, are described within Scottish Planning Policy (SPP) (Scottish Government, 2014), Historic Environment Policy for Scotland (HEPS) (HES, 2019b) and Planning Advice Notes (PAN) for Scotland. SPP, HEPS and PAN 2/2011 'Archaeology and Planning' (Scottish Government, 2011) deal specifically with planning policy in relation to heritage. The planning guidance expresses a general presumption in favour of preserving designated assets and non-designated features in situ. Their 'preservation by record' (i.e., through excavation and recording, followed by analysis and publication, by qualified archaeologists) is a less desirable alternative. SPP expresses the following policy principles:

'The planning system should:

- *promote the care and protection of the designated and non-designated historic environment (including individual assets, related settings and the wider cultural landscape) and its contribution to sense of place, cultural identity, social well-being, economic growth, civic participation and lifelong learning; and*
- *enable positive change in the historic environment which is informed by a clear understanding of the importance of the heritage assets affected and ensure their future use. Change should be sensitively managed to avoid or minimise adverse impacts on the fabric and setting of the asset, and ensure that its special characteristics are protected, conserved or enhanced' (Scottish Government 2014, Para 137).*

14.2.8 HEPS (HES, 2019b) sets out the Scottish Government's policy for decision making that affects the historic environment. It contains six policies for managing the historic environment, all of which favour protection, understanding and promotion of the historic environment as well as the preservation of the benefits of the historic environment for future generations. Historic environment policies 3 and 4 both state '*if detrimental impact on the historic environment is unavoidable, it should be minimised. Steps should be taken to demonstrate that alternatives have been explored, and mitigation measures should be in place*' (HES, 2019b). The following historic environmental policies are relevant to this assessment:

- *'HEP1: Decisions affecting any part of the historic environment should be informed by an inclusive understanding of its breadth and cultural significance.*
- *HEP2: Decisions affecting the historic environment should ensure that its understanding and enjoyment as well as its benefits are secured for present and future generations.*
- *HEP3: Plans, programmes, policies and strategies and the allocation of resources should be approached in a way that protects and promotes the historic environment.*

  If detrimental impact on the historic environment is unavoidable, it should be minimised. Steps should be taken to demonstrate that alternatives have been explored and mitigation measures should be put in place.
- *HEP4: Changes to specific assets and their context should be managed in a way that protects the historic environment. Opportunities for enhancement should be identified where appropriate.*

  If detrimental impact on the historic environment is unavoidable, it should be minimised. Steps should be taken to demonstrate that alternatives have been explored, and mitigation measures should be put in place.'

14.2.9 The sites are located in Unst, Shetland and the local authority is the Shetland Islands Council. Shetland Islands Council adopted the Local Development Plan (LDP) in September 2014 (SIC, 2014). The LDP sets out the vision and spatial strategy for the development of land in the Shetland Islands for the forthcoming 10 to 20 years.

14.2.10 The Historic Environment is recognised as having value and through the planning system Shetland Islands Council seeks to manage the Historic Environment in a sustainable way. The following policies are relevant to this assessment:

- *HE1 Historic Environment: The Council should presume in favour of the protection, conservation and enhancement of all elements of Shetland's historic environment, which includes buildings, monuments, landscapes and areas.*
- *HE2 Listed Buildings: Development affecting a listed building, or its setting, should preserve the building, its setting, and any features of special architectural or historic interest that it possesses.*
- *HE4 Archaeology: Scheduled monuments, designated wrecks and other identified nationally important archaeological resources should be preserved in situ, and within an appropriate setting. Developments that have an adverse effect on scheduled monuments and designated wrecks or the integrity of their settings should not be permitted unless there are exceptional circumstances.*

  All other significant archaeological resources should be preserved in situ wherever feasible. Where preservation in situ is not possible the planning authority should ensure that developers undertake appropriate archaeological excavation, recording, analysis, publication and archiving in advance of and/ or during development. (SIC, 2014: 31-34)

14.2.11 Shetland Islands Council published draft Supplementary Guidance on the Historic Environment (SGHE) in 2012 (SIC, 2012). The draft Supplementary Guidance sets out the policies which affect the historic environment and the setting of individual elements of the historic environment. The following draft policy is relevant to this assessment:

- *Policy SGHE 3 Archaeological assessment: Where archaeological remains are known or thought likely to exist the developer may be requested to supply a report of an archaeological evaluation prior to determination of a planning or listed building consent application.*

14.2.12 Shetland Islands Council planned for the emerging Local Development Plan 2 (LDP2) to be published in August 2019. However, at the time of writing, LDP2 has still not been published.

Guidance

Guidance to the regulator on environmental objectives relating to the exercise of its functions under the Space Industry Act 2018

14.2.13 The Department for Transport issued its document '*Guidance to the regulator on environmental objectives relating to the exercise of its function under the Space Industry Act 2018*' in 2021, clarifying the government's environmental objectives relating to spaceflight and associated activities in the UK:

The environmental objective for spaceflight are to:

- *Minimise emissions contributing to climate change resulting from spaceflight activities;*
- *Protect human health and the environment from the impacts of emissions on local air quality arising from spaceflight activities;*
- *Protect people and wildlife from the impacts of noise from spaceflight activities;*
- *Protect the marine environment from the impact of spaceflight activities.*

Guidance for the Assessment of Environmental Effects

14.2.14 The Guidance for the Assessment of Environmental Effects (AEE) explains the process for completing an assessment of environmental effects as part of a licence application under the Space Industry Act.

14.2.15 The AEE Guidance requires that potential direct and indirect significant effects of proposed spaceflight activities on environmental features, including noise and vibration, are considered. The guidance further requires that:

- Specific potential effects are identified and, where possible, quantified;
- The focus of the AEE should be on significant effects arising from the proposed activities;
- Applicants for a spaceport licence set an environmental budget, comprising a maximum number of launches per launch vehicle type which can take place over the course of a year that can be carried out in an environmentally sustainable manner, taking into account the cumulative effect of all launches; and
- The AEE must address a range of environmental topics, including material assets and cultural heritage.

HES Setting Guidance

14.2.16 HES's setting guidance defines setting as *'the way the surroundings of a historic asset or place contribute to how it is understood, appreciated, and experienced'* (HES, 2016, updated 2020). The guidance further notes that *'planning authorities must take into account the setting of historic assets or places when drawing up development plans and guidance, when considering various types of environmental and design assessments/statements, and in determining planning applications'*. It advocates a three-stage approach to assessing potential impacts upon setting which is followed by the setting assessment included in this assessment. The three-stage approach includes:

- Stage 1: Identify the historic asset;
- Stage 2: define and analyse the setting; and,
- Stage 3: evaluate the potential impact of the proposed changes.

14.3 Consultation

14.3.1 Extensive statutory consultation in relation to material assets and cultural heritage was carried out during preparation and determination of the planning application for the SaxaVord Spaceport, where the Proposed Project will be operated. Where directly relevant to this AEE, consultation responses received during the SaxaVord Spaceport planning application period have been summarised in Table 14.2.

Table 14.2 Consultation Relevant to AEE

Consultee	Summary	Response
Historic Environment Scotland (HES) Pre-Application Consultation Case ID: 300044616 (29th May 2020)	The Proposed Project is located within the Scheduled Monument known as Skaw, radar station (SM13097- centred Site 3- Drawing 14.1).	Direct and settings impacts on RAF Skaw and Inner Skaw were discussed at length within the EIA and as required are summarised for the operational phase in this AEE chapter. The settings assessment is cognisant of the relationship between the north and

Consultee	Summary	Response
		southern portions of RAF Skaw, as well as the character, setting and legibility of the surviving remains within the Scheduled Monument. Impacts upon the settings of other designated assets within 1 km have also been considered.
Historic Environment Scotland (HES) (16th June 2020) Meeting included Shetland Regional Archaeologist (Shetland Amenity Trust (SAT))	Cultural Heritage and Archaeology to be considered in the EIA. Cultural Heritage visualisations to be included and agreed with HES and SAT. An assessment of the direct impact of vibration on the upstanding RAF features within the Proposed Project needs to be undertaken.	Also included for the operational phase in the AEE at the request of the CAA. Proposed Cultural Heritage visualisation locations were submitted to HES on 10th July 2020 and were confirmed to HES on the 17th August 2020. AEE Chapter 8: Noise and Vibration
Val Turner, Regional Archaeologist Shetland Amenity Trust (SAT) (23rd July 2020- on-site)	Consultation on the proposed Cultural Heritage visualisations to be produced for the Proposed Project.	In addition to the proposed Cultural Heritage visualisations submitted on the 10th July 2020, three further visualisations were identified and agreed on-site and confirmed on 17th August 2020.

14.3.2 Upon review of the submitted Planning Application and EIA Report for the Proposed Project, HES issued a statutory consultation response on 29th March 2021 objecting to the planning application and requesting that further work be undertaken with the aim of reducing effects on the Historic Environment assets of the site at Lamba Ness, principally arising from direct effects on the derelict structures of the former Skaw Radar Station (Scheduled Monument 13097).

14.3.3 A review of the Proposed Project Site Layout was undertaken in response to HES' consultation comment on the planning application (Planning Application Reference 2021/005/PPF) that 'there is no indication that any alteration in design was considered to relocate this area to avoid the impact on these features despite the presence of open areas without known features in the near vicinity'.

14.3.4 Heritage assets impacted by the original design were reviewed, resulting in further changes to the site layout design:

- Car Park moved from the south to the west of the Administration Building.
- Hardstanding to the north of the assembly area moved east.
- Road and future west Assembly buildings moved as a block east.
- Hangar building moved to the south of the existing road.

14.3.5 These alterations have been included in the description of the Proposed Project included in Chapter 3 and are used as the basis of this assessment for AEE.

14.4 Assessment Methodology and Significance Criteria

Consultation

14.4.1 Consultation was undertaken directly with the relevant consultees namely HES and the Shetland Regional Archaeologist at Shetland Amenity Trust (SAT), as advisor to Shetland Islands Council. Online meetings were held with the Shetland Regional Archaeologist on the 26th May 2020 and with HES and the Shetland Regional Archaeologist on 16th June 2020 and 19th November 2020. The Shetland Regional Archaeologist also undertook a site visit with AOC on 23rd July 2020. A number of consultation responses were provided by HES as detailed in Table 14.2 above.

14.4.2 Upon review of the submitted Planning Application and EIA Report for the Proposed Project, HES issued a statutory consultation response on 29th March 2021 objecting to the planning application and requesting that further work be undertaken with the aim of reducing effects on the Historic Environment assets of the site at Lamba Ness, principally arising from direct effects on the derelict structures of the former Skaw Radar Station (Scheduled Monument 13097).

14.4.3 Heritage assets impacted by the original design were reviewed, resulting in further changes to the site layout design as described above.

Environmental Zone of Influence (EZI)

14.4.4 The Study Area for cultural heritage and archaeology comprising the Proposed Project boundary and an area of 1 km surrounding was identified for this assessment. This was considered to be sufficient to develop an historic environment baseline, identify assets which could be subject to impact and to identify archaeological potential. The Study Area is deemed sufficient given the height and nature of the Proposed Project and the density of known designated assets and heritage features within the study area. The study area was subject to agreement with HES and SAT during initial meetings as detailed above. The Study Area for cultural heritage and archaeology lies within the overall EZI for the AEE.

Desk Study

14.4.5 Data on known designated assets and heritage features within the sites and in the surrounding study area has been collated from the following sources:

- HES
  - National Record of Historic Environment (NRHE) data (downloaded in March 2020);
  - Designated asset data (downloaded in July 2020); and,
  - Published and unpublished archaeological reports.
- Shetland Amenity Trust (SAT) Sites and Monuments Record (SMR) obtained in May 2020
  - Designated heritage asset and heritage features as recorded by the Shetland Islands SMR; and,
  - Unpublished archaeological reports (referred to as Events).
- National Library for Scotland
  - Ordnance Survey maps and pre-Ordnance Survey historical maps.
- National Collection of Aerial Photography (NCAP), held by HES

- Vertical and oblique historic aerial photographs online and as reproduced in the Unexploded Ordnance assessment by Zetica (Zetica, 2020).

- Walkover Surveys and Site Visits
  - Walkover surveys of the Sites and site visits to designated assets within the study area were undertaken between 20th and 25th July 2020.
- Shetland Museum and Archives
  - Archival material including pre-Ordnance Survey mapping, and unpublished reports were viewed at the Shetland Museum and Archives, Lerwick on the 24th July 2020 by appointment.
- A History of RAF Saxa Vord blogpost
  - A series of blogs disseminating documentary research and oral histories relating to the Royal Airforce (RAF) bases on Unst were reviewed. Several relate to the construction, use and abandonment of the Scheduled Skaw, radar station, the former RAF Skaw.

Site Visit

14.4.6 A walkover survey of the Site was undertaken between the 20th and 25th July 2020. The survey was undertaken with the aim of identifying any previously unknown heritage features, and to confirm the presence and extent of previously recorded designated assets and heritage features. All known and accessible designated assets and heritage features were assessed in the field to establish their survival, extent, significance, and relationship to other designated assets and heritage features. Weather and any other conditions affecting the visibility during the surveys were also recorded. All heritage features encountered were recorded and photographed. The location of features noted in the field was recorded on an US GPS Navstar enabled iPad using ESRI's ArcGIS Collector software or an iPhone using iGIS. All features were recorded directly through ArcGIS Collector and iGIS in full British National Grid coordinates.

Assessment of Potential Effect Significance

14.4.7 This assessment distinguishes between the term 'impact' and 'effect'. An impact is defined as a physical change to a designated asset, heritage feature or its setting, whereas an effect refers to the significance of this impact. The first stage of the assessment involves establishing the value and importance of the designated assets and/or heritage feature and assessing the sensitivity of the asset or feature to change (impact). Using the proposed design for the Proposed Project, an assessment of the impact magnitude is made and a judgement regarding the level and significance of effect is arrived at.

Criteria for Assessing Sensitivity of Heritage Assets

14.4.8 The definition of cultural significance is readily accepted by heritage professionals both in the UK and internationally and was first fully outlined in the Burra Charter, which states in article one that 'cultural significance' or 'cultural heritage value' means aesthetic, historic, scientific, social or spiritual value for past, present or future generations (ICOMOS, 2005). This definition has since been adopted by heritage organisations around the world, including HES. HEPS notes that to have cultural significance an asset must have a particular '*aesthetic, historic, scientific or social value for past, present and future generations*' (HES, 2019b). Heritage assets also have value in the sense that they '*...create a sense of place, identity and physical and social wellbeing, and benefits the economy, civic participation, tourism and lifelong learning*' (Scottish Government, 2014).

14.4.9 All assets and/or features have significance; however, some are judged to be more important than others. The level of that importance is, from a cultural resource management perspective, determined by establishing the asset or feature's capacity to contribute to our understanding or

appreciation of the past (HES, 2019c). In the case of designated assets their importance has already been established through the designation (i.e., Scheduling, Listing and Inventory) processes applied by HES.

14.4.10 The rating of importance of assets and features is first and foremost made in reference to their designation. For non-designated assets importance will be assigned based on professional judgement and guided by the criteria presented in Table 14.3; which itself relates to the criteria for designations as set out in Designation Policy and Selection Guidance (HES, 2019c) and Scotland's Listed Buildings (HES, 2019d).

Table 14.3: Criteria for Establishing Relative Importance of Designated Assets and Heritage Features

Importance	Receptors
Very High	World Heritage Sites (as protected by SPP, 2014); Other designated or non-designated assets or heritage features with demonstrable Outstanding Universal Value.
High	Scheduled Monuments (as protected by the Ancient Monuments and Archaeological Areas Act 1979 (the '1979 Act'); Category A Listed Buildings (as protected by the Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997) (the '1997 Act'); Inventory Gardens and Designed Landscapes (as protected by the 1979 Act, as amended by the Historic Environment (Amendment) (Scotland) Act 2011); Inventory Battlefields (as protected by the 1979 Act, as amended by the 2011 Act); Outstanding examples of some period, style or type; Non-Designated features considered to meet the criteria for the designations as set out above (as protected by SPP, 2014).
Medium	Category B and C Listed Buildings (as protected by the 1997 Act); Conservation Areas (as protected by the 1997 Act); Major or representative examples of some period, style or type; or Non-designated features considered to meet the criteria for the designations as set out above (as protected by SPP, 2014);
Low	Locally Listed assets; Examples of any period, style or type which contribute to our understanding of the historic environment at the local level.
Negligible	Relatively numerous types of features; Findspots of artefacts that have no definite archaeological remains known in their context; The above non-designated features are protected by Paragraph 137 of SPP, 2014.

14.4.11 Determining cultural heritage significance can be made with reference to the intrinsic, contextual and associative characteristics of an asset or feature as set out in HEPS (HES, 2019b) and its accompanying Designation Policy and Selection Guidance (HES, 2019c). HEPS Designation Policy and Selection Guidance (HES, 2019c) indicates that the relationship of an asset or feature to its setting or the landscape makes up part of its contextual characteristics. The Xi'an Declaration (ICOMOS, 2005) set out the first internationally accepted definition of setting with regard to heritage assets and features, indicating that setting is important where it forms part of or contributes to the significance of a heritage asset or feature. While SPP does not differentiate between the importance of the asset itself and the importance of the asset's setting, HES's

Managing Change Guidance on setting (HES, 2016, updated 2020b), in defining what factors need to be considered in assessing the impact of a change on the setting of a historic asset or place, states that the magnitude of the proposed change should be considered *'relative to the sensitivity of the setting of an asset'* ; thereby making clear that assets vary in their sensitivity to changes in setting and thus have a relative sensitivity.

14.4.12 The EIA Handbook suggests that cultural significance aligns with sensitivity but also states that '*the relationship between value and sensitivity should be clearly articulated in the assessment'* (SNH et al., 2018). It is therefore recognised that the importance of an asset or feature is not the same as its sensitivity to changes to its setting. Elements of setting may make a positive, neutral or negative contribution to the significance of an asset. Thus, in determining the nature and level of effects upon assets and their settings by the development, the contribution that setting makes to an asset or feature's significance and thus its sensitivity to changes to setting needs to be considered.

14.4.13 This approach recognises the importance of preserving the integrity of the setting of an asset or feature in the context of the contribution that setting makes to the experience, understanding and appreciation of a given asset or feature. It recognises that setting is a key characteristic in understanding and appreciating of some, but by no means all, assets and features. Indeed, assets or features of High or Very High importance do not necessarily have high sensitivity to changes to their settings (e.g., do not necessarily have a high relative sensitivity). An asset or feature's relative sensitivity to alterations to its setting refers to its capacity to retain its ability to contribute to our understanding and appreciation of the past in the face of changes to its setting. The ability of an asset or feature's setting to contribute to an understanding, appreciation and experience of it and its significance also has a bearing on the sensitivity of that asset to changes to its setting. While heritage assets or features of High or Very High importance are likely to be sensitive to direct effects, not all will have a similar sensitivity to effects on their setting; this would be true where setting does not appreciably contribute to their significance. The HES guidance on setting makes clear that the level of effect may relate to '*the ability of the setting* [of an asset or feature] *to absorb new development without eroding its key characteristics'* (HES, 2016, updated 2020b). Assets or features with Very High or High relative sensitivity to settings effects may be vulnerable to any changes that affect their settings, and even slight changes may erode their key characteristics or the ability of their settings to contribute to the understanding, appreciation and experience of them. Assets or features whose relative sensitivity to changes to their setting is lower, may be able to accommodate greater changes to their settings without having key characteristics eroded.

14.4.14 The criteria used for establishing an asset or feature's relative sensitivity to changes to its setting is detailed in Table 14.4. This table has been developed based on AOC's professional judgement and experience in assessing setting effects. It has been developed with reference to the policy and guidance noted above including SPP (Scottish Government, 2014), HEPS (HES, 2019b) and its Designation Policy and Selection Guidance (HES, 2019c), the Xi'an Declaration (ICOMOS, 2005), the EIA Handbook (SNH et al., 2018) and HES's guidance on the setting of heritage assets and features (HES, 2016, updated 2020b).

Table 14.4 – Criteria for Establishing Relative Sensitivity of a Heritage Asset to Changes to its Setting

Relative Sensitivity	Criteria
Very High	An asset or feature, the setting of which, is critical to the ability to understand, appreciate and experience it should be thought of as having Very High Sensitivity to changes to its setting. This is particularly relevant for assets or features whose settings, or elements thereof, make an essential direct contribution to their cultural significance (e.g., form part of their Contextual Characteristics (HES, 2019c).
High	An asset or feature, the setting, of which, makes a major contribution to an understanding, appreciation and experience of it should be thought of as having High Sensitivity to changes to its setting. This is particularly relevant

Relative Sensitivity	Criteria
	for assets or features whose settings, or elements thereof, contribute directly to their cultural significance (e.g., form part of their Contextual Characteristics (HES, 2019c)).
Medium	An asset or feature, the setting of which, makes a moderate contribution to an understanding, appreciation and experience of it should be thought of as having Medium Sensitivity to changes to its setting. This could be an asset or feature for which setting makes a contribution to significance but whereby its value is derived mainly from its other characteristics (HES, 2019c).
Low	An asset or feature, the setting of which, makes some contribution to an understanding, appreciation and experience of it should generally be thought of as having Low Sensitivity to changes to its setting. This may be an asset or feature whose value is predominantly derived from its other characteristics
Marginal	An asset or feature whose setting makes minimal contribution to an understanding, appreciation and experience of it should generally be thought of as having Marginal Sensitivity to changes to its setting.

14.4.15 The determination of an asset or feature's relative sensitivity to changes to its setting is first and foremost reliant upon the determination of its setting and the key characteristics of setting which contribute to its cultural significance and an understanding and appreciation of that cultural significance. This aligns with Stage 2 of the HES guidance on setting (HES, 2016, updated 2020b). The criteria set out in Table 14.4 are intended as a guide. Assessment of individual assets and features is informed by knowledge of the asset or feature itself; of the asset or feature type if applicable and by site visits to establish the current setting of the assets and features. This will allow for the use of professional judgement and each asset and/or feature is assessed on an individual basis.

Criteria for Assessing Magnitude of Impact

14.4.16 Potential impacts, that is the physical change to known designated assets, heritage features, and unknown buried archaeological remains, or changes to their settings, in the case of the Proposed Project relate to the possibility of disturbance to upstanding RAF features due to vibrations during the operational phase or the placement of new features within their setting during the operational phase.

14.4.17 The magnitude of the impacts upon designated assets or heritage features caused by operation of the Proposed Project is rated using the classifications and criteria outlined in Table 14.5.

Table 14.5- Criteria for Classifying Magnitude of impact

Magnitude of impact	Criteria
High	Substantial loss of information content resulting from total or large-scale removal of deposits from an asset or feature; Major alteration of an asset's baseline setting, which materially compromises the ability to understand, appreciate and experience the contribution that setting makes to the significance of the asset or feature and erodes the key characteristics (HES 2020) of the setting.
Medium	Loss of information content resulting from material alteration of the baseline conditions by removal of part of an asset or feature; Alteration of an asset or feature's baseline setting that effects the ability to understand, appreciate and experience the contribution that setting makes to the significance of the asset to a degree but whereby the

Magnitude of impact	Criteria
	cultural significance of the monument in its current setting remains legible. The key characteristics of the setting (HES 2020) are not eroded.
Low	Detectable impacts leading to minor loss of information content. Alterations to the asset or feature's baseline setting, which do not affect the ability to understand, appreciate and experience the contribution that setting makes to the asset or feature's overall significance.
Negligible	Loss of a small percentage of the area of an asset or feature's peripheral deposits; A reversible alteration to the fabric of the asset or feature; A marginal alteration to the asset or feature's baseline setting.
None	No effect predicted

Criteria for Assessing Significance

14.4.18 The predicted level of effect on each designated asset or heritage feature is then determined by considering the asset or feature's importance and/or relative sensitivity in conjunction with the predicted magnitude of the impact. The method of deriving the level of effect is provided in Table 14.6.

Table 14.6 - Level of Effect based on Inter-Relationship between the Sensitivity of a Heritage Asset and/or its setting and the Magnitude of Impact

Magnitude of Impact	Important and/or Sensitivity				
	Negligible	Low	Medium	High	Very High
High	Minor	Moderate	Moderate	Major	Major
Medium	Negligible/Neutral	Minor	Moderate	Moderate	Major
Low	Negligible/Neutral	Negligible/Neutral	Minor	Minor	Moderate
Negligible	Negligible/Neutral	Negligible/Neutral	Negligible/Neutral	Minor	Minor

14.4.19 The level of effect is judged to be the interaction of the asset or feature's importance and/or relative sensitivity (Tables 14.3 and/or 14.4) and the magnitude of the impact (Table 14.5). In order to provide a level of consistency, the assessment of importance and relative sensitivity, the prediction of magnitude of impact and the assessment of level of effect is guided by pre-defined criteria. However, a qualitative descriptive narrative is also provided for each asset to summarise and explain each of the professional value judgements that have been made in establishing sensitivity and magnitude of impact for each individual asset.

14.4.20 Using professional judgment and with reference to the Guidelines for Environmental Impact Assessment (as updated) (IEMA, 2017), and the EIA Handbook (SNH et al., 2018) the assessment considers moderate and greater effects to be significant (shaded grey in Table 14.6), while minor and lesser effects are considered not significant.

Integrity of Setting

14.4.21 SPP notes that where there is potential for a proposed project to have an adverse effect on a Scheduled Monument or on the integrity of its setting permission should only be granted where there are '*exceptional circumstances*'. Adverse effects on integrity of setting are judged here to relate to whether a change would adversely affect those attributes or elements of setting which

contribute to an asset or feature's significance to the extent that the ability to understand and appreciate the asset is diminished.

14.4.22 In terms of effects upon the setting of designated assets or heritage features, it is considered that only those effects identified as 'significant' in the assessment will have the potential to adversely affect integrity of setting. Where no significant effect is found it is considered that the integrity of an asset or feature's setting will remain intact. This is because for many assets and features, setting may make a limited contribution to their significance and as such changes would not affect integrity of their settings. Additionally, as set out in Table 14.5, lower ratings of magnitude of change relate to changes that would not obscure or erode key characteristics of setting.

14.4.23 Where significant effects are found, a detailed assessment of adverse effects upon integrity of setting is made. Whilst non-significant effects are unlikely to affect integrity of setting, the reverse is not always true. That is, the assessment of an effect as being 'significant' does not necessarily mean that the adverse effect to the asset's or feature's setting will harm its integrity. The assessment of adverse effect upon the integrity of an asset or feature's setting, where required, will be a qualitative one, and will largely depend upon whether the effect predicted would result in a major impediment to the ability to understand or appreciate the designated asset or heritage feature such that its cultural significance is reduced.

Requirements for Mitigation

14.4.24 National and local planning policies and planning guidance outlined in Section 14.2, require a mitigation response that is designed to take cognisance of the possible impacts upon heritage assets and/or features by a proposed project and avoid, minimise or offset any such impacts as appropriate. The planning policies and guidance express a general presumption in favour of preserving heritage assets, features and remains in situ wherever possible. Their 'preservation by record' (i.e., through excavation and recording, followed by analysis and publication, by qualified archaeologists) is a less desirable alternative (Scottish Government, 2014), (SIC, 2014).

Assessment of Residual Effect Significance

14.4.25 The residual impact is what remains following the application of mitigation and management measures and is thus the final level of impact associated with the Proposed Project. The level of direct residual effect is defined using criteria outlined in Tables 14.3, 14.5 and 14.6. No direct mitigation, beyond those embedded in the in the Proposed Project's design, is possible for setting effects of the Proposed Project and therefore residual effects on the setting of heritage assets and/or feature will be the same as predicted without mitigation.

Limitations to Assessment

14.4.26 This assessment is based upon data obtained from publicly accessible archives as described in the Data Sources. Sites and Monuments Record (SMR) data was received in May 2020 and NRHE data on known heritage assets was downloaded from HES in March 2020 and checked in July 2020. This assessment does not include any records added after this date.

14.4.27 Access to historic vertical and oblique aerial photography is currently limited due to Covid-19 restrictions. AOC Archaeology Group have a subscription to NCAP and as such any available aerial photography which is available online has been viewed. Further copies of relevant aerial photographs obtained by Zetica for the unexploded ordnance assessment have been examined (Zetica 2020).

14.4.28 Due to Covid-19 Unst Heritage Centre was unfortunately be closed throughout 2020. Access to archival material held by Unst Heritage Centre regarding the former RAF Skaw was provided digitally by Lynn Thomson, Unst Heritage Centre.

14.4.29 Nevertheless, the assessment is considered to be robust and is based upon accepted principles of assessment.

14.5 Baseline Conditions

14.5.1 This section presents a summary of the baseline conditions relevant to the historic environment. Full discussion of the archaeological and historical background is set out in Appendix 14.6 and the results of the walkover survey undertaken to inform this assessment are presented in Appendix 14.7. All heritage assets and features referred to below are individually recorded within Appendix 14.1, Cultural Heritage Site Gazetteer. The numbering within the Gazetteer is not sequential due to the methodology employed during the walkover survey. All heritage assets and features referred to in the text and within Appendices 14.1, 14.6 and 14.7 are shown on Drawings 14.1-14.3.

14.5.2 Within the Gazetteer, Appendix 14.1, designated heritage assets are identified by their statutory designation, either 'Scheduled Monument' or 'Listed Building'. Individual heritage features within the southern portion of the RAF Skaw (centred Site 3) are identified by 'RAF feature within Scheduled Monument', 'Non-RAF feature within Scheduled Monument' or 'Features excluded from Scheduled Monument' to differentiate between the features which are directly related to the Scheduling, those of which are included within the Scheduled Area and those which have been specifically excluded from the Scheduling.

14.5.3 Features identified as 'Non-RAF feature within Scheduled Monument' relate to features within the Scheduled Area which are not specifically noted as being excluded in the Scheduling but which do not specifically relate to evidence of the construction, use and abandonment of the Chain Home radar station which forms the reason for designation. Individual heritage features within the Scheduled Monument of Inner Skaw (centred Site 2) are identified as 'Feature within Inner Skaw Scheduled Monument' where the feature relates to the specifics of the Inner Skaw Scheduling, or 'RAF feature within Inner Skaw Scheduled Monument', where a feature dating to the Second World War has been identified.

14.5.4 The Proposed Project comprises the following principal elements:

- 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.

14.5.5 The Proposed Project extends across the southern portion of the Scheduled Area of RAF Skaw (centred Site 3). RAF Skaw is the northernmost 20th century Chain Home Radar Station and is composed of two areas, the northern portion is located c. 830 m to the north-east of Skaw and is centred on Site 24, whilst the southern portion is centred on Site 3. Numerous individual features within the southern portion of RAF Skaw have been recorded, including the remains of radar structures, domestic blocks and defensive structures and these are shown on Drawings 14.2a-c.

14.5.6 Inner Skaw (Site 2) Scheduled monument is located immediately north of the Proposed Project. The Proposed Project boundary does not extend within it and no development is proposed within the Scheduled Area. The designated asset comprises the remains of a multiperiod settlement with associated agricultural remains which dates from the Early Historic period onwards.

14.5.7 The Scheduled Monument of St John's Church at Norwick (Site 1) is a multi-period asset which encompasses an Iron Age broch and the remains of a chapel located c. 1.19 km south-west of the Proposed Project.

14.5.8 There are two Listed Buildings (Sites 4 and 6) located within 1km of the Proposed Project. The Banks, Norwick (Site 4), a group of Category C Listed 19th century crofts, are recorded c. 670 m south-west of the Proposed Project. A Category C Listed boat-roofed shed (Site 6) is located c. 740 m north of the Proposed Project.

Geology and topography

14.5.9 According to the British Geological Survey GeoIndex (BGS 2020), the Proposed Project is underlain by Skaw Intrusion, a microgranite, porphyritic igneous bedrock formed approximately 359 to 444 million years ago in the Devonian and Silurian periods. This bedrock is indicative of an environment previously dominated by silica rich magma.

14.5.10 The superficial deposit recorded in the eastern and western portion of the Proposed Project is recorded by the BGS (2020) as Till and Morainic deposits, formed approximately 3 million years ago in the Quaternary period under Ice Age conditions. The central area is underlain by superficial blown sand deposits also formed approximately 3 million years ago in the Quaternary period. In the areas not subject to previous development during the Site's use as an RAF radar station, the ground investigation works have indicated that in general, the deposits encountered consist of peaty topsoil overlying peat, which in turn overlies blueish grey sandy clay. The clay overlies bedrock with varying levels of weathering. The peat across the Site varies in depth from c. 0.15 m to c. 2.75 m, with the deepest deposits being located in the vicinity of Launch Site 2.

14.5.11 The land slopes gently north-eastward. The western boundary is recorded at c.36 m AOD and the land slopes eastward to 1 m AOD and then rises slightly to 9 m AOD at the eastern end of the Proposed Project Site. The land in the south-western corner is recorded at 17 m AOD and slopes north-eastward to 2 m AOD.

Archaeological and Historical Background

Prehistoric

14.5.12 There is evidence of prehistoric activity in Shetland from the Mesolithic period and evidence of activity in Unst from at least the Neolithic period, largely in the form of chambered cairns. An Iron Age settlement which is thought to have been in use for at least 500 years between the late 1st millennium BC and the 1st millennium AD was uncovered between 2004 and 2007 at Sandwick, c.14 km south of the Site, on the south-eastern coast of Unst. Iron Age deposits associated with settlement remains were also recorded as underlying Viking remains at the Broch of Underhoull, on the south-west coast of Unst (Small, 1965).

14.5.13 Details of known prehistoric features within the Proposed Project Site and within the surrounding Study Area are set out in Detailed Archaeological and Historical Background in Appendix 14.6. Prehistoric features, including a possible cairn (Site 9) and a midden (Site 48) have been identified within the Proposed Project site and prehistoric activity is well documented in the surrounding 1 km and in Unst. As such there is judged to be a High potential for prehistoric remains to survive within the Proposed Project site, particularly around the edges of the peninsula and around natural boat landing locations.

Early Historic

14.5.14 Minimal Roman activity is known in the Shetland Islands, although a Roman brooch has been reported at Site 1 which suggests a potential trading relationship with the Romans further south or perhaps evidence of an heirloom. As such the end of the prehistoric period is generally regarded as the 9th century and the arrival of Norse peoples (SIC, 2019).

14.5.15 The Viking invasions started about 800AD and settlement subsequently followed. The Orkenyinga Sagas record Shetland as the northern third of the great earldom of Orkney (SIC, 2019). The etymology of Unst suggests a Norse origin for the name of the island. Unst is believed to have originated in 'Qstr' meaning 'corn stack', however it is argued that the name was converted from the pre-Norse name (Shetland Amenity Trust, n.d.). Norwick to the south-east of the Sites contains 'wick' which is thought to originate from 'Vik', a Norse word for 'bay', referencing the settlement's location.

14.5.16 The Scheduled Monument of Inner Skaw (Site 2) is located immediately north and west of the boundary for the Proposed Project. The Scheduled Area encompasses a series of settlement and agricultural remains dating from the Early Historic period onwards. Further evidence of Early

Historic remains has been encountered in the study area, the details of which are set out in Appendix 14.6.

14.5.17 Given the proximity of Inner Skaw Scheduled Monument (Site 2), which dates from this period, there is judged to be a High potential for hitherto unknown Early Historic remains to survive within the area of the Proposed Project.

Medieval

14.5.18 Shetland was mortgaged to the Scottish crown in 1468 as part of the dowry of Princess Margaret in her marriage to James III of Scotland (SIC, 2019). In 1471, as the Danish struggled to pay Margaret's dowry, Scotland annexed Orkney and Shetland in lieu of the dowry (SIC, 2019). As such, the annexation of Shetland to Scotland in 1471 draws to an end the period of Norse rule and as such acts as the boundary between the Early Historic and medieval period.

14.5.19 Full details of medieval assets and features within the Proposed Project Site and the surrounding Study Area are set out in the Detailed Archaeological and Historical Background in Appendix 14.6. The Proposed Project lies immediately south and east of the Scheduled Area of Inner Skaw (centred Site 2). The Scheduled Area is recorded as containing evidence of continuous settlement and agrarian activities from the Early Historic period onwards.

14.5.20 While there are no further medieval assets and/or features recorded within 1 km of the Proposed Project, post-medieval buildings and farmstead identified within the study area may have had earlier, medieval antecedents. As such there is judged to be a High potential for medieval remains to survive within the area of the Proposed Project; given the proximity to Inner Skaw these would most likely be associated with settlement or agricultural activities.

Post-Medieval

14.5.21 Pre-Ordnance Survey maps tend to be schematic and lack detail, although they give some idea of the nature of settlement. Blaeu's 1654 map depicts the Shetland Islands. In the north-east of Unst, 'Harolswick', to the south of the site, Norwick to the south-east and Saxa Vord, over 1 km to the west of the site are annotated. A pictogram of a church is depicted at each of the settlements recorded by Blaeu (1654) which indicates that each settlement had a chapel or church in the mid-17th century. Whilst the size of each settlement is not record by Blaeu (1654), the number of settlements annotated suggest that the north-eastern area of Unst was well populated in this period.

14.5.22 Moll's 1732 map is not dissimilar to Blaeu's earlier illustration; however, it appears to have been drawn at a larger scale and the settlements in Unst are not annotated, only noted by pictograms of churches.

14.5.23 A map by Preston (1781- not illustrated) records a singular church in the north-east of Unst, which is most likely the Scheduled Church of St John (Site 1), to the east of the Site. Norwick is annotated to the south-east of the site and Lamba Ness, on which the Proposed Project is situated, is labelled. This map is described as a hydrographical survey and was most likely designed to help in the navigation around the Shetland Islands. As such the map was less interested in recording land use or settlement density. However, the map does indicate that the Church of St John (Site 1) must have been a seaward point of interest, and potentially a navigational aid.

14.5.24 The Old Statistical Account of Scotland (OSA) for Unst was recorded in 1793 (Mouat and Barclay, 1793). A map engraved for the OSA (D6/158) annotates Lamba Ness, which appears to be occupied by at least three structures, a relatively large settlement at Norwick with a Chapel (Site 1) and another Kirk to the south (possibly Site 17). Unst is recorded in the OSA as being in the presbytery of Shetland in the late 18th century. Unst is described as having a ragged, and broken coastline with a number of bays and creeks, and Norwick to the south-east of the Proposed Project is noted as being one of the principal bays of Unst. Lamba Ness, where the Proposed Project is situated, is described as the most north-eastern point which has free communication to the North Atlantic Ocean. However, it was recorded that there was no lighthouse in the area in the late 18th century which made fishing and shipping in the area problematic. The OSA notes that Dr Webster recorded

the population of Unst as 1,368 in 1755, and the OSA recorded the population in 1793 as 1,988, which indicates a 45% growth in the population in the late 18th century. No proper roads are noted in Unst in 1793. Agriculture is documented as being the main employment type in Unst, largely dominated by black oats, potatoes and green and garden roots, black cattlemen, pigs and sheep, although in the years prior to the publication of the OSA, harsh winters had decreased the sheep population by a third. Fishing is noted as being another form of employment on the island, however the OSA suggests that it was a secondary pursuit in the late 18th century. No mines or quarrying activity was documented in Unst in 1793, and the main source of fuel was peat. Mills in Unst were recorded as being wheel-less, instead being 'tirl'-horizontal mills, two of which (Sites 19 & 20) are recorded within 1 km of the Proposed Project.

14.5.25 Two undated maps, probably dating to the late 18th or early 19th century, one by George Thomas (D23/123) and one of unknown origin (D16/389/112/12), depict the north-eastern area of Unst. Lamba Ness is depicted as a peninsula, and no structures are depicted on the peninsula. However, a group of buildings are depicted on a north-south aligned stream which runs to a beach on the north coast of the peninsula, possibly in the vicinity of Sites 48 and 75 and another group of buildings is depicted in the vicinity of Inner Skaw (Sites 2 & 25). Another building is recorded in the vicinity of Site 61. A north, south aligned boundary is depicted in the vicinity of the western boundary of the Proposed Project on these maps, which may also be a road which originates at The Floggie, the road from Norwick, along the coast to Lamba Ness which extends to the village of Skaw. Buildings are depicted around Skaw, and dispersed buildings, most likely small farmsteads or crofts, are depicted from Haroldswick to Norwick on these maps, although no roads are depicted in this area.

14.5.26 Thomson's 1827 map of Unst depicts the north-eastern coast of Unst. Topographically, an area of high land is depicted in the northern central area of Unst, and another slight area of high land is depicted at the western end of the Lamba Ness peninsula. A chapel labelled on the east coast of Unst is likely the Scheduled St John's Chapel (Site 1).

14.5.27 The New Statistical Account (NSA) for Unst (Ingram et al., 1845) records that the population of Unst was hit by two smallpox outbreaks, due to the lack of inoculations available in Unst, however overall the population was documented as 2,909 persons in 1831, an increase of 43% from the OSA (Mouat et al., 1793). A poor climate in the 5-6 years prior to the NSA being written, is noted as hitting the population as well as impacting on the number of people relying on fishing. Smaller farms than those recorded in the late 19th century further support the move of the population towards fishing over farming. Two thousand acres of arable land are recorded in Unst in 1845, which was organised as an infield, outfield system. Iron stone and limestone quarrying is record in Unst by 1845. A quarry (Site 62), visible on aerial photography taken in 2014 is located within the north-eastern area of the Proposed Project.

14.5.28 Full details of post-medieval assets and features both within the Proposed Project Site and in the Study Area are set out in the Detailed Archaeological and Historical Background presented in Appendix 14.6. This includes further map regression related to the Proposed Project itself. Heritage features comprise farm buildings and houses, crofts, enclosures and land boundaries both on site and in the surrounding study area. The site was clearly located within a post-medieval agricultural landscape. Given this, there is judged to be a High potential for remains associated with the post-medieval occupation and agricultural use of the Proposed Project Site.

Modern

14.5.29 The First World War destroyed the booming herring industry which had supported the population of the Shetland Islands from the post-medieval period. Emigration increased in the 1920s and 1930s which decreased the overall population (SIC, 2019). The Second World War caused a temporary boom on the Shetland Islands as it was utilised as a base for covert and secretive missions between the continent and the British Isles due to the bonds between Shetland and Norway. The 'Shetland Bus' which used fishing boats to support the Norwegian resistance ran from Shetland (SIC, 2019).

14.5.30 Map regression indicates little change on the Proposed Project Site in the early half of 20th century, prior to the development of RAF Skaw (Site 3) on Site. The radar station is the most northerly of the chain home radars of the Second World War. The Scheduled Area (Site 3) is composed of two separate areas, the largest and southern most within the site was the location of the Advanced Chain Home (ACH) and latterly the main Chain Home (CH) radar with the smaller reserve station located c. 855 m north. The Floggie, a route from Norwick northwards, along the coast was straightened, widened, and strengthened in 1940 to facilitate the construction of the radar station (Carle, 2018a).

14.5.31 A detailed history of the construction use and abandonment of RAF Skaw are provided in Appendix 14.6. Based on the presence of RAF Skaw within the Proposed Project boundary and having regard for the detail set out in Appendix 14.6, there is a High potential for further modern remains to survive within the Site. Any remains would most likely be associated with the construction, use and abandonment of RAF Skaw radar station (Site 3).

14.5.32 Modern assets within the study area include a Category C Listed boat-roofed shed (Sites 6 & 64), built in 1940 which is located c. 740 m north of the Proposed Project.

Walkover Survey

14.5.33 A walkover survey of the Site was undertaken between the 21st and 25th July 2020 in dry weather conditions which varied between bright sun and overcast. The weather provided ideal walkover survey conditions, good ground visibility was available and good visibility of the surrounding landscape and seascape was achieved. The walkover survey covered the Proposed Project Site and recorded the extent and condition of previously identified heritage features as well as recording any previously unrecorded features. The full results of the walkover survey are set out in Appendix 14.7; cultural heritage plates referred to in the walkover survey text can be found in Appendix 14.2.

Drone Survey

14.5.34 A drone survey has been undertaken across the Proposed Project Site. The drone survey noted the presence of many upstanding remains previously recorded via the NRHE, SMR and during the walkover survey.

14.5.35 Several linear features, potentially post-medieval field boundaries (Sites 484-486), not visible during the walkover survey were visible from the results of the drone survey. These features have not been directly dated but appear to be similar in form to others identified within the Proposed Project Site (Sites 214-217b, 230 & 434). It is possible that these linear features may be of post-medieval date or older, especially due to the proximity of Inner Skaw (centred Site 2) and the field system identified around Site 75.

14.5.36 A north to south aligned linear feature (Site 484) was identified to the west of Site 85 and a number of potentially interconnecting or overlapping linear features (Site 485) were identified around Site 85, to the east of Site 484. These may be the remains of a field system, similar to that recorded to the west centred Site 216 and the field system record around Site 75.

14.5.37 Another linear feature aligned north north-east to south south-west (Site 486) was identified to the west of Site 288. Historic maps record this area as '*The Garths*' and it is possible that this linear feature is an old field boundary associated with the post-medieval or earlier use of the land.

14.5.38 Two large negative features (482 & 483) were identified east of the CH Transmitter block (Site 85). These appear to be similar in form to the excavated areas identified during the walkover survey (Sites 321, 345,247, 373, 410) and may be additional areas which have been reduced around the CH Transmitter block (Site 85) and mast bases (centred Site 102 & 103) for either; spoil to create the banks and bunds around the CH radar blocks and other earthwork protective defences; or to enable the construction of the steel masts at Sites 102 & 103.

14.5.39 The field system within the Scheduled Inner Skaw (centred Site 2) and the field system around Site 75, a post-medieval stone building, is visible on the drone survey as a larger field system, extending south to the track which bisects the Proposed Project and further east and west, than either the Scheduled extent of Inner Skaw (centred Site 2) or the SMR recorded area around Site 75 indicate. The southern extent of the field system seems to survive in a relatively poor condition, compared to that observed around Site 75 and within Inner Skaw (centred Site 2). No evidence of rig and furrow is visible, and the field systems appear to be similar to the medieval and post-medieval infield, outfield systems.

Results of Ground Investigation Works and Archaeological Watching Brief

14.5.40 Ground investigation (GI) works were undertaken, with SMC, in October and November 2020. GI works were required to inform the design of the Proposed Project and were subject to an archaeological watching brief.

14.5.41 The GI works took place between the 27th October and the 3rd November 2020 and comprised of 304 peat probes, one Russian Core and the excavation of 42 machine dug test pits. Peat probes were sunk away from known archaeological remains and their locations were chosen in consultation with the onsite archaeologist, and they were undertaken in a regular grid pattern. Peat probes recorded the depth of peat across the Site between 0.15 m and 2.75 m in depth.

14.5.42 A singular Russian core was sunk beside TP020. No archaeological remains, buried land surfaces or the potential for environmental proxies were identified.

14.5.43 Test pits were positioned 5m away from all known archaeological features and five tests pits were abandoned due to the proximity of archaeological remains and the difficulty in reaching the proposed locations with a machine. One test pit was abandoned due to wet ground conditions. The probable hiatus of peat development was noted in TP017, a plastic pipe was encountered in the section of TP029 and a brick, denoting the presence of an electrical cable was identified in TP043. No archaeological remains were observed in any of the other excavated test pits. The full report on the results of the archaeological watching brief is included in Appendix 14.8.

Review of Existing Buildings

14.5.44 Aecom has produced a review of the existing buildings on Site and this is contained in Appendix 14.5. The review has considered the current condition of the extant upstanding buildings on site and commented on their condition and stability.

14.5.45 Overall, the review has indicated that there has been significant degradation of the buildings on site since the decommissioning of RAF Skaw. Concrete buildings and features are subject to degradation from weathering and carbonation and the review indicates that the degradation of exposed concrete features, given the location of the Site and the time since abandonment, has likely reached the reinforcement allowing decay.

14.5.46 Of particular note is the safety of the Power House (Site 77). The review indicates that as a result of loss of the roof and internal walls, the external walls are no longer supported at roof level. Large vertical cracks from the ground level are evident on the south-west elevation wall. The review indicates that the Power House is at risk of collapse in high winds.

14.5.47 Also, of note are the roofs of the CH Transmitter, Receiver and Power House (Sites 85, 93 and 111). The review indicates that waterproofing has deteriorated, exposing the roof slab in some areas. This in turn is impacting the surface of the roof and allowing significant deterioration of the concrete and the reinforcements.

14.5.48 Brick structures on Site, including the ACH buildings (Sites 96, 98 and 99), also show signs of deterioration due to weathering and carbonation. Buildings which remain roofed with concrete appear to be in reasonable condition. However, unroofed buildings no longer have roof support and in time will be at risk of collapse in high winds.

Conservation Management Plan (CMP)

14.5.49 A CMP incorporating a Condition Survey Report has been produced for the Skaw radar station and this is contained in Appendix 14.10. The CMP assesses the significance of Skaw radar station, evaluates the issues and opportunities it has and provides a range of conservation policies to guide the future development, preservation, interpretation and use of the site.

14.5.50 The Condition Survey was undertaken by Adams Napier Partnership and David Narro Associates to inform the CMP. Despite lack of any recent meaningful maintenance, the exposure of the Site and the widely acknowledged issues with deterioration of Second World War structures the Condition Survey has revealed the majority to be generally in a fair and stable condition, albeit some structures, including the Power House (Site 77), are in poor condition Detailed descriptions of each of the buildings surveyed is presented in the Condition Survey report

14.6 Receptors Brought Forward for Assessment

14.6.1 All designated heritage assets including individual features therein and all non-designated heritage features within the Proposed Project boundary are brought forward for assessment to allow for consideration of the potential for direct effects upon them resulting from operation of the Proposed Project.

14.6.2 All designated heritage assets within the study area for the Proposed Project were found to lie within the zone of theoretical visibility and, as such, all have been brought forward for assessment to allow for consideration of the potential for setting impacts upon these designated heritage assets as a result of the operation of the Proposed Project.

14.7 Standard Mitigation

14.7.1 It is acknowledged that operation of the Proposed Project will have a direct impact upon a number of features within the Scheduled RAF Skaw (Site 3). Further, and despite the extensive survey undertaken to inform this assessment, there may be potential for further previously unrecorded archaeological features within the Site.

Conservation Management Plan (CMP)

14.7.2 The CMP (appendix 14.10) represents a commitment to the ongoing management and maintenance of the Skaw radar station site during operation of the Proposed Project and presents a range of broad policies to allow for this commitment to be met.

14.7.3 An outline of proposed conservation works, and an assessment of their priority is provided within the CMP. In making these management, maintenance and repair recommendations, the aim has been to retain the surviving buildings and structures in a safe and manageable condition whilst respecting and preserving their significance.

14.7.4 In addition, a programme of annual inspection and maintenance will be carried out on all structures to control unwanted vegetation growth, stabilise loose brickwork and make good any localised areas of failing mortar, with regular inspections formalized to identify any defects.

Vibration and Terrain Monitoring

14.7.5 A review of the upstanding buildings on Site has been undertaken to inform the planning application, to identify any structures which are already in a state of compromise and therefore may be more vulnerable to direct impacts resulting from vibrations from satellite launches. The results of this are outlined in Appendix 14.5. The mitigation measures to be implemented to monitor and protect these buildings during the operational phase are outlined below.

Vibration Modelling

14.7.6 HES requested that consideration be given to the potential for the operation of the Proposed Project to directly impact upon standing structures within the Proposed Project Site. A review of the condition and stability of the upstanding buildings on Site has therefore been undertaken to establish, insofar as possible, a baseline structural stability for these features. Modelling ground and structural vibration is complex and dependent on the unique material properties of each element and its respective boundary conditions, the maintenance condition of the structure, and the incident sound wave characteristics. These complexities have resulted in structural damage criteria for launch vehicle environmental reviews that are largely based on findings from anecdotal evidence and static horizontal rocket testing. Thus, while it is acknowledged that future research is needed, the damage claim criteria used in the Shetland noise study (AEE Chapter 8) represents the best available dataset regarding the potential for structural damage resulting from launch noise – as the findings are based on actual rocket noise and community surveys over a large number of events. This indicates that the potential for structural damage is likely to be low.

14.7.7 For structures of historical significance, typical practice is to document conditions prior, during, and after a launch event. In extremely sensitive cases, measurements on individual structural elements of interest may be performed during launch for comparison with established damage criteria. On this basis vibration monitoring will be undertaken on Sites 96, 98, 99 and 111 in the vicinity of Launch Site 3 and Site 85 in the vicinity of Launch Site 2 and Site 90 between Launch Sites 2 and 3. Further, baseline data will be gathered prior to launches commencing on Site and monitoring will initially take place during launches to ensure that there is no damage to structures as a result of the operation of the Proposed Project. A programme of regular monitoring will be established thereafter and be dependent upon the results of initial monitoring. Where monitoring identifies the potential for structural damage, HES and the Shetland Regional Archaeologist will be informed immediately and further mitigation strategies will be discussed, agreed and implemented to prevent damage to any affected structures.

14.8 Potential Effects

Direct effects

14.8.1 Ongoing launches and works associated with the operational phase of the Proposed Project have the potential to directly impact the heritage features within the Proposed Project Site. Vibrations from proposed launches have the potential to cause structural damage to upstanding features.

14.8.2 Several upstanding buildings within the Proposed Project Site have been identified as part of review of existing structures presented in Appendix 14.5, as being in various states of degradation. These include the unroofed brick structures at Sites 90, 96, 98 and 99, the roofs of the CH buildings (Sites 85, 93 and 111) and the Power House (Site 77), which have been structurally compromised to some extent. A detailed study of these structures is also presented in the Condition Survey Report in Appendix 14.10.

14.8.3 These reviews have established a baseline structural stability for these features insofar as possible, as set out in Appendix 14.5 and 14.10. However, the extent to which they might suffer impacts as a result of the vibration associated with launches is difficult to assess at this stage. This is because modelling ground and structural vibration is complex and dependent on the unique material properties of each element and its respective boundary conditions, the maintenance condition of the structure, and the incident sound wave characteristics. These complexities have resulted in structural damage criteria for launch vehicle environmental reviews that are largely based on findings from anecdotal evidence and static horizontal rocket testing. Thus, while it is acknowledged that future research is needed, the damage claim criteria used in the Shetland noise study (Chapter 8) represents the best available dataset regarding the potential for structural damage resulting from launch noise – as the findings are based on actual rocket noise and community surveys over a large number of events. This indicates that the potential for structural damage is likely to be low. However, as per the above, the potential magnitude of impact cannot be accurately identified at

this stage. Mitigation measures outlined in Section 14.7 will ensure that any potential for impact is identified early and mitigation is put in place to ensure that no significant effects arise.

Setting effects

14.8.4 Zone of Theoretical Visibility (ZTV) analysis and mapping have been used to identify those designated assets that could potentially be affected by changes to their settings during the operational phase of the Proposed Project and all designated heritage assets within the study area have been carried forward for assessment. The detailed assessments have included a review of the contextual characteristics of each asset using information drawn from their designation documentation, supplemented by observations on the morphology, condition and character of each asset and the nature of their settings made during site visits undertaken in July 2020.

14.8.5 The qualitative setting assessment for each asset considered is set out below. The assessment follows HES guidance on setting assessment (HES, 2016, updated 2020). Having identified the assets which could be affected, this section defines the setting of each heritage asset and how this contributes to the understanding, appreciation and experience of the assets. This is followed by consideration of the impact of the Proposed Project on the setting of the asset in question and consideration as to whether the integrity of the assets' setting would be adversely affected. Sensitivity of the assets to changes to their settings, the magnitude of impact and the resulting level of effect are given in line with the methodology set out in Section 14.4.

St John's Church, remains of, Norwick (Site 1)

14.8.6 St John's Church (Site 1) comprises the remains of a former church which survives as the turf covered footings of the walls of the nave. The asset is thought to be located on the site of a former Iron Age broch. The chancel has been built over with a later memorial. The Statement of National Importance associated with the Scheduling states that:

> '*The monument is of national importance as the remains of a simple pre-Reformation parish church, with the potential to provide information about medieval church architecture and parish organisation. It was probably constructed at about the time that Shetland was passing from Danish to Scottish rule*.' (HES, 2020a).

14.8.7 The current setting of the church is defined by the post-medieval and modern burial ground, which currently occupies the site, and the surrounding residential properties of the village of Norwick. The church sits on elevated ground above Nor Wick bay which lies to the north-east and there are views down to the associated beach, across Nor Wick and to the Lamba Ness peninsula to the north. The ground rises to the south to the summit of the Hill of Clibberswick. The current surroundings of the asset contribute to an understanding of it as a place of worship for the immediately surrounding settlement, within which it forms a moderately prominent landmark. Salvage excavations in 2003 found evidence for Viking and Iron Age settlement at the site, though not necessarily a broch –as local tradition holds. The setting, on a knoll above, but with access to the sea at the beach and Nor Wick bay, and the natural defensive cliffs of Lamba Ness and the Hill of Clibberswick to the north and south respectively contribute to an understanding and appreciation of reasons for selecting this site for settlement in earlier periods. On this basis St John's Church is judged to have a high relative sensitivity to changes to its setting.

14.8.8 Elements of the Proposed Project would be visible, above the cliffs of Lamba Ness, from St John's Church. In particular, the buildings associated with the Assembly and Storage Area and some security fencing around these would be visible. A small portion of two of the dishes associated with the Satellite Tracking Area and the upper portions of the Integration Hangar would also be visible. The Integration Hanger would be visible behind the CH/S Power House (Site 93). Launch vehicles and lightning towers required for launches from the Proposed Project would also be visible for a

limited amount of time. However, only one launch pad would be utilised at any given time and these items of infrastructure would only be visible on launch days.

14.8.9 While the elements of the Proposed Project described above would be visible, they would only occupy a small proportion of the view of Lamba Ness when viewed from the church; and they would not obscure or detract from the ability to understand, appreciate or experience the relationship between the church and the settlement of Norwick, Nor Wick bay or the surrounding and inherently defensive coastline. In addition, launch events may be audible but these impacts would be short-lived and number no more than 30 per year. As such they are not considered to materially impact upon the setting of the church.

14.8.10 On this basis the Proposed Project is judged to constitute an alteration to the setting of the church but one which would not affect an ability to understand the contribution that setting makes to the asset's overall significance. The magnitude of impact is predicted to be low and this would result in a minor level of effect, resulting in **no significant effects**.

Inner Skaw, houses and field system (Site 2)

14.8.11 Inner Skaw, houses and field system (Site 2) is a Scheduled Monument which comprises the remains of a series of farmhouses, the earliest of which may be of early Norse date, and their associated field system(s). The monument is visible as a series of stone wall and building foundations or footings with some upstanding walls remaining. The field systems extend, within the Scheduled area to the north, north-east and north-west of the structural remains and also appear to extend further east and south beyond the Scheduled Inner Skaw area, as shown by the walkover survey and the drone survey (see Site 75 extents). The Statement of National Importance associated with the Scheduling states that:

> '*The monument is of national importance as a remarkably fine example of a long-lived agricultural settlement, which may have its roots in the period immediately after the Norse settlement of Shetland in the ninth century AD, and which has been re-used on several occasions up to the nineteenth century.*
>
> *The settlement's importance is enhanced by the adjacent field systems, which represent several episodes of use, and although the earliest visible remains are probably Medieval rather than Norse, there is the potential for further investigation to clarify this and the whole settlement sequence*. (HES, 2020b).

14.8.12 The Scheduled Monument sits on land either side of a burn which flows north from the centre of the peninsula, down to the Sand of Inner Skaw. The buildings are primarily located in the south of the Scheduled Area and to the west of the burn. The field systems extend down slope to the coast and to the burn, where they then rise upslope on the eastern side of the burn, where the cultivation remains are particularly well defined (Plate 145). An ashy midden (Site 48) was found within the Scheduled Area and excavated in 2001, and numerous artefacts including steatite vessels, pottery and stone tools were recovered. The Scheduled remains are separated from land to the south by a post and wire fence which largely runs along the access road associated with the remains of RAF Skaw, the post and wire fence also dog legs north on the eastern side of the burn cutting across cultivation remains and the Scheduled Area.

14.8.13 The agricultural nature of the settlement and field systems is discernible in the current setting of the asset, even with the juxtaposition with later Second World War remains. The relationship between the building remains and the visible cultivation remains contained with the field system are particularly important in understanding the nature and longevity of settlement at this site, along with the asset's relationship to the burn which it straddles and the sea, at Inner Skaw Sands, to the north. The placement of the settlement, and indeed its longevity, would likely have been predicated on access to suitable agricultural land as well as other resources which could be exploited, as represented by the burn and easy access to the coast. The asset is considered to be of high relative sensitivity to changes which would affect the ability to understand the relationship between its built and agricultural elements and which would diminish the ability to appreciate its relationship to the

important topographic and landscape features noted here, namely the burn, sloping land and Inner Skaw Sands beach and inlet.

14.8.14 Viewpoint 1 indicates that the infrastructure associated with the Satellite Tracking would be prominent in views towards the south-east, truncating views in this direction. A portion of the Satellite Tracking Station would also be located in part of the field system outwith Inner Skaw Scheduled Area but within RAF Skaw Scheduled Area and would be located c. 73 m to the south-east of the boundary of the Inner Skaw Scheduled Area. Launch Site 1 would be located c. 250 m to the east and Launch Sites 2 and 3 would be visible behind this. The Integration Hangar would also be visible as a large new structure in views eastwards. While not indicated on Viewpoint 1, buildings associated with the Assembly and Storage Area are likely to be partially visible on higher ground to the west from the western edges of the Scheduled Area.

14.8.15 The Launch Sites and Integration Hangar would all be located outwith the designated area of Inner Skaw though it would be located in the wider associated field system and they further would not affect the relationship between the built and agricultural remains and the topographical features of the burn, the sloping land to the north and the beach at Inner Skaw Sands. However, the proximity and nature of these elements of the Proposed Project to the remains at Inner Skaw are such that they would change the current setting of the asset. Similar impacts upon the setting of Inner Skaw would have been experienced during the operational period of RAF Skaw, given the extent of former buildings and masts at the Site. On balance and given the above, and particularly as a result of the proposed construction of the security fencing and portions of the Satellite Tracking Station within the wider and less well-preserved portions of the field system, the predicted magnitude of impact would be medium. This would result in a moderate level of effect which is equivalent to a **likely significant effect**. As elements of the monument would largely remain legible in terms of their function and relationship to one another, it is considered that this effect would not adversely affect the integrity of the asset's setting.

Skaw, radar station (RAF Skaw) (Site 3)

14.8.16 The history and the features of RAF Skaw are outlined in Section 14.5, Appendix 14.6 and Appendix 14.7 and, as such, are not repeated in full here. A key reason for the asset's designation is the fact that it has survived as a coherent monument representing a largely intact RAF complex. The statement of National Importance makes particular reference to the asset as providing a '*complete example of the technical, support and domestic buildings and structures necessary to provide an early warning reporting function*'. And further states that '*the loss of the monument would significantly diminish our future ability to appreciate and understand the scale of the efforts employed on the home front in the defence of Britain*' (HES, 2020a).

14.8.17 As it currently stands the buildings, structures and individual features contained within the bounds of the RAF Skaw and their function and historical relationship to one another are easily interpreted and understood by an informed observer. Taken together the features within the boundaries of RAF Skaw allow for a detailed understanding of the construction and operation of the site as a chain home radar base during the Second World War. The topographical setting of RAF Skaw, on a peninsula with cliffs to the coastline on three sides, also contributes to an understanding of the strategic placement of the base in a location which provided a naturally defendable position from the sea, in a location between mainland Europe and the Atlantic. It is of high relative sensitivity to changes within its boundaries.

14.8.18 The continued operation of new infrastructure in the vicinity of these locations will result in a number of new features within and amongst the RAF structures and these will impact upon the character and setting of the asset and the ability to understand how the base functioned as a whole.

14.8.19 Cultural Heritage Viewpoint 2 (Appendix 14.4) was chosen as the location offers a good vista over the eastern portion of RAF Skaw from which the CH Transmitter (Site 85), the CH/S Power House and the CH Receiver Block (Site 111) are clearly visible along with the Power House (Site 77) and a number of ACH buildings (Sites 96 & 98). The field system associated with Inner Skaw (Site 2) is also clearly visible from this location. While a clear understanding of the above RAF features and the

relationship to one another requires closure examination and consideration of some of the less visible features to allow for a true understanding of construction, use and abandonment of RAF Skaw; the viewpoint does allow for an understanding of the strategic location of the site on the defensible Lamba Ness peninsula and for an understanding of the scale and distribution of the RAF remains. The visualisation indicates that Launch Site 1 is likely to obscure views of the CH Transmitter (Site 85). Views of the CH/S Power House and CH Receiver along with views of the northern ACH buildings will remain possible but they will be juxtaposed with the Integration Hangar and Launch Site 3 respectively. The Satellite Tracking Area would be seen in the foreground of views of the Power House. The interspersion of the Proposed Project amongst the RAF remains would diminish the ability to understand the relationship of the RAF remains to one another from this location. The strategic nature of the topographic position of the site would remain clear.

14.8.20 Cultural Heritage Viewpoint 3 (Appendix 14.4) was chosen for similar reasons to Viewpoint 1, in that it provides an overview of RAF Skaw from the east, looking west and inland over the CH/S Power House (Site 93) and the nearby guard hut (Site 142). From this position the remains of the CH masts (Sites 102 & 103) are visible with the top of the CH Transmitter building (Site 85) beyond. The Power House (Site 77) and another small guard hut (Site 84; due to be lost) are visible further to the west. The visualisation indicates that the Integration Hangar building would obscure the most westerly RAF buildings currently visible in this view and it would form a prominent new feature, located adjacent to the CH/S Power House. It will obscure views westward of much of the access road and it would remove portions of the remains of southern most of the two masts (Site 103). The security fencing and infrastructure associated with Launch Site 2 would remove the remains of the mast at Site 102 and would obscure views of the CH Transmitter (Site 85). When operational, prior to launch, the launch vehicles at Launch Sites 1 and 2 would form high vertical features. Though it is noted in the case of Launch Site 2 that this may allow for an understanding of some elements of the former character of the Site when it was an operational RAF facility; as the Launch Site would be in the location of a former mast (Site 102) and when operational the Launch Site would reintroduce a tall vertical feature in this location. However, overall, the interspersion of the Proposed Project amongst the RAF remains would diminish the ability to understand the relationship of the RAF remains to one another from this location and the some of the ability to understand how the site operated.

14.8.21 Cultural Heritage Viewpoint 4 (Appendix 14.4) was taken from the north-east corner of the CH Transmitter (Site 85) which is one of the most prominent and imposing remaining RAF buildings on the Site. It is of concrete construction with double blast walls, the outer of which has been banked up with earthen bunding. The view looks towards the remains of one of the transmitter masts (Site 102) associated with the transmitter. Launch Site 2 is proposed to be constructed at the location of the former mast and, as the visualisation indicates, security fencing and infrastructure associated with the Launch Site would be visible in close proximity. The loss of the remains of the mast footings (discussed in terms of direct effects above) would have an impact upon the contextual understanding of the CH Transmitter as directly associated features would be removed. Though it is noted in the case of Launch Site 2 that this may allow for some understanding of the former character of the Site when it was an operational RAF facility; as the Launch Site would reintroduce a tall vertical feature in this former mast location. As such it may allow, for short periods and with proper interpretation, for the appreciation of the height and location of the lost mast and its relationship to Site 85.

14.8.22 Cultural Heritage Viewpoint 5 (Appendix 14.4) is taken from near the gun and crew shelter (Site 74) and looks north-eastward. It marks the probable location of a strategic surveillance position with billets (Site 79) in the foreground and an air raid shelter (Site 78) located further to the south-east. The position is elevated above land further east along the peninsula and located near to the cliff top offering views over Nor Wick bay and out to sea in a south-easterly direction. The location also affords views over much of the radar infrastructure associated with RAF Skaw with several guard huts and the Power House (Site 77) visible along the access road and the CH Transmitter (Site 85), the CH/S Power House (Site 93) and the CH Receiver (Site 111) all clearly visible north-east and east. Elements of the early accommodation block (centred around Site 83 & 109) are also visible directly

to the east and elements of the ACH infrastructure are visible on the northern coast of the end of Lamba Ness peninsula. As such this viewpoint offers a vantage point which illustrates the contextual relationship between several of the main elements of RAF Skaw.

14.8.23 The visualisation indicates that the Integration Hangar would be a prominent feature in views from this location and that while the CH Transmitter, CH/S Power House and the CH Receiver would still be visible they would be backed by infrastructure associated with Launch Sites 2 and 3 and in the case of the CH/S Power House the Integration Hangar would be seen in a dominant position adjacent to the power house. As the new infrastructure is proposed to be interspersed with the remains of the RAF infrastructure and given the extent and the scale of the Proposed Project, the contextual relationships between and functional associations of individual elements of RAF Skaw would be more difficult to appreciate.

14.8.24 Cultural Heritage Viewpoint 6 (Appendix 14.4) was taken from the track (85hh) looking towards the CH Transmitter (Site 85) with the remains of the transmitter masts (Sites 102 & 103) in the background. It, like Viewpoint 5, was chosen to demonstrate the contextual and functional relationship between particular elements of the CH Transmitter infrastructure. The large cuttings (Sites 410, 392, 479 and 402) are also apparent in the slope to the east of the track and leading up towards the mast locations. Elements of the ACH infrastructure and the CH Receiver (Site 111) are visible in the background. This viewpoint in particular allows for understanding, by an informed observer, as to the extent of construction work that was required to establish RAF Skaw. The construction of the access track between Launch Site 2 and the Integration Hangar would remove much of the remains of the large cuttings which appear to be associated with the transmitter masts and would result not only in an inability to understand them as coherent features but would also prevent an understanding of their relationship to the former masts. Security fencing and infrastructure associated with operations at Launch Site 2 would sit above the CH Transmitter and the satellite in preparation for launch would form a prominent feature behind it. Though it is noted that when in launch preparation the vertical feature would be located in the historical location of the former vertical mast. The Integration Hangar will largely prevent views of the RAF features located at the extreme eastern extent of the peninsula from this location. The Proposed Project when considered from this viewpoint will diminish the ability to understand the relationship between individual elements of the CH Transmitter operations.

14.8.25 Cultural Heritage Viewpoint 7 (Appendix 14.4) is included at the request of the Shetland Regional Archaeologist and has been taken from the top of the northern bank surrounding the CH/S Power House (Site 93) looking north towards the CH Transmitter (Site 85) and the former masts (Sites 102 & 103). Given the proximity of the Integration Hangar to the CH/S Power House it would obscure all views in this direction from the CH/S Power House.

14.8.26 Cultural Heritage Viewpoint 8 (Appendix 14.4) was also included at the request of the Shetland Regional Archaeologist and has been taken from the north-east corner of the bank surrounding the CH Receiver block (Site 111). The security fencing along with the infrastructure associated with Launch Site 3 will largely prohibit views of the topography of the peninsula and the cliff edge in this view.

14.8.27 Consideration has also been given to how the Proposed Project might impact upon the setting and character of RAF Skaw in terms of its relationship to the northern element of the Scheduled Area which represents the reserve radar station. Currently the large buildings associated with the main site at RAF Skaw (the CH Receiver and the CH/S Power House) are clearly visible from the northern portion of the Scheduled Monument. LVIA viewpoint 1-1 (Drawing 13.3.1.1) indicates the launch sites and the Integration Hangar would be seen in this view but that the CH Receiver and Power House would remain obvious features.

14.8.28 Operation of the Proposed Project will result in the continued use of new structures interspersed amongst the RAF remains which adversely affect the ability of to understand the contextual relationships and associations of the individual features. Given the above, the Proposed Project would impact upon the intactness and the coherence of the Scheduled Monument and the impact upon its character and setting is judged to be high. The level of effect would be **major** and result in

likely significant effects. The integrity of the asset's setting would be adversely affected as a result of the diminishment of the coherence of the monument and intrinsic and contextual characteristics of the asset would be adversely affected.

14.8.29 HES have also requested specific comment on how the Proposed Project might impact upon the associative characteristics and social value of the asset. Associative characteristics can relate to how the asset is perceived and valued by people today. As noted above, associative value for RAF Skaw can be measured, in part, by the interest shown in the monument by local people and by military enthusiasts. This is evident in previous exhibitions held at Unst Heritage Centre and in the publication of a blog on the History of RAF Skaw. However, it would seem that most of that value resides in the historical associations of the asset which are well recorded. It is also the case that these characteristics can be appreciated remotely/indirectly through interactions with representations of and information regarding the asset. On this basis, while there is likely to be an adverse effect on associative characteristics there is potential to mitigate these effects, and indeed to enhance appreciation of the asset, through the proposed Interpretation Strategy set out below and in Appendix 14.9.

Norwick, The Banks, Including Cottage, Outbuilding, Ruin, Boundary and Sea Walls (Site 4)

14.8.30 The Banks (Site 4) comprise a group of buildings including a house, cottage, outbuilding and sea walls along with a ruin. The group is Listed together at Category C and the main house dates to the later 19th Century. The Listing description states the following in the Statement of Special Interest:

> *The Banks was originally known as The Bod. Despite the installation of modern glazing, this group retains its traditional appearance characterised by low-pitched tarred roofs and thick rubble walls. The contrast of the startling white walls with the black tarred roofs enhances the picturesque quality of this group in its dramatic and rocky setting.* (HES, 2020c).

14.8.31 The group sits to the north of the beach at Nor Wick bay and its main elevations face south and east across the beach and out to the bay. The land rises steeply behind (to the north) of the buildings up The Cliffs towards Braehead and eventually the Ward of Norwick and extends east along the cliffs of the Lamba Ness landform (Plate 146; and visible in LVIA viewpoint 1.6 (Drawing 13.3.1.6). As the Statement of Special Interest notes the buildings' setting against the beach and the rocky cliffs contributes to an understanding of its placement. That being a relatively protected location for a croft in an otherwise rocky and potentially harsh location. The Statement of Special Interest also references the picturesque qualities of the buildings assigning significance to their aesthetic qualities. The buildings' setting primarily relates to the Nor Wick bay and cliff side setting and is less sensitive to changes beyond this setting. On balance the group is judged to have a medium relative sensitivity to changes to its setting, as the setting makes an overall moderate contribution to an understanding, appreciation and experience of the buildings.

14.8.32 Elements of the Proposed Project would be visible, largely in views of The Banks when approached along the beach road from the south and from further way, along the B9087 travelling towards Norwick (LVIA viewpoint 1.6 (Drawing 13.3.1.6)). Views of the Proposed Project from the buildings themselves would be more limited given their orientation and steeply rising cliffs to the north and north-east. In views of The Banks from the south infrastructure associated with Storage and Assembly Area would be visible above and behind the Listed Buildings as would limited elements of the Satellite Tracking equipment. Launch vehicles at all three Launch Sites would be visible when preparing for launch but infrastructure associated with the Launch Sites would not. While these elements would be visible, they would not obscure or detract from the ability to understand, appreciate or experience the relationship between The Banks and Nor Wick bay or the surrounding coastline. The relationship between The Banks and the beach, bay and cliffs would not be obscured. In addition, launch events may be audible at The Banks, but these impacts would be short-lived and number no more than 30 per year. As such they are not considered to materially contribute to the impact upon the setting of The Banks.

14.8.33 On this basis, the Proposed Project would constitute an alteration to the setting of The Banks but one which would not affect the ability to understand the contribution that setting makes to its

significance. The magnitude of impact is predicted to be low and this would result in a minor level of effect, resulting in **no significant effects**.

Papil, Valsgarth, Including Outbuildings and Walls (Site 5)

14.8.34 The croft buildings at Papil, Valsgarth (Site 5) are Category B Listed and include a house and outbuildings located within improved fields with their main elevation facing south towards the bay at Harold's Wick (Plates 147 & 148). The land slopes up behind the buildings towards the rise on which Saxa Vord Resort is located and to the summit of the Hill of Clibberswick to the east. The Statement of Special Interest states:

'*A particularly fine example of a larger crofthouse and outbuildings in little-altered condition and sporting an excellent glazed timber porch of the type that was once a common characteristic of buildings in Unst. The building may have been altered to its present form by settlers from Sutherland in the 1870s, accounting for its larger size and quality of construction. This picturesque group is prominently sited near the road.'* (HES, 2020d)

The setting of Papil, such that it contributes to an understanding, appreciation and experience of the asset, primarily relates to its location on the road, the surrounding improved agricultural fields and its relationship with Harold's Wick Bay to the south. These features contribute to an understanding and appreciation of the croft's siting in a location where agricultural resources could be readily exploited and, in a location, which provided access to good transport and communication links. It is sensitive to changes within this defined setting and less sensitive to changes in the wider landscape. On balance it is considered to be of medium relative sensitivity to changes to its setting, as its setting makes an overall moderate contribution to an understanding, appreciation and experience of it.

14.8.35 The Proposed Project would not be discernible from Papil due to intervening topography and built structures. None of the elements of the Proposed Project would affect the ability to understand the relationship of Papil to its setting as described above. Launch events may be audible, but these impacts would be short-lived and number no more than 30 per year. As such they are not considered to materially contribute to any impact upon the setting of Papil.

14.8.36 As such the magnitude of impact upon the setting of Papil by the Proposed Project would be negligible at most. The level of effect would be neutral and result in **no significant effects**.

Skaw, Boat-Roofed Shed (Site 6)

14.8.37 Skaw, Boat-Roofed Shed (Site 6) is designated as a Category C Listed Building. It dates to c. 1940 and forms an outbuilding to Skaw Cottage (Plate 149). It is set at the opening of the deeply incised valley associated with the Burn of Skaw where it opens onto Skaw beach to the east. The boat-roofed shed is orientated with its main elevation to the south-east towards the road and the beach. The ground rises to the north of the shed towards Skaw and rises steeply to the south on the other side of Skaw Burn (Plate 150). The Statement of Special Interest implies that the majority of the assets cultural value lies in its architectural and historical interest and in its rarity.

> *The boat used for this shed was one of 2 lifeboats from the British steamer Sea Venture, which was sunk by a German submarine on 20th October 1939. Once a fairly common sight in Shetland, these boat-roofed sheds are becoming increasingly rare.* (HES, 2020e).

14.8.38 The setting of the boat-roofed shed is largely limited to the Wick of Skaw and the settlement at Skaw cottage and the wider landscape does not contribute to an understanding, appreciation or experience of it, though it does have wider contextual value as noted in the Statement of Special Interest. On this basis it is considered to have low relative sensitivity to changes to its wider setting.

14.8.39 None of the Proposed Project would be visible from the boat-roofed shed, with the possible exception of upper elements of launch vehicles when in preparation for launch. Launch events may be audible, but these impacts would be short-lived and number no more than 30 per year. As such they are not considered to materially contribute to any impact upon the setting of the boat-roofed

shed at Skaw. A precautionary negligible magnitude of impact is predicted which would result in a neutral level effect, which would give rise to **no significant effects**.

14.9 Additional Mitigation and Enhancement

14.9.1 It is acknowledged that operation of the Proposed Project will have a major and significant effect upon RAF Skaw and the integrity of its setting. There will also be a moderate and significant effect upon the setting of Inner Skaw. As such, it proposed to offer compensatory measures aimed at enhancing the understanding and appreciation of RAF Skaw and Inner Skaw, which would include the opportunity for enhancement of the assets' associated characteristics.

14.9.2 The Proposed Project offers the opportunity for investment into the protection and interpretation of the remains at RAF Skaw. As the review of existing buildings (see Appendix 14.5) has shown, many of the buildings would benefit from regular monitoring to prevent further degradation and loss. The detailed policies outlined in the CMP in Appendix 14.10 along with the regular monitoring of structural integrity recommended in Appendix 14.5, will ensure that further deterioration can be mitigated through intervention or, if a building is structurally unsound such that it is beyond repair ensure that it can be adequately recorded prior to any required demolition which may need to take place on H&S grounds. As such, the Proposed Project may be able to help limit further loss from degradation through weathering and carbonation and, where loss cannot be minimised, ensure preservation by record.

14.9.3 In addition to the potential for increased care of the features within RAF Skaw, interpretative measures could be used to enhance the associative characteristics of the asset, making it more readily understandable and accessible to a wider audience. This will ensure that the surviving elements of RAF Skaw are secured for the understanding and enjoyment of present and future generations (HES, 2019b). The programme would aim to make the knowledge about RAF Skaw and its significance accessible to the widest audience possible (Scottish Government , 2014) . In line with Our Place in Time: The Historic Environment Strategy for Scotland the mitigation package would seek to '*enhance participation through encouraging access to and interpretation and understanding of the significance*' of RAF Skaw and Inner Skaw (ibid, 24),

14.9.4 To achieve this aim, it is envisaged that the mitigation package will include, as noted in part above, the following:

- **Implementation of the Conservation Management Plan** - to ensure that the significance of the remaining features of RAF Skaw and Inner Skaw are not impacted upon during the operation of the Proposed Project and to ensure that any works undertaken to facilitate interpretation and access are done in such a way as to avoid further impact upon RAF Skaw and Inner Skaw.
- **Interpretation Strategy** - to enhance understanding, appreciation and experience of RAF Skaw and Inner Skaw. This will include some or all of the following with the agreement of the Shetland Islands Council and relevant consultees:
  - On-site interpretation hubs for both RAF Skaw and Inner Skaw.
  - School packs for dissemination to Shetland schools e.g., to fit in with Second World War topics (RAF Skaw) and Viking's topics (Inner Skaw) for both primary and secondary students.
  - A mobile-friendly website (standalone or linked to the Shetland Space Centre Website) which could include 3D models, VR/AR tour, history of the base including its context in the wider Chain Home Radar network.
  - Potential re-use of one of the RAF Skaw buildings as an on-site interpretation centre with standing and/or rotating exhibits subject to further structural assessment.

14.9.5 Appendix 14.9 sets out these proposals in greater detail.

14.10 Residual Effects

14.10.1 There is potential for residual direct effects during the operational phase as a result of the vibration associated with launches. Mitigation has been put forward in Section 14.7 to ensure that upstanding historic structures will be monitored during the operational period and that this will ensure that the potential for further impacts are identified prior to any harm being experienced and that steps are taken to mitigate this. This will ensure that any residual direct operational effects are negligible and there are **no likely significant effects**.

14.10.2 The predicted residual impacts on the settings and character of designated heritage assets will be the same as assessed for the operational effects. However, as set out in Section 14.9 and Appendix 14.9, compensatory measures are proposed.

14.11 Cumulative Assessment

14.11.1 Cumulative effects can be either inter-project or intra-project effects.

14.11.2 Inter-project cumulative effects are those where an environmental topic/receptor is affected by impacts from more than one project at the same time and the impacts act together. Due to the location of the Proposed Project on the north coast of Unst, the most northerly of the Shetland Islands, it is considered that there are no potential inter-project cumulative effects as there are no other existing or proposed developments in the Study Area for cultural heritage and archaeology.

14.11.3 Shetland Islands Council was contacted during the planning application stage of the Proposed Project and confirmed that there are no committed development or infrastructure projects on the Island which should be considered in the assessment.

14.11.4 Intra-project cumulative effects are those where an environmental topic/receptor is affected by more than one impact from the same Proposed Project and the impacts act together. Given that with the exception of noise and vibration, none of the other environmental topics considered impact directly on archaeology and cultural heritage, and the fact that noise and vibration is not considered to result in significant effects and that only one launch will occur at any given time and launches will be phased with time enough for the EZI to return fully to its baseline state between launches, it is considered that there is no potential for additive or intra-project cumulative effects.

14.12 Summary

14.12.1 This chapter identifies the archaeological and cultural heritage significance of the Proposed Project Site and assesses the potential for direct and settings effects on cultural heritage assets and features resulting from the operation of the Proposed Project. This chapter also identifies measures that should be taken to mitigate predicted adverse effects.

14.12.2 Major and significant direct and setting effects are predicted upon the Scheduled remains of RAF Skaw (Site 3) resulting from the operation of the Proposed Project. This would result from the removal of a number of features associated with the construction, use and abandonment of RAF Skaw and, from the construction of new and large-scale structures associated the Proposed Project. The impacts would adversely affect the integrity of the asset's setting.

14.12.3 Moderate and significant setting effects are expected on the Inner Skaw Scheduled Monument (Site 2) as a result of the Proposed Project. There would be no direct effects upon the Scheduled Monument. The relationship of the component parts of the asset to each other and to its surroundings would still largely be legible and so the integrity of the asset's setting would not be adversely affected.

14.12.4 Significant effects upon RAF Skaw and on the setting of Inner Skaw Scheduled Monuments are acknowledged and a programme of compensatory measures are proposed to enhance the

understanding and appreciation of these designated assets and provide increased access to them through implementation of a CMP and Interpretation Strategy.

14.12.5 The CMP represents a commitment to the ongoing management and maintenance of the Skaw radar station site during operation of the Proposed Project and presents a range of broad policies to allow for this commitment to be met. An outline of proposed conservation works and an assessment of their priority is provided within the CMP. In making these management, maintenance and repair recommendations, the aim has been to retain the surviving buildings and structures in a safe and manageable condition whilst respecting and preserving their significance. In addition, a programme of annual inspection and maintenance will be carried out on all structures to control unwanted vegetation growth, stabilise loose brickwork and make good any localised areas of failing mortar, with regular inspections formalized to identify any defects

14.12.6 In terms of residual effects, vibration monitoring will take place during the operational phase to ensure that the potential for any impact upon upstanding remains resulting from vibration during launch events is identified early and that further steps are taken to avoid or minimise any harm. As such any direct residual effects resulting from vibration during the operational phase are predicted to be negligible and as such no likely significant effects are predicted. There will however be major and significant residual setting effects upon RAF Skaw and moderate and significant residual setting effects upon Inner Skaw.

14.13 References

Aecom. (2020a). *Preliminary Ground Investigation Factual Report.*

BGS. (2020). *British Geological Society Geology of Britain Viewer*. Retrieved from http://mapapps.bgs.ac.uk/geologyofbritain/home

Carle. (2018a). *Carle, G. A History of RAF Skaw (AMES No.56)- Part 1- Inception to Jan 41.* http://ahistoryofrafsaxavord.blogspot.com/2018/04/a-history-of-raf-skaw-ames-no56-part-1.html.

Carle. (2018b). *Carle, G. A History of RAF Skaw (AMES No.56)- Part 2- Advance CH -From Jan 41 to May 42*. Retrieved from http://ahistoryofrafsaxavord.blogspot.com/2018/05/a-history-of-raf-skaw-ames-56-part-2.html

Carle. (2018c). *Carle, G. History of RAF Skaw (AMES No.56)- Part 3- CH Ops – May 42-Aug 45*. Retrieved from http://ahistoryofrafsaxavord.blogspot.com/2018/05/a-history-of-raf-skaw-ames-56-part-3-ch.html

Carle. (2018d). *Carle, G. A History of RAF Skaw (AMES 56) - Post War Skaw*. Retrieved from http://ahistoryofrafsaxavord.blogspot.com/2018/10/a-history-of-raf-skaw-ames-56-post-war.html

Carle. (2019). *Carle, G. History of RAF Skaw (AMES 56) - Some Civilian Anecdotes*. Retrieved from http://ahistoryofrafsaxavord.blogspot.com/2019/04/a-history-of-raf-skaw-ames-56-some.html

Carle. (2020a). *Carle,G. A History of RAF Skaw (AMES No.56)- Part 1- Inception to Jan 41*. Retrieved from http://ahistoryofrafsaxavord.blogspot.com/2018/04/a-history-of-raf-skaw-ames-no56-part-1.html

Carle. (2020b). *Carle, G. A History of RAF Skaw (AMES 56)-The Out-Post Volume 2 Issue I*. Retrieved from http://ahistoryofrafsaxavord.blogspot.com/2020/02/a-history-of-raf-skaw-ames-56-out-post.html

Carle. (2020c). *Carle, G. A History of RAF Skaw (AMES 56)-The Out-Post Volume 4 Issue I*. Retrieved from http://ahistoryofrafsaxavord.blogspot.com/2020/04/

CIfA. (2014a). *The Chartered Institute for Archaeologists Standard and guidance for Commissioning Work or Providing Consultancy Advice on the*. Retrieved from http://www.archaeologists.net/sites/default/files/CIfAS&GCommissioning_1.pdf

CIfA. (2017). *The Chartered Institute for Archaeologists Standard and guidance for historic environment desk-based assessment*. Retrieved from http://www.archaeologists.net/sites/default/files/CIfAS%26GDBA_3.pdf

CIfA. (2019a). *Chartered Institute for Archaeologists' (CIfA) Code of Conduct*. Retrieved 07 30, 2020, from https://www.archaeologists.net/sites/default/files/CodesofConduct.pdf

CIfa. (2019b). *Chartered Institute for Archaeologists' (CIfA) Regulations for Professional Conduct.* Retrieved from https://www.archaeologists.net/codes/cifa

CIfA. (2020). *Chartered Institute for Archaeologists Standard and Guidance for archaeological evaluation.* Retrieved from https://www.archaeologists.net/sites/default/files/CIfAS%26GFieldevaluation_2.pdf

Dickson et.al. (2000, Dickson, C and Dickson, J (2000) Plants & People in Ancient Scotland Tempus, Stroud Gloucestershire). *Plants and People in Ancient Scotland* . Stroud, Gloustershire: Tempus.

Francis. (1996). *British Military Airfield Architecture: From Airships to the Jet Age.* Patrick Stephens Limited.

HES. (2019c). *Historic Environment Scotland Designation Policy and Selection Guidance*. Retrieved from https://www.historicenvironment.scot/archives-and-research/publications/publication/?publicationId=8d8bbaeb-ce5a-46c1-a558-aa2500ff7d3b

HES. (2016, updated 2020). *Historic Environment Scotland Managing Change in the Historic Environment*. Retrieved from https://www.historicenvironment.scot/archives-and-research/publications/publication/?publicationId=80b7c0a0-584b-4625-b1fd-a60b009c2549

HES. (2016, updated 2020b). *Managing Change in the Historic Environment: Setting*. Retrieved from https://www.historicenvironment.scot/archives-and-research/publications/publication/?publicationId=80b7c0a0-584b-4625-b1fd-a60b009c2549

HES. (2019a). *Historic Environnebt Scotland Scheduled Monument Consent Policy 2019.*

HES. (2019b). *Historic Environment Scotland Historic Environment Policy for Scotland*. Retrieved from https://www.historicenvironment.scot/advice-and-support/planning-and-guidance/historicenvironment-

HES. (2019d). *Historic Environment Scotland Scotland's Listed Buildings*. Retrieved from https://www.historicenvironment.scot/archives-and-research/publications/publication/?publicationId=34c90cb9-5ff3-45c3-8bc3-a58400fcbc44.

HES. (2020a). *Historic Environment Scotland Designations- RAF Skaw*. Retrieved from https://portal.historicenvironment.scot/designation/SM7636

HES. (2020b). *Historic envoronment Scotland Designations- Inner Skaw*. Retrieved from https://portal.historicenvironment.scot/designation/SM7664

HES. (2020c). *Historic Environment Scotland Designations- The Banks including cottage,outbuilding, ruin, boundary and sea walls*. Retrieved from http://portal.historicenvironment.scot/designation/LB45295

HES. (2020d). *Historic Environment Scotland Designations - Papil, Valsgarth, Including Outbuildings And Walls.* Retrieved from http://portal.historicenvironment.scot/designation/LB45296

HES. (2020e). *Historic Environment Scotland Designations- Skaw, Boat-roofed shed*. Retrieved from http://portal.historicenvironment.scot/designation/LB45297

Historic England. (2016). *Historic England Understanding Historic Buildings: A Guide to Good Recording Practice*. Retrieved from https://historicengland.org.uk/images-books/publications/understanding-historicbuildings/heag099-understanding-historic-buildings/

HMSO. (1979). *Ancient Monuments and Archaeological Areas Act.*

HMSO. (1997a). *Town and Country Planning (Scotland) Act 1997.*

HMSO. (1997b). *Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997.*

HMSO. (2011). *Historic Environment (Amendment) (Scotland) Act 2011.*

ICOMOS. (2005). *Xi'an Declaration On The Conservation Of The Setting Of Heritage Structures, Sites And Areas*. Retrieved from https://www.icomos.org/charters/xian-declaration.pdf

IEMA. (2017). *Institute of Environmental Management and Assessment Environmental Impact Assessment Guide*. Retrieved from https://www.iema.net/assets/newbuild/documents

Ingram et al. (1845). *Unst. County of Shetland, NSA, Vol XV*. Retrieved from https://stataccscot.edina.ac.uk/static/statacc/dist/viewer/nsa-vol15-Parish_record_for_Unst_in_the_county_of_Shetland_in_volume_15_of_account_2/

IUCN. (2014). *UK Committee Peatland Programme Breifing Note Complete Set 1-10*. Retrieved from http://www.iucn-uk-peatlandprogramme.org/sites/www.iucn-uk-

peatlandprogramme.org/files/1-10%20Peatland%20Briefings%20-%205th%20November%202014.pdf

Mouat et al. (1793). *Mouat, T. & Barclay, J. Rev. Unst, County of Shetland, OSA Vol V*. Retrieved from https://stataccscot.edina.ac.uk/static/statacc/dist/viewer/osa-vol5-Parish_record_for_Unst_in_the_county_of_Shetland_in_volume_5_of_account_1/

Priest. (2020, July). Personal Communication Wilma Priest to V. Olesky .

Saxa Vord Resort. (2020). *Saxa Vord Resort*. Retrieved from http://www.saxavord.com/

Scottish Government . (2014). *Our Place in Time: The Historic Environment Strategy for Scotland. .* Retrieved from http://www.gov.scot/Resource/0044/00445046.pdf.

Scottish Government. (2011). *PAN2/2011 Planning and Archaeology*. Retrieved from https://www.gov.scot/publications/pan-2-2011-planning-archaeology/

Scottish Government. (2014). *Scottish Planning Policy*. Retrieved from https://www.gov.scot/publications/scottish-planning-policy/

Shetland Amenity Trust. (n.d.). *Shetland Amenity Trust Placenames – Signpost to the past*. Retrieved from https://www.shetland-heritage.co.uk/assets/files/brochures/themedleaflets/Placenames.pdf

SIC. (2012). *Shetland Islands Council Shetland Local Development Plan 2012- DRAFT Supplementary Guidance Historic Environment*. Retrieved from https://www.shetland.gov.uk/planning/LocalDevelopmentPlan.asp

SIC. (2014). *Shetlands Islands Council Shetland Local Development Plan*. Retrieved from https://www.shetland.gov.uk/planning/LocalDevelopmentPlan.asp

SIC. (2019). *Shetland Islands Council Shetland Pride of Place- History*. Retrieved from https://www.shetland.org/about/history

Small. (1965). *Excavations at Underhoull, Unst, Shetland*. Retrieved from http://journals.socantscot.org/index.php/psas/article/view/8682

SNH et al. (2018). *Scottish Natural Heritage and Historic Environment Scotland Environmental Impact Assessment Handbook*. Retrieved from https://www.nature.scot/sites/default/files/2018-05/Publication%202018%20-%20Environmental%20Impact%20Assessment%20Handbook%20V5.pdf

Zetica. (2020). *UXO Desk Study & Risk Assessment.*

Cartographic References

Pre-Ordnance Survey and historic Ordnance Survey maps were viewed online via the National Library of Scotland, map viewer (Available at https://maps.nls.uk/) last accessed on the 13th August 2020. Ordnance Survey maps after 1950 were viewed at https://www.old-maps.co.uk/#/, last accessed 13th August 2020.

Blaeu, W. 1654. Orcadum et Schetlandiae Insularum accuratissima descripto

Moll, H. 1745. The Islands of Shetland

Preston, T. 1781. A new hydrographical survey of the islands of Shetland

Thomson, J. 1827. Shetland Islands

Ordnance Survey. 1882. Shetland, Sheet III (includes: Unst) Survey date: 1877 Publication date: 1882

Ordnance Survey. 1882. Shetland, Sheet II (includes: Unst) Survey date: 1878 Publication date: 1882

Ordnance Survey. 1902. Zetland Sheet III (includes: Unst) Publication date: 1902 Date revised: 1900

Ordnance Survey. 1902. Zetland Sheet II (includes: Unst) Publication date: 1902 Date revised: 1900

Ordnance Survey. 1961. Shetland Islands (Yell & Unst): Surveyed: 1957; Published: 1961

Ordnance Survey. 1973. OS Plan 1971-73 1:10000

Archival References

Shetland Museum and Archives, Lerwick were visited in person, by appointment, on the 24th August 2020. The following archival material, including historic maps and unpublished archaeological reports were viewed. References in the text are to the archive reference number (starts 'D£ or 'SA').

D6/158-Offprints of map of Unst by Thomas Mouat, circa 1790- Original in E.S. Reid Tait ed., The Statistical Account of Shetland 1791 - 1799, Lerwick 1925

D16/389/112/12- Undated- Tracing of map of Unst.

D23/123- Undated- Tracing of map by George Thomas, of Yell, Unst and Skerries

SA4/4222- Different maps of different pages- Fleet, Christopher; Wilkes, Margaret and Withers, Charles W.J.

SA6/255- Map, Ordnance Survey of Scotland, Unst and Yell, War Revision- 1940

SA6/398/17- Map of Orkney and Shetland, with panel showing part of coastline of Unst surveyed by Lieutenant Edward H. Columbine in January 1795

SA6/432- Undated- Map showing proposed road to Northdale, Haroldswick, Unst

D9/179a/27- Undated- Lists of field- and shore-names in North Unst (in handwriting of Joan Sinclair, Skaw)

D50/23/1- Sketch map of Unst with coloured symbols and key to symbols on reverse.- 1950's

SA6/523- Plans of archaeological excavations at Skaw House, Unst, Author Unknown- 1974

SA7/1/15- Papers concerning excavations at Skaw, Unst

SA7/1/15/1-5- Papers by Ray Mitchell, Archaeology Club, RAF Saxavord, concerning excavation at Skaw, Unst.- 1972

SA7/1/15/1/1- Letter by Flight Lieutenant W C Case, Education Section, RAF Saxa Vord, Unst, to Alan Small, Department of Geography, Aberdeen University, concerning pieces of pottery found by David Leask at an eroded part of cliffs, north of Skaw beach, with description of the eroded cliff. -1965

D16/389/73/1-18- Norwick, Unst.- 1822-88

D16/389/73/2- Article requesting information about a 'heathen temple' evidenced by four large blocks at Bartle's Kirk, Norwick

D16/389/73/5- Sketch of, and calculations concerning Norwick.- 1822

D16/389/73/6- Report on division of town and enclosures of Norwick. – 1824

D16/389/73/7- Report on the survey of Norwick- 1823

SA6/72- Lithographed plan of the Scattalds of Norwick and Clibberswick.- 1861

SA6/78- Manuscript plan of the scattalds of Norwick and Clibberswick.- 1861

SA6/470/4/3- Plan of proposed road to Norwick churchyard

SA6/475- Copy of plan showing land ownership in Norwick, Unst- 1822

SA6/470/4/25- Plan of proposed road at Millfield, Norwick, Unst

SA7/1/16/1-2- Letter by R Mitchell, 42 Setters Hill Estate, Baltasound, to Mr [Tom] Henderson, with copy of 'Report on experimental excavations carried out on the Taing, Norwick, Unst, by R. Mitchell and P. Homden on 15 April 1972'.

SA7/3/40- Duplicated typescript of Amanda Foster, 'An early Viking steatite assemblage from Norwick, Unst, Shetland'.

Appendix 3 -

Appendix 4 -

Appendix 5.1a Shetland Space Centre Breeding Bird Survey 2020

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



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.

REFERENCES

Gilbert, G., Gibbons, D.W. and Evans, J. 1998. Bird Monitoring Methods: a manual of techniques for key UK species. RSPB, Sandy.

Hardey, J., Crick, H., Wernham, C., Riley, H., Etheridge, B. and Thompson, D. 2006 (2nd Edition 2009; 3rd Edition 2013). Raptors, a field guide to survey and monitoring. The Stationery Office, Edinburgh.

Mitchell, I.P., Newton, S.F., Ratcliffe, N. and Dunn, T.E. 2004. Seabird populations of Britain and Ireland. Poyser.

Owen, E., Prince, O., Cachia-Zammit, C., Cartwright, R., Coledale, T., Elliot, S., Haddon, S., Longmore, G., Swale, J., West, F. and Hughes, R., 2018. Counts of Puffins in Shetland suggest an apparent decline in numbers. Scottish Birds 38: 223-231.

Pennington, M., Osborn, K., Harvey, P., Riddington, R., Okill, D., Ellis, P and Heubeck, M. 2004. The Birds of Shetland. Helm, London.

Ruddock, M. and Whitfield, D.P. 2007. A review of disturbance distances in selected bird species. A report from Natural Research (Projects) Ltd to SNH.

Shetland Bird Club. May 2020. Newsletter 188.

SNH. 2005 (amended 2010 and subsequently). Survey Methods for Use in Assessing the Impacts of Onshore Windfarms on Bird Communities

Walsh, P.M., Halley, D.J., Harris, M.P., del Nevo, A., Sim, I.M.W. and Tasker, M.L. 1995 (reprinted 2011). Seabird monitoring handbook for Britain and Ireland. Published by JNCC / RSPB / ITE / Seabird Group, Peterborough.

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 5.1b Shetland Space Centre Breeding Bird Survey 2022

SaxaVord UK Spaceport Breeding Bird Survey 2022



Non-confidential version

October 2022

This report should be quoted as '*Alba Ecology Ltd. SaxaVord UK Spaceport Breeding Birds Survey 2022*'.

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INTRODUCTION & METHODS

Following planning approval for a satellite launch facility on Unst, Shetland - known as the SaxaVord UK Space Port (previously known as the 'Shetland Space Centre'), breeding bird surveys (BBS) were conducted in 2022. The BBS surveys included a terrestrial walkover BBS and boat-based seabird counts. This BBS work was undertaken to inform planned pre-construction and construction work and also update the ornithological baseline ahead of launches commencing in 2023.

The Study Area for walkover BBS comprised of the Application Boundary, plus fields to the north of the entrance in an area known as Swartling (Figure 1). Boat-based seabird counts of coastal seabird cliffs were undertaken over a much larger area between the Ura (east side of the Noup), east and southwards down to The Nev (southeast of Hill of Clibberswick) (Figure 1). Black guillemot surveys were conducted by walking along the coast between Ura and The Nev. Additional searches of potential breeding red-throated diver lochans within 4km of the launch site(s) were also undertaken occasionally throughout spring/summer 2022.

Previously the Study Area for the walkover BBS was surveyed under SNH Schedule 1 licence for breeding birds in 2018, 2019 and 2020 by David Cooper. David Cooper and Brydon Thomason also undertook boat-based seabird counts in 2018 and 2020. Both David Cooper and Brydon Thomason are highly experienced and locally based ornithologists and used the relevant standard BBS methods (previously agreed with SNH/NatureScot) during suitable weather conditions. To reduce observer variability and maintain highly experienced observer coverage, the same ornithological surveyors conducted the BBS in 2022.

The boat-based seabird cliff survey methods used were the same as previously reported in Alba Ecology 2018 and 2020 and followed agreed (with SNH/NatureScot) standardised methods e.g. Gilbert *et al*., 1998, Walsh *et al.,* 1995. Terrestrial walkover BBS were conducted under licence twice weekly across the Application Boundary and Swartling between March 2022 and August 2022 (typically up to eight walkover surveys per month).

This report summaries the results for key breeding birds of conservation interest and identifies relatively predictable breeding sites/areas which may make them potentially suitable in terms of setting up monitoring cameras for satellite launches in the future.

RESULTS

The following non-target bird species were recorded breeding within the Study Area in 2022: blackbird, starling, skylark, meadow pipit, rock pipit, pied wagtail, wren, wheatear, snipe and greylag goose.

Black guillemot

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).

- First black guillemot survey: 27-29th April 2022 = 93 adults.
- Second black guillemot survey: 5-8th May 2022 = 91 adults.

Table 1 summarises the maximum number of adult black guillemots seen on cliffs in 2018, 2020 and 2022 between the coast/cliffs from Ura, east and southwards down to The Nev.

Table 1. Maximum number of black guillemots, Ura to The Nev, Unst, 2018, 2020 and 2022.

Species	2018	2020	2022
Back guillemot maximum count	84 adults	101 adults	93 adults

Black guillemots are mostly hole/crevice nesters and so nest sites are invariably hidden and underground. As a consequence, they are probably a low priority for direct nest monitoring during satellite launches because nests underground will experience much lower noise levels during satellite launches than open, above ground nests. Nevertheless, nest monitoring cameras could be placed into relatively predictable, underground nests.

Cliff nesting seabirds

The summary results in Table 2 give the number of Apparently Occupied Nests (AON) recorded from three boat-based counts undertaken on 19th, 26th June 2022 and 1st July 2022. These boat-based surveys covered the coast/cliffs from Ura, east and southwards down to The Nev. This is the same area previously surveyed by the same surveyors from a boat in 2018 and 2020.

Table 2. Boat-based seabird cliff counts, Ura to The Nev, Unst, June 2022

Species	AON 19/06/22	AON 26/06/22	AON 01/07/22
Shag	28	29	32
Fulmar	3,416	3,150	3,393
Kittiwake	115	118	123
Great black-backed gull	11	8	14
Herring gull	15	19	17
Common guillemot*	96	102	80
Razorbill*	15	20	10
Puffin*	44	115	86

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

Table 3 summarises the maximum number of AON or adults on land recorded in 2018, 2020 and 2022 between the coast/coastal cliffs from Ura, east and southwards down to The Nev.

Table 3. Maximum boat-based seabird cliff counts, Ura to The Nev, Unst, 2018, 2020 and 2022.

Species	2018 max AON	2020 max AON	2022 max AON
Shag	55 nests	26 nests	32 nests
Fulmar	4,330 AON	2,657 AON	3,416 AON
Kittiwake	55 nests	0 nests	123 nests
Great black-backed gull	2 nests	6 nests	14 nests
Herring gull	0 nests	5 nests	19 nests
Common guillemot*	80 birds	20 birds	102 birds
Razorbill*	11 birds	4 birds	20 birds
Puffin*	49 birds	41 birds	115 birds

*Maximum number of individual adults on land in the colony recorded – not AON.

Comparison from three years' survey work of boat-based surveys covering the coast/cliffs from Ura, east and southwards down to The Nev show substantial annual changes in terms of the maximum Apparently Occupied Nests and/or adults on land recorded in 2018, 2020 and 2022 (Table 3).

Of the eight cliff nesting seabird species recorded, none had their worst breeding year in 2022. Shag numbers slightly improved on the 2020 low of 26 pairs to reach 32 pairs in 2022. Fulmar numbers rebounded after the 2020 low of 2,657 to reach 3,416 AON in 2022 but were not up to the 4,330 AON recorded in 2018. The three cliff-nesting gulls all had their best year to date, with great-black-backed gull improving year on year to each a high of 14 nests in 2022, herring gull reached 19 nests in 2022 and kittiwake rebounded from a complete blank year in 2020 to reach a high of 123 nests in 2022. The three cliff nesting auks all had their best year to date in 2022, with guillemot reaching 102 adults, razorbill with 20 adults and puffin with 115 adults.

Seven of the eight open cliff-nesting species breed in locations that are regularly used and so relatively predictable in terms of potentially setting up nest monitoring cameras for satellite launches. Puffins, like black guillemots, are hole nesters and so nest sites are hidden and underground. As a consequence, they are probably a low priority for monitoring cameras during satellite launches. Nevertheless, cameras could be placed into relatively predictable, underground burrows likely to be used in successive years. With several seabird cliffs used out to 4km from the launch pads (and indeed beyond into the Hermaness, Saxa Vord and Valla Field SPA), there are multiple regularly used locations potentially suitable for monitoring cameras during satellite launches. It should be noted that monitoring seabird colonies on cliffs may require skilled and professionally qualified rope operators; something not considered necessary for other species' monitoring.

Ringed plover

The results of BBS walkovers for ringed plover are summarised in Table 4. It is important to recognise that pairs displaying do not necessarily translate to breeding attempts within the Study Area. Passage ringed plover can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 4. Estimated number of pairs of ringed plover within the Study Area in 2022.

Study Area	April 2022	May 2022	June 2022	July 2022	August 2022
Max no' pairs displaying	1 pair Lamba Ness headland	3 pairs Lamba Ness headland	3 pairs, 2 same as May, other failed & new/relay	2 pairs seen, one of other with fledged chicks	0
Confirmed nest/young	0	1 nest (4 eggs), 2 pairs distraction display	1 pair with chicks, 2nd pair distraction	1 pair with chicks, presumed different to June	0

Based on BBS walkover data collected between April and August 2022, there was evidence of 3 pairs of ringed plovers breeding, with 2 presumed different pairs fledging young successfully. All confirmed breeding ringed plovers in 2022 were east of the Garths, out towards the Lamba Ness headland. These nesting locations are very close to the launch pads and would likely be a high priority for early nest camera monitoring.

Oystercatcher

The results of BBS walkovers for oystercatcher are summarised below (Table 5). It is important to recognise that pairs displaying do not necessarily translate to breeding attempts within the Study Area. Passage oystercatcher can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 5. Estimated number of pairs of oystercatcher within the Study Area in 2022.

Study Area	April 2022	May 2022	June 2022	July 2022	August 2022
Max no' pairs displaying	8 pairs across Study Area	9 pairs across Study Area	14 pairs across Study Area	13 pairs across Study Area	8 pairs in 1st week of August, down to 4 pairs by the 2nd week
Confirmed nest/young	0	2 pairs incubating & 3 pairs distraction display	12 pairs incubating, alarming & distraction display	10 pairs alarming & distraction display, 4 pairs with chicks	4 pairs alarming

Based on BBS walkover data collected between April and August 2022, there was evidence of up to 12 pairs of oystercatcher breeding. Breeding oystercatchers were spread across the whole Study Area from Swartling east to the Lamba Ness headland. Oystercatcher nests are relatively easy to locate and being spread throughout the Study Area, nest camera monitoring of this species could take place at different distances from the satellite launches (i.e. nests are not all clumped together), making them a high priority for early nest camera monitoring.

Golden plover

The results of BBS walkovers for golden plover are summarised below (Table 6). It is important to recognise that pairs displaying do not necessarily translate to breeding attempts within the Study Area. Passage golden plover can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 6. Estimated number of pairs of golden plover within the Study Area in 2022.

Study Area	April 2022	May 2022	June 2022	July 2022	August 2022
Max no' pairs displaying	3 pairs present & displaying on 26/04/22	0	1 pair in Swartling early June, then disappeared	1 pair in Swartling mid July, then disappeared	0
Confirmed nest/young	0	0	0	0	0

Based on BBS data collected between April and August 2022, there was intermittent evidence of a pair present at Swartling in June and July, but no evidence of any successful breeding. With only an apparently single pair, intermittently present, this species is probably a low priority for nest camera monitoring during satellite launches.

Eider

A female eider was found with a nest at Inner Skaw (@ HP 658 155). It fledged successfully. This is the first time this species has been recorded breeding successfully in the Study Area since monitoring began. With only a single breeding attempt, this species is considered a low priority for nest camera monitoring during satellite launches.

Curlew

The results of BBS walkovers for curlew are summarised below (Table 7). It is important to recognise that pairs displaying do not necessarily translate to breeding attempts within the Study Area. Passage curlew can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 7. Estimated number of pairs of curlew within the Study Area in 2022.

Study Area	April 2022	May 2022	June 2022	July 2022	August 2022
Max no' pairs displaying	5 pairs on 07/04/22, later 4 pairs on 25/04/22	4-5 pairs across Study Area	2 pairs	4 pairs	3-4 pairs still alarming
Confirmed nest/young	0	0	0	2 pairs with chicks, other 2 pairs alarming	2 pairs with chicks

Based on BBS walkover data collected between April and August 2022, there was evidence of 4-5 pairs of curlews breeding, with a minimum of 2 presumed different pairs fledging young successfully (possibly more). Confirmed breeding curlews in 2022 were present north and south of Swartling, and between Inner Skaw and the middle of the Study Area. With multiple pairs spread throughout the Study Area, nest camera monitoring of this species could take place at different distances from the satellite launches (i.e. nests are not all clumped together), making them a high priority for early nest camera monitoring.

Redshank

The results of BBS walkovers for redshank are summarised below (Table 8). It is important to recognise that pairs displaying do not necessarily translate to breeding attempts within the Study Area. Passage redshank can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 8. Estimated number of pairs of redshank within the Study Area in 2022.

Study Area	April 2022	May 2022	June 2022	July 2022	August 2022
Max no' pairs displaying	3 pairs, inc 1 copulating at Swartling	1 pair Swartling	1 pair, mid Study Area	1 pair & 2 chicks, mid-east Study Area	0
Confirmed nest/young	0	0	0	1	0

Based on BBS walkover data collected between April and August 2022, there was evidence of 1 pair of redshank breeding successfully at Swartling. Later in the year, adults (which had disappeared from Swartling) were recorded with chicks towards the mid-east of the Study Area and were presumed to be the Swarling pair moving with their precocial chicks. By mid-late July the chicks were considered to have fledged successfully. With only one breeding attempt in 2022, this species is probably a low priority for nest camera monitoring during satellite launches.

Dunlin

One pair displayed in June at Swartling and were not seen again. There was no evidence for breeding in the Study Area in 2022. With no evidence of any successful breeding in 2022, this species is probably a low priority for nest camera monitoring during satellite launches.

Arctic skua

One pair held territory on the slope just west of the Site entrance. In late July the pair were seen with one juvenile, which had fledged by mid-August. With only one breeding attempt in 2022, this species is probably a low priority for nest camera monitoring during satellite launches. Nevertheless, Arctic skua has attempted to bred within the Study Area previously during monitoring and so it is possible that more pairs may occur in the future and so potential nest monitoring should not be wholly discounted.

Birdflu casualties

In common with many parts of Shetland and Unst, surveys in 2022 recorded several dead species which were presumed to have died from birdflu (H5N1 is the strain of avian flu in Scotland). The photographs below of dead great skua and gannet, presumed birdflu casualties, were taken within the Study Area in 2022. According to the RSPB, the virus has killed tens of thousands of seabirds, including many in key Shetland colonies of gannets and great skuas in 2022 (How together we can protect wild birds from Avian Flu | The RSPB).



DISCUSSION

There is direct evidence in 2022 from the Study Area of potentially sensitive and specially protected target bird species breeding within, and adjacent to, the consented planning Application Boundary. The presence of these species should inform the planned monitoring of breeding birds during satellite launches.

Without exception, cliff-nesting seabirds in 2022 had a relatively good breeding season and this has been attributed to reduced predation pressure from great skuas which were particularly adversely affected by avian bird flu, although this was not specifically investigated in this study. Species such as kittiwake have recovered from zero breeding in 2020 to 123 pairs in 2022.

With a good understanding of the up-to-date ornithological baseline, monitoring plans can be developed for a range of species. Following the NatureScot consultation response dated 11 March 2021, Saxa Vord Spaceport made a commitment to a no-launch window whereby no satellite launches, or static tests will be carried out between mid-May and the end of June (subject to ongoing monitoring and appraisal).

Table 10 illustrates the typical breeding calendar of potentially sensitive and protected target Study Area bird species.

Table 10. Typical Breeding Calendar of Potentially Important Study Area Species.

Species	April		May		June		July		August		Reference
Black guillemot											Incubation 23-40 days; Fledging 40 days[1,2,3]
Common guillemot											Incubation 34 days; Fledging 20 days[1,2,3]
Puffin											Incubation 42 days; Fledging 50 days[1,2,3]
Razorbill											Incubation 34 days; Fledging 20 days[1,2,3]
Shag											Incubation 31 days; Fledging 53 days[1,2,3]
Kittiwake											Incubation 29 days; Fledging 43 days[1,2,3]
Herring gull											Incubation 28-30 days; fledging 35-40 days[1,2,3]
Great-black-backed gull											Incubation 27-28 days; fledging 49-56 days[1,2,3]
Fulmar											Incubation 51 days; Fledging 49 days[3]
Ringed plover											Incubation 24 days; Fledging 24 days[1,2,3]
Golden plover											Incubation 29 days; Fledging 30 days[1,2,3]
Dunlin											Incubation 22 days; Fledging 20 days[1,2,3]
Curlew											Incubation 28 days; Fledging 34 days[1,2,3]
Oystercatcher											Incubation 24-27 days; Fledging 30 days[1,2,3]
Redshank											Incubation 22-24 days; Fledging 30-35 days[1,2,3]
Arctic skua											Incubation 27 days; Fledging 28 days[1,2,3]

Red = typical main egg laying/incubation period, Yellow = typical main period dependent young present. Note, table does not include relay or 2nd brood dates. 1 = Gilbert *et al.,* 1998 (reprinted 2011); 2 = Forrester and Andrews (eds), 2007; 3 = Snow and Perrins (eds), 1998.

The six week no-launch window means that the following potentially sensitive and protected target Study Area species may be egg-laying/incubating prior to mid May:

- Common guillemot – potential 4 week window, mid April-mid May.
- Puffin – potential 6 week window, early April- mid May.
- Razorbill – potential 4 week window, mid April-mid May.
- Shag - potential 6 week window, early April- mid May.
- Herring gull – potential 4 week window, mid April-mid May.
- Great-black-backed gull - potential 2 week window, early-mid May.
- Fulmar - potential 2 week window, early-mid May.
- Ringed plover - potential 6 week window, early April- mid May.
- Golden plover - potential 6 week window, early April- mid May.
- Dunlin - potential 4 week window, mid April-mid May.
- Curlew - potential 4 week window, mid April-mid May.
- Oystercatcher – potential 4 week window, mid April-mid May.
- Redshank - potential 6 week window, early April- mid May.

Given the main egg-laying/incubating period prior to mid May and the 2022 BBS results, the following regularly occurring potentially sensitive and protected species are identified for nest monitoring if satellite launches are scheduled in the runup to the six week no-launch window:

1. Common guillemot.
2. Razorbill.
3. Shag.
4. Herring gull.
5. Great-backed gull.
6. Fulmar.
7. Ringed plover.
8. Curlew.
9. Oystercatcher.

Should redshank, golden plover, dunlin and confidential Schedule 1 species breeding numbers increase, then these would also be candidate species for direct nest camera monitoring.

Recent developments in mobile thermal imaging equipment have dramatically increased the success of ornithologists finding the nests of ground nesting birds. A high-quality thermal imager, such as the Pulsar Helion xp28 (or equivalent), is considered by some UK wader researchers to be '*a complete game-changer*' in rapidly locating ground-nesting wader nests as even the eggs 'glow' warm (*Dave Cooper pers comm*). Use of such a thermal imager would potentially save a lot of time in locating suitable wader nests for the cameras to monitor, specifically ringed plover, curlew, oystercatcher and potentially redshank, golden plover, and dunlin.

REFERENCES

Forrester, R. and Andrews, I. (eds). (2007). *The Birds of Scotland*. The Scottish Ornithologists' Club, Aberlady.

Gilbert, G., Gibbons, D.W. and Evans, J. 1998. *Bird Monitoring Methods: a manual of techniques for key UK species*. RSPB, Sandy

Snow, D.W. and Perrins, C.M. (eds) 1998. *Birds of the Western Palearctic*. Oxford.

Walsh, P.M., Halley, D.J., Harris, M.P., del Nevo, A., Sim, I.M.W. and Tasker, M.L. 1995 (reprinted 2011). *Seabird monitoring handbook for Britain and Ireland*. Published by JNCC / RSPB / ITE / Seabird Group, Peterborough.

Appendix 5.2 Background Literature Review

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

Alba Ecology Ltd.

2020

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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.

Hebrides Range (Benbecula)

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.

REFERENCES

Barron, D. G., Brawn, J. D., Butler, L. K., Romero L. M. & Weatherhead, P. J. 2012. *Effects of Military Activity on Breeding Birds*. The Journal of Wildlife Management, 76, 911-918.

Beale, C. M. 2007. *The Behavioral Ecology of Disturbance Responses*. International Journal of Comparative Psychology, 20, 111-120.

Beason, R. C. 2004. *What Can Birds Hear?* USDA National Wildlife Research Center – Staff Publications. 78. (https://digitalcommons.unl.edu/icwdm_usdanwrc/78).

Bowles, A. E., Aubrey, F. T. & Jehl, J. R. 1991. *The effect of high amplitude impulsive noise on hatching success - a reanalysis of the Sooty Tern Incident. Noise and Sonic Boom Impact Technology Program*, Report #HSD-TP-91-0006 (https://apps.dtic.mil/dtic/tr/fulltext/u2/a234766.pdf).

Bowles, A. E. 1995. Chapter 8 - Responses of Wildlife to Noise. In "*Wildlife and Recreationists – coexistence through management and research*", Island Press (ISBN-13: 978-1559632577).

Breininger, D. R., Barkaszi, M. J. O., Smith, R. B. Oddy, D. M. & Provancha, J. A. 1994. *Endangered and potentially endangered wildlife on John F. Kennedy Space Center and faunal integrity as a goal for maintaining biological diversity*. NASA Technical Memorandum 109204.

Brown, A. L. 1990. *Measuring the effect of aircraft noise on birds*. Environment International, 16, 587–592.

Bundy, G. 1976. *Breeding Red-throated Divers in Shetland*. British Birds, 71, 199-208.

Canso Spaceport Facility. 2019. *Canso Spaceport Facility Project* | *Environmental Assessment* | Nova Scotia Environment https://www.novascotia.ca/nse/ea/canso-spaceport-facility.

Cotanche, D. A. 2008 *Genetic and pharmacological intervention for treatment/prevention of hearing loss*. Journal of Communication Disorders, 41, 421–433.

Derose-Wilson, A., Fraser, J. D., Karpanty, S. M. & Hillman, M. D. 2015. *Effects of overflights on incubating Wilson's plover behavior and heart rate.* The Journal of Wildlife Management. 79, 1246–1254.

Dunnet, G. M. 1977. *Observation on the effects of low-flying aircraft at seabird colonies on the coast of Aberdeenshire, Scotland*. Biological Conservation 12, 55-63.

Encyclopedia Britanica 2020. https://www.britannica.com/science/sound-reception/Hearing-in-birds (accessed 06/08/2020).

Environment Australia. 2000. *Environment Assessment Report - Proposal to construct and operate a satellite launching facility on Christmas Island*. (http://www.ga.gov.au/webtemp/image_cache/GA20982.pdf).

Francis, C. D. & Barber, J. R. 2013. *A framework for understanding noise impacts on wildlife: an urgent conservation priority*. Frontiers in Ecology and the Environment, 11, 305–13.

Forsdyke, M. R. 2004. *Assessment of Noise Effects on Sensitive Animal Communities*. PhD thesis. The Open University.

Gougie, R. I. & Jones, I. L. 2004. *Dose-response relationships of harlequin duck behaviour to noise from low-level military jet over-flights in central Labrador*. Environmental Conservation, 31, 289–298.

Grant, M. C. 1991. *Relationships between egg size, chick size at hatching, and chick survival in the Whimbrel* Numenius phaeopus. Ibis, 133, 127-133.

Grubb, T.G., Delaney, D.K., Bowerman, W.W. & Wierda, M.R. 2010. *Golden eagle indifference to heli-skiing and military helicopters in northern Utah*. Journal of Wildlife Management 74(6): 1275–1285.

Halfwerk, W., Holleman, L. J. M., Lessells, C. M. & Slabbekoorn, H. 2011. *Negative impact of traffic noise on avian reproductive success*. Journal of Applied Ecology, 48, 210–219.

Injaian, A. S., Taff, C. C. & Patricelli, G. L. 2018. *Experimental anthropogenic noise impacts avian parental behaviour, nestling growth and nestling oxidative stress*. Animal Behaviour, 136, 31–39.

National Geographic. 2011. *Why are birds falling from the sky?* https://www.nationalgeographic.com/news/2011/1/110106-birds-falling-from-sky-bird-deaths-arkansas-science/ (accessed 16/07/20).

Karolewski, K., Bocheński, M., Ciebiera, O., Markulak, D. & Jerzak, L. 2014. *New Year's Eve fireworks impact on the number of magpies on the roosting place*. International Study of Sparrows, 38, 27-29.

Larkin, R. P., Pater, L. L. & Tazik, D. J. 1996. *Effects of Military Noise on Wildlife: A Literature Review*. Lab US Army Corps of Engineers Construction Engineering Research, Report No, USACERL-TR-96/21.

Liebezeit, J. R., Kendall, S. J., Brown, S., Johnson, C. B., Martin, P., McDonald, T. L., Payer, D. C., Rea, C. L., Streever, B., Wildman, A. M. & Zack, S. 2009. *Influence of human development and predators on nest survival of tundra birds, Arctic Coastal Plain, Alaska.* Ecological Applications, 19, 1628–1644.

Lubert, C. P. 2017. *Sixty years of launch vehicle acoustic*. Conference proceedings of 174th Meeting of the Acoustical Society of America.

Mooney, T. A., Smith, A., Hansen, K. A., Larsen, O. N., Wahlberg, M. & Rasmussen, M. 2019. *Birds of a feather: Hearing and potential noise impacts in puffins (*Fratercula arctica*).* Conference Proceedings - 5th International Conference on the Effects of Noise on Aquatic Life.

Pepper, C., Nascarella, M. & Kendall, R. 2003. *A Review of the Effects of Aircraft Noise on Wildlife and Humans, Current Control Mechanisms, and the Need for Further Study*. Environmental management, 32, 418-432.

Roby, D.D., Murphy S.M., Ritchie, R.J., Smith, M.D., Palmer, A.G., Nordermeyer-Elmore, D.L., Pruitt, E. & Kull, J.C. 2002. *The effects of noise on birds of prey. A study of Peregrine falcons Falco peregrinus in Alaska.* United States Air Force Academy.

Rojek, N.A., Parker, M.W., Carter, H.R. & McChesney, G.J. 2007. *Aircraft and vessel disturbances to Common Murres* Uria aalge *at breeding colonies in central California, 1997–1999*. Marine Ornithology, 35, 61–69.

Ruddock, M. & Whitfield, D.P. 2007. *A review of disturbance distances in selected bird species*. A report from Natural Research (Projects) Ltd to SNH.

Schlierf, R., Hight, R., Payne, S., Shaffer, J., Missimer, B. & Willis, C. 2007. *Kennedy Space Center (KSC) Launch Pad Avian Abatement Efforts Including Related KSC Road Kill Reduction Effort*. Proceedings of the 2007 International Conference on Ecology and Transportation (ICOET 2007) 42 – 55.

Schultz, S. J. 1997. *Californian Least Tern Monitoring Report for the July 9, 1997.* SLC-2 Delta Space Vehicle Launch, Vandenberg Air Force Base.

Shamoun-Baranes, J., Dokter, A., van Gasteren, H., Loon, E., Leijnse, H. & Bouten, W. 2011. *Birds flee en mass from New Year's Eve fireworks*. Behavioural Ecology, 22, 1173-1177.

Smit, C. J., & Visser, G. J. M. 1993. *Effects of disturbance on shorebirds: A summary of existing knowledge from the Dutch Wadden Sea and delta area*. Wader Study Group Bulletin, 68, 6-19.

Smith, R. B. & Breininger, D. R. 1995. *Wading Bird Populations of the Kennedy Space Center*. Bulletin of Marine Science, 57, 230-236.

Space Exploration Technologies. 2011. *Final Environmental Assessment Falcon 9 and Falcon 9 Heavy Launch Vehicle Programs from Space Launch Complex 4 East Vandenberg Air Force Base California.*

Weigand, JF; and McChesney, GJ. 2008. *Seabird and marine mammal monitoring and response to a fireworks display at Gualala Point Island, California, Sonoma County, May to August 2007*. Unpublished report, USDI Bureau of Land Management, California State Office, Sacramento, CA; and USDI Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge Complex, Newark, CA.

Wolfenden, A. 2017. *The effects of aircraft noise on avian communities and communication*. PhD Thesis, Manchester Metropolitan University.

Wolfenden, A. D., Slabbekoorn, H., Kluk, K & de Kort, S. R. 2019. *Aircraft sound exposure leads to song frequency decline and elevated aggression in wild chiffchaffs*. Journal of Animal Ecology, 88, 1720-1731.

Wright, M. D., Goodman, P. & Cameron, T. C. 2010. *Exploring behavioural responses of shorebirds to impulsive noise.* Wildfowl, 60, 150–167.

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).

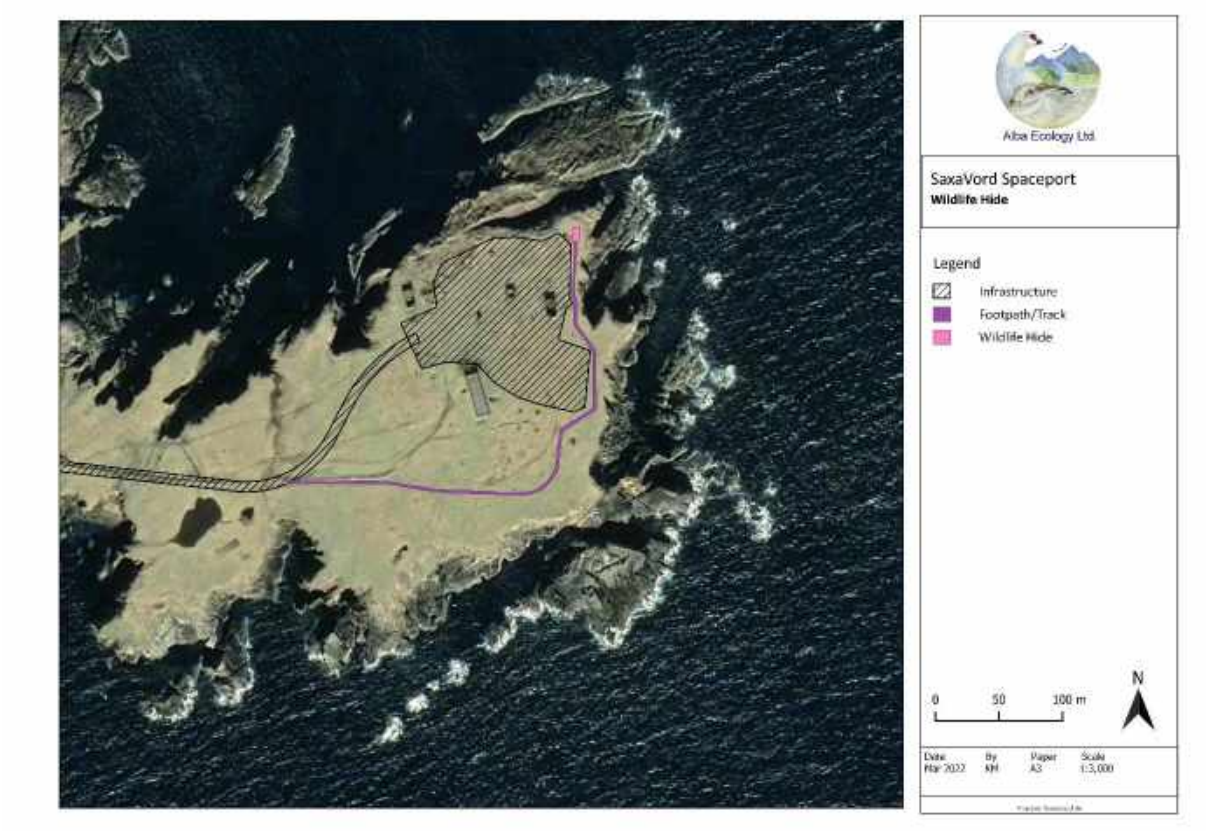

Figure 1: Location of Wildlife Hide on Lamba Ness

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).

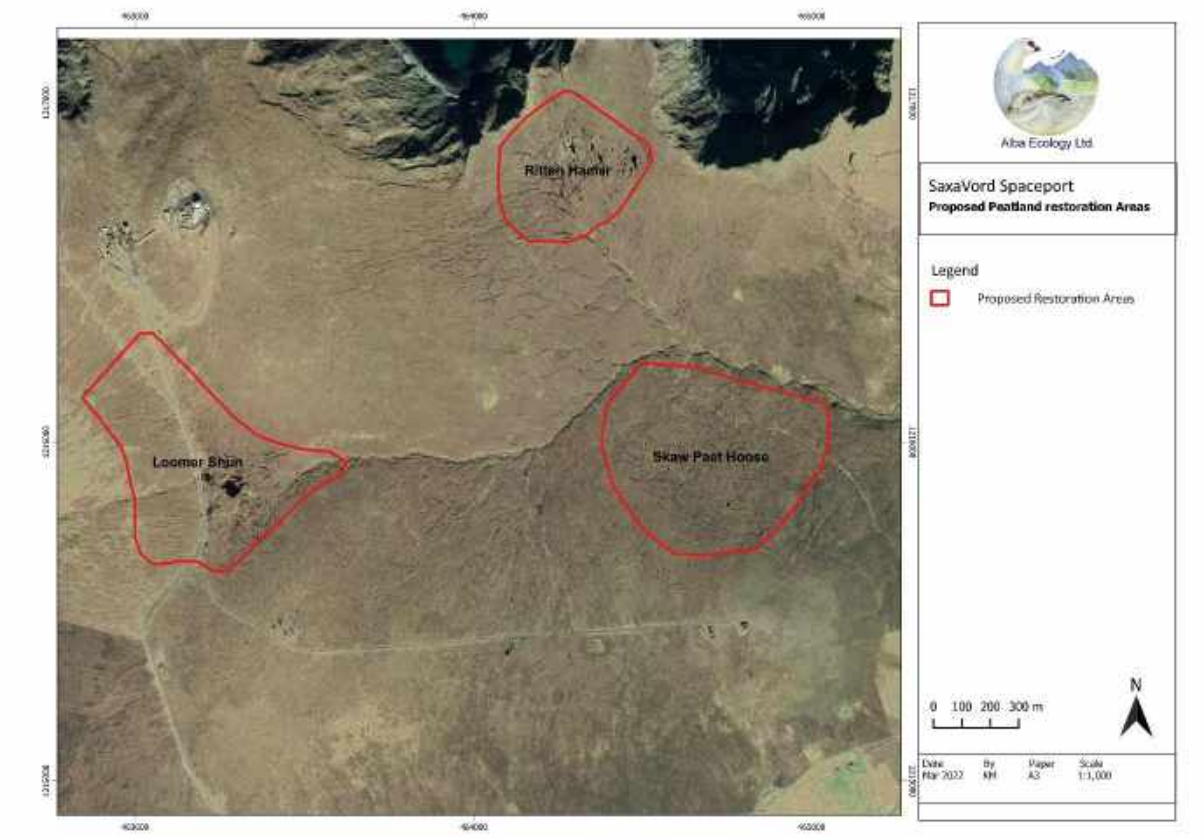

Figure 2: Indicative Peatland Restoration Areas

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.

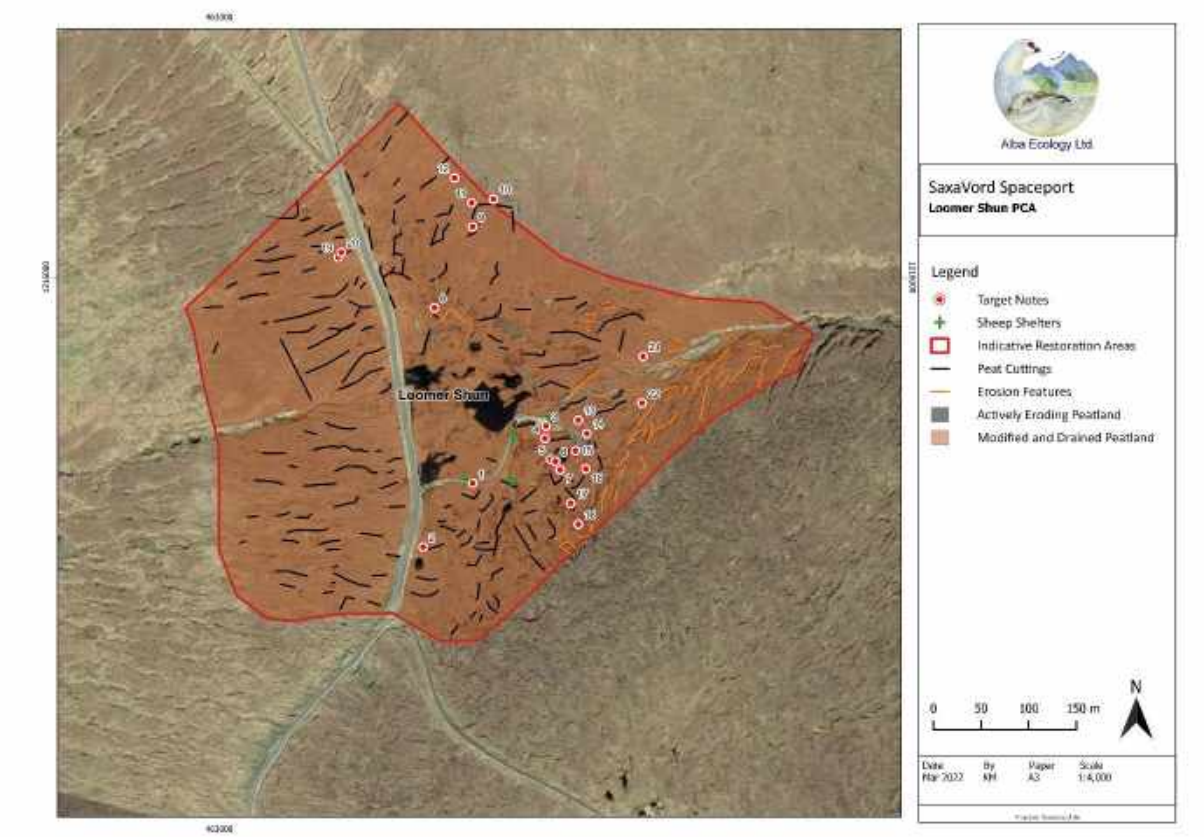

Figure 3: PCA and Target Note locations for Loomer Shun

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.

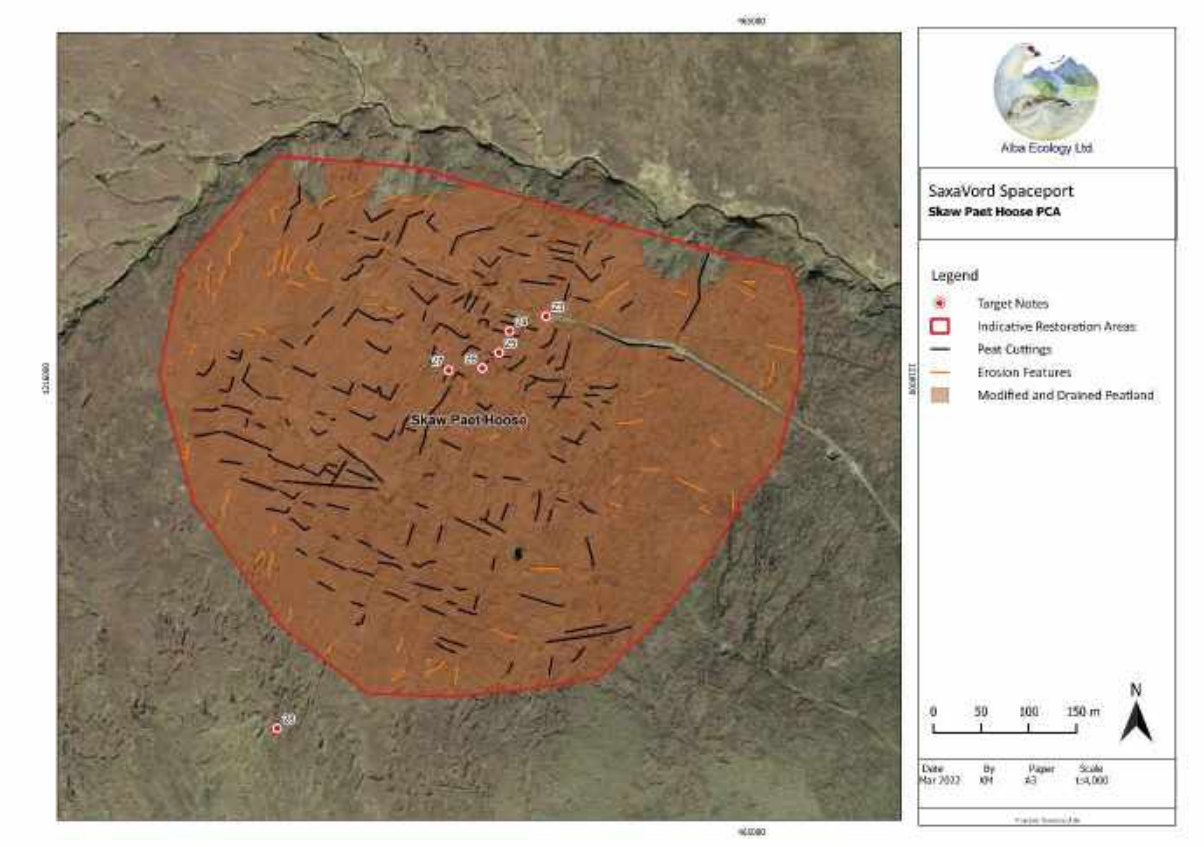

Figure 4: PCA and Target Note locations for Skaw Paet Hoose

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].

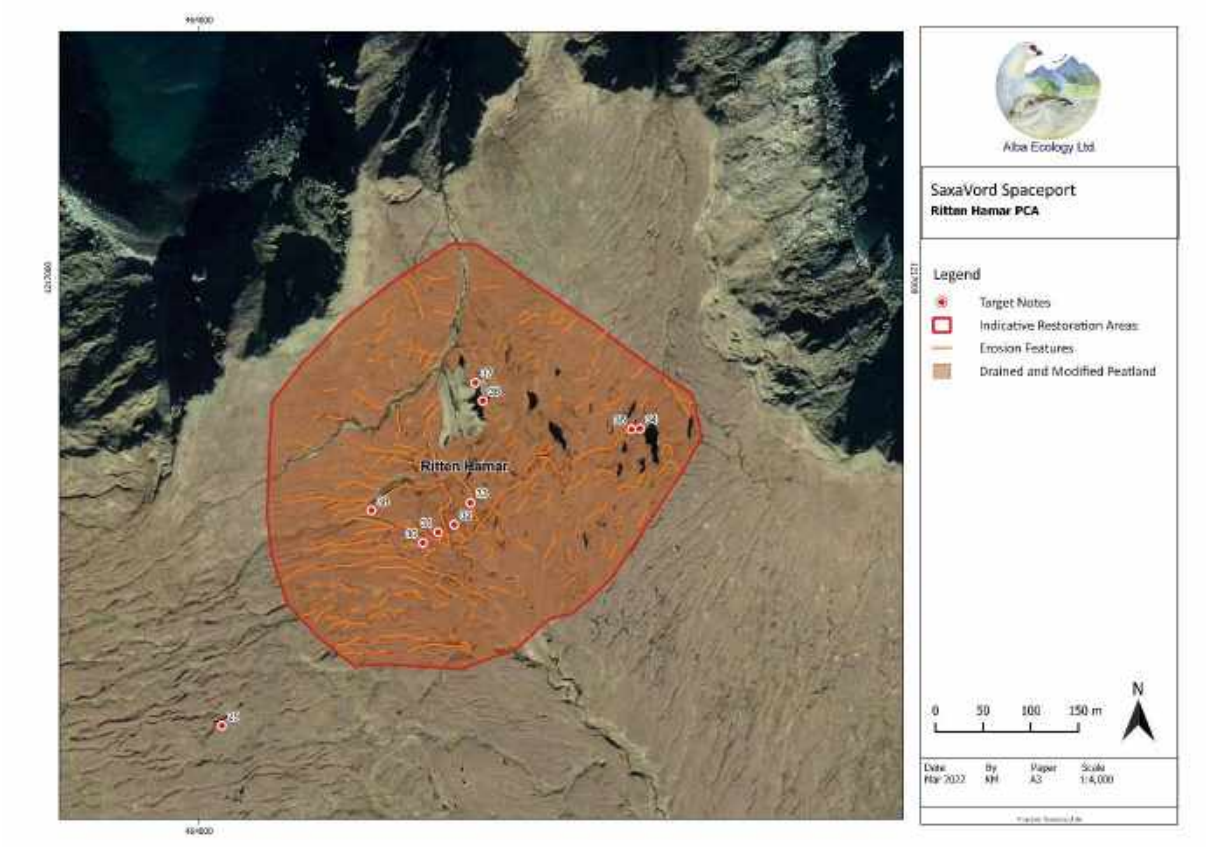

Figure 5: PCA and Target Note locations for Ritten Hamar

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.

[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.

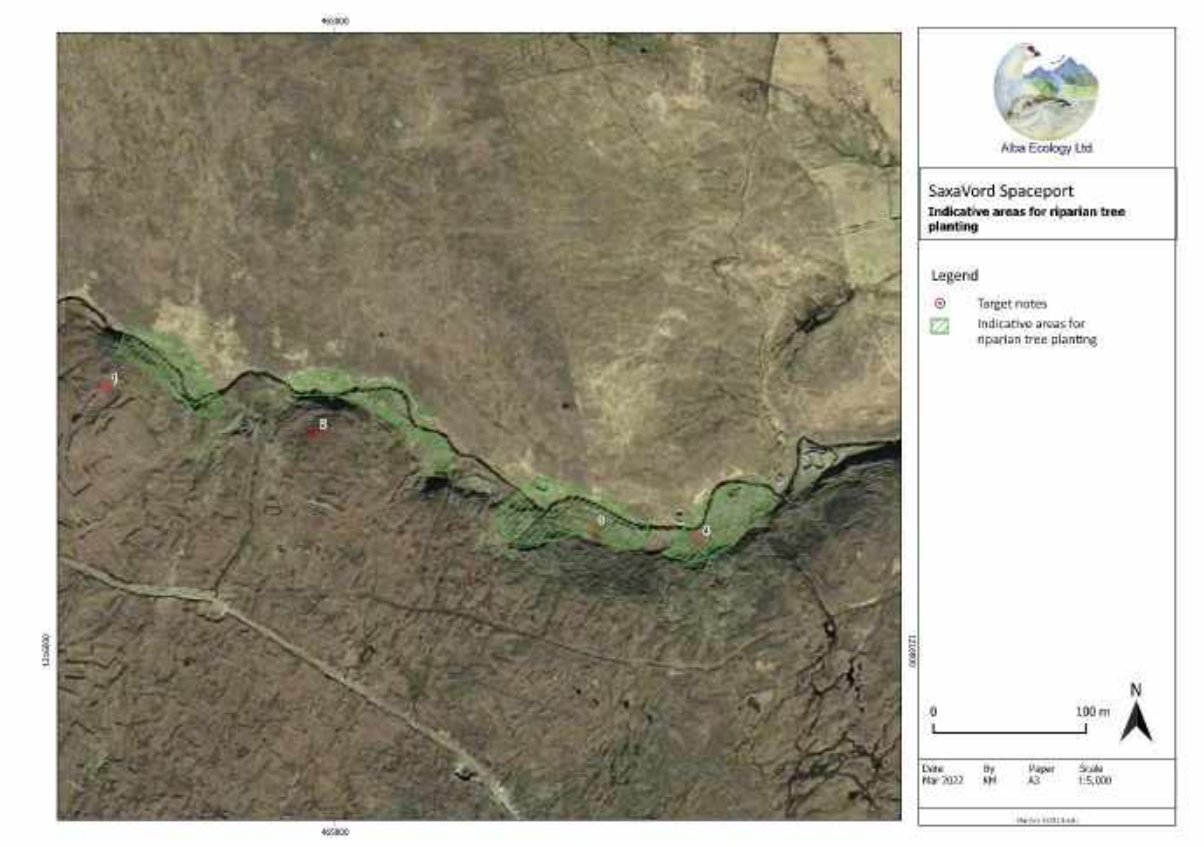

Figure 6: The indicative area for tree riparian tree planting along the Burn of Skaw

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

References

Bird Guides. 2022. DPFv2HPW0AkGtkF.jpg (2048×1280) (birdguides-cdn.com).

Brown, A.F and Shepherd, K.B. 1993. A method for censusing upland breeding waders. Bird Study 40: 189-195.

Moors for the Future. 2020. Grip and gully blocking. Grip-and-gully-blocking-Factsheet.pdf (moorsforthefuture.org.uk)

Natural Born Birds. 2022. Sea watching Hides. Seawatching Hides (naturalbornbirder.com).

Peatland Action. 2016. Peatland Condition Assessment. Guidance-Peatland-Action-Peatland-Condition-Assessment-Guide-A1916874.pdf (nature.scot).

PlantLife. 2014. Coastal grasslands, a management guide. www.plantlife.org.uk/application/files/4714/8155/7847/Coastal_grasslands_FINAL.pdf.

SaxaVord Spaceport. 2020. Shetland Space centre Outline Habitat Management Plan.

SaxaVord Spaceport. 2022. A Summary Report Outlining Peatland Restoration Proposals for Unst Space Port.

SNH Peatland ACTION. 2015. Video 3 Reprofiling: https://youtu.be/xHURdFQycO8?t=3

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.

Appendix 6.1 Natural Heritage Desk Study

Natural Heritage Information Desk Study for Shetland Space Centre

Alba Ecology Ltd.

August 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 to conduct a natural heritage desk study to identify biological records within the potential zones of influence and to locate conservation designated sites within a 10km radius of the Site.

The SSC Proposed Development comprises of work in three discrete areas: (i) a Proposed Launch Site at Lamba Ness, (ii) a Proposed Launch and Range Control Centre Site, and (iii) a Proposed New Section of Access Road at Northdale. This report considers all three of these areas.

The Search Area for the Desk Study comprised of the Proposed Development plus a 1km buffer. The zone of influence from Proposed Launch Site was considered potentially greater than this for certain taxa, therefore a 4km buffer was considered a suitable Search Area for birds and mammal species. A location map can be seen in Appendix 7.1 Drawing 1[1] with the 1km Search Area and the additional 4km bird and mammal Search Area shown.

A search of biological records was conducted in 2020 using data obtained from the Shetland Biological Records Centre, from the NatureScot (formerly Scottish Natural Heritage; SNH) SiteLink Website and other relevant web-based sources such as the Shetland Island Council web pages, designated site citations and the National Biodiversity Network (NBN) Atlas.

A previous desk study was written in 2017 (to help inform potential surveys) for this proposal based on a wider search area as the design layout had not be finalised at that time. The previous desk study is superseded by this more up to date report and associated spreadsheets.

This desk study aims to identify records of species and habitats of conservation importance within the Search Area, using the relevant potential zones of influence, and designated sites within 10km of the Site.

Study methods

The data search for this desk study follows the Chartered Institute of Ecology and Environmental Management (CIEEM) best practice guidelines (CIEEM, 2016; CIEEM, 2017). The background data aims to provide the following information:

- Designated site information;
- Existing records of protected/priority/notable species for the Site;
- Existing records of protected/priority/notable species for the surrounding area; and

[1] Drawing 1 is provided within this report document, but a higher resolution version is provided separately as a PDF.

- Habitat information where available.

Designated site information

Sites with biological conservation designations located within 10km of the Application Boundary were identified using the NatureScot SiteLink Website (2020). These included Sites of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC), Special Protection Areas (SPA), Marine Protection Areas (MPA) and Ramsar sites. The local nature conservation sites were identified using the Shetland Island Development Plan Local Nature Conservation Site guidance (SIC, 2015).

Existing species records for the Search Area

Species records were obtained by commissioning data searches from the local biological records centre, as per CIEEM best practice guidelines. The Shetland Biological Records Centre was commissioned to search for biological records within the Search Area. Provision of the data by the recorders is neutral and should not be regarded, either explicitly or implicitly, as approving or opposing any project informed by the data provided.

As with all desk studies, the data collected are only as good as the data supplied to the recording schemes. The recording schemes and recorders provide disclaimers in relation to the quality and quantity of the data they provide and these should be considered when examining the outputs of this desk study. No attempt has been made to verify these records. Common (vernacular) names are used where they have been provided by the recorder.

All biological records within the Search Area were searched for on the NBN Atlas. The CIEEM (2016) guidance stipulated avoiding the use of the NBN for commercial purposes due to constraints to the licence of the data. However, the Guidance notes that there is a "*general trend, supported by governments, towards Open Data to increase access to data for all stakeholders and the situation is likely to change significantly in the coming years"*. Due to the updated and explicit guidance on the use of the Open Data for commercial purposes on the NBN Atlas website, the CIEEM guidance is deviated from on this point, but it is considered to be in keeping with its aims and expectations.

All records for the Proposed Development plus a 1km buffer, were downloaded on the NBN Atlas website in August 2020. As per NBN Atlas guidance for commercial use, only the records which have an Open Data licence (coded CCO, CC-BY and OGL) have been considered and presented here. These data "*can be used for any purpose*" (NBN Atlas, 2020). Those data with a non-commercial licence (CC-BY-NC) were not included and were not inspected or considered. This is accordance with the NBN Atlas terms and conditions for commercial use (NBN Atlas, 2020).

It should be noted that the Data Provider, Original Recorder [where identified], and the NBN Trust bear no responsibility for any further analysis or interpretation of that material, data and/or information.

Relevant literature sources, including Living Shetland LBAP documents, nearby designated site citations and relevant literature sources such as Rare Plants of Shetland (Scott, *et al.* 2002) were considered for species that could potentially be present within the Search Area.

All records, from all sources, were compared against the Scottish Biodiversity List and the Local Biodiversity Action Plan (LBAP) list of important species.

Existing habitat records for the Search Area and surrounding area

Relevant sources, such as the Living Shetland LBAP documents, the nearby designated site citation and relevant literature sources were considered in relation to the habitats likely to be present within and around the Search Area.

Results

Designated site information

A total of 10 designated sites with ecological qualifying features within a 10km radius of the Proposed Development have been identified (Table 1). The closest was Norwick Meadows SSSI, which is between the Proposed New Section of Access Road at Northdale and the Proposed Launch and Range Control Centre Site. There are a number of Local Nature Conservation Sites on Unst. These are listed in Table 2.

Designated site	**Designation type**	**Area (ha)**	**Distance (km) and direction from Proposed Development**	**Biological Qualifying features**
Hermaness, Saxa Vord and Villa Field	SPA	6,832ha	1.5km, West	Breeding birds: • Fulmar (*Fulmarus glacialis*) • Gannet (*Morus bassanus*) • Great skua (*Stercorarius skua*) • Guillemot (*Uria aalge*) • Kittiwake (*Rissa tridactyla*) • Puffin (*Fratercula arctica*) • Red-throated diver (*Gavia stellata*) • Shag (*Phalacrocorax aristotelis*) Breeding bird assemblages
Keen of Hamar	SAC	40ha	3.2km, South	Upland habitats: • Base rich scree • Dry heath Grasslands on soils rich in heavy metals
Keen of Hamar	SSSI	50ha	3.2km, South	Calaminarian grassland and serpentine heath

Designated site	Designation type	Area (ha)	Distance (km) and direction from Proposed Development	Biological Qualifying features
				Vascular plant assemblages
Hill of Colvadale and Sobul	SSSI	809ha	5.7km, South	Arctic sandwort (*Arenaria norvegica*) Breeding birds: • Arctic skua (*Stercorarius parasiticus*) • Whimbrel (*Numenius phaeopus*) Breeding bird assemblages Calaminarian grassland and serpentine heath
Valla Field	SSSI	629ha	4.2km, Southwest	Breeding birds: • Great skua • Red-throated diver
Crussa Field and Heogs	SSSI	469ha	2.0km, South	Breeding birds: • Arctic skua • Whimbrel Breeding bird assemblages Vascular plant assemblages Calaminarian grassland and serpentine heath
Hermaness	SSSI	978ha	2.9km, West	Breeding birds: • Fulmar • Gannet • Great skua • Guillemot • Puffin Breeding seabird colony
Saxa Vord	SSSI	56ha	2.3km, West	Breeding birds: • Fulmar • Guillemot Breeding seabird colony
Norwick Meadows	SSSI	25ha	0.1km, South and North	Sand dune habitats Valley fen wetlands
Fetlar to Haroldswick	MPA	216000ha	0.9km, South	Aggregation of breeding birds: • Black guillemot (*Cepphus grylle*) Horse mussel beds Circalittoral sand and coarse sediment communities Kelp and seaweed communities on sublittoral sediment

Table 1: Biological Designated Sites within 10km of the Site.

Local Conservation Sites on Unst	Primary Interest	Justification for Local Conservation Site
Baltasound	Species	Glasswort (*Salicornia europea*) and annual sea-blite (*Suaeda maritima*).
Burn of Mailand	Species	Rare plants. Lesser tussock sedge (*Carex diandra*) and small bur-reed (*Sparganium natans*) are found nowhere else in Shetland. Rich bryophyte flora.
Haroldswick mires	Species	Schedule 1 bird species. The pool at Haroldswick is attractive to migrant birds. The base-rich mire vegetation is unusual in Shetland.
Lochs of Bordastubble and Stourhoull	Species	These water bodies are on the Unst serpentine; they are nutrient rich and support a variety of aquatic species. Breeding Schedule 1 bird species.
Skeo Taing	Species	The herb-rich turf with base-rich shell sand provides habitat for a diverse range of plants. The nationally rare autumn gentian (*Gentianella amarelle septentrionalis*) is found on site. This is the only site in Shetland where harebell (*Campanula rotundifolia*) may still occur.
Wick of Skaw	Geology	Easily identifiable exposure of a granite intrusion contact zone.
Belmont Quarry	Geology	Rock exposures across a major shear zone/ophiolite thrust. Part of the Shetland Ophiolite Suite.
Clibberswick Cross Geo	Geology	Part of the Shetland Ophiolite suite.
Hill of Clibberswick	Species	Two nationally scarce plant species are present on-site, Arctic sandwort and northern rock cress (*Arabis petraea*)

Table 2: The Local Nature Conservation Sites on Unst with their features of primary interest and the justification as specified in the Shetland Island Development Plan Local Nature Conservation Site guidance (SIC, 2015).

Existing species records for the Search Area

Shetland Biological Records Centre data

The Shetland Biological Records Centre searched for all biological records within the Search Area. Due to the large number of data the search on birds was limited to post 2000 records and the search on all other taxa was limited to post 1990 records. The search provided a total of 4,392 bird records with a total of 105 species and a further 2,719 species records for other taxa, including 782 different species. Many of these records were beyond the 1km buffer of the Study. The full list of species and SBL species can be seen in Annex 1: Desk Study Data Sheet - Shetland Biological Records Centre Search.

Table 3 provides a summary of data by taxonomic groups.

Order/Class/Group	Notes (includes)	No' of species recorded
Amphibian		1 Species
Arachnids	Spiders & mites	58 Species
Birds		105 Species
Coleoptera	Beetles	50 Species
Diptera	Two-winged or true flies	36 Species
Hemiptera	True bugs	1 Species
Hymenoptera	Bees, wasps, ants & sawflies	5 Species
Lepidoptera	Butterflies & moths	132 Species
Lichen		130 Species
Mammals		17 Species
Mosses and liverworts		76 Species
Vascular plants		276 Species

Table 3: Summary of biological records provided by Shetland Biological Records Centre (search conducted in 2020).

A total of 56 species recorded from the Shetland Biological Records Centre are on the Scottish Biodiversity List (Annex 1). These include two mammals, 13 insects, five plants, six lichens and 30 birds (Annex 1; Table 4). The list of species recorded as part of the Shetland Biological Records Centre data search on the SBL can be seen in Annex 1.

The two terrestrial mammal species recorded within the Search Area from the Shetland Biological Records Centre which are on the SBL were otter (*Lutra lutra*) and Nathusius's pipistrelle (*Pipistrellus nathusii*). Nathusius's pipistrelle is a long-distance migrant and most UK records are for solitary individuals. Fewer than ten maternity colonies have been discovered in Britain and all from the east coast; Kent, Norfolk and Northumberland (Crawley *et al.,* 2020). Consequently, this Unst record is considered likely to be from a continental migrant as bats are not known to breed in Shetland. Otters have been recorded around Norwick on numerous occasions. Appendix 7.3 Otter Survey Report provides detail of the otter surveys conducted as part of the EIAR. Marine mammals are considered in EIAR Chapter 13: Marine and Transboundary Effects. Birds are considered in EIAR Chapter 6: Ornithology.

The insects that are on the SBL and are recorded as part of the Shetland Biological Records Centre data search are all within the "*watching brief only"* category of the SBL. Four species were recorded within the vicinity of the Proposed Development. Haworth's minor (*Celaena haworthii*) is "*mainly a moorland species, occurring most commonly in northern England, Wales and Scotland… Cotton-grass (*Eriphorium *spp.) is the main foodplant, the larvae feeding internally on the stems*" (UK Moths, 2020). Autumnal rustic (*Eugnorisma glareosa*) inhabits "*woodland fringes, moorland and sandy or chalky soils, it is widely distributed, though not always common, throughout Britain. The adults fly in August and September, and the caterpillars are polyphagous, living on a wide variety of plants and grasses*" (UK Moths, 2020). Ghost moth (*Hepialus humuli*) is considered a "*common species over much of Britain… The adults fly during June and July. The larvae feed underground on the roots of grasses and small plants* (UK Moths, 2020). Red carpet (*Xanthorhoe decoloraria*) is "*a locally common species in northern Britain, occurring from Shropshire and Staffordshire northwards, into Scotland, where a local subspecies* hethlandica *occurs on the Shetland Isles… The favoured habitat is rocky moorland,*

where the larvae feed on lady's mantle Alchemilla spp., possibly also on other low plants (UK Moths, 2020).

The lichens that are on the SBL and were recorded as part of the Shetland Biological Records Centre data search are all within the "*watching brief only*" category of the SBL. Although three of the lichen species have EU obligations and four of the lichen species are considered rare in Scotland (SBL, 2013, Annex 1). Four of the lichen species were recorded on Lamba Ness. These include two that have international obligations and three that are considered nationally rare (SBL, 2013). The lichen *Caloplaca britannica* "*is found on coastal rocks, in the spray zone and is undoubtedly under-recorded*" (Images of British Lichens, 2013). In Shetland it is known to be located in "*sheltered crevices in landward-facing rock face*" (Dalby and Dalby, 2005). The lichen *Leptogium britannicum* is found on coastal rocks (Images of British Lichens, 2013). In Shetland it is known to be located amongst mosses in salt marshes and on cliffs (Dalby and Dalby, 2005). The lichen *Opegrapha areniseda* is found on "*slightly acid or neutral soft rocks near the seashore (schists) and mainly on old walls, notably of chapels*" (Maritime Lichens, 2020). No information was found on the UK habitat requirements of the lichen *Thelenella muscorum var. octospora*.

Of the five vascular plants on the SBL, chicory (*Cichorium intybus*) and wild pansy (*Viola tricolor*) are in the "*conservation action needed*" category and field gentian (*Gentianella campestris*) and frog orchid (*Coeloglossum viride*) are considered to be vulnerable in Scotland. All five species were recorded >700m away from the Proposed Development.

Species name	Common name	Number of records	Closest record to Proposed Development
Lutra lutra	Otter	5	>700m, Norwick
Pipistrellus nathusii	Nathusius's pipistrelle	5	>600m, Norwick
Bombus (Thoracombus) muscorum	Moss carder-bee	3	150m, Houlanbrindy
Apamea remissa	Dusky brocade	3	150m, Houlanbrindy
Arctia caja	Garden tiger	1	>1km, SW of Saxa Vord
Celaena haworthii	**Haworth's minor**	**6**	**1 in Saxa Vord, 1 150m, Houlanbrindy**
Celaena leucostigma	Crescent	1	150m, Houlanbrindy
Dasypolia templi	Brindled ochre	6	150m, Houlanbrindy
Diarsia rubi	Small square-spot	3	150m, Houlanbrindy
Entephria caesiata	Grey mountain carpet	2	>500m, Norwick
Eugnorisma glareosa	**Autumnal rustic**	**1**	**Within Saxa Vord**
Hepialus humuli	**Ghost moth**	**5**	**Near Northdale**
Hydraecia micacea	Rosy rustic	4	>600m, Norwick
Xanthorhoe decoloraria	**Red carpet**	**1**	**Within Saxa Vord**
Monocephalus castaneipes	Broad groove-head spider	2	>900m, Norwick
Cichorium intybus	Chicory	1	>700m, Millfield
Coeloglossum viride	Frog orchid	1	>1.2km, beyond Skaw
Gentianella campestris	Field gentian	1	>1km, beyond Skaw
Lathyrus japonicus	Sea pea	7	>700m, Norwick
Viola tricolor	Wild pansy	1	>950m, Ward of Norwick
Brigantiaea fuscolutea	A lichen	2	>1km, Hill of Cibberswick
Caloplaca britannica	**A lichen**	**1**	**Lamba Ness**
Leptogium britannicum	**A lichen**	**2**	**Lamba Ness**
Lobaria virens	Green satin lichen	1	>1km, Hill of Cibberswick
Opegrapha areniseda	**A lichen**	**1**	**Lamba Ness**
Thelenella muscorum var. octospora	**A lichen**	**1**	**Lamba Ness**

Table 4: Species from the Shetland Biological Records Centre data search, within the Search Area, which are listed on the SBL (except birds). Bold indicates close proximity to Proposed Development.

Additional information, courtesy of Paul Harvey of the Shetland Biological Records Centre, provides details of species in the data search which are considered to be rare, scarce, or threatened in Shetland (Harvey, *pers comm*, May 2020).

Bryophytes

- Lindberg's bog-moss (*Sphagnum lindbergii*) is considered Nationally Scarce and this is the only location known in Shetland. This species was recorded >2km northwest of the Proposed Launch Site on Saxa Vord hill (not the Saxa Vord Resort).
- Dwarf streak-moss (*Rhabdoweisa fugax*) is considered rare in Shetland on current knowledge. This was recorded >2km northwest of the Proposed Launch Site at Ritten Hamar.

Vascular plants

- Wilson's filmy-fern (*Hymenophyllum wilsonii*) is considered Near Threatened and is scarce in Shetland. This species was recorded >2km northwest of the Proposed Launch Site on Saxa Vord hill (not the Saxa Vord Resort).
- White sedge (*Carex curta*) is scarce in Shetland. This species was recorded along the Burn of Norwick, likely within the Norwick Meadows SSSI, approximately 330m from the Proposed Launch and Range Control Centre.
- Bog sedge (*Carex limosa*) is scarce in Shetland. This species was recorded along the Burn of Norwick, likely within the Norwick Meadows SSSI, approximately 330m from the Proposed Launch and Range Control Centre.
- Frog orchid (*Coeloglossum (Dactylorhiza) viride*) is considered Vulnerable nationally. This species was recorded >1km north of the Proposed Launch Site.
- Oysterplant (*Mertensia maritima*) is considered Near Threatened and Nationally Scarce and scarce in Shetland. This was recorded in Inner Skaw in July 2019 as well as some locations north of the Proposed Launch Site.
- Arctic sandwort is considered Vulnerable nationally and rare in Shetland. This species was recorded >1.5km south west of the Proposed Launch and Range Control Centre at Hill of Cibberwick.
- Sea kale (*Crambe maritima*) is rare in Shetland. This species was recorded ca. 850m north of the Proposed Launch Site.
- Northern rock-cress is considered Vulnerable nationally and Nationally Scarce and scarce in Shetland. This species was recorded >1.5km south west of the Proposed Launch and Range Control Centre near Hill of Cibberwick.
- Corn spurry (*Spergula arvensis*) considered as Vulnerable nationally. This species as recorded at Northdale, near the New Section of Access Road at Northdale and near the Proposed Launch and Range Control Centre.
- Sea pea (*Lathyrus japonica*) is now extinct at this site. This species was historically recorded at Norwick.
- Long-headed poppy (*Papaver dubium*) is scarce in Shetland. This species was recorded in Norwick cemetery.

Corn spurry and oysterplant are of most relevance as they have both been recorded near the Proposed Development. Corn spurry was recorded at Northdale and near the Proposed Launch and Range Control Centre. Oysterplant was recorded in Inner Skaw which is within the vicinity of the Proposed Launch Site.

NBN Atlas data

The NBN Atlas data search provided a total of 793 records for the Search Area from a variety of taxa and from freely available data sources. The total number of species was 531. Species which were already considered as part of the Shetland Biological Records Centre search were removed. This left 288 additional species for the Search Area. These are presented in Annex 2 Desk Study Data Sheet – NBN Atlas Search.

Table 5 provides a summary of the additional species found using the NBN Atlas (listed by taxonomic group).

Order/Class/Group	Notes (includes)	No' of species recorded
Actinopterygii	Fish	5
Algae		8
Annelida	Earthworm	1
Birds		8
Chromista		3
Coleoptera	Beetles	7
Diptera	Two-winged or true flies	5
Lichen and fungi		80
Mammal		2
Mollusca	Mussels	4
Mosses and liverworts		120
Neuroptera	Net-winged insects, e.g. lacewings	1
Plants		27
Plecoptera	Stoneflies	2
Sessilia	Barnacles	2
Trichoptera	Caddisflies	13

Table 5: Summary of biological records provided by the NBN Atlas (search conducted August 2020).

The full list of additional species is provided in the accompanying Annex 2.

A total of 10 species recorded from the NBN Atlas data search are on the SBL (Annex 2). These include three fish, five birds and two lichens (Annex 2; Table 6). The list of species recorded as part of the NBN Atlas data search on the SBL can be seen in Annex 2.

The three fish species are all of conservation importance, but as they are non-terrestrial species they are not considered further.

The two lichen species are both within the "*watching brief only*" category of the SBL. *Caloplaca dichroa* "*occurs on sunny, exposed limestone rocks*" (Dorset Nature, 2020) and was recorded at Haroldswick Methodist Church. Little information on habitat was found for the species *Gyalecta foveolaris* which was recorded within the 10km grid square on Unst in the 1960s.

Species name	Common name	Number of records	Closest record to Proposed Development
Anguilla anguilla	Eel	1	Sea
Salmo salar	Atlantic salmon	1	Sea
Salmo trutta	Sea/brown trout	1	Sea
Caloplaca dichroa	A lichen	1	Haroldswick - Methodist Church
Gyalecta foveolaris	A lichen	1	No details (record from 1960)

Table 6: Species listed in the NBN Atlas dataset from the Search Area which are on the SBL (except birds).

LBAPs – Species Action Plans

There are number of Species Action Plans, as part of the Living Shetland LBAP (SIC, 2020). These include:

- Arable Birds;
    - Twite (*Carduelis flavirostris*), house sparrow (*Passer domesticus*), skylark (*Alauda arvensis*), meadow pipit (*Anthus pratensis*), starling (*Sturnus vulgaris*), and rock dove (*Columba livia*) (Ellis, 2004).
- Arable Plants;
    - Knotgrass (*Polygonum aviculare*): restricted to Fair Isle.
    - Lesser trefoil (*Trifolium dubium*): always restricted to southernmost south Mainland where it was once well established, but not seen since 1982.
    - Henbit dead-nettle (*Lamium amplexicaule*): occurred occasionally in south Mainland, but last recorded in 1987.
    - Common cornsalad (*Valerianella locusta*): formerly found in two sandy arable areas at the north of Unst and southernmost south Mainland, but not seen since 1966.
    - Wood burdock (*Arctium nemorosum*): always restricted to southernmost South Mainland, with just 20 plants counted in 2000.
    - Long-headed poppy: formerly a widespread but scarce weed of arable ground, now restricted to a handful of locations, the majority of which are in the south Mainland.
    - Field pansy (*Viola arvensis*): formerly a regular arable weed in north Unst, north Yell and southern south Mainland, but only occasional sightings in south Mainland since 1997.
    - Slender parsley-piert (*Aphanes australis*): although always having a localised distribution it was last seen in 1982.
    - Sun spurge (*Euphorbia helioscopia*): formerly found on arable ground on Unst, Fetlar, Yell and the limestone of central Mainland, but since 1990 almost confined to the southern South Mainland.
    - Dove's-foot crane's-bill (*Geranium molle*): always a localised distribution but in recent years rarely seen and now restricted to North Yell, South Mainland and a holm off Vementry.
    - Red bartsia (*Odontites vernus*): formerly used to grow along the edges of cornfields but now restricted to sandy pastures at four sites in Shetland.
    - Corn marigold (*Chrysanthemum segetum*): once scattered amongst oats or potatoes in various parts of Shetland (Harvey, 2004).
- Arctic char (*Salvelinus alpinus*).
- Breeding Waders;
    - Oystercatcher (*Haematopus ostralegus*), ringed plover (*Charadrius hiaticula*), golden plover (*Pluvialis apricaria*), lapwing (*Vanellus vanellus*), dunlin (*Calidris alpina*), snipe (*Gallinago gallinago*), whimbrel (*Numenius phaeopus*), curlew (*Numenius arquata*), redshank (*Tringa totanus*), greenshank (*Tringa nebularia*) and common sandpiper (*Actitis hypoleucos*) (Ellis, 2004).

- Bumblebees (*Bombus spp*.).
- Eider (*Somateria mollissima*).
- Harbour porpoise (*Phocoena phocoena*).
- Hawkweeds (*Hieracium* spp.).
- Merlin (*Falco columbarius*).
- Oysterplant.
- Red-necked phalarope (*Phalaropus lobatus*).
- Red-throated diver.
- Skylark.

Only oysterplant, of the LBAP plant species, have recently been recorded in the Search Area. Many of the LBAP bird species are known to use the Proposed Development Area.

Existing habitat records for the Search Area and surrounding area

Few records of existing habitat surveys within the Search Area were located. The main two were;

- Norwick Meadows SSSI citation (NatureScot, 2020);
- A draft NVC survey of Norwick Meadows SSSI (Smedley and Uttley, 1994, provided by Johnathan Swale of SNH in June 2018); and
- Sand Dune Vegetation Survey of Scotland (Dargie, 1998), which included the sand dunes at Inner Skaw.

There were some additional, more general published resources for habitats in Shetland such as coastal grassland management guide and the Habitat Action Plans for Shetland. Habitats around the Proposed Development are detailed in Appendix 7.2: Phase 1 Habitat, NVC and Groundwater Dependent Terrestrial Ecosystems report.

SSSI citation data

Norwick Meadows SSSI is also very close to the Proposed New Section of Access Road at Northdale (ca. 200m south), Proposed Launch and Range Control Centre (ca. 230m north) and near to the Proposed Launch Site (ca. 600m south). Norwick Meadows SSSI is designated for its valley fen wetlands and sand dunes (NatureScot, 2020).

The SSSI citation for Norwick Meadows describes the habitats as "*On the eastern end of Norwick Meadows SSSI between the marsh and the sea, there is a small but floristically rich sand dune system with marram grass* Ammophila arenaria*, sand couch* Elymus farctus*, yarrow* Achillea millefolium*, tufted vetch* Vicia cracca *and meadow vetchling* Lathyrus pratensis*. The nationally scarce and locally rare sea pea* Lathyrus japonicus subsp. maritimus*, internationally rare and locally scarce autumn gentian* Gentianella amarella subsp. septentrionalis *and nationally scarce curved sedge* Carex maritima *have been recorded from the site. Norwick Meadows SSSI provides one of the best and most extensive examples of mesotrophic (moderately nutrient-rich) marsh in Shetland. The meadows are species-rich with much of the*

area dominated by bottle sedge Carex rostrata *with bogbean* Menyanthes trifoliata*, marsh cinquefoil* Potentilla palustris *and amphibious bistort* Persicaria amphibiaalso *present. It is the most important site in Shetland for the locally rare white sedge* Carex curta*. The wettest parts of the marsh support the largest beds of mare's-tail* Hippuris vulgaris *in Shetland*".

Norwick Meadows NVC Survey data

The draft 1994 NVC survey of Norwick Meadows SSSI provides relatively detailed data on the SSSI (Smedley and Uttley, 1994, provided by Johnathan Swale of SNH in June 2018). It describes Norwick Meadows as: "*Norwick Meadows, along the Burn of Norwick, from Norwick Meadow to Northdale, consists of a valley fen, mainly* Carex rostrata – Potentilla palustris *tall-herb fen (S27) with localised development of mire communities, both poor- and rich-fen, including* Carex rostrata – Sphagnum squarrosum *mire (M5) and* Carex rostra – Calliergon cuspidatum/giganteum mire *(M9)."*

It goes on to describe the NVC communities:

- S27 *Carex rostrata – Potentilla palustris* tall-herb fen;
- M5 *Carex rostrata – Sphagnum squarrosum* mire;
- M6bi *Carex nigra – Sphagnum palustre/fallax; and*
- M9 *Carex rostra – Calliergon cuspidatum/giganteum.*

The report mentions the presence of MG8 *Cynosurus cristatus – Caltha palustris* grassland, S10 *Equisetetum fluviatile* swamp, S19 *Eleocharis palustris* swamp, S28 *Phalaris arundinacea* tall-herb fen, M28 *Iris pseudacorus – Filipendula ulmaria mire*, U6 *Juncus squarrosus – Festuca ovina* grassland, M25 *Molinia caerulea – Potentilla erecta* and MG12 *Festuca arundinacea* grassland within the SSSI boundary.

Sand Dune Vegetation Survey of Scotland

Inner Skaw, Wick of Skaw and Norwick formed part of the Shetland report of the Sand Dune Vegetation Survey of Scotland (SDVSS, Dargie, 1998a, 1998b, 1998c).

Inner Skaw is within the Proposed Launch Site boundary. The SDVSS survey reported a combination of SD4 *Elytrigia juncea* fore-dune community and SD8d *Festuca rubra – Galium verum* fixed dune grassland *Bellis perennis - Ranunculus acris* sub-community at Inner Skaw. SD8d was reported as the most common of the fixed dune grassland in Shetland and was considered to be generally species poor (Dargie, 1998a). MC8 *Festuca rubra – Holcus lanatus* maritime grassland was also recorded as the dune habitats transitioned to grassland.

Dargie (1998b) stated that "*The nature conservation interest of the site* [Inner Skaw] *is low due to small site area and limited range of vegetation*".

Similar NVC communities were reported at Wick of Skaw and Norwick, including:

- SD2 *Honkenya peploides – Cakile maritima* strandline community;

- SD4 *Elytrigia juncea* fore-dune community;
- SD8d *Festuca rubra – Galium verum* fixed dune grassland;
- MC8 *Festuca rubra – Holcus lanatus* maritime grassland;
- MG7 *Lolium perenne – Plantago lanceolata* community; and
- MG11 *Festuca rubra – Agrostis stolonifera – Potentilla anserine* grassland community.

Habitats in Shetland

In general, habitats in Shetland are reported to be "*strongly influenced by the islands' climate together with the nature of the terrain and underlying rocks*" as well as "*human influence on the natural heritage have been, and remain, strong*" (SNH, 2002). Habitats found across Shetland are discussed in a variety of published sources including the Habitat Actions Plans for freshwater (Hardy, 2004), strandlines (Davies and Gillham, 2004), ungrazed areas (Swale, 2004) and woodlands (McKenzie, Johnson, and Davies 2004); Scottish saltmarsh survey national report (Haynes, 2016) and Plantlife documents including "*A management Guide to Coastal grasslands*" (PlantLife, 2014).

Discussion

This desk study has identified several records of important ecological sensitivities within the Search Area, as far as existing and freely available data allows. Desk-based studies of this nature have limitations, such as the reliability of third-party records, the coverage of reported studies and the age of some records.

There was a relatively high number of records for some taxonomic groups e.g. birds, lichens, bryophytes and vascular plants for the Search Area, indicating a good base level of knowledge for these groups. However, there was a relatively paucity of biological records available for other taxonomic groups, such as Hymenoptera indicating either that there was a low of biodiversity within the Search Area and/or a low level of invertebrate biological recording.

There was some historic record of the habitats in and around the Search Area and general information available in relation to habitats found in Shetland.

It is important to understand that a lack of information for a species (or indeed Class/Order) does not necessarily mean absence and previous historical occurrence does not necessarily mean current presence.

References

Chartered Institute of Ecology and Environmental Management (CIEEM). 2016. *UK Guidelines for Accessing and Using Biodiversity Data.* CIEEM.

CIEEM. 2017. *Guidelines for Preliminary Ecological Appraisal*. CIEEM.

Crawley, D., Coomber, F., Kubasiewicz, L., Harrower, C., Evans, P., Waggit, J., Smith, B. and Mathews, F. 2020. *Atlas of Mammals of Great Britain and Northern Ireland*. Pelagic Publishing.

Dalby, K, and Dalby C (2005) Shetland Lichens. Shetland Amenity Trust.

Dargie, T. 1998a. *Sand dune vegetation survey of Scotland: Shetland*. *Volume 1: Main report*. Scottish Natural Heritage (SNH) Research, Survey and Monitoring Report No. 122 (Volume 1 of 3).

Dargie, T. 1998b. *Sand dune vegetation survey of Scotland: Shetland*. *Volume 2: Site report*. SNH Research, Survey and Monitoring Report No. 122 (Volume 2 of 3).

Dargie, T. 1998c. *Sand dune vegetation survey of Scotland: Shetland*. *Volume 3: NVC maps*. SNH Research, Survey and Monitoring Report No. 122 (Volume 3 of 3).

Davies, N. and Gillham, K. 2004. Living Shetland Biodiversity Action Plan. *Habitat Action Plan – Strandlines*.

Dorset Nature. 2020. http://www.dorsetnature.co.uk/pages-lichen/lch-257.html. Accessed August 2020.

Ellis, P. 2004. Living Shetland Biodiversity Action Plan *Grouped Species Action Plan - Arable birds*.

Ellis, P. 2004. Living Shetland Biodiversity Action Plan *Grouped Species Action Plan – breeding waders*.

Hardy, D. 2004. Living Shetland Biodiversity Action Plan. *Habitat Action Plan – Freshwater*.

Harvey, P. 2004. Living Shetland Biodiversity Action Plan *Grouped Species Action Plan -Arable associated* plants.

Haynes, T.A. 2016. *Scottish saltmarsh survey national report*. SNH Commissioned Report No. 786.

Images of British Lichens, 2020. http://www.lichens.lastdragon.org/. Accessed August 2020.

Maritime Lichens, 2020. http://www.lichensmaritimes.org/index.php?task=fiche&lichen=85&lang=en. Accessed August 2020.

McKenzie, J., Johnson, A., and Davies, N. 2004. Living Shetland Biodiversity Action Plan. *Habitat Action Plan – Woodlands*.

National Biodiversity Network (NBN) Atlas, 2020. https://nbnatlas.org/.

NatureScot. 2020. Sitelink. https://sitelink.nature.scot/home Accessed in April and August 2020.

NBN Atlas occurrence download at NBN Atlas accessed on Tues 11 August 2020.

PlantLife. 2014. Coastal grasslands, a management guide. https://www.plantlife.org.uk/application/files/4714/8155/7847/Coastal_grasslands_FINAL.pdf.

Scott, W., Harvey, P., Riddington, R. and Fisher, M. 2002. Rare Plants of Shetland. Shetland Amenity Trust.

Scottish Biodiversity List (SBL). 2013. https://www.webarchive.org.uk/wayback/archive/20160402063428/http://www.gov.scot/Topics/Environment/Wildlife-Habitats/16118/Biodiversitylist/SBL.

Scottish Natural Heritage (SNH). 2002. Natural Heritage Futures: Shetland.

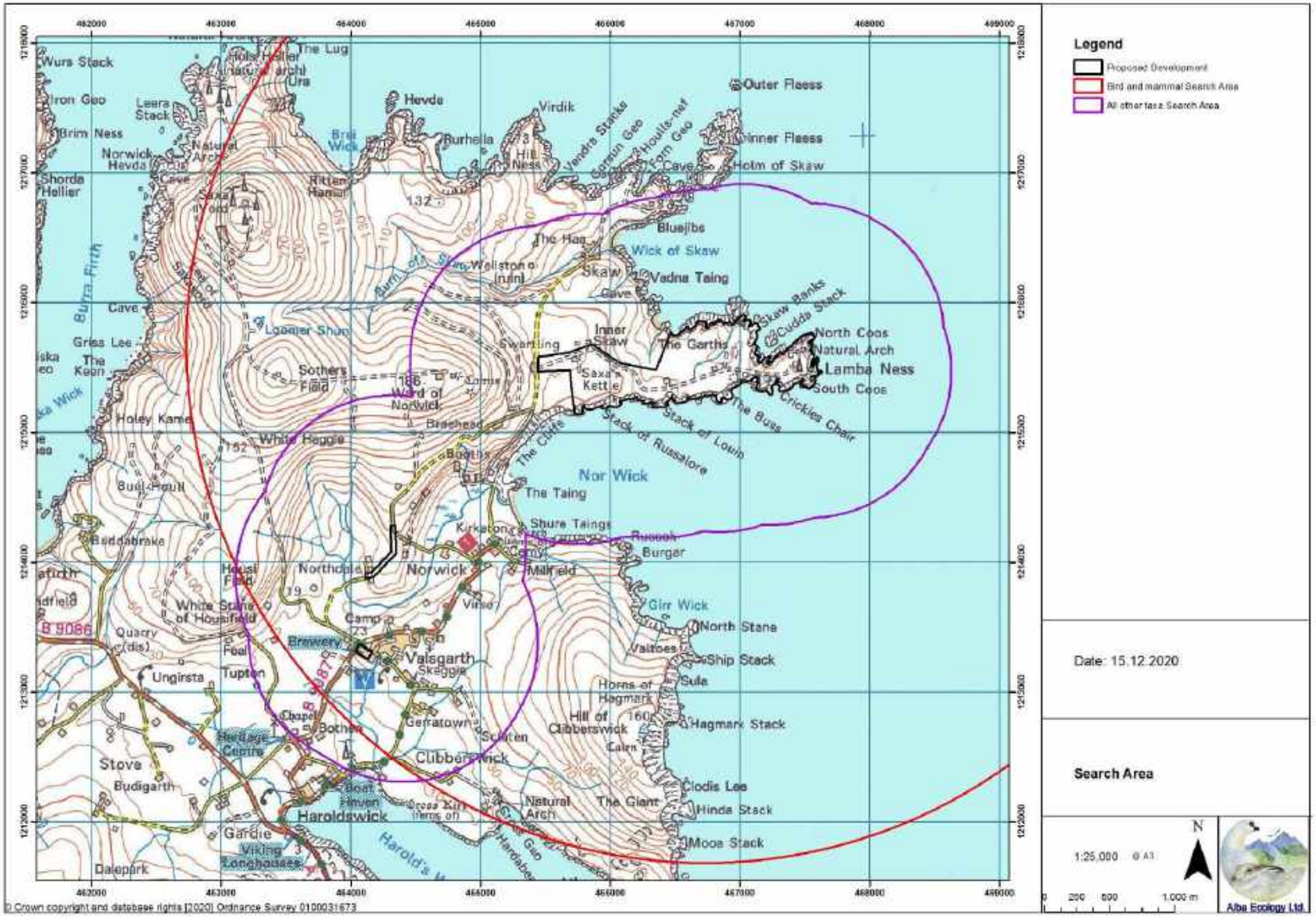
Shetland Island Council (SIC). 2015. *Shetland Local Development Plan, Supplementary Guidance Local Nature Conservation Sites*, 2014, Adopted 2015.

Smedley, M.D., and Uttley, J. 1994. Draft Norwick Meadows SSSI NVC survey. Provided by Johnathan Swale of SNH in June 2018.

Swale, J. 2004. Living Shetland Biodiversity Action Plan. *Habitat Action Plan – Ungrazed Areas*.

UK Moths. 2020. https://ukmoths.org.uk/species/celaena-haworthii. Accessed August 2020.

Appendix 7.1 Drawing 1: Desk Study Search Area



Species	Common Name	Reference(s)
Lutra lutra	European Otter	Shetland Biological Records Centre, 2002-2011
Rattus norvegicus	Brown Rat	Shetland Biological Records Centre, 1997-2004
Oryctolagus cuniculus	European Rabbit	Shetland Biological Records Centre, 2003
Cetorhinus maximus	Basking Shark	Shetland Biological Records Centre, 2011-2019
Cytophora cristata	Hooded Seal	Shetland Biological Records Centre, 2013
Balaenoptera acutorostrata	Minke Whale	Shetland Biological Records Centre, 2001-2019
Megaptera novaeangliae	Humpback Whale	Shetland Biological Records Centre, 2017
Globicephala melas	Long-finned Pilot Whale	Shetland Biological Records Centre, 2017
Grampus griseus	Risso's Dolphin	Shetland Biological Records Centre, 1991-2017
Lagenorhynchus acutus	Atlantic White-sided Dolphin	Shetland Biological Records Centre, 2001-2009
Lagenorhynchus albirostris	White-beaked Dolphin	Shetland Biological Records Centre, 2000-2003
Orcinus orca	Killer Whale	Shetland Biological Records Centre, 1990-2019
Phocoena phocoena	Common Porpoise	Shetland Biological Records Centre, 2002-2006
Erinaceus europaeus	West European Hedgehog	Shetland Biological Records Centre, 2002-2009
Chiroptera	Bats	Shetland Biological Records Centre, 2011-2015
Pipistrellus nathusii	Nathusius's Pipistrelle	Shetland Biological Records Centre, 1996-2011
Vespertilio murinus	Parti-coloured Bat	Shetland Biological Records Centre, 2003

Species	Common Name	Reference(s)
Cygnus olor	Mute Swan	Shetland Biological Records Centre, 2001-2019
Cygnus cygnus	Whooper Swan	
Anser fabalis	Bean Goose	
Anser fabalis subsp. rossicus	Tundra Bean Goose	
Anser brachyrhynchus	Pink-footed Goose	
Anser albifrons subsp. albifrons	European Greater White-fronted G	
Anser anser	Greylag Goose	
Branta canadensis	Canada Goose	
Branta leucopsis	Barnacle Goose	
Branta bernicla subsp. hrota	Light-bellied Brent Goose	
Tadorna tadorna	Shelduck	
Anas penelope	Wigeon	
Anas crecca	Teal	
Anas platyrhynchos	Mallard	
Anas acuta	Pintail	
Aythya ferina	Pochard	
Aythya fuligula	Tufted Duck	
Somateria mollissima	Eider	
Clangula hyemalis	Long-tailed Duck	
Melanitta nigra	Common Scoter	
Melanitta perspicillata	Surf Scoter	
Melanitta fusca	Velvet Scoter	
Bucephala clangula	Goldeneye	
Mergus cucullatus	Hooded Merganser	
Mergus serrator	Red-breasted Merganser	
Mergus merganser	Goosander	
Coturnix coturnix	Quail	
Gavia stellata	Red-throated Diver	
Gavia immer	Great Northern Diver	
Fulmarus glacialis	Fulmar	
Fulmarus glacialis subsp. glacialis	Fulmarus glacialis subsp. glacialis	
Phalacrocorax carbo	Cormorant	
Phalacrocorax aristotelis	Shag	
Ardea cinerea	Grey Heron	
Tachybaptus ruficollis	Little Grebe	
Podiceps auritus	Slavonian Grebe	
Rallus aquaticus	Water Rail	
Porzana porzana	Spotted Crake	
Crex crex	Corncrake	
Gallinula chloropus	Moorhen	
Fulica atra	Coot	
Grus grus	Crane	
Haematopus ostralegus	Oystercatcher	
Pluvialis apricaria	Golden Plover	
Vanellus vanellus	Lapwing	
Charadrius dubius	Little Ringed Plover	
Charadrius hiaticula	Ringed Plover	
Charadrius morinellus	Dotterel	
Numenius phaeopus	Whimbrel	
Numenius arquata	Curlew	
Limosa limosa	Black-tailed Godwit	
Arenaria interpres	Turnstone	
Calidris canutus	Knot	
Philomachus pugnax	Ruff	
Calidris ferruginea	Curlew Sandpiper	
Calidris alba	Sanderling	

Calidris alpina	Dunlin
Calidris maritima	Purple Sandpiper
Phalaropus lobatus	Red-necked Phalarope
Tringa nebularia	Greenshank
Tringa totanus	Redshank
Lymnocryptes minimus	Jack Snipe
Scolopax rusticola	Woodcock
Gallinago gallinago	Snipe
Stercorarius parasiticus	Arctic Skua
Fratercula arctica	Puffin
Cepphus grylle	Black Guillemot
Alca torda	Razorbill
Uria aalge	Guillemot
Sterna hirundo	Common Tern
Sterna paradisaea	Arctic Tern
Rissa tridactyla	Kittiwake
Chroicocephalus ridibundus	Black-headed Gull
Larus canus	Common Gull
Larus fuscus	Lesser Black-backed Gull
Larus fuscus subsp. graellsii	British Lesser Black-Backed Gull
Larus argentatus	Herring Gull
Larus glaucoides	Iceland Gull
Larus hyperboreus	Glaucous Gull
Larus marinus	Great Black-backed Gull
Columba palumbus	Woodpigeon
Falco columbarius	Merlin
Falco peregrinus	Peregrine
Corvus corone subsp. cornix	Hooded Crow
Alauda arvensis	Skylark
Hirundo rustica	Swallow
Delichon urbica	House Martin
Phylloscopus collybita	Chiffchaff
Hippolais icterina	Icterine Warbler
Acrocephalus palustris	Marsh Warbler
Troglodytes troglodytes	Wren
Sturnus vulgaris	Starling
Turdus merula	Blackbird
Turdus pilaris	Fieldfare
Turdus iliacus	Redwing
Oenanthe oenanthe	Wheatear
Passer domesticus	House Sparrow
Passer montanus	Tree Sparrow
Motacilla cinerea	Grey Wagtail
Motacilla alba subsp. yarrellii	Pied Wagtail
Motacilla alba subsp. alba	White Wagtail
Anthus pratensis	Meadow Pipit
Anthus petrosus	Rock Pipit
Actitis hypoleucos	Common Sandpiper
Stercorarius skua	Great Skua

Species	Common Name	Reference(s)
Rana temporaria	Common Frog	Shetland Biological records 1999

Species	Common Name	Reference(s)
Huperzia selago	Fir Clubmoss	Shetland Biological Records Centre, 1991-2018
Selaginella selaginoides	Lesser Clubmoss	
Equisetum arvense	Field Horsetail	
Equisetum fluviatile	Water Horsetail	
Equisetum palustre	Marsh Horsetail	
Polypodium vulgare agg.	Polypody	
Asplenium adiantum-nigrum	Black Spleenwort	
Blechnum spicant	Hard-fern	
Dryopteris dilatata	Broad Buckler-fern	
Hymenophyllum wilsonii	Wilson's Filmy-fern	
Botrychium lunaria	Moonwort	
Ophioglossum azoricum	Small Adder's-tongue	
Dryopteris filix-mas agg.	Male Fern	
Poa pratensis	Smooth Meadow-Grass	
Trichophorum cespitosum subsp. germanicum	Deergrass	
Callitriche stagnalis	Common Water-Starwort	
Trichophorum cespitosum	Deergrass	
Elytrigia repens subsp. repens	Common Couch	
Callitriche hamulata	Intermediate Water-Starwort	
Carex arenaria	Sand Sedge	
Carex bigelowii	Stiff Sedge	
Carex binervis	Green-ribbed Sedge	
Carex curta	White Sedge	
Carex echinata	Star Sedge	
Carex flacca	Glaucous Sedge	
Carex hostiana x viridula = C. x fulva	Sedge	
Carex limosa	Bog-sedge	
Carex nigra	Common Sedge	
Carex ovalis	Oval Sedge	
Carex panicea	Carnation Sedge	
Carex paniculata	Greater Tussock-sedge	
Carex pilulifera	Pill Sedge	
Carex pulicaris	Flea Sedge	
Carex rostrata	Bottle Sedge	
Carex viridula subsp. oedocarpa	Common Yellow-sedge	
Eleocharis palustris	Common Spike-rush	
Eriophorum angustifolium	Common Cottongrass	
Eriophorum vaginatum	Hare's-tail Cottongrass	
Crocosmia pottsii x aurea = C. x crocosmiiflora	Montbretia	
Iris pseudacorus	Yellow Iris	
Juncus articulatus	Jointed Rush	
Juncus bufonius	Toad Rush	
Juncus bulbosus	Bulbous Rush	
Juncus conglomeratus	Compact Rush	
Juncus effusus	Soft-rush	
Juncus squarrosus	Heath Rush	
Luzula campestris	Field Wood-rush	
Luzula multiflora	Heath Wood-rush	
Luzula multiflora subsp. congesta	Heath Wood-Rush	
Luzula multiflora subsp. multiflora	Heath Wood-Rush	
Luzula sylvatica	Great Wood-rush	
Triglochin palustre	Marsh Arrowgrass	
Hyacinthoides non-scripta x hispanica = H. x massartiana	Bluebell	
Narthecium ossifragum	Bog Asphodel	
Scilla verna	Spring Squill	
Coeloglossum viride	Frog Orchid	
Dactylorhiza	Marsh-Orchid	
Dactylorhiza fuchsii x purpurella = D. x venusta	Marsh-Orchid	
Dactylorhiza incarnata subsp. pulchella	Early Marsh-Orchid	
Dactylorhiza maculata	Heath Spotted-orchid	
Dactylorhiza purpurella	Northern Marsh-orchid	
Listera cordata	Lesser Twayblade	
Agrostis canina	Velvet Bent	
Agrostis capillaris	Common Bent	
Agrostis stolonifera	Creeping Bent	
Agrostis vinealis	Brown Bent	
Aira praecox	Early Hair-grass	
Atriplex prostrata agg.	Atriplex prostrata agg.	
Alopecurus geniculatus	Marsh Foxtail	
Alopecurus pratensis	Meadow Foxtail	
Ammophila arenaria	Marram	
Lychnis flos-cuculi	Ragged-Robin	
Anthoxanthum odoratum	Sweet Vernal-grass	
Arrhenatherum elatius	False Oat-grass	
Cochlearia officinalis agg.	Common Scurvygrass	
Bromus hordeaceus	Lesser Soft-Brome	
Cynosurus cristatus	Crested Dog's-tail	
Dactylis glomerata	Cock's-foot	
Deschampsia cespitosa	Tufted Hair-Grass	
Deschampsia flexuosa	Wavy Hair-grass	
Elytrigia juncea subsp. boreoatlantica	Sand Couch	
Elytrigia repens	Common Couch	
Festuca arundinacea	Tall Fescue	
Festuca rubra	Red Fescue	
Festuca rubra subsp. arctica	Red Fescue	
Festuca rubra subsp. rubra	Red Fescue	
Festuca vivipara	Viviparous Sheep's-fescue	
Glyceria fluitans	Floating Sweet-grass	
Holcus lanatus	Yorkshire-fog	
Leymus arenarius	Lyme-grass	
Lolium perenne	Perennial Rye-grass	
Molinia caerulea	Purple Moor-grass	

Nardus stricta	Mat-grass
Phalaris arundinacea	Reed Canary-grass
Poa annua	Annual Meadow-grass
Poa humilis	Spreading Meadow-grass
Poa trivialis	Rough Meadow-grass
Puccinellia distans	Reflexed Saltmarsh-Grass
Potamogeton	Pondweed
Potamogeton polygonifolius	Bog Pondweed
Typha latifolia	Bulrush
Angelica sylvestris	Wild Angelica
Anthriscus sylvestris	Cow Parsley
Conopodium majus	Pignut
Heracleum sphondylium	Hogweed
Heracleum sphondylium subsp. sphondylium	Hogweed
Hydrocotyle vulgaris	Marsh Pennywort
Ligusticum scoticum	Scots Lovage
Achillea millefolium	Yarrow
Achillea ptarmica	Sneezewort
Artemisia vulgaris	Mugwort
Aster novi-belgii	Confused Michaelmas-daisy
Bellis perennis	Daisy
Centaurea montana	Perennial Cornflower
Cichorium intybus	Chicory
Cirsium arvense	Creeping Thistle
Cirsium vulgare	Spear Thistle
Hypochaeris radicata	Cat's-ear
Leontodon autumnalis	Autumn Hawkbit
Matricaria discoidea	Pineappleweed
Petasites albus	White Butterbur
Senecio aquaticus	Marsh Ragwort
Senecio jacobaea	Common Ragwort
Senecio vulgaris	Groundsel
Solidago virgaurea	Goldenrod
Sonchus arvensis	Perennial Sow-thistle
Tanacetum vulgare	Tansy
Taraxacum	Dandelion Agg.
Taraxacum faeroense	Dandelion
Taraxacum officinale agg.	Dandelion
Tripleurospermum inodorum	Scentless Mayweed
Tripleurospermum maritimum	Sea Mayweed
Anchusa arvensis	Bugloss
Borago officinalis	Borage
Mertensia maritima	Oysterplant
Myosotis arvensis	Field Forget-me-not
Myosotis discolor	Changing Forget-me-not
Myosotis laxa	Tufted Forget-me-not
Myosotis scorpioides	Water Forget-me-not
Myosotis secunda	Creeping Forget-me-not
Arabis petraea	Northern Rock-cress
Cakile maritima	Sea Rocket
Cakile maritima subsp. integrifolia	Cakile maritima subsp. integrifolia
Capsella bursa-pastoris	Shepherd's-purse
Cardamine hirsuta	Hairy Bitter-cress
Cardamine pratensis	Cuckooflower
Cochlearia officinalis	Common Scurvygrass
Cochlearia officinalis subsp. officinalis	Scurvygrass
Crambe maritima	Sea-kale
Callitriche	Water-Starwort
Jasione montana	Sheep's-bit
Arenaria norvegica subsp. norvegica	Arctic Sandwort
Cerastium diffusum	Sea Mouse-ear
Cerastium fontanum	Common Mouse-ear
Cerastium fontanum subsp. holosteoides	Common Mouse-Ear
Cerastium glomeratum	Sticky Mouse-ear
Honckenya peploides	Sea Sandwort
Sagina maritima	Sea Pearlwort
Sagina procumbens	Procumbent Pearlwort
Silene acaulis	Moss Campion
Silene dioica	Red Campion
Silene uniflora	Sea Campion
Spergula arvensis	Corn Spurrey
Stellaria alsine	Bog Stitchwort
Stellaria uliginosa	Bog Stitchwort
Stellaria media	Common Chickweed
Atriplex glabriuscula	Babington's Orache
Atriplex prostrata	Spear-leaved Orache
Chenopodium album	Fat-hen
Convolvulus arvensis	Field Bindweed
Sedum rosea	Roseroot
Succisa pratensis	Devil's-bit Scabious
Drosera rotundifolia	Round-leaved Sundew
Empetrum nigrum	Crowberry agg.
Empetrum nigrum subsp. nigrum	Crowberry
Calluna vulgaris	Heather
Erica cinerea	Bell Heather
Erica tetralix	Cross-leaved Heath
Vaccinium myrtillus	Bilberry
Vaccinium uliginosum	Bog Bilberry
Vaccinium vitis-idaea	Cowberry
Anthyllis vulneraria	Kidney Vetch
Lathyrus japonicus	Sea Pea
Lathyrus pratensis	Meadow Vetchling
Lotus corniculatus	Common Bird's-foot-trefoil
Trifolium pratense	Red Clover

Trifolium repens	White Clover
Ulex europaeus	Gorse
Vicia cracca	Tufted Vetch
Vicia sepium	Bush Vetch
Gentianella campestris	Field Gentian
Geranium psilostemon	Armenian Crane's-bill
Geranium robertianum	Herb-Robert
Hippuris vulgaris	Mare's-tail
Lamium confertum	Northern Dead-nettle
Lamium purpureum	Red Dead-nettle
Mentha spicata	Spear Mint
Prunella vulgaris	Selfheal
Thymus polytrichus	Thymus polytrichus
Pinguicula vulgaris	Common Butterwort
Linum catharticum	Fairy Flax
Menyanthes trifoliata	Bogbean
Epilobium brunnescens	New Zealand Willowherb
Epilobium montanum	Broad-leaved Willowherb
Epilobium palustre	Marsh Willowherb
Papaver dubium	Long-headed Poppy
Plantago coronopus	Buck's-horn Plantain
Plantago lanceolata	Ribwort Plantain
Plantago major	Greater Plantain
Plantago major subsp. major	Greater Plantain
Plantago maritima	Sea Plantain
Armeria maritima subsp. maritima	Thrift
Polygala serpyllifolia	Heath Milkwort
Polygala vulgaris	Common Milkwort
Persicaria amphibia	Amphibious Bistort
Persicaria bistorta	Common Bistort
Persicaria maculosa	Redshank
Polygonum aviculare	Knotgrass
Polygonum boreale	Northern Knotgrass
Rheum palmatum x rhaponticum = R. x hybridum	Rhubarb
Rumex acetosa	Common Sorrel
Rumex acetosa subsp. acetosa	Common Sorrel
Rumex acetosella	Sheep's Sorrel
Rumex acetosella subsp. acetosella	Sheep's Sorrel
Rumex crispus	Curled Dock
Rumex crispus subsp. littoreus	Curled Dock
Rumex crispus x obtusifolius = R. x pratensis	Dock
Rumex longifolius	Northern Dock
Rumex obtusifolius	Broad-leaved Dock
Claytonia perfoliata	Springbeauty
Montia fontana	Blinks
Montia fontana subsp. fontana	Blinks
Anagallis tenella	Bog Pimpernel
Caltha palustris	Marsh-marigold
Ranunculus acris	Meadow Buttercup
Ranunculus ficaria	Lesser Celandine
Ranunculus ficaria subsp. ficaria	Lesser Celandine
Ranunculus flammula	Lesser Spearwort
Ranunculus flammula subsp. flammula	Lesser Spearwort
Ranunculus repens	Creeping Buttercup
Alchemilla glabra	Smooth Lady's-mantle
Potentilla erecta	Tormentil
Potentilla erecta subsp. erecta	Tormentil
Potentilla palustris	Marsh Cinquefoil
Rosa rugosa	Japanese Rose
Rubus idaeus	Raspberry
Galium aparine	Cleavers
Galium palustre	Marsh-bedstraw
Galium palustre subsp. palustre	Common Marsh-bedstraw
Galium saxatile	Heath Bedstraw
Galium verum	Lady's Bedstraw
Salix cinerea x phylicifolia = S. x laurina	Laurel-leaved Willow
Euphrasia	Eyebright
Euphrasia arctica	an Eyebright
Euphrasia micrantha	Eyebright
Euphrasia nemorosa	Eyebright
Euphrasia officinalis agg.	Eyebright
Hebe elliptica x speciosa = H. x franciscana	Hedge Veronica
Mimulus guttatus	Monkeyflower
Pedicularis palustris	Marsh Lousewort
Pedicularis sylvatica	Lousewort
Rhinanthus minor	Yellow-rattle
Rhinanthus minor subsp. stenophyllus	Yellow-Rattle
Scrophularia nodosa	Common Figwort
Veronica scutellata	Marsh Speedwell
Veronica serpyllifolia	Thyme-leaved Speedwell
Veronica serpyllifolia subsp. serpyllifolia	Thyme-Leaved Speedwell
Urtica dioica	Common Nettle
Viola arvensis	Field Pansy
Viola palustris	Marsh Violet
Viola palustris subsp. palustris	Marsh Violet
Viola riviniana	Common Dog-violet
Viola tricolor	Wild Pansy
Armeria maritima	Sea Pink
Potentilla anserina	Silverweed
Polypodium vulgare	Polypody

Species	Common Name	Liverwort/Moss	Reference
Aneura pinguis	Greasewort	Liverwort	Shetland Biological records 2008
Blepharostoma trichophyllum	Hairy Threadwort	Liverwort	Shetland Biological records 2008
Calypogeia fissa	Common Pouchwort	Liverwort	Shetland Biological records 2008
Calypogeia muelleriana	Mueller's Pouchwort	Liverwort	Shetland Biological records 2008
Cephalozia bicuspidata	Two-horned Pincerwort	Liverwort	Shetland Biological records 2008
Cephalozia leucantha	Pale Pincerwort	Liverwort	Shetland Biological records 2008
Cephaloziella divaricata	Common Threadwort	Liverwort	Shetland Biological records 2008
Cephaloziella hampeana	Hampe's Threadwort	Liverwort	Shetland Biological records 2008
Diplophyllum albicans	White Earwort	Liverwort	Shetland Biological records 2008
Kurzia trichoclados	Heath Fingerwort	Liverwort	Shetland Biological records 2008
Lepidozia reptans	Creeping Fingerwort	Liverwort	Shetland Biological records 2008
Lophocolea bidentata	Bifid Crestwort	Liverwort	Shetland Biological records 2008
Lophozia incisa	Jagged Notchwort	Liverwort	Shetland Biological records 2008
Lophozia ventricosa	Tumid Notchwort	Liverwort	Shetland Biological records 2001-2008
Lunularia cruciata	Crescent-cup Liverwort	Liverwort	Shetland Biological records 2008
Mylia anomala	Anomalous Flapwort	Liverwort	Shetland Biological records 2008
Mylia taylori	Taylor's Flapwort	Liverwort	Shetland Biological records 2001-2008
Nardia compressa	Compressed Flapwort	Liverwort	Shetland Biological records 2001
Pellia epiphylla	Overleaf Pellia	Liverwort	Shetland Biological records 2001-2008
Pellia neesiana	Nees' Pellia	Liverwort	Shetland Biological records 2001-2008
Ptilidium ciliare	Ciliated Fringewort	Liverwort	Shetland Biological records 2008
Riccardia latifrons	Bog Germanderwort	Liverwort	Shetland Biological records 2008
Scapania gracilis	Western Earwort	Liverwort	Shetland Biological records 2001-2008
Scapania undulata	Water Earwort	Liverwort	Shetland Biological records 2008
Tritomaria exsectiformis	Larger Cut Notchwort	Liverwort	Shetland Biological records 2008
Sphagnum	Bog Moss	Moss	Shetland Biological records 1991-2015
Aulacomnium palustre	Bog Groove-moss	Moss	Shetland Biological records 1991-2016
Barbula convoluta var. convoluta	Lesser Bird's-claw Beard-moss	Moss	Shetland Biological records 1991-2017
Barbula unguiculata	Bird's-claw Beard-moss	Moss	Shetland Biological records 1991-2018
Brachythecium rutabulum	Rough-stalked Feather-moss	Moss	Shetland Biological records 1991-2019
Bryum capillare	Capillary Thread-moss	Moss	Shetland Biological records 1991-2020
Bryum pseudotriquetrum	Marsh Bryum	Moss	Shetland Biological records 1991-2021
Calliergon giganteum	Giant Spear-moss	Moss	Shetland Biological records 1991-2022
Calliergon cuspidatum	Pointed Spear-moss	Moss	Shetland Biological records 1991-2023
Campylopus paradoxus	Rusty Swan-neck Moss	Moss	Shetland Biological records 1991-2024
Cratoneuron filicinum	Fern-leaved Hook-moss	Moss	Shetland Biological records 1991-2025
Dicranella varia	Variable Forklet-moss	Moss	Shetland Biological records 1991-2026
Dicranum bonjeanii	Crisped Fork-moss	Moss	Shetland Biological records 1991-2027
Dicranum fuscescens	Dusky Fork-moss	Moss	Shetland Biological records 1991-2028
Dicranum majus	Greater Fork-moss	Moss	Shetland Biological records 1991-2029
Dicranum scoparium	Broom Fork-moss	Moss	Shetland Biological records 1991-2030
Barbula fallax	Fallacious Beard-moss	Moss	Shetland Biological records 1991-2031
Barbula cylindrica	Cylindric Beard-moss	Moss	Shetland Biological records 1991-2032
Barbula rigidula	Rigid Beard-moss	Moss	Shetland Biological records 1991-2033
Drepanocladus revolvens	Rusty Hook-moss	Moss	Shetland Biological records 1991-2034
Eurhynchium praelongum	Common Feather-moss	Moss	Shetland Biological records 1991-2035
Homalothecium sericeum	Silky Wall Feather-moss	Moss	Shetland Biological records 1991-2036
Hylocomium splendens	Glittering Wood-moss	Moss	Shetland Biological records 1991-2037
Hypnum jutlandicum	Heath Plait-moss	Moss	Shetland Biological records 1991-2038
Isothecium myosuroides var. brach	Isothecium myosuroides var. brachythecioides	Moss	Shetland Biological records 1991-2039
Mnium hornum	Swan's-neck Thyme-moss	Moss	Shetland Biological records 1991-2040
Plagiomnium undulatum	Hart's-tongue Thyme-moss	Moss	Shetland Biological records 1991-2041
Polytrichum commune	Common Haircap	Moss	Shetland Biological records 1991-2042
Polytrichum commune var. commu	Polytrichum commune var. commune	Moss	Shetland Biological records 1991-2043
Polytrichum juniperinum	Juniper Haircap	Moss	Shetland Biological records 1991-2044
Polytrichum alpestre	Strict Haircap	Moss	Shetland Biological records 1991-2045
Barbula hornschuchiana	Hornschuch's Beard-moss	Moss	Shetland Biological records 1991-2046
Racomitrium lanuginosum	Woolly Fringe-moss	Moss	Shetland Biological records 1991-2047
Rhabdoweisia fugax	Dwarf Streak-moss	Moss	Shetland Biological records 1991-2048
Rhizomnium punctatum	Dotted Thyme-moss	Moss	Shetland Biological records 1991-2049
Rhytidiadelphus loreus	Little Shaggy-moss	Moss	Shetland Biological records 1991-2050
Rhytidiadelphus squarrosus	Springy Turf-moss	Moss	Shetland Biological records 1991-2051
Schistidium maritimum	Seaside Grimmia	Moss	Shetland Biological records 1991-2052
Sphagnum capillifolium	Red Bog-moss	Moss	Shetland Biological records 1991-2053
Sphagnum cuspidatum	Feathery Bog-moss	Moss	Shetland Biological records 1991-2054
Sphagnum recurvum var. mucronat	Flat-topped Bog-moss	Moss	Shetland Biological records 1991-2055
Sphagnum lindbergii	Lindberg's Bog-moss	Moss	Shetland Biological records 1991-2056
Sphagnum palustre	Blunt-leaved Bog-moss	Moss	Shetland Biological records 1991-2057
Sphagnum papillosum	Papillose Bog-moss	Moss	Shetland Biological records 1991-2058
Sphagnum squarrosum	Spiky Bog-moss	Moss	Shetland Biological records 1991-2059
Sphagnum subnitens	Lustrous Bog-moss	Moss	Shetland Biological records 1991-2060
Sphagnum tenellum	Soft Bog-moss	Moss	Shetland Biological records 1991-2061
Tortula muralis	Wall Screw-moss	Moss	Shetland Biological records 1991-2062
Drepanocladus fluitans	Floating Hook-moss	Moss	Shetland Biological records 1991-2063
Bryum bicolor	Bryum bicolor	Moss	Shetland Biological records 1991-2064
Hypnum cupressiforme	Hypnum cupressiforme	Moss	Shetland Biological records 1991-2065

Species	Common Name	Reference(s)
Acarospora fuscata		Shetland Biological Records Centre, 1990-2018
Agonimia tristicula		
Amandinea punctata		
Anaptychia runcinata		
Arthonia phaeobaea		
Arthonia varians		
Aspicilia caesiocinerea		
Aspicilia leprosescens		
Bacidia carneoglauca		
Bacidia scopulicola		
Baeomyces rufus		
Brigantiaea fuscolutea		
Caloplaca britannica		
Caloplaca ceracea		
Caloplaca crenularia		
Caloplaca crenulatella		
Caloplaca littorea		
Caloplaca marina	Orange Sea Lichen	
Caloplaca microthallina		
Caloplaca saxicola		
Caloplaca thallincola		
Caloplaca verruculifera	Orange Sea Star	
Candelariella vitellina		
Catapyrenium cinereum		
Cetraria aculeata		
Cetraria muricata		
Cladonia arbuscula subsp. squarrosa		
Cladonia bellidiflora		
Cladonia cervicornis subsp. cervicornis		
Cladonia ciliata var. tenuis		
Cladonia floerkeana		
Cladonia foliacea		
Cladonia gracilis		
Cladonia portentosa	Reindeer Moss	
Cladonia pyxidata		
Cladonia rangiformis		
Cladonia squamosa var. subsquamosa		
Cladonia subcervicornis		
Cladonia uncialis subsp. biuncialis		
Cliostomum griffithii		
Cliostomum tenerum		
Coccotrema citrinescens		
Evernia prunastri	Oak Moss	
Fuscidea cyathoides var. cyathoides		
Halecania ralfsii		
Hydropunctaria maura	Tar Lichen	
Hypogymnia physodes	Dark Crottle	
Ionaspis lacustris		
Lecania baeomma		
Lecanora albescens		
Lecanora confusa		
Lecanora expallens		
Lecanora farinaria		
Lecanora gangaleoides		
Lecanora helicopis		
Lecanora poliophaea		
Lecanora polytropa		
Lecanora pulicaris		
Lecanora rupicola var. rupicola		
Lecanora saligna		
Lecanora sulphurea		
Lecanora symmicta		
Lecanora umbrina		
Lecidea hypnorum		
Lecidea lactea		

Lecidella asema	
Lecidella meiococca	
Lecidella prasinula	
Lecidella scabra	
Lecidella stigmatea	
Leptogium britannicum	
Leptogium gelatinosum	
Lichenomphalia hudsoniana	
Lichina confinis	
Lichina pygmaea	Black Lichen
Lobaria virens	
Micarea lignaria	
Micarea peliocarpa	
Ochrolechia frigida	
Ochrolechia parella	Parelle
Opegrapha areniseda	
Opegrapha atra	
Opegrapha cesareensis	
Opegrapha multipuncta	
Pannaria pezizoides	
Parmelia omphalodes	
Parmelia saxatilis	Netted Shield Lichen
Parmelia sulcata	
Parmotrema chinense	
Parmotrema crinitum	Dog Lichen
Parmotrema perlatum	
Peltigera canina	
Peltigera hymenina	
Peltigera leucophlebia	
Peltigera membranacea	
Pertusaria albescens var. corallina	
Phaeophyscia orbicularis	
Physcia tenella	
Polyblastia cupularis	
Porina chlorotica f. chlorotica	
Porpidia macrocarpa	
Porpidia macrocarpa f. macrocarpa	
Porpidia platycarpoides	
Porpidia tuberculosa	
Protopannaria pezizoides	
Psoroma hypnorum	
Ramalina cuspidata	
Ramalina farinacea	Sea Ivory
Ramalina siliquosa	
Ramalina subfarinacea	
Rhizocarpon richardii	
Rinodina confragosa	
Rinodina oleae	
Roselliniopsis tartaricola	
Solorina spongiosa	
Sphaerophorus globosus	
Tephromela atra	
Tephromela grumosa	
Thelenella muscorum var. muscorum	
Thelenella muscorum var. octospora	
Toninia aromatica	
Trapelia coarctata	
Trapeliopsis pseudogranulosa	
Verrucaria fusconigrescens	Tar Lichen
Verrucaria maura	
Verrucaria nigrescens	
Violella fucata	Common Orange Lichen
Xanthoria aureola	
Xanthoria parietina	
Opegrapha calcarea	

Species	Common Name	Reference(s)
Dicymbium brevisetosum		Shetland Biologcal Records Centre 1991-2014
Hilaira frigida		
Lepthyphantes tenuis		
Lepthyphantes zimmermanni		
Lepthyphantes ericaeus		
Lepthyphantes mengei		
Latithorax faustus		
Meioneta beata		
Robertus lividus		
Ceratinella brevipes		
Walckenaeria clavicornis		
Walckenaeria nudipalpis		
Walckenaeria acuminata		
Dicymbium tibiale		
Hypomma bituberculatum		
Metopobactrus prominulus		
Gonatium rubens		
Peponocranium ludicrum		
Oedothorax gibbosus		
Oedothorax fuscus		
Silometopus elegans		
Cnephalocotes obscurus		
Tiso vagans		
Monocephalus castaneipes	Broad Groove-head Spider	
Lophomma punctatum		
Erigonella hiemalis		
Savignia frontata		
Diplocephalus permixtus		
Araeoncus crassiceps		
Scotinotylus evansi		
Pocadicnemis pumila		
Erigone arctica		
Erigone atra		
Erigone promiscua		
Leptorhoptrum robustum		
Micrargus herbigradus		
Agyneta decora		
Agyneta olivacea		
Centromerus prudens		
Meioneta saxatilis		
Centromerita bicolor		
Centromerita concinna		
Oreonetides vaginatus		
Saaristoa abnormis		
Bathyphantes gracilis		
Poeciloneta variegata		
Microlinyphia pusilla		
Allomengea scopigera		
Pardosa pullata		
Trochosa terricola		
Pirata piraticus		
Cryphoeca silvicola		
Amaurobius fenestralis		
Clubiona trivialis		

Xysticus cristatus
Ozyptila trux
Nemastoma bimaculatum
Mitopus morio

Species	Common Name	Reference(s)
Calathus melanocephalus		Shetland Biological Records Centre, 1991 - 2007
Agabus bipustulatus		Shetland Biological Records Centre, 2001
Agabus guttatus		Shetland Biological Records Centre, 2001
Hydroporus erythrocephalus		Shetland Biological Records Centre, 2001
Cychrus caraboides	Snail Hunter	Shetland Biological Records Centre, 2001 - 2007
Leistus rufescens		Shetland Biological Records Centre, 2004 - 2007
Nebria brevicollis		Shetland Biological Records Centre, 2001
Notiophilus palustris		Shetland Biological Records Centre, 2001
Loricera pilicornis		Shetland Biological Records Centre, 2001 - 2007
Trechus obtusus		Shetland Biological Records Centre, 2001 - 2007
Bembidion tetracolum		Shetland Biological Records Centre, 2001
Patrobus assimilis		Shetland Biological Records Centre, 2001 - 2007
Pterostichus oblongopunctatus		Shetland Biological Records Centre, 2001 - 2007
Pterostichus melanarius		Shetland Biological Records Centre, 2001
Pterostichus rhaeticus		Shetland Biological Records Centre, 2001 - 2007
Pterostichus strenuus		Shetland Biological Records Centre, 2001 - 2007
Calathus fuscipes		Shetland Biological Records Centre, 2001 - 2007
Agonum fuliginosum		Shetland Biological Records Centre, 2001 - 2007
Cercyon unipunctatus		Shetland Biological Records Centre, 2001
Megasternum obscurum		Shetland Biological Records Centre, 2001 - 2007
Leiodes obesa		Shetland Biological Records Centre, 2001 - 2007
Agathidium laevigatum		Shetland Biological Records Centre, 2001 - 2007
Olophrum piceum		Shetland Biological Records Centre, 2005 - 2007
Bryaxis bulbifer		Shetland Biological Records Centre, 2001
Tachinus signatus		Shetland Biological Records Centre, 2001 - 2007
Tachyporus dispar		Shetland Biological Records Centre, 2001 - 2007
Atheta graminicola		Shetland Biological Records Centre, 2001 - 2007
Boreophilia eremita		Shetland Biological Records Centre, 2001 - 2007
Geostiba circellaris		Shetland Biological Records Centre, 2001
Atheta fungi		Shetland Biological Records Centre, 2001
Anotylus rugosus		Shetland Biological Records Centre, 2001 - 2007
Stenus impressus		Shetland Biological Records Centre, 2001 - 2007
Stenus juno		Shetland Biological Records Centre, 2001 - 2007
Stenus brunnipes		Shetland Biological Records Centre, 2001
Lathrobium fulvipenne		Shetland Biological Records Centre, 2005 - 2007
Philonthus decorus		Shetland Biological Records Centre, 2001 - 2007
Quedius fuliginosus		Shetland Biological Records Centre, 2001
Quedius molochinus		Shetland Biological Records Centre, 2001 - 2007
Quedius umbrinus		Shetland Biological Records Centre, 2001 - 2007
Othius angustus		Shetland Biological Records Centre, 2001 - 2007
Byrrhus pilula	Pill Beetle	Shetland Biological Records Centre, 2005
Hypnoidus riparius		Shetland Biological Records Centre, 2001 - 2007
Dalopius marginatus		Shetland Biological Records Centre, 2001 - 2007
Anatis ocellata	Eyed Ladybird	Shetland Biological Records Centre, 1994 - 2009
Apion frumentarium		Shetland Biological Records Centre, 2004
Holotrichapion aethiops		Shetland Biological Records Centre, 2001 - 2005
Protapion assimile	Clover Seed Weevil	Shetland Biological Records Centre, 2005 - 2007
Barynotus squamosus		Shetland Biological Records Centre, 1991 - 2007
Otiorhynchus arcticus		Shetland Biological Records Centre, 1991 - 2007
Otiorhynchus singularis	Clay-coloured Weevil	Shetland Biological Records Centre, 2005 - 2007

Species	Common Name	Reference(s)
Pieris brassicae	Large White	Shetland Biological Records Centre, 1990-2017
Vanessa atalanta	Red Admiral	
Cynthia cardui	Painted Lady	
Aglais urticae	Small Tortoiseshell	
Inachis io	Peacock	
Paradiarsia glareosa subsp. glareosa	Autumnal Rustic	
Cydia succedana	Grey Gorse Piercer	
Hepialus humuli	Ghost Moth	
Zygaena filipendulae	Six-spot Burnet	
Anthophila fabriciana	Common Nettle-tap	
Glyphipterix thrasonella	Speckled Fanner	
Yponomeuta evonymella	Bird-cherry Ermine	
Plutella xylostella	Diamond-back Moth	
Rhigognostis senilella	Rock-cress Smudge	
Rhigognostis annulatella	Coast Smudge	
Elachista argentella	Swan-feather Dwarf	
Hofmannophila pseudospretella	Brown House-moth	
Endrosis sarcitrella	White-shouldered House-moth	
Depressaria badiella	False Brown Flat-body	
Agonopterix heracliana	Common Flat-body	
Bryotropha terrella	Cinerous Groundling	
Scrobipalpa samadensis subsp. plantaginella		
Aethes smeathmanniana	Yarrow Conch	
Eupoecilia angustana	Marbled Conch	
Syndemis musculana	Dark-barred Twist	
Clepsis senecionana	Obscure Twist	
Timandra griseata	Blood-Vein	
Eana osseana	Dotted Shade	
Eana penziana	Large Mottled Shade	
Eana penziana subsp. colquhounana		
Acleris sparsana	Ashy Button	
Acleris aspersana	Ginger Button	
Olethreutes lacunana	Common Marble	
Lobesia abscisana	Smoky-barred Marble	
Lobesia littoralis	Shore Marble	
Bactra lancealana	Rush Marble	
Epinotia mercuriana	Moorland Bell	
Rhopobota naevana	Holly Tortrix	
Eucosma cana	Hoary Belle	
Dichrorampha montanana	Spike-marked Drill	
Crambus lathoniellus	Hook-streak Grass-veneer	
Agriphila straminella	Straw Grass-veneer	
Agriphila tristella	Common Grass-veneer	
Scoparia subfusca	Large Grey	
Scoparia ambigualis	Common Grey	
Eudonia alpina	Highland Grey	
Eudonia angustea	Narrow-winged Grey	
Udea lutealis	Pale Straw Pearl	
Nomophila noctuella	Rush Veneer	
Pleuroptya ruralis	Mother of Pearl	
Dioryctria abietella	Dark Pine Knot-horn	
Scopula imitaria	Small Blood-vein	
Xanthorhoe munitata	Red Carpet	
Xanthorhoe decoloraria	Red Carpet	
Xanthorhoe montanata	Silver-ground Carpet	
Xanthorhoe fluctuata	Garden Carpet	
Entephria caesiata	Grey Mountain Carpet	
Eulithis testata	Chevron	
Eulithis populata	Northern Spinach	
Chloroclysta miata	Autumn Green Carpet	
Chloroclysta citrata	Dark Marbled Carpet	
Hydriomena furcata	July Highflyer	
Operophtera brumata	Winter Moth	
Perizoma albulata	Grass Rivulet	
Perizoma didymata	Twin-spot Carpet	
Eupithecia venosata	Netted Pug	
Eupithecia satyrata	Satyr Pug	
Eupithecia assimilata	Currant Pug	
Eupithecia pusillata	Juniper Pug	

Gymnoscelis rufifasciata	Double-striped Pug
Agrius convolvuli	Convolvulus Hawk-moth
Macroglossum stellatarum	Humming-bird Hawk-moth
Hyles galii	Bedstraw Hawk-moth
Arctia caja	Garden Tiger
Agrotis ipsilon	Dark Sword-grass
Standfussiana lucernea	Northern Rustic
Noctua pronuba	Large Yellow Underwing
Noctua fimbriata	Broad-bordered Yellow Underwing
Noctua janthe	Lesser Broad-bordered Yellow Underwing
Eugnorisma glareosa	Autumnal Rustic
Paradiarsia glareosa subsp. edda	Autumnal Rustic
Lycophotia porphyrea	True Lover's Knot
Diarsia mendica	Ingrailed Clay
Diarsia mendica subsp. thulei	Ingrailed Clay
Diarsia brunnea	Purple Clay
Diarsia rubi	Small Square-spot
Xestia c-nigrum	Setaceous Hebrew Character
Xestia baja	Dotted Clay
Xestia xanthographa	Square-spot Rustic
Eurois occulta	Great Brocade
Discestra trifolii	Nutmeg
Hada plebeja	Shears
Lacanobia suasa	Dog's Tooth
Lacanobia oleracea	Bright-Line Brown-Eye
Hadena confusa	Marbled Coronet
Hadena bicruris	Lychnis
Cerapteryx graminis	Antler Moth
Orthosia gothica	Hebrew Character
Mythimna pallens	Common Wainscot
Dasypolia templi	Brindled Ochre
Xylena vetusta	Red Sword-grass
Mniotype adusta	Dark Brocade
Eupsilia transversa	Satellite
Agrochola circellaris	Brick
Phlogophora meticulosa	Angle Shades
Enargia paleacea	Angle-striped Sallow
Parastichtis suspecta	Suspected
Cosmia trapezina	Dun-bar
Hepialus fusconebulosa	Map-winged Swift
Apamea monoglypha	Dark Arches
Apamea zeta	Exile
Apamea oblonga	Crescent Striped
Apamea crenata	Clouded-bordered Brindle
Apamea lateritia	Scarce Brindle
Apamea furva subsp. britannica	Confused
Apamea remissa	Dusky Brocade
Apamea ophiogramma	Double Lobed
Oligia fasciuncula	Middle-barred Minor
Mesapamea secalis	Common Rustic
Mesapamea didyma	Lesser Common Rustic
Photedes pygmina	Small Wainscot
Chortodes pygmina	Small Wainscot
Luperina testacea	Flounced Rustic
Amphipoea lucens	Large Ear
Amphipoea fucosa subsp. paludis	Saltern Ear
Hydraecia micacea	Rosy Rustic
Celaena haworthii	Haworth's Minor
Celaena leucostigma	Crescent
Plusia festucae	Gold Spot
Autographa gamma	Silver Y
Autographa pulchrina	Beautiful Golden Y
Syngrapha interrogationis	Scarce Silver Y

Species	Common Name	Reference(s)
Tipula varipennis		Shetland Biological Records Centre, 2014
Tipula paludosa		Shetland Biological Records Centre, 2008
Tipula lateralis		Shetland Biological Records Centre, 2008 - 2014
Erioptera trivialis		Shetland Biological Records Centre, 2008
Platycheirus clypeatus agg.	Platycheirus clypeatus agg.	Shetland Biological Records Centre, 2001
Empis tessellata		Shetland Biological Records Centre, 1983 - 2014
Empis trigramma		Shetland Biological Records Centre, 1983 - 2014
Episyrphus balteatus	Marmalade Hoverfly	Shetland Biological Records Centre, 1995 - 2016
Eristalis arbustorum		Shetland Biological Records Centre, 1990 - 2016
Eristalis intricarius		Shetland Biological Records Centre, 1990 - 2016
Eristalis pertinax		Shetland Biological Records Centre, 1995 - 2016
Eupeodes corollae		Shetland Biological Records Centre, 1894 - 2016
Eupeodes luniger		Shetland Biological Records Centre, 1995
Helophilus pendulus		Shetland Biological Records Centre, 1991 - 2016
Lejogaster metallina		Shetland Biological Records Centre, 1991 - 1996
Chrysogaster hirtella		Shetland Biological Records Centre, 1991 - 2014
Melanogaster hirtella		Shetland Biological Records Centre, 2014 - 2016
Melanostoma mellinum		Shetland Biological Records Centre, 1995 - 2015
Melanostoma scalare		Shetland Biological Records Centre, 1995 - 2016
Meliscaeva auricollis		Shetland Biological Records Centre, 1997 - 2014
Platycheirus albimanus		Shetland Biological Records Centre, 1995 - 2016
Platycheirus clypeatus		Shetland Biological Records Centre, 1996 - 2016
Platycheirus manicatus		Shetland Biological Records Centre, 1991 - 2016
Rhingia campestris		Shetland Biological Records Centre, 1991 - 2006
Scaeva pyrastri		Shetland Biological Records Centre, 1994 - 2016
Scaeva selenitica		Shetland Biological Records Centre, 1991- 2013
Sericomyia silentis		Shetland Biological Records Centre, 1991 - 2016
Syritta pipiens		Shetland Biological Records Centre, 1995 - 2014
Syrphus ribesii		Shetland Biological Records Centre, 1995 - 2016
Syrphus torvus		Shetland Biological Records Centre, 1995 - 2000
Xanthandrus comtus		Shetland Biological Records Centre, 2000 - 2015
Dioxyna bidentis		Shetland Biological Records Centre, 2015
Scathophaga stercoraria		Shetland Biological Records Centre, 1991 - 2014
Calliphora uralensis		Shetland Biological Records Centre, 1991 - 2014
Syrphus spp.		Shetland Biological Records Centre, 1995 - 2016
Melanostoma spp.		Shetland Biological Records Centre, 1995 - 2015

Species	Common Name	Reference(s)
Bombus muscorum	Moss Carder-bee	Shetland Biological Records Centre, 1991 - 2016
Bombus magnus	Northern White-tailed Bumblebee	Shetland Biological Records Centre, 1992 - 2016
Bombus hortorum	Small Garden Bumble Bee	Shetland Biological Records Centre, 1992 - 2014
Tenthredopsis coquebertii		Shetland Biological Records Centre, 2014
Bombus (Bombus) terrestris	Buff-Tailed Bumble Bee	Shetland Biological Records Centre, 2017-18

Species	Common Name	Reference(s)
Elasmostethus interstinctus	Birch Shieldbug	Shetland Biological Records Centre, 2002 - 2006

Licence	Rightsholder	Scientific Name	Common Name	Date	Data Provider	Institution Code	Kingdom	Phylum	Class	Order	Family	Genus
OGL		*Oligochaeta*	Earthworm	2005	Scottish Environment Protection Agency		Animalia	Annelida	Oligochaeta			
CC-BY		*Atomaria nitidula*		1960	Biological Records Centre	Biological Records Centre	Animalia	Arthropoda	Insecta	Coleoptera	Cryptophagidae	Atomaria
CC-BY		*Atomaria fuscipes*		1960	Biological Records Centre	Biological Records Centre	Animalia	Arthropoda	Insecta	Coleoptera	Cryptophagidae	Atomaria
CC0		*Boreonectes multilineatus*		1983	Balfour-Browne Club	Balfour-Browne Club	Animalia	Arthropoda	Insecta	Coleoptera	Dytiscidae	Boreonectes
CC0		*Hydroporus obscurus*		1983	Balfour-Browne Club	Balfour-Browne Club	Animalia	Arthropoda	Insecta	Coleoptera	Dytiscidae	Hydroporus
CC0		*Hydroporus tristis*		1983	Balfour-Browne Club	Balfour-Browne Club	Animalia	Arthropoda	Insecta	Coleoptera	Dytiscidae	Hydroporus
CC0		*Hydroporus pubescens*		1983	Balfour-Browne Club	Balfour-Browne Club	Animalia	Arthropoda	Insecta	Coleoptera	Dytiscidae	Hydroporus
CC0		*Rhantus suturellus*		1983	Balfour-Browne Club	Balfour-Browne Club	Animalia	Arthropoda	Insecta	Coleoptera	Dytiscidae	Rhantus
CC-BY	Highland Biological Recording Group	*Calliphora vicina*	Common Bluebottle	1983	Highland Biological Recording Group	HBRG	Animalia	Arthropoda	Insecta	Diptera	Calliphoridae	Calliphora
OGL		*Chironomidae*	Non-biting midges	2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Diptera	Chironomidae	
OGL		*Empididae*		2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Diptera	Empididae	
OGL		*Psychodidae*	Indet. Mothfly	2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Diptera	Psychodidae	
OGL		*Tipulidae*	Cranefly	2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Diptera	Tipulidae	
CC-BY		*Wesmaelius (Kimminsia) subnebulosus*		1808	Biological Records Centre	Biological Records Centre	Animalia	Arthropoda	Insecta	Neuroptera	Hemerobiidae	Wesmaelius
OGL		*Chloroperlidae*		2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Plecoptera	Chloroperlidae	
OGL		*Leuctridae*	Needle or willow stoneflies	2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Plecoptera	Leuctridae	
CC-BY	UK Caddisfly Recording Scheme	*Lepidostoma hirtum*		1889	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Lepidostomatidae	Lepidostoma
CC-BY	UK Caddisfly Recording Scheme	*Athripsodes cinereus*		1889	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Leptoceridae	Athripsodes
CC-BY	UK Caddisfly Recording Scheme	*Ceraclea fulva*		1889	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Leptoceridae	Ceraclea
CC-BY	UK Caddisfly Recording Scheme	*Mystacides azurea*		1889	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Leptoceridae	Mystacides
CC-BY	UK Caddisfly Recording Scheme	*Limnephilus incisus*		1889	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Limnephilidae	Limnephilus
CC-BY	UK Caddisfly Recording Scheme	*Limnephilus lunatus*		1895	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Limnephilidae	Limnephilus
CC-BY	UK Caddisfly Recording Scheme	*Limnephilus rhombicus*		1895	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Limnephilidae	Limnephilus
CC-BY	UK Caddisfly Recording Scheme	*Mesophylax impunctatus*		1895	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Limnephilidae	Mesophylax
CC-BY	UK Caddisfly Recording Scheme	*Micropterna sequax*		1895	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Limnephilidae	Micropterna
OGL		*Limnephilidae*		2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Trichoptera	Limnephilidae	
CC-BY	UK Caddisfly Recording Scheme	*Polycentropus flavomaculatus*		1889	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Polycentropodidae	Polycentropus
OGL		*Polycentropodidae*		2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Trichoptera	Polycentropodidae	
CC-BY	UK Caddisfly Recording Scheme	*Tinodes waeneri*		1889	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Psychomyiidae	Tinodes
OGL		*Semibalanus balanoides*	Acorn Barnacle	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Animalia	Arthropoda	Maxillopoda	Sessilia	Archaeobalanidae	Semibalanus
OGL		*Chthamalus stellatus*	Poli's Stellate Barnacle	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Animalia	Arthropoda	Maxillopoda	Sessilia	Chthamalidae	Chthamalus
CC-BY		*Anguilla anguilla*	European Eel	2000	Biological Records Centre	Biological Records Centre	Animalia	Chordata	Actinopterygii	Anguilliformes	Anguillidae	Anguilla
CC-BY		*Gasterosteus aculeatus*	Three-spined Stickleback	2000	Biological Records Centre	Biological Records Centre	Animalia	Chordata	Actinopterygii	Gasterosteiformes	Gasterosteidae	Gasterosteus
CC-BY		*Platichthys flesus*	Flounder	2000	Biological Records Centre	Biological Records Centre	Animalia	Chordata	Actinopterygii	Pleuronectiformes	Pleuronectidae	Platichthys
CC-BY		*Salmo salar*	Atlantic Salmon	2000	Biological Records Centre	Biological Records Centre	Animalia	Chordata	Actinopterygii	Salmoniformes	Salmonidae	Salmo
CC-BY		*Salmo trutta*	Brown/Sea Trout	2000	Biological Records Centre	Biological Records Centre	Animalia	Chordata	Actinopterygii	Salmoniformes	Salmonidae	Salmo
CC-BY		*Vanellus vanellus*	Lapwing	2005	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Charadriiformes	Charadriidae	Vanellus
CC-BY		*Gallinago gallinago*	Snipe	2006	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Charadriiformes	Scolopacidae	Gallinago
CC-BY		*Tringa totanus*	Redshank	2006	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Charadriiformes	Scolopacidae	Tringa
CC-BY		*Numenius arquata*	Curlew	2006	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Charadriiformes	Scolopacidae	Numenius
CC-BY		*Haliaeetus albicilla*	White-tailed Eagle	1983	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Falconiformes	Accipitridae	Haliaeetus
CC-BY		*Gavia stellata*	Red-throated Diver	1994	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Gaviiformes	Gaviidae	Gavia
CC-BY		*Crex crex*	Corncrake	2004	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Gruiformes	Rallidae	Crex
CC-BY		*Linaria flavirostris*	Twite	2006	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Passeriformes	Fringillidae	Linaria
CC-BY		*Phoca vitulina*	Harbour Seal	1970	Biological Records Centre	Biological Records Centre	Animalia	Chordata	Mammalia	Carnivora	Phocidae	Phoca
CC-BY		*Halichoerus grypus*	Grey Seal	1970	Biological Records Centre	Biological Records Centre	Animalia	Chordata	Mammalia	Carnivora	Phocidae	Halichoerus
OGL		*Mytilus edulis*	Blue Mussel	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Animalia	Mollusca	Bivalvia	Mytiloida	Mytilidae	Mytilus
OGL		*Littorina saxatilis/arcana*	Rough Periwinkle	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Animalia	Mollusca	Gastropoda	Littorinimorpha	Littorinidae	Littorina
OGL		*Nucella lapillus*	Dog Whelk	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Animalia	Mollusca	Gastropoda	Neogastropoda	Muricidae	Nucella
OGL		*Patella vulgata*	Common Limpet	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Animalia	Mollusca	Gastropoda		Patellidae	Patella
OGL		*Himanthalia elongata*	Thongweed	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Chromista	Ochrophyta	Phaeophyceae	Fucales	Himanthaliaceae	Himanthalia
OGL		*Alaria esculenta*	Dabberlocks	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Chromista	Ochrophyta	Phaeophyceae	Laminariales	Alariaceae	Alaria
OGL		*Laminaria digitata*	Oarweed	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Chromista	Ochrophyta	Phaeophyceae	Laminariales	Laminariaceae	Laminaria
CC-BY		*Arthonia radiata*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Arthoniomycetes	Arthoniales	Arthoniaceae	Arthonia
CC-BY		*Acrocordia macrospora*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Dothideomycetes	Monoblastiales	Monoblastiaceae	Acrocordia
CC-BY		*Collemopsidium foveolatum*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Dothideomycetes	Pyrenulales	Xanthopyreniaceae	Collemopsidium
CC-BY		*Verrucaria mucosa*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Eurotiomycetes	Verrucariales	Verrucariaceae	Verrucaria
CC-BY		*Verrucaria viridula*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Eurotiomycetes	Verrucariales	Verrucariaceae	Verrucaria
CC-BY		*Verrucaria hochstetteri*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Eurotiomycetes	Verrucariales	Verrucariaceae	Verrucaria
CC-BY		*Verrucaria muralis*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Eurotiomycetes	Verrucariales	Verrucariaceae	Verrucaria
CC-BY		*Verrucaria striatula*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Eurotiomycetes	Verrucariales	Verrucariaceae	Verrucaria
OGL		*Verrucaria*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Fungi	Ascomycota	Eurotiomycetes	Verrucariales	Verrucariaceae	Verrucaria
CC-BY		*Polysporina simplex*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Acarosporales	Acarosporaceae	Polysporina
CC-BY		*Myriospora scabrida*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Acarosporales	Acarosporaceae	Myriospora
CC-BY		*Placynthiella uliginosa*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Baeomycetales	Trapeliaceae	Placynthiella
CC-BY		*Trapeliopsis granulosa*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Baeomycetales	Trapeliaceae	Trapeliopsis
CC-BY		*Candelariella aurella f. aurella*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Candelariales	Candelariaceae	Candelariella
CC-BY		*Candelariella vitellina f. vitellina*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Candelariales	Candelariaceae	Candelariella
CC-BY		*Cladonia diversa*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia cervicornis*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia coccifera s. lat.*	Scarlet-Cup Lichen	1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia firma*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia ramulosa*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia furcata subsp. furcata*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia verticillata*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia chlorophaea s. lat.*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia pocillum*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Myriolecis albescens*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Lecanoraceae	Myriolecis
CC-BY		*Myriolecis dispersa*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Lecanoraceae	Myriolecis
CC-BY		*Lecidella elaeochroma f. elaeochroma*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Lecanoraceae	Lecidella
CC-BY		*Lecanora campestris subsp. campestris*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Lecanoraceae	Lecanora
CC-BY		*Myriolecis actophila*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Lecanoraceae	Myriolecis
CC-BY		*Myriolecis zosterae*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Lecanoraceae	Myriolecis
CC-BY		*Megalaria grossa*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Megalariaceae	Megalaria
CC-BY		*Tephromela atra var. atra*	Black Shields	2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Mycoblastaceae	Tephromela
CC-BY		*Hypogymnia tubulosa*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Parmeliaceae	Hypogymnia
CC-BY		*Parmelia saxatilis s. lat.*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Parmeliaceae	Parmelia
CC-BY		*Melanelixia fuliginosa*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Parmeliaceae	Melanelixia
CC-BY		*Platismatia glauca*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Parmeliaceae	Platismatia
CC-BY		*Pseudevernia furfuracea s. lat.*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Parmeliaceae	Pseudevernia
CC-BY		*Tuckermannopsis chlorophylla*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Parmeliaceae	Tuckermannopsis
CC-BY		*Bryoria fuscescens*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Parmeliaceae	Bryoria
CC-BY		*Micarea lignaria var. lignaria*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Pilocarpaceae	Micarea
CC-BY		*Protoblastenia rupestris*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Psoraceae	Protoblastenia
CC-BY		*Lecania erysibe s. lat.*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Ramalinaceae	Lecania

CC-BY		*Scoliciosporum umbrinum*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Scoliciosporaceae	Scoliciosporum
CC-BY		*Lepraria finkii*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Stereocaulaceae	Lepraria
CC-BY		*Lepraria incana s. lat.*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Stereocaulaceae	Lepraria
CC-BY		*Porpidia speirea*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecideales	Lecideaceae	Porpidia
CC-BY		*Lecidea berengeriana*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecideales	Lecideaceae	Lecidea
CC-BY		*Clauzadea monticola*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecideales	Lecideaceae	Clauzadea
CC-BY		*Porpidia crustulata*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecideales	Lecideaceae	Porpidia
CC-BY		*Gyalecta foveolaris*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Ostropales	Gyalectaceae	Gyalecta
CC-BY		*Porina multipuncta*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Ostropales	Porinaceae	Porina
CC-BY		*Collema crispum var. crispum*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Collemataceae	Collema
CC-BY		*Collema furfuraceum*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Collemataceae	Collema
CC-BY		*Leptogium lichenoides*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Collemataceae	Leptogium
CC-BY		*Leptogium teretiusculum*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Collemataceae	Leptogium
CC-BY		*Collema tenax var. tenax*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Collemataceae	Collema
CC-BY		*Leptogium pulvinatum*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Collemataceae	Leptogium
CC-BY		*Pectenia plumbea s. lat.*	Bladder Stalks	1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Pannariaceae	Pectenia
CC-BY		*Peltigera rufescens*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Peltigeraceae	Peltigera
CC-BY		*Vahliella atlantica*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Vahliellaceae	Vahliella
CC-BY		*Aspicilia contorta subsp. contorta*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Pertusariales	Megasporaceae	Aspicilia
CC-BY		*Varicellaria lactea*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Pertusariales	Ochrolechiaceae	Varicellaria
CC-BY		*Ochrolechia tartarea*	Cudbear	1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Pertusariales	Ochrolechiaceae	Ochrolechia
CC-BY		*Ochrolechia androgyna*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Pertusariales	Ochrolechiaceae	Ochrolechia
CC-BY		*Ochrolechia frigida f. frigida*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Pertusariales	Ochrolechiaceae	Ochrolechia
CC-BY		*Pertusaria pseudocorallina*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Pertusariales	Pertusariaceae	Pertusaria
CC-BY		*Catillaria chalybeia var. chalybeia*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Rhizocarpales	Catillariaceae	Catillaria
CC-BY		*Rhizocarpon reductum*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Rhizocarpales	Rhizocarpaceae	Rhizocarpon
CC-BY		*Buellia stellulata*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Caliciaceae	Buellia
CC-BY		*Physcia adscendens*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Physciaceae	Physcia
CC-BY		*Caloplaca dichroa*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Caloplaca
CC-BY		*Caloplaca oasis*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Caloplaca
CC-BY		*Xanthoria ucrainica*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Xanthoria
CC-BY		*Caloplaca limonia*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Caloplaca
CC-BY		*Caloplaca holocarpa s. str.*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Caloplaca
CC-BY		*Xanthoria candelaria s. str.*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Xanthoria
CC-BY		*Caloplaca sorediella*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Caloplaca
OGL		*Caloplaca*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Caloplaca
CC-BY		*Fuscidea lygaea*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes		Fuscideaceae	Fuscidea
CC-BY	Highland Biological Recording Group	*Puccinia urticata*	Cawod Goch Danadl	2014	Highland Biological Recording Group	HBRG	Fungi	Basidiomycota	Pucciniomycetes	Pucciniales	Pucciniaceae	Puccinia
CC-BY	British Bryological Society	*Archidium alternifolium*	Clay Earth-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Archidiales	Archidiaceae	Archidium
CC-BY	British Bryological Society	*Breutelia chrysocoma*	Golden-head Moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Bartramiaceae	Breutelia
CC-BY	British Bryological Society	*Philonotis fontana*	Fountain Apple-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Bartramiaceae	Philonotis
CC-BY	British Bryological Society	*Bryum dichotomum*		2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Bryaceae	Bryum
CC-BY	British Bryological Society	*Anomobryum julaceum*			British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Bryaceae	Anomobryum
CC-BY	British Bryological Society	*Bryum pallens*	Pale Thread-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Bryaceae	Bryum
CC-BY	British Bryological Society	*Bryum argenteum*	Silver-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Bryaceae	Bryum
CC-BY	British Bryological Society	*Bryum alpinum*	Alpine Thread-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Bryaceae	Bryum
CC-BY	British Bryological Society	*Pohlia camptotrachela*	Crookneck Nodding-moss	1969	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Mielichhoferiaceae	Pohlia
CC-BY	British Bryological Society	*Pohlia nutans*	Nodding Thread-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Mielichhoferiaceae	Pohlia
CC-BY	British Bryological Society	*Pohlia annotina*	Pale-fruited Thread-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Mielichhoferiaceae	Pohlia
CC-BY	British Bryological Society	*Dicranum elongatum*	Dense Fork-moss	1907	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Dicranaceae	Dicranum
CC-BY	British Bryological Society	*Dicranella heteromalla*	Silky Forklet-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Dicranaceae	Dicranella
CC-BY	British Bryological Society	*Dicranella subulata*	Awl-leaved Forklet-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Dicranaceae	Dicranella
CC-BY	British Bryological Society	*Distichium capillaceum*	Fine Distichium		British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Ditrichaceae	Distichium
CC-BY	British Bryological Society	*Pseudephemerum nitidum*	Delicate Earth-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Ditrichaceae	Pseudephemerum
CC-BY	British Bryological Society	*Ceratodon purpureus*	Redshank	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Ditrichaceae	Ceratodon
CC-BY	British Bryological Society	*Fissidens osmundoides*	Purple-stalked Pocket-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Fissidentaceae	Fissidens
CC-BY	British Bryological Society	*Fissidens adianthoides*	Maidenhair Pocket-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Fissidentaceae	Fissidens
CC-BY	British Bryological Society	*Campylopus schimperi*	Schimper's Swan-neck Moss	1878	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Leucobryaceae	Campylopus
CC-BY	British Bryological Society	*Campylopus brevipilus*	Compact Swan-neck Moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Leucobryaceae	Campylopus
CC-BY	British Bryological Society	*Campylopus fragilis*	Brittle Swan-neck Moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Leucobryaceae	Campylopus
CC-BY	British Bryological Society	*Leucobryum glaucum*	Large White-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Leucobryaceae	Leucobryum
CC-BY	British Bryological Society	*Campylopus pyriformis*	Dwarf Swan-neck Moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Leucobryaceae	Campylopus
CC-BY	British Bryological Society	*Campylopus flexuosus*	Rusty Swan-neck Moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Leucobryaceae	Campylopus
CC-BY	British Bryological Society	*Dichodontium pellucidum*		1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Rhabdoweisiaceae	Dichodontium
CC-BY	British Bryological Society	*Dichodontium palustre*	Marsh Forklet-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Rhabdoweisiaceae	Dichodontium
CC-BY	British Bryological Society	*Entosthodon obtusus*	Blunt Cord-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Funariales	Funariaceae	Entosthodon
CC-BY	British Bryological Society	*Racomitrium fasciculare*	Green Mountain Fringe-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Grimmiales	Grimmiaceae	Racomitrium
CC-BY	British Bryological Society	*Racomitrium canescens*		1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Grimmiales	Grimmiaceae	Racomitrium
CC-BY	British Bryological Society	*Racomitrium aciculare*	Yellow Fringe-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Grimmiales	Grimmiaceae	Racomitrium
CC-BY	British Bryological Society	*Grimmia pulvinata*	Grey-cushioned Grimmia	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Grimmiales	Grimmiaceae	Grimmia
CC-BY	British Bryological Society	*Schistidium apocarpum*		1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Grimmiales	Grimmiaceae	Schistidium
CC-BY	British Bryological Society	*Hookeria lucens*	Shining Hookeria	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hookeriales	Hookeriaceae	Hookeria
CC-BY	British Bryological Society	*Campylium stellatum*		1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Amblystegiaceae	Campylium
CC-BY	British Bryological Society	*Hygrohypnum ochraceum*	Claw Brook-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Amblystegiaceae	Hygrohypnum
CC-BY	British Bryological Society	*Kindbergia praelonga*	Common Feather-moss	2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Brachytheciaceae	Kindbergia
CC-BY	British Bryological Society	*Brachythecium albicans*	Whitish Feather-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Brachytheciaceae	Brachythecium
CC-BY	British Bryological Society	*Pseudoscleropodium purum*	Neat Feather-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Brachytheciaceae	Pseudoscleropodium
CC-BY	British Bryological Society	*Scorpidium cossonii*	Intermediate Hook-moss	2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Calliergonaceae	Scorpidium
CC-BY	British Bryological Society	*Sarmentypnum exannulatum*	Ringless Hook-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Calliergonaceae	Sarmentypnum
CC-BY	British Bryological Society	*Calliergon cordifolium*	Heart-leaved Spear-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Calliergonaceae	Calliergon
CC-BY	British Bryological Society	*Scorpidium scorpioides*	Hooked Scorpion-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Calliergonaceae	Scorpidium
CC-BY	British Bryological Society	*Warnstorfia fluitans*	Floating Hook-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Calliergonaceae	Warnstorfia
CC-BY	British Bryological Society	*Scorpidium revolvens*	Rusty Hook-moss	2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Calliergonaceae	Scorpidium
CC-BY	British Bryological Society	*Fontinalis antipyretica*	Greater Water-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Fontinalaceae	Fontinalis
CC-BY	British Bryological Society	*Rhytidiadelphus triquetrus*	Big Shaggy-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Hylocomiaceae	Rhytidiadelphus
CC-BY	British Bryological Society	*Pleurozium schreberi*	Red-stemmed Feather-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Hylocomiaceae	Pleurozium
CC-BY	British Bryological Society	*Calliergonella cuspidata*	Pointed Spear-moss	1996	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Hypnaceae	Calliergonella
CC-BY	British Bryological Society	*Hypnum cupressiforme var. resupinatum*	Supine Plait-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Hypnaceae	Hypnum
CC-BY	British Bryological Society	*Hypnum cupressiforme var. lacunosum*	Great Plait-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Hypnaceae	Hypnum
CC-BY	British Bryological Society	*Ctenidium molluscum*	Chalk Comb-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Hypnaceae	Ctenidium
CC-BY	British Bryological Society	*Isothecium myosuroides*	Slender Mouse-tail Moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Lembophyllaceae	Isothecium
CC-BY	British Bryological Society	*Antitrichia curtipendula*	Pendulous Wing-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Leucodontaceae	Antitrichia
CC-BY	British Bryological Society	*Thamnobryum alopecurum*	Fox-tail Feather-moss	1907	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Neckeraceae	Thamnobryum
CC-BY	British Bryological Society	*Plagiothecium undulatum*	Waved Silk-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Plagiotheciaceae	Plagiothecium
CC-BY	British Bryological Society	*Thuidium tamariscinum*	Common Tamarisk-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Thuidiaceae	Thuidium
CC-BY	British Bryological Society	*Ulota phyllantha*	Frizzled Pincushion	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Orthotrichales	Orthotrichaceae	Ulota

CC-BY	British Bryological Society	*Zygodon viridissimus var. viridissimus*		1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Orthotrichales	Orthotrichaceae	Zygodon
CC-BY	British Bryological Society	*Didymodon rigidulus*	Rigid Beard-moss	2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Didymodon
CC-BY	British Bryological Society	*Pseudocrossidium hornschuchianum*	Hornschuch's Beard-moss	2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Pseudocrossidium
CC-BY	British Bryological Society	*Barbula convoluta*		2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Barbula
CC-BY	British Bryological Society	*Didymodon insulanus*	Cylindric Beard-moss	2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Didymodon
CC-BY	British Bryological Society	*Didymodon fallax*	Fallacious Beard-moss	2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Didymodon
CC-BY	British Bryological Society	*Hymenostylium recurvirostrum*	Hook-beak Tufa-moss		British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Hymenostylium
CC-BY	British Bryological Society	*Tortula subulata*	Awl-leaved Screw-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Tortula
CC-BY	British Bryological Society	*Tortella tortuosa*	Frizzled Crisp-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Tortella
CC-BY	British Bryological Society	*Didymodon tophaceus*	Olive Beard-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Didymodon
CC-BY	British Bryological Society	*Trichostomum brachydontium*	Variable Crisp-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Trichostomum
CC-BY	British Bryological Society	*Bryoerythrophyllum recurvirostrum*	Red Beard-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Bryoerythrophyllum
CC-BY	British Bryological Society	*Weissia brachycarpa*	Small-mouthed Beardless-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Weissia
CC-BY	British Bryological Society	*Oligotrichum hercynicum*	Hercynian Haircap	1974	British Bryological Society	BBS	Plantae	Bryophyta	Polytrichopsida	Polytrichales	Polytrichaceae	Oligotrichum
CC-BY	British Bryological Society	*Pogonatum aloides*	Aloe Haircap	1974	British Bryological Society	BBS	Plantae	Bryophyta	Polytrichopsida	Polytrichales	Polytrichaceae	Pogonatum
CC-BY	British Bryological Society	*Pogonatum urnigerum*	Urn Haircap	1974	British Bryological Society	BBS	Plantae	Bryophyta	Polytrichopsida	Polytrichales	Polytrichaceae	Pogonatum
CC-BY	British Bryological Society	*Polytrichastrum alpinum*	Alpine Haircap	1974	British Bryological Society	BBS	Plantae	Bryophyta	Polytrichopsida	Polytrichales	Polytrichaceae	Polytrichastrum
CC-BY	British Bryological Society	*Polytrichum piliferum*	Bristly Haircap	1974	British Bryological Society	BBS	Plantae	Bryophyta	Polytrichopsida	Polytrichales	Polytrichaceae	Polytrichum
CC-BY	British Bryological Society	*Polytrichum strictum*	Strict Haircap	1974	British Bryological Society	BBS	Plantae	Bryophyta	Polytrichopsida	Polytrichales	Polytrichaceae	Polytrichum
CC-BY	British Bryological Society	*Sphagnum teres*	Rigid Bog-moss		British Bryological Society	BBS	Plantae	Bryophyta	Sphagnopsida	Sphagnales	Sphagnaceae	Sphagnum
CC-BY	British Bryological Society	*Sphagnum fimbriatum*	Fringed Bog-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Sphagnopsida	Sphagnales	Sphagnaceae	Sphagnum
CC-BY	British Bryological Society	*Sphagnum denticulatum*	Cow-horn Bog-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Sphagnopsida	Sphagnales	Sphagnaceae	Sphagnum
CC-BY	British Bryological Society	*Sphagnum recurvum*		1974	British Bryological Society	BBS	Plantae	Bryophyta	Sphagnopsida	Sphagnales	Sphagnaceae	Sphagnum
OGL		*Cladophora*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Chlorophyta	Ulvophyceae	Cladophorales	Cladophoraceae	Cladophora
OGL		*Enteromorpha*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Chlorophyta	Ulvophyceae	Ulvales	Ulvaceae	Enteromorpha
CC-BY	British Bryological Society	*Fossombronia incurva*	Weedy Frillwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Fossombroniales	Fossombroniaceae	Fossombronia
CC-BY	British Bryological Society	*Calypogeia sphagnicola*	Bog Pouchwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Calypogeiaceae	Calypogeia
CC-BY	British Bryological Society	*Hygrobiella laxifolia*	Lax Notchwort		British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Cephaloziaceae	Hygrobiella
CC-BY	British Bryological Society	*Cephalozia loitlesbergeri*	Scissors Pincerwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Cephaloziaceae	Cephalozia
CC-BY	British Bryological Society	*Harpanthus flotovianus*	Great Mountain Flapwort		British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Geocalycaceae	Harpanthus
CC-BY	British Bryological Society	*Harpanthus scutatus*	Stipular Flapwort	1878	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Geocalycaceae	Harpanthus
CC-BY	British Bryological Society	*Saccogyna viticulosa*	Straggling Pouchwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Geocalycaceae	Saccogyna
CC-BY	British Bryological Society	*Marsupella emarginata*	Notched Rustwort	1878	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Gymnomitriaceae	Marsupella
CC-BY	British Bryological Society	*Marsupella emarginata var. emarginata*		1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Gymnomitriaceae	Marsupella
CC-BY	British Bryological Society	*Herbertus stramineus*	Straw Prongwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Herbertaceae	Herbertus
CC-BY	British Bryological Society	*Nardia scalaris*	Ladder Flapwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Jungermanniaceae	Nardia
CC-BY	British Bryological Society	*Solenostoma paroicum*	Round-fruited Flapwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Jungermanniaceae	Solenostoma
CC-BY	British Bryological Society	*Solenostoma gracillimum*	Crenulated Flapwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Jungermanniaceae	Solenostoma
CC-BY	British Bryological Society	*Kurzia pauciflora*	Bristly Fingerwort		British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Lepidoziaceae	Kurzia
CC-BY	British Bryological Society	*Bazzania tricrenata*	Lesser Whipwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Lepidoziaceae	Bazzania
CC-BY	British Bryological Society	*Chiloscyphus pallescens*	St Winifrid's Other Moss		British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Lophocoleaceae	Chiloscyphus
CC-BY	British Bryological Society	*Mylia taylorii*	Taylor's Flapwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Myliaceae	Mylia
CC-BY	British Bryological Society	*Plagiochila punctata*	Spotty Featherwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Plagiochilaceae	Plagiochila
CC-BY	British Bryological Society	*Plagiochila porelloides*	Lesser Featherwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Plagiochilaceae	Plagiochila
CC-BY	British Bryological Society	*Lophozia sudetica*	Hill Notchwort	1907	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Scapaniaceae	Lophozia
CC-BY	British Bryological Society	*Diplophyllum obtusifolium*	Blunt-leaved Earwort	1843	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Scapaniaceae	Diplophyllum
CC-BY	British Bryological Society	*Gymnocolea inflata*	Inflated Notchwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Scapaniaceae	Gymnocolea
CC-BY	British Bryological Society	*Scapania scandica*	Norwegian Earwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Scapaniaceae	Scapania
CC-BY	British Bryological Society	*Scapania irrigua*	Heath Earwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Scapaniaceae	Scapania
CC-BY	British Bryological Society	*Tritomaria quinquedentata*	Lyon's Notchwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Scapaniaceae	Tritomaria
CC-BY	British Bryological Society	*Scapania degenii*	Degen's Earwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Scapaniaceae	Scapania
CC-BY	British Bryological Society	*Riccardia multifida*	Delicate Germanderwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Metzgeriales	Aneuraceae	Riccardia
CC-BY	British Bryological Society	*Metzgeria furcata*	Forked Veilwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Metzgeriales	Metzgeriaceae	Metzgeria
CC-BY	British Bryological Society	*Pellia endiviifolia*	Endive Pellia	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Pelliales	Pelliaceae	Pellia
CC-BY	British Bryological Society	*Frullania teneriffae*	Sea Scalewort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Porellales	Frullaniaceae	Frullania
CC-BY	British Bryological Society	*Frullania tamarisci*	Tamarisk Scalewort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Porellales	Frullaniaceae	Frullania
CC-BY	British Bryological Society	*Frullania dilatata*	Dilated Scalewort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Porellales	Frullaniaceae	Frullania
CC-BY	British Bryological Society	*Lejeunea patens*	Pearl Pouncewort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Porellales	Lejeuneaceae	Lejeunea
CC-BY	British Bryological Society	*Radula complanata*	Even Scalewort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Porellales	Radulaceae	Radula
CC-BY	British Bryological Society	*Blasia pusilla*	Common Kettlewort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Marchantiopsida	Blasiales	Blasiaceae	Blasia
CC-BY	British Bryological Society	*Marchantia polymorpha subsp. montivagans*		1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Marchantiopsida	Marchantiales	Marchantiaceae	Marchantia
CC-BY	British Bryological Society	*Marchantia polymorpha*	Common Liverwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Marchantiopsida	Marchantiales	Marchantiaceae	Marchantia
OGL		*Porphyra*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta	Bangiophyceae	Bangiales	Bangiaceae	Porphyra
OGL		*Ceramium*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta	Florideophyceae	Ceramiales	Ceramiaceae	Ceramium
OGL		*Membranoptera alata*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta	Florideophyceae	Ceramiales	Delesseriaceae	Membranoptera
OGL		*Corallina officinalis*	Coral Weed	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta	Florideophyceae	Corallinales	Corallinaceae	Corallina
OGL		*Lithothamnion*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta	Florideophyceae	Corallinales	Hapalidiaceae	Lithothamnion
OGL		*Mastocarpus stellatus*	False Irish Moss	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta	Florideophyceae	Gigartinales	Phyllophoraceae	Mastocarpus
OGL		*Rhodymenia*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta	Florideophyceae	Rhodymeniales	Rhodymeniaceae	Rhodymenia
OGL		*Rhodophyta*	Dark red crusts	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta				
CC0	BSBI	*Aegopodium podagraria*	Ground-elder	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Apiales	Apiaceae	Aegopodium
CC0	BSBI	*Allium moly*	Yellow Garlic	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Asparagales	Amaryllidaceae	Allium
CC0	BSBI	*Crocosmia paniculata*	Aunt-Eliza	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Asparagales	Iridaceae	Crocosmia
CC0	BSBI	*Kniphofia uvaria*	Red-hot-poker	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Asparagales	Xanthorrhoeaceae	Kniphofia
CC0	BSBI	*Artemisia abrotanum*	Southernwood	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Asterales	Asteraceae	Artemisia
CC0	BSBI	*Calendula officinalis*	Pot Marigold	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Asterales	Asteraceae	Calendula
CC0	BSBI	*Aster novi-belgii x lanceolatus = A. x salignus*	Common Michaelmas-daisy	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Asterales	Asteraceae	Aster
CC0	BSBI	*Hesperis matronalis*	Dame's-violet	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Brassicales	Brassicaceae	Hesperis
CC0	BSBI	*Sambucus nigra*	Elder	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Dipsacales	Adoxaceae	Sambucus
CC0	BSBI	*Symphoricarpos albus*	Snowberry	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Dipsacales	Caprifoliaceae	Symphoricarpos
CC0	BSBI	*Lonicera periclymenum*	Honeysuckle	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Dipsacales	Caprifoliaceae	Lonicera
CC0	BSBI	*Lysimachia punctata*	Dotted Loosestrife	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Ericales	Primulaceae	Lysimachia
CC0	BSBI	*Lupinus arboreus x polyphyllus = L. x regalis*	Russell Lupin	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Fabales	Fabaceae	Lupinus
CC0	BSBI	*Alnus viridis*	Green Alder	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Fagales	Betulaceae	Alnus
CC0	BSBI	*Geranium pratense*	Meadow Crane's-bill	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Geraniales	Geraniaceae	Geranium
CC0	BSBI	*Salix hookeriana*		2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Malpighiales	Salicaceae	Salix
CC0	BSBI	*Sidalcea*		2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Malvales	Malvaceae	Sidalcea
CC0	BSBI	*Chamerion angustifolium*	Rosebay Willowherb	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Myrtales	Onagraceae	Chamerion
CC0	BSBI	*Fuchsia magellanica*	Ffiwsia	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Myrtales	Onagraceae	Fuchsia
CC0	BSBI	*Meconopsis cambrica*	Welsh Poppy	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Ranunculales	Papaveraceae	Meconopsis
CC0	BSBI	*Papaver pseudoorientale*	Oriental Poppy	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Ranunculales	Papaveraceae	Papaver
CC0	BSBI	*Thalictrum minus*	Lesser Meadow-rue	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Ranunculales	Ranunculaceae	Thalictrum
CC0	BSBI	*Geum*		2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Rosales	Rosaceae	Geum
CC0	BSBI	*Sedum spectabile*	Butterfly Stonecrop	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Saxifragales	Crassulaceae	Sedum
CC0	BSBI	*Paeonia officinalis*	Garden Peony	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Saxifragales	Paeoniaceae	Paeonia
CC0	BSBI	*Saxifraga umbrosa x spathularis = S. x urbium*	Londonpride	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Saxifragales	Saxifragaceae	Saxifraga

Appendix 6.2 Phase 1 Habitat, NVC and Potential GWDTE Survey Report

Phase 1 Habitat, National Vegetation Classification and Groundwater Dependent Terrestrial Ecosystems Survey Report for the Shetland Space Centre, Unst



August 2020, updated December 2020

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Summary

A proposal for a space centre has been made by the Applicant in north Unst, Shetland. As part of this proposal, Alba Ecology Ltd. was commissioned to survey and map the habitats and plant communities within the boundary of the proposed development plus appropriate buffer zones. The proposal comprises of work in three discrete areas: (i) a Satellite Launch Facility at Lamba Ness, (ii) Saxa Vord Resort, and (iii) a new road at Northdale. This report considers all three of these Study Areas.

Field survey work was undertaken in July 2018 and updated in July 2020. Fieldwork included an extended Phase 1 Habitat survey, a National Vegetation Classification (NVC) survey and an assessment of wetland habitats. Habitats and community types were described and mapped, species lists were compiled and target notes made. From this, an assessment of potential Groundwater Dependent Terrestrial Ecosystems (GWDTE) was made and is reported on.

The Satellite Launch Facility Study Area held a variety of habitats and communities, the most common of which were wet modified bog, wet modified bog/wet heath and coastal grassland. Appendix 7.2 Drawing 2 displays all the Phase 1 Habitats found in the Satellite Launch Facility Study Area and Table 3 lists the Phase 1 Habitats and the total area of each habitat mapped. Appendix 7.2 Drawing 3 displays the NVC communities that were described and mapped in the Study Area.

The wet modified bog, wet modified bog/wet heath, dry dwarf shrub heath, blanket bog, sand dune, coastal grassland, acid flush and some water margin vegetation habitats were evaluated as approaching or being equivalent to the descriptions of the Scottish Biodiversity List (SBL) habitats and/or Annex 1 habitat descriptions. The sand dunes and a water margin habitat were assessed as being of regional importance. The other habitats were evaluated as being of local importance due to a combination of factors including condition, size and the widespread nature of the habitat types in Shetland. Several habitats, including wet modified bog and neutral grassland, were assessed as being potentially moderately groundwater dependent. The acid flush habitat (NVC community M6) was assessed as being a potentially highly GWDTE.

The Saxa Vord Study Area held a small number of habitats and communities, all of which are common in and around built-up areas and agricultural land. These included frequently mown amenity grassland, improved grassland, buildings and roads and small patches of neutral grassland. None of these habitats were considered to have particular ecological importance or sensitivities. Japanese knotweed, a non-native invasive species, is known to be present on Unst, including a patch near the Saxa Vord Study Area, and so a watching brief should be kept for this species.

The Northdale Road Study Area held a small number of habitats, which were considered to be typical of Shetland. These included dry dwarf shrub heath, acid grassland, improved grassland and small patches of neutral grassland mapped as a mosaic with the acid grassland and improved grassland. The dry dwarf shrub heath was evaluated as being of local importance.

The very small amount of MG9 and MG10 grassland in the Northdale Road Study Area and the MG10 grassland in the Saxa Vord Study Area was assessed as being potentially moderately groundwater dependent. It was assessed as being potentially hydrologically connected to the nationally important, designated wetland habitats in Norwick Meadows SSSI. Care should be taken to ensure there are no direct or indirect impacts on the potentially sensitive habitats and the adjacent designated site.

Introduction

A proposal for a space centre has been made by the Applicant in north Unst, Shetland. As part of this proposal, Alba Ecology Ltd. was commissioned to survey and map the habitats and plant communities within the boundary of the proposed development plus appropriate buffer zones which together form the Study Area. Alba Ecology Ltd. was commissioned by the developer to conduct a Phase 1 Habitat and National Vegetation Classification (NVC) survey and to report on Groundwater Dependent Terrestrial Ecosystems (GWDTE). The proposal comprises of work in three discrete areas: (i) a Satellite Launch Facility at Lamba Ness, (ii) Saxa Vord Resort, and (iii) a new road at Northdale. This report considers all three of these areas.

This document reports the findings of the Phase 1 Habitat and NVC survey and GWDTE assessment of the three Study Areas that was undertaken by Alba Ecology Ltd. in July 2018 and updated in July 2020.

Aims and Objectives

The objectives for this survey and report are:

- To identify, map and describe Phase 1 Habitats and NVC communities in the three Study Areas;
- To identify any particularly important habitats and species in the three Study Areas;
- To identify if any wetland habitats present are potential GWDTEs; and
- To evaluate the vegetation identified, with an appraisal of implications for the proposed Shetland Space Centre according to Ecological Impact Assessment (EcIA) guidelines (CIEEM, 2018).

Study Area

The proposal comprises of work in three discrete Study Areas: the Satellite Launch Facility Study Area, Saxa Vord Study Area and the Northdale Road Study Area (Appendix 7.2 Drawings 1 and 2).

Satellite Launch Facility Study Area

The centre of the Satellite Launch Facility Study Area is situated at approximate OS Grid reference HP660155, north to the village of Norwick in northeast Unst (Appendix 7.2 Drawing 1). The Satellite Launch Facility Study Area comprised of the proposed Application Boundary, plus a 250m buffer. It extended from the eastward tip of Lamba Ness, to west of the road at Swartling. This gives an area of 137ha (1.37km^2). A location map can be seen in Appendix 7.2 Drawing 1 with this Satellite Launch Facility Study Area indicated with a red outline.

The Satellite Launch Facility Study Area includes the sea cliffs of Lamba Ness with maritime grassland habitats. Further to the west the habitats transition into more upland heath and blanket bog habitats. Current and historic land uses were evident across the Satellite Launch Facility Study Area. There are a series of old, derelict, military buildings, roads and foundations

from World War II. Currently the area is grazed by sheep and has a series of artificial drainage ditches on it.

Saxa Vord Study Area

The centre of the Saxa Vord Study Area is situated at approximate OS Grid reference HP643134, at the Saxa Vord Resort, south of the village of Norwick in northeast Unst (Appendix 7.2 Drawing 2).

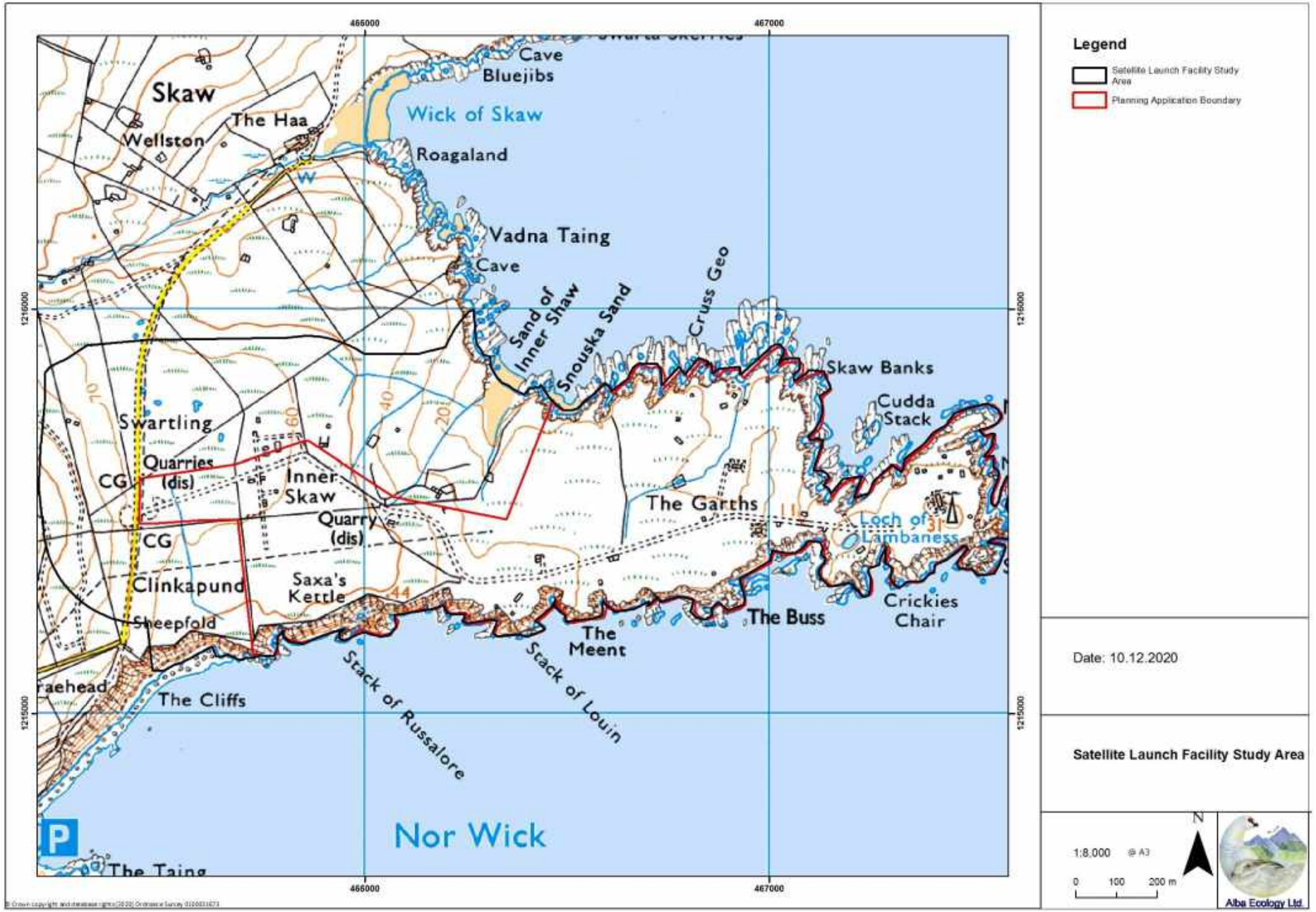
The Saxa Vord Study Area comprised of the proposed Application Boundary, plus a 100m buffer. Due to changes in design iteration in late 2020 the Application Boundary included an additional location at the current distillery, this was given a 100m buffer and had been surveyed in July 2018. This gives an area of 17.4ha (0.17km^2). A location map can be seen in Appendix 7.2 Drawing 2 with this Saxa Vord Study Area indicated with a pink outline.

The term 'Saxa Vord Resort' is used in this report to describe the buildings at the centre of the Saxa Vord Study Area including the restaurant, youth hostel and other accommodation. The Saxa Vord Study Area also includes the distillery building, roads, amenity grassland and sheep grazed fields.

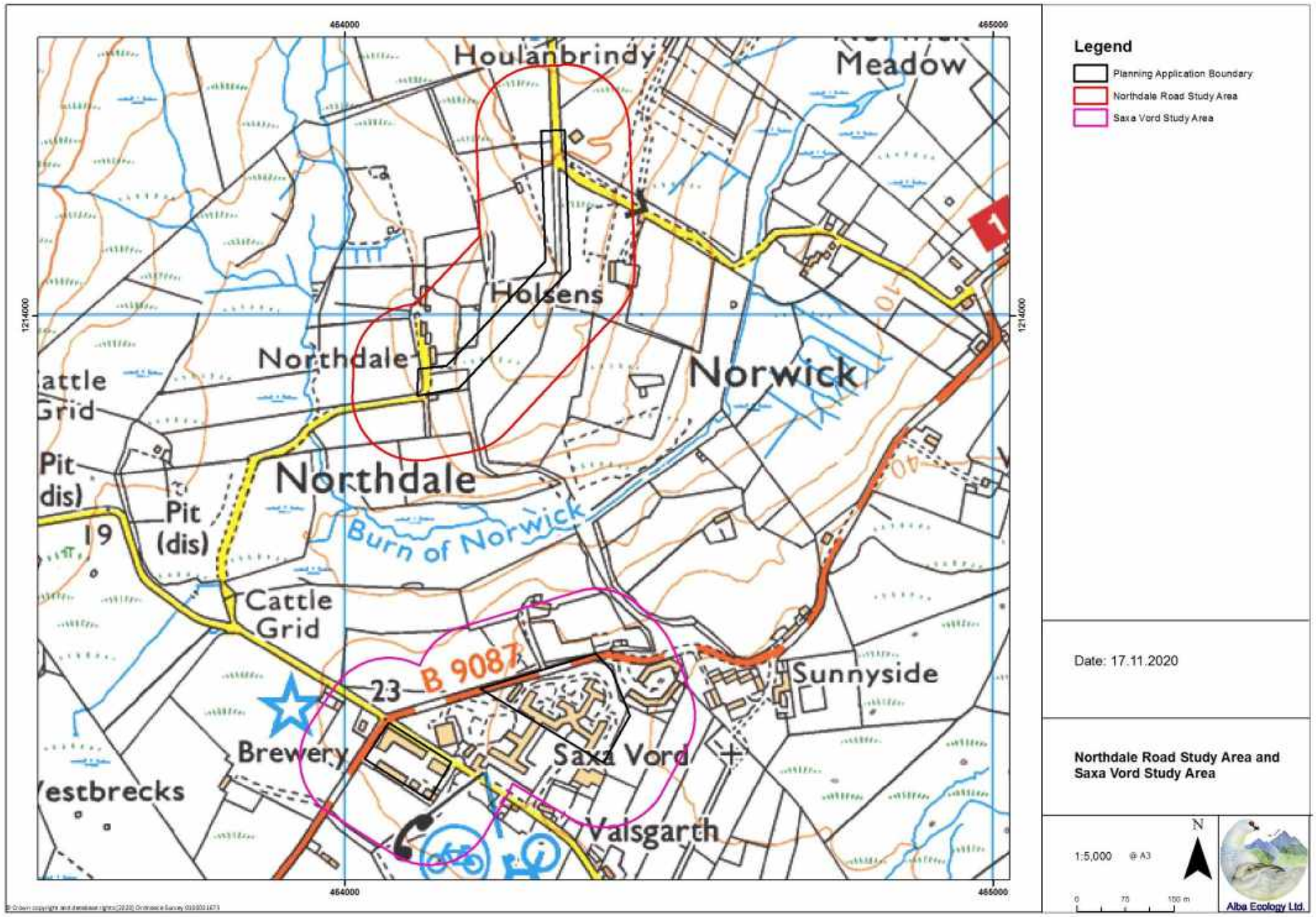
Northdale Road Study Area

A short section of connecting road is required between Northdale and Houlanbrindy. This Northdale Road Study Area is situated at approximate OS Grid reference HP643140, west of the village of Norwick in northeast Unst (Appendix 7.2 Drawing 2). The Northdale Road Study Area was comprised of the proposed Application Boundary, plus a 100m buffer which gives an area of 16.0ha (0.16km^2). A location map can be seen in Appendix 7.2 Drawing 2 with this Northdale Road Study Area indicated with a purple outline.

The Northdale Road Study Area includes sections of roads at Northdale and Houlanbrindy and the surrounding vegetation which was mostly sheep grazed grassland and dry dwarf shrub heath.



Appendix 7.2 Drawing 1: Satellite Launch Facility Study Area



Appendix 7.2 Drawing 2: Saxa Vord Study Area and Northdale Road Study Area

Considerations of Rare Plants

The geological and climatic extremes and isolation of Shetland have resulted in the islands having a wide range of vascular plants including at least 23 endemic species and a large number of rare and scarce species (Scott *et al.,* 2002). A notable botanical feature on Unst is the presence of some of these rare and endemic plant species. For example, the Keen of Hamar SSSI and SAC are designated for Shetland mouse-ear/Edmondston's chickweed; (*Cerastium nigrescens*); nationally rare Scottish sandwort (*Arenaria norvegica ssp. Norvegica*) and nationally scarce northern rock-cress (*Arabis petraea*) (NatureScot, 2020).

During initial Pre-application correspondence with SNH, Alba Ecology suggested conducting a rare/endemic species survey of the initial Application Boundary (a larger area than is considered in this report, including the new road at Northdale, Saxa Vord Resort, a Satellite Launch Facility at Lamba Ness and also area an around Unst airport). Johnathan Swale of SNH responded on 16/02/2018. In his correspondence he recommended that a rare species survey should be limited to the area around Unst airport due to the ultrabasic "serpentine" bedrock that occurs at that location. This area was subsequently dropped from the Application Boundary and so a rare/endemic plant species survey is not included within this report, although a watching brief for rare/endemic plant species was kept during Phase 1 Habitat and NVC surveys.

Soil and Geology

Soil and geological information can provide insight into the vegetation expected in the Study Areas and can inform decisions regarding Phase 1 Habitats categories and GWDTEs (McMullan, 2020). Therefore, the British Geological Society's (BGS) hydrogeological and geological mapping and the Scotland's Soils (2017) carbon and peatlands maps have been consulted to inform this survey report.

The carbon and peatland map describes the area of Lamba Ness and The Garths as having peaty soils with no peaty vegetation (Category 5 soils). It describes a small section of the northwest of the Satellite Launch Facility Study Area as having peatland with peatland vegetation (Category 1). The rest of the Satellite Launch Facility Study Area, including Saxa's Kettle and Inner Skaw, towards Swartling is classed as predominantly mineral soils with some peaty soils. The vegetation for this area is described as heath with some peatland vegetation (Category 4; Scotland's Soils. 2017).

The BGS open mapping data describes the superficial deposits over the majority of the Satellite Launch Facility Study Area as "*till and Morainic deposits (undifferentiated) – Diamicton*" and provides information on these as such "*these sedimentary deposits are glacigenic in origin. They are detrital, created by the action of ice and meltwater, they can form a wide range of deposits and geomorphologies associated with glacial and inter-glacial periods*" (BGS, 2020a). There were also some superficial deposits, within the centre the Satellite Launch Facility Study Area, near Inner Skaw, described as 'Blown Sands' with further information describing the soil in this area as "*These sedimentary deposits are aeolian in origin. They are detrital, comprising medium- to fine- grained materials, forming lenses, beds (and locally) dunes*" (BGS, 2020a).

Site specific Surveys in 2020 demonstrated that there was peaty soils and deep peat within the Satellite Launch Facility Study Area (Appendix 12.3).

The bedrock for the majority of the Satellite Launch Facility Study Area is described by the BGS as the "*Skaw Intrusion - Microgranite, Porphyritic. Igneous Bedrock formed approximately 359 to 444 million years ago in the Devonian and Silurian Periods*". It goes on to describe these as "*These igneous rocks are magmatic (intrusive) in origin. Rich in silica, they form intruded batholiths, plutons, dykes and sills*" (BGS, 2020a). The hydrogeological maps describe this bedrock as a "*low productivity aquifer*" with "*small amounts of groundwater in near surface weathered zone and secondary fractures; rare springs*" (BGS, 2020b).

There is a change in the geology, which coincides with the road running north to south in the far west of the Satellite Launch Facility Study Area. To the west of the road the bedrock is described as "*Hevda Phyllite Formation - Pelite, Phyllitic. Metamorphic bedrock formed approximately 541 to 1000 million years ago in the Period. Originally sedimentary rocks. Later altered by low-grade metamorphism*" (BGS, 2020a). The hydrogeological maps described this bedrock as a "*Low productivity aquifer*" with "*small amounts of groundwater in near surface weathered zone and secondary fractures*" (BGS, 2020b).

Details regarding the soils, bedrock, and hydrogeology at the Saxa Vord Study Area and the Northdale Road Study Area are shown in Table 1.

	Saxa Vord Study Area	Northdale Road Study Area
Carbon and peatland maps	Peaty soils with no peatland vegetation (Category 5)	Mineral soils with no peaty vegetation (Category 0)
BGS – superficial deposits	Till and Morainic Deposits (undifferentiated) - Diamicton. Superficial Deposits formed up to 3 million years ago in the Quaternary Period. Local environment previously dominated by ice age conditions. These sedimentary deposits are glacigenic in origin. They are detrital, created by the action of ice and meltwater, they can form a wide range of deposits and geomorphologies associated with glacial and inter-glacial periods during the Quaternary.	Till and Morainic Deposits (undifferentiated) - Diamicton. Superficial Deposits formed up to 3 million years ago in the Quaternary Period. Local environment previously dominated by ice age conditions. These sedimentary deposits are glacigenic in origin. They are detrital, created by the action of ice and meltwater, they can form a wide range of deposits and geomorphologies associated with glacial and inter-glacial periods during the Quaternary.
BGS – bedrock	Gruting Greenschist Formation - Metalava and Metatuff. Metamorphic Bedrock formed approximately 419 to 485 million years ago in the Silurian and Ordovician Periods. Originally igneous rocks formed by eruptions of magma. Later altered by low-grade metamorphism. Setting: Originally igneous rocks formed by eruptions of magma. These rocks were igneous in origin, possibly formed as volcanic (extrusive) flows of lava but have subsequently undergone metamorphism.	Norwick Phyllite Formation - Pelite, Phyllitic. Metamorphic Bedrock formed approximately 419 to 485 million years ago in the Silurian and Ordovician Periods. Originally sedimentary rocks formed in shallow seas. Later altered by low-grade metamorphism. Setting: Originally sedimentary rocks formed in shallow seas. These rocks were sedimentary in origin, possibly shallow-marine (siliciclastic units), but have subsequently undergone metamorphism.
BGS - hydrogeological maps	Low productivity aquifer with small amounts of groundwater in near surface weathered zone and secondary fractures.	Low productivity aquifer with small amounts of groundwater in near surface weathered zone and secondary fractures.

Table 1: Summary descriptions of the soils, bedrock, and hydrogeology at the Saxa Vord Study Area and the Northdale Road Study Area (BGS, 2020a; BGS, 2020b; Scotland's Soils, 2017)

Methods

The vegetation surveys were conducted using 1:25,000 Ordnance Survey maps and aerial photographs with a resolution of 25cm that were taken in June 2016 purchased from emapsite. The Phase 1 Habitat survey and the NVC survey were conducted at a scale of 1:2,500 for the Satellite Launch Facility and Saxa Vord Study Area and 1:5,000 for the Northdale Road Study Area using the Ordnance Survey maps and aerial photographs.

Habitat Surveys

Two standard methodologies were used to survey the vegetation within the three Study Areas: the Phase 1 Habitat survey (JNCC, 2010; revised 2016 and JNCC, 2012) and the NVC (Rodwell, 2006). Phase 1 Habitat surveys are a standard national classification scheme of broad habitat types and are based on plant species presence and some abiotic indicators such as soil type. The NVC is a more detailed survey of plant communities using plant species

abundance as well as presence and often using quadrat data. More than one NVC community may be present within a single Phase 1 Habitat category, and visa-versa. GWDTE were determined from the NVC survey results and from the Functional Wetland Typology (FWT) guidance (SNIFFER, 2009a). The FWT was designed to enable a basic identification of wetland habitats in Scotland and Northern Ireland using landscape features and field indicators. The FWT data and NVC communities were compared with the published table to assess whether wetlands were potential GWDTE (SEPA, 2017).

Some of the habitats within the Study Areas were identified as peatlands. Therefore, the Peatland Condition Assessment (PCA) was consulted during the surveys and consideration given to the condition of the peatland based on this guide (Peatland Action, 2016). CIEEM provide no specific guidance on use of PCA in EcIA but given both the advisory and regulatory roles NatureScot (formerly SNH) have, PCA is considered a guidance support tool and is used as such.

The surveys that were conducted at and around Saxa Vord Study Area and the Northdale Road Study Area were completed from publicly accessible roads and viewpoints. The surveyors did not enter any of the gardens or fields to complete the survey as public access was not clear or assumed.

Phase 1 Habitat Survey

A Phase 1 Habitat survey was conducted by Dr Kate Massey and Dr Fergus Massey of Alba Ecology Ltd. in July 2018. The vegetation was described and mapped following the methods described in the Joint Nature Conservation Committee (JNCC) Handbook for Phase 1 Habitat surveys (JNCC, 2010; revised 2016, and JNCC, 2012).

All three Study Areas were walked at a slow pace to accurately map all the habitats present. Plant species were identified and habitat types assigned and mapped in the field. The Phase 1 Habitat survey was extended to include plant species lists for each habitat type and an assessment of each species' overall abundance using the DAFOR scale (Dominant, Abundant, Frequent, Occasional and Rare). The smallest habitat size mapped was approximately 10m×10m. For smaller features, target notes were made, including a 10-digit grid reference taken using a hand-held Garmin geographical positioning system (GPS) unit.

In July 2020, the three Study Areas were revisited by Dr Kate Massey, as per best practice guidance (CIEEM, 2019). The habitats were considered for any changes since the 2018 field surveys, and any updates made as necessary.

National Vegetation Classification (NVC) Survey

An NVC survey was conducted in July 2018 by Dr Kate Massey and Dr Fergus Massey of Alba Ecology Ltd. The vegetation was classified and mapped following the methods described in the JNCC National Vegetation Classification User's Handbook (JNCC, 2006).

All three Study Areas were walked at a slow pace, ensuring comprehensive coverage to accurately describe and map all communities and sub-communities. Each NVC community

and sub-community type was assigned in the field by an experienced surveyor with the use of NVC field guides (e.g. Elkington *et al.*, 2001; Cooper, 1997). These data were subsequently compared with the published NVC communities using the definitions and the floristic tables (Rodwell, 1991; Rodwell, 1992; Rodwell, 1995; Rodwell, 2001; Averis *et al.*, 2004; Dargie, 1998a).

Quadrat data were taken where deemed appropriate particularly if, in the surveyor's professional judgment, the vegetation did not obviously fall into an existing published NVC community, or combination of communities. Standard NVC methodology does not require quadrats to be taken in each stand of vegetation (Rodwell, 2006). Where quadrat data was taken, the quadrats were 2×2m in size. All higher plants and common mosses were identified and their percentage cover assessed. The data was tabulated into consistency tables and compared to the published NVC communities using the keys and the floristic tables (Rodwell, 1991; Rodwell, 1992; Rodwell, 1995; Rodwell, 2001). In addition, the new version of TABLEFIT (Marrs *et al.,* 2020) was used for comparison. TABLEFIT calculates the top five community types that the data fits and provides a co-efficient of best-fit. The NVC community was then judged by comparing the results of these two approaches and using the author's professional experience and judgment.

The minimum size of vegetation mapped was approximately 10m×10m. Smaller stands were described as target notes, located with 10-digit grid reference using a GPS. Target notes were also made of any unusual features, rare species, management activities or other points of particular interest.

In July 2020 the three Study Areas were revisited by Dr Kate Massey, as per best practice guidance (CIEEM, 2019). The communities were considered for any changes since the 2018 field surveys, and any updates made as necessary.

Groundwater Dependant Terrestrial Ecosystems (GWDTE)

Wetland habitats were identified in the field using the FWT (SNIFFER, 2009a and 2009b). Where a wetland was noted, a grid reference, and target note was made and sample photographs were taken. SNIFFER (2009a) cross-mapped the wetland typology with Phase 1 Habitats and NVC vegetation types to allow comparison. Therefore, the Phase 1 and NVC communities were used to inform wetlands categorisation. Where wetlands were identified, an assessment was made as to whether they were potentially GWDTEs as defined in SEPA Guidance Note LUPS-GU31 Version 3 (SEPA, 2017).

Peatland Condition Assessment (PCA)

As some of the habitats within the three Study Areas were classed as peatlands, the Peatland Condition Assessment (PCA) was consulted. PCA bases the condition of peatlands on indicators such as bog-moss cover, extent of bare peat and evidence of grazing and burning (Peatland Action, 2016). The PCA recognises four broad 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 rare, 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.

At least one category from the PCA was assigned to each area mapped as the Phase 1 Habitat category 'bog'.

The PCA Support Tool also gives descriptions of peatlands as being in 'good, intermediate or bad condition' (Glenk *et al*., 2017). The criteria for these are shown in Table 2.

Signs	Good condition	Intermediate condition	Bad condition
Water	Plenty of water, visible on the surface	Surface water is rarely visible	Deep gullies have formed from wind and water erosion
Vegetation	Small grasses, bog-mosses (*Sphagnum spp*.) common and very wet	Taller plants, such as cottongrasses (*Eriophorum spp*.) and heather	Rarely any plants grow on the areas that are exposed. Patches of grasses or heather are still found on 'islands' in between exposed bare peat
Bare peat	Little to no bare peat patches	Bare peat patches are occasional, burning may occur	Bare peat areas will continue to expand, leaving less plant cover as protection on the surface. Peat will continue to be lost until the solid rock is exposed
Water quality	Water flowing from good quality peatland is clear	Water flowing from peatland likely to be slightly brown, especially after heavy rainfall	Bad quality, it can be dark brown from the peat content
Wildlife	Good for wildlife	Wildlife less abundant than in good condition	Home to little wildlife
Resultant activity level	Active	Stopped growing, inactive	Inactive

Table 2: Peatland Condition Assessment Support Tool categories of good, intermediate and bad peatland (Glenk et al., 2017).

Nomenclature

Both common and binomial scientific names are given the first time a species is mentioned within this report. Thereafter, common names only are used. Nomenclature follows Streeter (2016) for higher plant species, and Atherton *et al*., (2010) for bryophyte species.

Habitat and Species Evaluation

Evaluation of the species and habitats identified during the survey was completed using the best practice guidance (CIEEM, 2018). This considered a number of facets, including (but not necessarily limited to):

- Naturalness.
- Animal or plant species, sub-species or varieties that are rare or uncommon, either internationally, nationally or more locally, including those that may be seasonally transient.
- Ecosystems and their component parts, which provide the habitats required by important species, populations and/or assemblages.
- Endemic species or locally distinct sub-populations of a species.
- Habitats that are rare or uncommon.
- Habitats that are effectively irreplaceable.
- Habitat diversity.
- Size of habitat or species population.
- Habitat connectivity and/or synergistic associations.
- Habitats and species in decline.
- Rich assemblages of plants and animals.
- Large populations of species or concentrations of species considered uncommon or threatened in a wider context.
- Plant communities (and their associated animals) that are considered to be typical of valued natural/semi-natural vegetation types, including examples of naturally species-poor communities.
- Species or habitats on the edge of their range, particularly where their distribution is changing as a result of global trends and climate change.
- Geographical context (range/abundance when considered against known extent at various levels, local, regional, national etc.).
- Rarity listing and legal protection status.
- Presence on the Scottish Biodiversity Lists (SBL)
- Annex 1 habitat and species lists.

The SBL is a list of animals, plants and habitats that Scottish Ministers consider to be of principal importance for biodiversity conservation in Scotland under the Nature Conservation (Scotland) Act 2004 (NatureScot, 2020). The UK BAP list of species and habitats has been superseded by the SBL (CIEEM, 2017). However, the classification system used for habitats within the SBL is the UK BAP priority habitats (Scottish Government, 2013). Therefore, UK BAP habitat descriptions are referred to within the habitat evaluation sections of this report.

For the avoidance of doubt, CIEEM EcIA guidance (2018) makes it clear that species and habitats which appear on national lists e.g. Schedule 1 of the Wildlife and Countryside Act (1981 as amended) are not necessarily evaluated as nationally important simply by appearing on such a list. Importance evaluation must consider the number of individuals of species within

a geographical context/scale, i.e. how many of a particular species are likely to be affected by the Proposed Development and what proportion of the local/regional/national population does this constitute. Legal listing/protection is a separate but important consideration.

Habitat categories and the 'condition' of these categories are human (or artificial) constructs and, therefore, to a degree are subjective and a matter of professional judgement. Furthermore, different conditions can co-exist in an area of habitat (e.g. through drainage, preferential grazing, trampling etc.) and so it is not appropriate to assume an entire area of habitat is in one condition or another. Under these circumstances, it is usually reported that the habitat is approaching a particular condition. This is fully recognised in Phase 1 Habitat and NVC assessments and consequently it is not always possible to be unequivocal when making judgements such as whether a particular habitat is classified under one condition or another. Where these have occurred with vegetation communities, they have been noted and explained.

Limitations

Standard sampling methods were followed, and any biases or limitations associated with these methods could potentially affect the results collected. Furthermore, while every effort was made to provide a full assessment and comprehensive description of the three Study Areas, it is unlikely that one survey can achieve full characterisation due to variations that occur with time. This survey report should be considered as a snapshot in time, specifically July 2018 and July 2020.

As with all Phase 1 Habitat and NVC surveys, the intention of the survey work was not to create a full inventory of the botanical species in the three Study Areas, but to map and describe the habitats and communities present. Species were recorded when they were encountered, but it is likely that additional species, not listed, are present within the Study Areas, particular as species presence and visibility varies throughout the growing season. Additionally, some of the habitats within the Study Areas, particularly within the Satellite Launch Facility Study Area, were particularly heavily grazed by sheep rendering some plant identification more challenging. In these instances, professional judgement was applied. These are recognised limitations common to all Phase 1 Habitat and NVC surveys but were minimised by conducting the survey within the optimal survey period during two different growing seasons.

Similarly, the walkover surveys are not intended to count all individuals of any particular species. When a count of a particular species is mentioned within the report or target notes, it is visual estimate only, based on what was easily seen at the time of survey. Where precise locations are provided for a particular species, it is to provide an example location. It is highly unlikely that every individual, of any species, was located during the walkover survey.

Plant species occurrence and visibility change both temporally and spatially. This is particularly true for colonising and invasive species. The data provided by habitat surveys is a snapshot in time (specifically July 2018 and July 2020 for this survey) and cannot account for changes that occur outwith this time period. Non-native invasive species can be prolific colonisers. For example, Japanese knotweed (*Fallopia japonica*) spreads from rhizomes,

rhizome fragments, as well as stem and crown fragments. Spread is usually a result of human intervention, such as spreading fragments in tyre treads (Fennell *et al.,* 2018). Additionally, at different times of year (e.g. winter) or life-stage (e.g. early colonisation) the identification of non-native invasive species can be challenging. Therefore, although non-native invasive species were considered during field surveys and field surveys were conducted at the optimal time of year, it is possible for non-native invasive species to be present within the Study Areas.

The Phase 1 Habitat, NVC and GWDTE maps are only indicative of the habitat boundaries of the Study Areas. It is challenging to map the area to a higher degree of accuracy because there is often no clear boundary between vegetation types, there being instead a gradual gradation. Also, many of the NVC communities in the Study Areas contained a similar assemblage of species and were often at a transitional stage between two community types. This is a recognised limitation of all vegetation mapping. Surveying in Scotland as a whole, and even more so for Shetland, has the added limitation that the NVC community descriptions were often derived from work carried out in England. Therefore, the fit of the communities to the published accounts are often imperfect and the closest approximation of the communities is described.

Estimating peat depth can be an important component for determining some Phase 1 Habitat types and FWT types. However, it is important to note that measuring peat depth was outside the scope of these vegetation surveys. Apparent peat depth as discussed in this report is estimated based on visual assessments only.

Results – Satellite Launch Facility Study Area

The Phase 1 Habitat survey map for the Satellite Launch Facility Study Area is shown in Appendix 7.2 Drawing 3 and a list of habitat types are displayed in Table 3. The NVC survey map of the Satellite Launch Facility Study Area is shown in Appendix 7.2 Drawing 4 with the potential GWDTE and PCA maps in Appendix 7.2 Drawing 5 and 6 respectively[1]. These drawings are supported with list a of target notes (Annex 1, Appendix 7.2 Drawing 7). Photographs of the habitats and interesting features are shown in Annex 2.

Overview

The Satellite Launch Facility Study Area included distinctive maritime grassland in the east, on Lamba Ness, which had a range of pools and damp grassland. This transitioned into an area of wet modified bog dominated by purple moor-grass (*Molinia caerulea*). More westerly in the Satellite Launch Facility Study Area the habitats were made up of wet modified bog/wet heath habitat, which was dominated by heather (*Calluna vulgaris*) and common cottongrass (*Eriophorum angustifolium*). The most westward side of the Satellite Launch Facility Study Area transitioned into blanket bog habitats.

There were small areas of other habitats, including standing water, marginal vegetation at the edge of pools and saltmarsh perched within the coastal vegetation. The old military buildings and roads and other infrastructure were also mapped across the Satellite Launch Facility Study Area and often had distinct vegetation around them, enriched from the sheep that sheltered in them.

All the habitats within the Satellite Launch Facility Study Area had clearly been subject to modification through current and historic management practices including sheep grazing and drainage. Sheep were evident across the Satellite Launch Facility Study Area and the impacts of fertilisation, grazing and sheep lay-down areas were recorded. Drainage ditches, both very recently cut, and older, were also recorded in the wet modified bog and wet modified bog/wet heath habitats. There were areas of naturally occurring haggs, within the blanket bog, which were likely to be exacerbated by sheep.

[1] Drawings are provided within this report document for ease of reference, but higher resolution versions are provided separately as PDFs.

Phase 1 Habitats	**Area (ha)**	**% of Satellite Launch Facility Study Area**
Wet modified bog/wet heath	30.5	26.1
Wet modified bog	28.2	24.2
Coastal grassland	19.7	16.8
Semi-improved acid grassland	16.3	14.0
Unimproved acid grassland	7.3	6.2
Wet modified bog/wet heath/dry heath	6.5	5.6
Buildings and roads	1.8	1.5
Fen	1.5	1.3
Blanket bog/bare peat	1.5	1.3
Blanket bog	1.1	1.0
Dry dwarf shrub heath	0.7	0.6
Saltmarsh	0.4	0.3
Wet modified bog/wet heath/bare peat	0.3	0.2
Sand dunes	0.3	0.2
Marginal and inundation	0.2	0.2
Wet modified bog/wet heath/acid flush	0.2	0.2
Bare ground	0.1	<0.1
Acid flush	0.1	<0.1
Bare peat	0.1	<0.1
Neutral grassland	0.1	<0.1
Standing water	<0.1	<0.1
Open vegetation	Too small to map separately	N/A
Water courses and drains	Mapped as lines	N/A
Total	***116.9***	***100.0***

Table 3: The area of each of the Phase 1 Habitats found in the Satellite Launch Facility Study Area.

Habitat and Community Descriptions

The habitats and communities that were found within the three Study Areas are described in the following manner: firstly a Phase 1 Habitat description, followed secondly by the corresponding NVC community(ies) and finally a comment on the FWT category and potential groundwater dependency where relevant.

Coastal grassland

Coastal grassland was mapped for much of the cliff tops of Lamba Ness and The Garths in the east of the Satellite Launch Facility Study Area. The coastal grasslands were dominated by red fescue (*Festuca rubra*) with a variety of maritime species such as thrift (*Armeria maritima*), maritime plantain (*Plantago maritima*) and buck's-horn plantain (*Plantago coronopus*).

Lamba Ness was a military base during WWII and the associated abandoned infrastructure was evident across the peninsula. However, the main landuse at the time of surveying was sheep grazing which was evident and influential in the coastal grassland habitat. Many of the military buildings were used as shelter by the livestock resulting in localised fertilisation.

The coastal grassland was short (3-10cm) and tightly entwined, with cushions of thrift and mats of plantains. They were wind swept and had dung and fleece evident from the sheep. There were areas where sheep laydown and used as shelter within the coastal grassland. These areas often showed signs of localised enrichment. Some areas, where sheep clearly found shelter, the soil profile was revealed showing a thin richer (peaty soil) layer, followed by sands and gravels.

There were four coastal NVC communities mapped and described.

MC8d *Festuca rubra* – *Holcus lanatus* maritime grassland, *Holcus lanatus* sub-community

The MC8d maritime grassland community was dominated by red fescue with thrift abundant and conspicuous in the sward. Yorkshire fog (*Holcus lanatus*) was variable in cover, but generally quite abundant. It was a closed, thick, low sward of approximately 5-10cm on what appeared to be shallow peaty soil over sand. This community showed signs of extensive grazing by sheep.

There were a variety of species that were common throughout the sward including abundant white clover (*Trifolium repens*), creeping buttercup *(Ranunculus repens*) and maritime plantain along with the appearance of species such as ribwort plantain (*Plantago lanceolata*) and common bent (*Agrostis capillaris*).

Less abundant forbs included red clover (*Trifolium pratense*), daisy (*Bellis perennis*), ragged robin (*Lychnis flos-cuculi*), bird's-foot trefoil (*Lotus corniculatus*), squill (*Scilla spp.*) and common mouse-ear (*Cerastium fontanum*).

Other graminoids present at lower abundances included smooth meadow-grass (*Poa pratensis*), mat grass (*Nardus stricta*), sheep's fescue (*Festuca ovina*) and sweet vernal grass (*Anthoxanthum odoratum*). In wetter patches sedges became more apparent including carnation sedge (*Carex panacea*) and common sedge (*Carex nigra*).

In patches where the sheep lay in hollows, within the MC8d grassland, there were small patches of sheep's fescue with common chickweed (*Stellaria media*). These areas were too small to map separately, although some were target noted.

MC10a *Festuca rubra* - *Plantago spp*. maritime grassland, *Armeria maritima* sub-community

The red fescue – plantain grassland, thrift sub-community, MC10a, was described most extensively on the point of Lamba Ness. The grassland was generally less species rich than the other coastal grassland communities. It was close cropped by sheep grazing. Sea plantain was dominant, with thrift, red fescue, and some ribwort and buck's-horn plantain all abundant and constant in the sward. No other species had any prominence on these sea cliff grasslands, although there was a little autumn hawkbit (*Scorzoneroides autumnalis*), bird's-foot trefoil, sheep's fescue, sweet vernal grass and creeping buttercup.

There were small areas of MC10a grassland on the banks of some military buildings. Red fescues, plantains and thrift were all abundant, but there were a variety of other grasses including sheep's fescue, wavy hair-grass (*Deschampsia flexuosa*), Yorkshire fog and sweet vernal grass. There was also a little common bent and creeping bent (*Agrostis stolonifera)*. There was frequent creeping buttercup and white clover with occasional mouse ear, heath bedstraw (*Galium saxatile*), and daisy in these areas.

MC10b *Festuca rubra* - *Plantago spp*. maritime grassland, *Carex panacea* sub-community

The red fescue – plantain grassland was commonly found on the seaward facing slopes of Lamba Ness. The grassland was generally close cropped by sheep grazing. Red fescue was abundant along with sheep's fescue and mat grass. The plantain species, including maritime, ribwort and buck's-horn were all very common and constant in the sward. Thrift was apparent and abundant as were some of the sedge species, particularly carnation sedge, but also common sedge and sometime common yellow sedge (*Carex viridula ssp. oedocarpa*). In some stands of this grassland common sedge was the dominant species. Other forb species present included bird's-foot trefoil, autumn hawkbit, ragged robin, eyebright and creeping buttercup. In wetter patches lesser spearwort (*Ranunculus flammula*) was seen.

Graminoids that were recorded at lower frequencies included smooth meadow-grass, Yorkshire fog and jointed-rush (*Juncus articulatus*).

MG11 *Festuca rubra – Agrostis stolonifera – Potentilla anserine* grassland community

MG11 is a community which is associated with improved vegetation with coastal influences. Due to the cliff top location and clear maritime influence the MC11 grassland has been included in the coastal grassland category, as per the Saltmarsh Survey of Scotland, rather than as a saltmarsh where it is often included (Haynes, 2016). The MG11 community appeared to best describe some of the very small (often <5m wide) bright green grasslands around the old military buildings on Lamba Ness where sheep sheltered and grazed heavily and so enriched the vegetation.

Red fescue, creeping bent and Yorkshire fog were the most abundant grasses, although some stands had a high abundance of perennial rye grass (*Lolium perenne*). These areas have obvious associations with the MG11a sub-community and also included white clover and creeping buttercup. Other grasses in the MG11 community included smooth meadow-grass, Yorkshire fog, and sheep's fescue, but these were generally all at low abundances.

Silverweed (*Potentilla anserina*) was abundant in most stands, but had a more occasional presents, or absence in other stands. There were patches in some stands where common chickweed was abundant to dominant. Thrift, plantains, sheep's sorrel and autumn hawkbit were all present in low frequencies.

The MG11 community was closely cropped, but there were occasional taller patches of soft rush (*Juncus effusus*), nettles (*Urtica dioica*) and marsh thistle (*Cirsium palustre*) and rarely spear thistle (*Cirsium vulgare*).

Wet grassland

The coastal grasslands MC8 and MC10 are not considered to be wetlands in the FWT and are not listed as potentially GWDTE. MG11 is considered to be a wet grassland in the FWT and is listed as potentially moderately GWDTE depending on the hydrological setting by SEPA guidance.

Saltmarsh

There were several very small areas of perched saltmarsh recorded on the cliff tops of Lamba Ness. Perched saltmarshes can form on sea cliffs where shallow sediment develops in the wave splash-zone or from sea spray (Haynes, 2016). There was one saltmarsh NVC community recorded which was dominated by saltmarsh rush.

The Scottish Saltmarsh Survey recorded the most northerly saltmarsh in the UK in Baltasound (ca. 6km south of the Satellite Launch Facility Study Area (Haynes, 2016)). However, the very small perched saltmarsh communities found in the Satellite Launch Facility Study Area were likely smaller than the smallest mappable unit considered in the large scale Saltmarsh Survey of Scotland (Haynes, 2016).

SM16b *Festuca rubra* salt-marsh community, *Juncus gerardii* dominant sub-community

There were several small peaty channels on Lamba Ness which were dry at the time of the survey but clearly had periods where they were inundated and impacted by sea spray. They were ca. 2-3m wide and likely to be old ditch channels. These areas were dominated by saltmarsh rush, sometimes overwhelmingly so. These areas were mapped as SM16b which is one of the few sub-communities found on perched sites where thin layers of sediment develop in the sea splash zone (Haynes, 2016).

The other constant species in the SM16b community were red fescue and sea plantain with additionally species being more patchily distributed. In one stand, lesser spearwort was conspicuous with common sedge and carnation sedge abundant. Other species recorded were sweet vernal grass, eyebright and jointed rush.

There was a very small patch (ca. 6m×3m) of a seepage line in which sea arrowgrass (*Triglochin maritimum*) was the most notable species. There was also thrift, red fescue and sea plantain. There may have been association with the perched saltmarsh community SM19 although, given the very limited size and the proximity to the SM16 community it has been included as part of the SM16.

Saltmarsh is included as a wetland within the FWT. However, SM16 and SM19 are not listed as potentially GWDTEs by SEPA guidance (SEPA, 2017).

Sand dunes

There was a small area of sand dune, including open dune and dune grassland vegetation, at a small inlet at Inner Skaw, in the north of the Satellite Launch Facility Study Area. There was an accumulation of bare sand in the inlet which formed a small beach. There was ca. 20m wide, stretch of open dune (SD4), followed by a ca. 20m wide stretch of dune grassland (SD8d), although they transitioned into one another. Inner Skaw formed part of the Shetland report of the Sand Dune Vegetation Survey of Scotland (SDVSS, Dargie, 1998a, 1998b, 1998c). The mapping and descriptions from the 1998 SDVSS coincide closely with this report, although, the NVC data are not identical. This would be expected as the surveys were conducted in different years and likely at different times of year. There would also variation in the surveyor's use of the NVC and their professional judgement. This between surveyor variation is a well-known and understood limitation to NVC surveying (e.g. Hearn *et al.* 2011).

SD4 *Elytrigia juncea* fore-dune community

The SD4 vegetation fore-dune was sparsely vegetated on wind-blown bare sand. It was made up of sand couch (*Elytrigia juncea*), with occasional lyme grass (*Leymus arenarius*) with a little ribwort plantain and sea sandwort (*Honckenya peploides*). Oysterplant (*Mertensia maritima*) was occasional in this community. This is consistent with the descriptions of SD4 within the Shetland report of the SDVSS where it describes sand couch as the only consistent species in SD4 in Shetland, and that it is a species poor community (Dargie, 1998a).

SD8d *Festuca rubra – Galium verum* fixed dune grassland *Bellis perennis - Ranunculus acris* sub-community

The SD8d vegetation was more species rich and made up a higher proportion of the ground cover than the SD4, although there were still areas where there was 20-30% bare sand. It was a narrow section of dune grassland which had influences from both the maritime grassland and the fore-dune vegetation. Red fescue was the most common species, with ribwort plantain abundant. Daisy, white clover, creeping buttercup were constant but with low frequencies. Eyebright (*Euphrasia spp.*) and mouse-ear were more rarely seen. Species associated with the maritime grassland communities were more common on the landward side, such as thrift and sea plantain. Lyme grass and sand couch were more frequent as it transitioned into the fore-dune.

SD8d is reportedly the most common of the SD8 grasslands in Shetland and was considered to be generally species poor (Dargie, 1998a).

The sand dune communities SD4 and SD8 are not considered to be wetlands in the FWT and are not listed as potentially GWDTE.

Semi-improved acid grassland

The semi-improved acid grassland was found in the more inland areas of the Satellite Launch Facility Study Area in areas around Inner Skaw and Skaw. It was mapped in several large fields and some smaller areas beside buildings, road verges, tracks and old borrow pits.

The semi-improved acid grassland habitat was sheep grazed and likely to be on shallow peaty soils. It often formed part of a mosaic with other grassland types or wet modified bog/wet heath, although it usually made up the largest portion of the habitat mosaic present.

One semi-improved acid grassland NVC community type was described, U4b, although this was split into two types. One type was more improved than the other, evidenced by the high proportion of perennial rye grass.

U4b *Festuca ovina – Agrostis capillaris – Galium saxatile* grassland, *Holcus lanatus – Trifolium repens* sub-community

The U4b grassland was usually highly grazed, to 2-3cm, although it could have a rougher appearance with taller tussocks of less palatable species.

There was a mixture of abundant grasses, particularly red fescue, sheep's-fescue, common bent and Yorkshire fog. Other grasses were present at low abundances including smooth meadow-grass, sweet vernal grass, brown bent (*Agrostis vinealis*) and creeping bent. The grassland was forb rich, although most of these forbs were patchily distributed in the grassland, with none having a high prominence except perhaps white clover and ribwort plantain. Other forbs present included yarrow (*Achillea millefolium*), eyebright, sheep's sorrel (*Rumex acetosella*), creeping buttercup, spring squill (*Scilla verna*), dandelion (*Taraxacum agg*.), autumn hawkbit, selfheal (*Prunella vulgaris*), St. John's wort (*Hypericum spp.*) and heath spotted orchid (*Dactylorhiza maculata*) to name but a few. Where U4b was found in borrow pits and there were exposed rocks there was occasionally some thyme (*Thymus polytrichus*) present.

Some stands of U4b grassland had a high portion of perennial rye grass and showed signs of improvement. In these stands daisy and white clover tended to have a high-very high abundance. These stands had affinity to MG7, although, the species richness, and other grasses, particularly fescues and bent-grasses, placed it into the U4b community. To distinguish this more improved U4b type from the less improved U4b grassland it was mapped as U4b (MG7).

The semi-improved acid grassland U4 is not included in the FWT and is not a GWDTE.

Unimproved acid grassland

The unimproved acid grassland was generally recorded on the lower slopes of the hill side, and as part of the dry dwarf shrub heath mosaic.

Unimproved acid grasslands are generally unenclosed hill-grazed land and are relatively species poor (JNCC, 2010 revised 2016). The unimproved acid grassland within the Satellite Launch Facility Study Area was generally dominated by either mat grass or heath rush (*Juncus squarrosus*). Heath bedstraw was the most common forb species. Grazing by sheep was apparent.

A total of three unimproved acid grassland NVC sub-communities were described in the Satellite Launch Facility Study Area.

U5a *Nardus stricta – Galium saxatile* grassland, species poor sub-community

The U5a acid grassland community was a rough grassland mainly found in small patches around The Garths. It was strongly dominated by mat grass with tormentil abundant and conspicuous in the vegetation. It included a variety of other grass species at low abundances such as Yorkshire fog, sweet vernal grass, common bent, red fescue, smooth meadow-grass

and a little purple moor-grass. Forbs were restricted to selfheal, common dog violet (*Viola riviniana*) and rarely mouse ear and ragged robin.

There was a little heath wood-rush (*Luzula multiflora*) present. The moss layer was not well developed.

U5b *Nardus stricta – Galium saxatile* grassland, *Agrostis canina – Polytrichum commune* sub-community

The U5b grassland was well defined, with mat grass dominant, but not overwhelmingly so, and a variety of other grass had some prominence, including red fescue, sweet vernal grass and wavy hair-grass. Tormentil was the most abundant forb. There was occasional heath spotted orchid and eyebright. The moss layer was much more developed than the U5a sub-community with common haircap (*Polytrichum commune*), red bog-moss (*Sphagnum capillifolium*) and red-stemmed feather-moss (*Pleurozium schreberi*) all being present with varying abundances.

This community was found as a mosaic with the heath rush dominated grassland U6, particularly to the southwest of the Satellite Launch Facility Study Area, but also in small patches (sometimes too small to map). In these areas U5 was generally the most common grassland community, with U6 making up small patches.

U6 *Juncus squarrosus – Festuca ovina* grassland community

There were small patches of the U6 heath rush dominated grassland across the Satellite Launch Facility Study Area. Heath rush was dominant although mat grass could be very abundant in some stands, making it difficult to distinguish between U5 mat grass grassland and U6 heath rush grassland in some locations. However, where heath rush was considered to be dominant, and mat grass subordinate, it was assigned the U6 grassland category. There were also patches where heath rush dominated, but with purple moor-grass abundant. These were mapped as M25b, but the association with U6 was obvious.

The U6 grassland community was found in flushes and at transitions between grassland and heath and bog. It included heath bedstraw, but more frequently tormentil. There were a variety of other graminoids present including wavy hair-grass, sweet vernal grass and heath wood-rush which were occasional. Forbs that were seen, but only rarely, in the U6 grassland included sheep's-bit (*Jasione montana*) and sheep's sorrel.

The ground layer was usually dominated by common haircap, although there were hypnum mosses present too.

Montane grassland

Montane grasslands, as defined by the FWT, are wet areas of very short dense vegetation which may include some of the unimproved acid grassland Phase 1 Habitats and NVC communities (SNIFFER, 2009b). The NVC community U5 is not considered GWDTE (SEPA, 2017). However, the U6 community is classified as potentially moderately groundwater dependant depending on the hydrogeological setting (SEPA, 2017).

Neutral grassland

The Phase 1 Habitat category neutral grassland includes species-poor wet grasslands where soft rush and Yorkshire fog are abundant. The neutral grassland within the Satellite Launch Facility Study Area was dominated by soft rush. A single NVC community was described.

MG10a *Holcus lanatus – Juncus effusus* rush-pasture, typical sub-community

There were some small patches of MG10a rush pasture. These were damp swards where soft rush stood out amongst the other grassland and heath vegetation. Yorkshire fog was abundant below the rushes. The MG10a community was species poor, although occasional species such as white clover and marsh willow herb were present. Several small patches were mapped within the Satellite Launch Facility Study Area including within ditches. However, much of this community type was mapped as part of a mosaic as it appeared as small patches within other acid grasslands.

Marshy grassland

Marshy grassland, as described by the FWT, includes vegetation dominated by tussock forming grasses and rushes in damp soils. This includes the Phase 1 Habitat neutral grassland and NVC community MG10. The NVC communities MG10 is considered potentially moderately groundwater dependant depending on the hydrological setting (SEPA, 2017).

Blanket bog

The bog within the Satellite Launch Facility Study Area was considered to be on peat which appeared deeper than 0.5m. In Phase 1 Habitat surveys bog-moss abundance is an indicator of whether bog should be classified as modified or unmodified, with '*sphagnum-rich vegetation'*, or '*abundant sphagnum'* indicating unmodified, and *'little to no sphagnum'* indicating modified bog (JNCC, 2010; Revised 2016).

All the bog within the Satellite Launch Facility Study Area had clearly been subject to modification through current and historic management practices including sheep grazing and drainage. There were areas of naturally occurring haggs, which occurred within the peatlands, and were likely to have been exacerbated by sheep. However, there were bog-mosses present, not always forming a carpet, but more frequent than *'little to no sphagnum'.* Therefore, the blanket bog has not been described as modified using Phase 1 Habitat terminology.

The PCA bases the condition of blanket bog on indicators such as bog-moss cover, extent of bare peat and evidence of grazing and burning (Peatland Action, 2016). Given that the bog habitat within the Satellite Launch Facility Study Area was clearly grazed and drained and there were patches of bare peat, using PCA terminology, the blanket bog was considered to

be modified and some areas drained. Using the PCA Support Tool, the blanket bog would be considered of intermediate condition.

Three NVC communities were described, including one bog pool community.

M2b *Sphagnum cuspidatum/fallax* bog pool, *Sphagnum fallax* sub-community

There were several small M2b bog pools in within the blanket bog and wet modified bog habitats. M2b bog pools were easily visible as bright green mats of flat-topped bog-moss (*Sphagnum fallax*). The carpet of flat-topped bog-moss was generally quite thin over peat. This community formed in the bases of peat haggs and in bog pool complexes usually with M3 pools. There were often few vascular plants within it including common sedge, common cottongrass and bent-grasses.

These bog pool communities were usually small or very small. Several M2b bog pools were mapped within the wet modified bog in the southwest of the Satellite Launch Facility Study Area. However, some were too small to mark on the map and examples are target noted.

M19 *Calluna vulgaris – Eriophorum vaginatum* blanket mire community

M19 blanket mire community is common in northern areas and tolerates drier peat than other NVC mire communities (Averis *et al.,* 2004).

It was dominated by heather with hare's-tail cottongrass (*Eriophorum vaginatum*) and common cottongrass both abundant. Crowberry (*Empetrum nigrum*) was a frequent dwarf shrub growing as a mat below the heather. There were a few occasional other graminoids but none formed any bulk of the vegetation, these included wavy hair-grass and heath rush. Tormentil was the commonest forb species.

Below the vascular plants, red bog-moss was abundant and constant, although its cover was patchy. Glittering wood-moss (*Hylocomium splendens*) was highly abundant and red-stemmed feather-moss was also frequent.

The M19 community was on a flat area in the north of the survey area which appeared to be waterlogged. It had some M2 and M3 bog pools present with damp patches of feathery bog-moss.

Although this community was distinctively M19, it did not show any of the described sub-communities characteristics and so it has been mapped as M19 and not given a sub-community.

M18 *Erica tetralix - Sphagnum papillosum* raised and blanket mire

There was a small area in the southwest of the Satellite Launch Facility Study Area that had a higher abundance of papillose bog-moss (*Sphagnum papillosum*) than the surrounding areas. Common cottongrass was dominant with hare's-tail cottongrass also more frequent than the surrounding area. Heather, cross-leaved heath (*Erica tetralix*) and crowberry were present as low, open dwarf shrub layer. Tormentil was abundant in the vegetation and there were several other forb species present including lousewort (*Pedicularis sylvatica*), heath spotted orchid, devil's-bit scabious (*Succisa pratensis*), bog asphodel (*Narthecium ossifragum*) and heath speedwell (*Veronica officials*). There were a series of M2a bog pools present.

Peat bog (peatland setting)

In the FWT peat bog is defined as wet peat, which is generally thicker than 0.5m, with heather, cottongrasses and some small sedge species (SNIFFER, 2009b). The Phase 1 Habitat blanket bog fits into this peat bog category and the NVC communities M2, M18 and M19 are within this FWT category. They are not considered to be potential GWDTE (SEPA, 2017).

Wet modified bog/wet heath

There was a large area in the west of the Satellite Launch Facility Study Area that was made up of wet heath vegetation usually dominated by heather with deergrass (*Trichophorum germanicum*), purple moor-grass and common cottongrass. There was less frequent crowberry, cross-leaved heath and bell heather (*Erica cinerea*).

In Phase 1 Habitat surveys, the classification of heath requires there to be greater than 25% cover of dwarf shrub and peat less than 0.5m deep or mineral soil (JNCC, 2010; Revised 2016; JNCC, 2012). Wet modified bog is defined as "*modified bog vegetation with little or no Sphagnum, often with bare peat and patches of* Trichophorum cespitosum *and/*or Molina Caerulea*. Ericoids may be abundant, sparse or absent. This vegetation is mainly found on drying and degraded blanket bogs … It may resemble wet heath, but is distinguished by having a peat depth greater than 0.5m"* (JNCC, 2010; Revised 2016; JNCC, 2012).

This demonstrates that where there is wet heath vegetation the key diagnostic feature classifying it, for Phase 1 Habitat purposes, is peat depth, with <0.5m being wet heath and >0.5m being wet modified bog (JNCC 2010, Revised 2016).

A peat depth survey was undertaken and demonstrated that a section of the wet heath vegetation was on peaty soils/peat between ca. 30cm and 65cm deep (Appendix 12.3). Which is at the transition point of these two Phase 1 Habitat types. Therefore, this vegetation type has been mapped as a transition of wet modified bog/wet heath. It was thought that some areas within the wet heath vegetation were likely to be on areas of deeper peat particularly around the M3 pools, and so would technically be wet modified bog. Nevertheless, some was clearly on shallower soils (meaning some areas were technically wet heath). Given the variation in peat depth the areas considered to be wet heath vegetation were defined as wet modified bog/wet heath.

It should be noted that this habitat survey does not constitute a formal peat depth survey. Visual clues from e.g. ditches, haggs, bedrock exposure and pushing a walking pole into the ground as well as professional judgement are used for habitat survey purposes. The peat depth survey data provides site specific evidence for peat depth in some parts of the Satellite Launch Facility Study Area (Appendix 12.3).

The PCA bases the condition of bog on indicators such as bog-moss cover, extent of bare peat and evidence of grazing and burning (Peatland Action, 2016). Given that the wet modified bog/wet heath habitat within the Satellite Launch Facility Study Area was clearly grazed and drained using PCA terminology, the blanket bog was considered to be modified and some areas drained. Using the PCA Support Tool, the wet modified bog/wet heath would be considered of intermediate condition.

Two NVC communities were described as wet modified bog/wet heath, M15d and M15.

M15d *Trichophorum germanicum – Erica tetralix* wet heath, *Vaccinium myrtillus* sub-community

The M15d varied in its appearance across the Satellite Launch Facility Study Area with some locations having a taller, more apparent dwarf shrub layer. In other areas the graminoids, particularly cottongrass, were more apparent, with dwarf shrubs short or less conspicuous below. These differences are likely to be attributable to differing grazing regimes areas across the Satellite Launch Facility Study Area. The M15d community was drained and experienced grazing pressure from sheep.

There was a mixture of dwarf shrubs, including heather, crowberry and more occasionally cross-leaved heath and bell heather. Bilberry (*Vaccinium myrtillus*) was sparsely represented. The dwarf shrubs were usually short and over topped by grasses and sedges which is a common feature of this sub-community. Purple moor-grass, deergrass, heath rush, common cottongrass and mat grass were present too. Common cottongrass could be very abundant similar to the M15 community. Heath rush was often very conspicuous and, combined with the mat grass, some areas had some affinity with U6 grassland. There was a variety of other graminoids present including viviparous sheep's fescue (*Festuca vivipara*), wavy hair-grass and heath wood-rush.

Tormentil was generally the most common forb, but there were a variety of occasional other species including devil's-bit scabious, common butterwort (*Pinguicula vulgaris*), lousewort, round-leaved sundew (*Drosera rotundifolia*) and bog asphodel. The moss layer was not well developed but included patches of red bog-moss and more occasionally woolly fringe moss (*Racomitrium lanuginosum*).

There were occasional patches of hare's-tail cottongrass and there was a patch of M15d community in the north of the Satellite Launch Facility Study Area in which bog asphodel and devil's-bit scabious were highly abundant. Sheep's-bit was present, but only rarely and there was a record of goldenrod (*Solidago virgaurea*).

Pools were present within the M15d community. These were described as M2a and M3 bog pools. M3 were generally the most common.

M15 *Trichophorum germanicum – Erica tetralix* wet heath community

There were some small (too small to map), and one large area (forming a mosaic with other communities) in which the vegetation was strongly dominated by common cottongrass. Dwarf shrubs (heather and crowberry) were present, but below a common cottongrass carpet. This community was defined as M15, without an associated sub-community. It appeared to form a transitional habitat type, between the M3x and more distinct M15d.

Wet modified bog

In Phase 1 Habitat surveys, wet modified bog is defined as "*modified bog vegetation with little or no Sphagnum, often with bare peat and patches of* Trichophorum cespitosum *and/*or Molina Caerulea*. Ericoids may be abundant, sparse or absent. This vegetation is mainly found on drying and degraded blanket bogs … It may resemble wet heath, but is distinguished by having a peat depth greater than 0.5m.* Molina *dominated vegetation on deep peat is included in this category, rather than in marshy grassland"* (JNCC, 2010; Revised 2016; JNCC, 2012).

In the central part of the Satellite Launch Facility Study Area there were large areas of purple moor-grass dominated vegetation which was determined, as part of a subsequent site specific survey, to be on peat >0.5m (Appendix 12.3). As per Phase 1 Habitat classification this area has also been defined as wet modified bog, with marshy grassland vegetation over the peat.

The wet modified bog has been subjected to current and historic management practices including the grazing regimes and drainage as well as the extensive impact from historic military buildings and associated military uses.

It is considered possible that some areas, described as wet modified bog, are on shallower peat and/or sandy soils and so technically marshy grassland. However, on balance of the evidence, it has all been described as wet modified bog. It should be noted again that this habitat survey does not constitute a formal peat depth survey or soils survey. The peat depth survey data provides site specific evidence for deep peat (Appendix 12.3).

The PCA bases the condition of blanket bog on indicators such as bog-moss cover, extent of bare peat and evidence of grazing and burning (Peatland Action, 2016). Given that the wet modified bog habitat within the Satellite Launch Facility Study Area was clearly grazed and drained using PCA terminology, the blanket bog was considered to be modified and some areas drained. Using the PCA Support Tool, the blanket bog would be considered of intermediate condition.

Two NVC communities were described as wet modified bog, M25b which was purple moor-grass dominated and M3x which was common cottongrass dominated.

M25b *Molinia caerulea – Potentilla erecta* mire, *Anthoxanthum odoratum* sub-community

The centre of Lamba Ness had a large area mapped as M25b. This area was heavily drained and sheep grazed. The drainage ditches were ca. 1m wide and 50-60cm deep, some were recently dug, with the spoil still evident beside them. They were not flowing with water at the time of the survey but were likely to be active drains in wetter times of the year. Draining and grazing are considered important in maintaining this particular sub-community of M25 (Rodwell, 1991).

The vegetation was 10-20cm tall and fairly variable but was dominated by purple moor-grass with mat grass abundant in places. Sweet vernal grass had lower abundance but was constant. There was also sheep's fescue and smooth meadow-grass frequently present. Common cottongrass could be very abundant in some places with common sedge and carnation sedge. Below these taller graminoids, tormentil was creeping through the vegetation with occasional creeping buttercup, devil's-bit scabious, ragged robin, white clover, common dog violet and selfheal occasionally present. Rarer forb species included dandelion, tufted vetch (*Vicia cracca*), mouse-ear, spring squill, sheep's-bit and heath spotted orchid. Common butterwort and bog asphodel were found, but only rarely, in the M25b community.

Bog-mosses were generally absent in the M25b community with only very occasionally red bog-moss. Dwarf shrubs were also generally absent, although small sprigs of heather were present in some stands.

Some small stands of M25b had an abundance of heath rush showing some affinity to U6 grassland, but in other respects were similar to that of the M25b community as a whole.

Within some stands of M25b there were open water pools, generally 2m×2m in size, but varying up to about 5m×5m in size. The pools were either bulbous rush dominated (NVC community A24) or common spike-rush dominated with lesser spearwort (NVC community S19a). Bent-grasses appeared to be common to all these pools. These communities were also found in drainage ditches and were common in some areas of M25b.

The M25b vegetation was set between coastal grassland and bog habitat. As the coastal grassland gave way to the M25b vegetation there was a period of transition between the habitat types.

M3x *Eriophorum angustifolium* community

There were areas dominated by common cottongrass that did not fit well within the NVC community descriptions as they appeared to be well developed. They clearly had affinity with the M3 community. However, the vegetation was usually a full cover, particularly of common cottongrass, rather than an establishing/stabilising community on exposed or redistributed peat as M3 usually is. Therefore, it has been denoted as M3x.

There were some small patches of M3x on Lamba Ness in old peaty channels, ditches and in some shallow hollows. These were dominated by common cottongrass, sometimes overwhelmingly so. Other species represented were tormentil, purple moor-grass, common yellow sedge and a little red bog-moss. However, there were also species related to the surrounding habitats, such as lesser spearwort, carnation sedge, ribwort plantain, marsh arrowgrass (*Triglochin palustre*), marsh pennywort (*Hydrocotyle vulgaris*), devils-bit scabious and marsh willowherb (*Epilobium palustre*).

There were some larger expanses of M3x within the M15d community in which common cottongrass was strongly dominant. Common cottongrass made up to 80-90% of the vegetation cover, and there was little dwarf shrub below it (<25% of the ground cover). However, there were generally a variety of other species, particularly tormentil but also devil's bit scabious, lousewort, heath spotted orchid and common dog violet. It is thought that these areas, mapped as M3x, represent a transitional point between M3 and M15. It is possible that some areas may have been on shallower peaty soils.

Peat bog (peatland setting)

In the FWT peat bog is defined as wet peat, which is generally deeper than 0.5m, with heather, cottongrasses and some small sedge species (SNIFFER, 2009b). Peat bogs are generally considered rainwater fed, and not considered to be potential GWDTE (SEPA, 2017). However, the NVC community M25 is considered potentially moderately groundwater dependant depending on the hydrological setting (SEPA, 2017). M3 is not considered to be a potential GWDTE in SEPA guidance.

Bare peat

Bare peat was mapped where there were extensive areas of bare peat within the Satellite Launch Facility Study Area with common cottongrass was the main colonising species. This was seen as part of the hagging within the blanket bog and as bare peat areas in wet modified bog/wet heath. These may have been pools in wetter months.

The PCA bases the condition of peatlands on indicators such as bog-moss cover, extent of bare peat and evidence of grazing and burning (Peatland Action, 2016). In PCA terminology the bare peat was considered to be both modified and actively eroding. Using the PCA Support Tool, the blanket bog would be considered of bad condition.

One NVC community was mapped within the bare peat classification.

M3 *Eriophorum angustifolium* bog pool community

Areas that had a high proportion of bare peat with common cottongrass were mapped as the NVC community M3.

M3 is a species poor community, generally made up of common cottongrass on redistributed peat or areas where the peat bog has been lost. Within the Satellite Launch Facility Study Area, the majority of the M3 community was found in hagg fields, or bare peat areas within wet modified bog/wet heath.

In the hagg fields the M3 bare peat could be filled with water or as bare peat pans with little vegetation. In these areas common cottongrass with perhaps a little feathery bog-moss (*Sphagnum cuspidatum*) and/or flat-topped bog-moss were present.

Peat bog (peatland setting)

In the FWT peat bog is defined as wet peat, which is generally deeper than 0.5m, with heather, cottongrasses and some small sedge species (SNIFFER, 2009b). The Phase 1 Habitat bare peat could fit into this peat bog category (although some areas were not considered to be on peat >0.5m) and the NVC community M3 is within this FWT category. M3 is not considered to be potential GWDTE (SEPA, 2017).

Fen

Fens are defined as minerotrophic mires usually over deep peat. The fen community was dominated by common sedge. A single NVC community was described.

Mxd *Carex nigra* provisional fen, *Molinia caerulea* sub-community

Dargie (1998a, 1998d) describes a provisional fen community that was not included in the original NVC publications. It is described as a rich fen, dominated by common sedge, developing in areas which are very wet, and poorly drained, but not inundated for long periods.

Within the Satellite Launch Facility Study Area there were several locations where the species composition best fit this provision NVC community descriptions. These areas were generally in damp hollows and seepage lines. Common sedge was dominant with purple moor-grass abundant. Sweet vernal grass and Yorkshire fog were also frequently present. Tormentil was the only forb with any prominence, although there were small amounts of bog asphodel, marsh willowherb and common dog violet.

Fen

In the FWT fen is defined as tall herb vegetation, including flowering plants, reeds, sedges and rushes (SNIFFER, 2009b). The NVC community Mxd was found in seepage lines and hollows and may fit within this FWT category. Mxd is not included in SEPA guidance (SEPA, 2017).

Dry dwarf shrub heath

Dry dwarf shrub heath was recorded within the Satellite Launch Facility Study Area. It was dominated by heather, with crowberry and bell heather both prominent. The dry dwarf shrub heath was found on steep slopes and on dry, raised patches within the blanket bog habitat in the north of the Satellite Launch Facility Study Area and within the wet modified bog/wet heath to the west of the Satellite Launch Facility Study Area. It was formed on peat which was apparently less than 0.5m deep, although it is possible some of the dry heath that was mapped was actually on dry (and degraded) deeper peat, with no visible indication of the peat depth.

There was a single dry heath NVC community described within the Satellite Launch Facility Study Area.

H10b *Calluna vulgaris – Erica cinerea* heath, *Racomitrium lanuginosum* sub-community

The H10b heath community was dominated by heather although the heather was grazed short giving an open structure. Bell heather and crowberry were both present, with crowberry abundant and a preferential for this sub-community along with the woolly fringe moss and lichens (*Cladonia spp.*). Mat grass and heath rush were common, as was purple moor-grass. Tormentil was a common forb along with devil's-bit scabious in some stands. There was occasionally heath wood-rush and common sedge present.

Dry heath communities are not considered to be wetland habitats in the FWT and are not potential GWDTE.

Acid flush

There was a small flush running downhill in the west of the Satellite Launch Facility Study Area. The flush was bog-moss dominated, with a variety of mosses, including flat-topped bog-moss. Common sedge and bulbous rush were the most common species, although they were sparse. It was mapped as a mosaic with the heath rush dominated acid grassland (U6) and as it became more diffuse on the lower slopes it was mapped as a mosaic with wet modified bog/wet heath (M15d) and acid grassland.

M6b *Carex echinata – Sphagnum fallax* mire, *Carex nigra – Nardus stricta* sub-community

The M6b sub-community was dominated by bog-mosses, particularly flat-topped bog-moss. Common haircap was occasional. The community was species poor, and sparsely vegetated over with common sedge and bulbous rush most common. Mat grass and heath rush were occasional, more at the transition with the U6 grassland than in the M6 community itself.

Seepage/Flush (slope settings)

In the FWT seepage/flushes are defined as variable vegetation associated with diffuse springs on hill slopes. This is similar to the Phase 1 Habitat acid flush and the NVC community M6. This category is defined as a potentially highly GWDTE (SEPA, 2017). According to the BGS geological maps the M6 was located in close proximity to the intersection between two different bedrock types, with the Saxa Vord Pelite Formation to the west and Skaw Intrusion to the east. This indicates a fault line (or some geological change), which can cause groundwater to discharge. It is, therefore, considered possible or even likely that the M6 flush was associated with groundwater.

Open vegetation

There were small patches of nettles, which fit the NVC community OV25. These were not mapped separately but formed very small stands within the acid grasslands.

OV25 *Urtica dioica – Cirsium arvense* community

There were occasionally, usually small, patches of nettles and/or creeping thistle (*Cirsium arvense*) across the Satellite Launch Facility Study Area, usually associated with the buildings and surrounding enriched grasslands.

This dominated community is not considered a wetland and is not a potential GWDTE.

Standing water

There were several small standing water pools within the Satellite Launch Facility Study Area. Most were dry, or partially dry at the time of survey. On Lamba Ness the marginal vegetation was often (but not exclusively) brackish in nature, while inland pools were more regularly dystrophic. Where there was marginal, emergent or inundation vegetation they were described separately.

Water margin and inundation vegetation

This habitat type comprises of emergent or frequently inundated vegetation. There were a number of small vegetated, or partly vegetated pools, and pool margins within the Satellite Launch Facility Study Area, particularly on Lamba Ness, with a variety of vegetation types within them. They were generally very small, being just a few meters in size. Some were mapped, and some target noted. A total of four water margin and inundation NVC communities were described:

- The pools dominated by common spiked-rush (*Eleocharis palustris*) were classed as NVC community S19a.
- Species poor marginal vegetation dominated by shoreweed was classed as NVC community A22a.
- Species poor marginal vegetation dominated by bulbous rush was classed as NVC community A24.
- A single area dominated by creeping bent and creeping buttercup was classed as NVC community OV28.

S19a *Eleocharis palustris swamp, Eleocharis palustris* sub-community

The S19a community was found in wet hollows on Lamba Ness. These areas were dominated by common spiked-rush standing in damp to wet ground at the time of the survey. Lesser spearwort was common in some stands but it was generally very species poor with limited records of common sedge and jointed rush. In one stand marsh pennywort was apparent and there was also occasional velvet bent, common chickweed and bulbous rush. This particular patch had some affinities with the S19c descriptions.

A22a *Littorella uniflora - Lobelia dortmanna* community, *Littorella uniflora* sub-community

There were two small areas where shoreweed dominated. One area was where peaty-sandy soil had been cut away in the past leaving a pool with shoreweed around the edges. The other area was over the foundations of an old building. Shoreweed formed a dense, species poor mat, where it was dominant with few other species recorded at the time of survey.

The pool had several large rocks within it and the water was smelly with thick algae growth.

A24 *Juncus bulbosus* community

There were some dry (at the time of survey) pools, with bare, cracked peaty soil which was poached by sheep. In these dried pools there was approximately 50% bare peaty soil and 50% bulbous rush, with some velvet bent also present. These areas were clearly water filled at certain times of the year.

OV28 *Agrostis stolonifera – Ranunculus repens* community

Creeping bent and creeping buttercup were found where a small stream met a small, sheltered beach. The stolons and runners were growing across a wet sandy surface substrate with a small 30cm wide stream running through the middle. There was also common chickweed, cuckooflower (*Cardamine pratensis*) and marsh willowherb occasionally present.

Swamp

Despite the association with pools, the water margins and inundation communities A22, A24, and OV28 are not considered to be wetlands in the FWT and are not listed as potentially GWDTE. S19 is considered as part of the swamp category in the FWT but is not listed as a potential GWDTE.

Watercourses and drains

There were a number of small watercourses across the Satellite Launch Facility Study Area (defined using the OS 1:25,000 maps), which were subject to artificial management and so were often straight and well defined. Drains were also mapped across the Satellite Launch Facility Study Area. These were generally associated with the wet modified bog and wet modified bog/wet heath. Some of the drains were target noted. They were usually about 1m wide and 50-60cm deep (but some were up to ca. 1m deep). A total of ca. 2.3km were mapped as watercourses with an additional ca. 2.2km mapped as ditches.

Bare ground

Some small areas were mapped as bare ground. These were either areas of bare sand or of exposed peaty-mineral soils.

Buildings and roads

Lamba Ness was previously a military base during the wars with associated infrastructure evident across the peninsula. Many of the military buildings were derelict and used as shelter by the livestock resulting in localised fertilisation. There were also some areas that were ruined, with only foundations remaining. Roads and tracks were mapped across the Satellite Launch Facility Study Area. These included the road that links Norwick and Skaw and the track that leads to the head of Lamba Ness.

Results – Saxa Vord and Northdale Road Study Area

The Phase 1 Habitat survey map for the Saxa Vord Study Area and the Northdale Road Study Area is shown in Appendix 7.2 Drawing 8 and a list of habitat types are displayed in Table 4. The NVC survey map of the Saxa Vord and Northdale Road Study Area is shown in Appendix 7.2 Drawing 9 with the potential GWDTE shown in Appendix 7.2 Drawing 10[2]. These drawings are supported with a list of target notes (Annex 1, Appendix 7.2 Drawing 11). Photographs of the habitats and interesting features are provided in Annex 2.

Overview

The centre of the Saxa Vord Study Area was largely made up of buildings, roads and car parking spaces. Much of the grassland around the buildings and roads was frequently mown amenity grassland with perennial rye grass and daisy. The most common habitat surrounding the buildings and roads was improved grassland which was subject to varying intensities of sheep grazing. There were small patches of semi-improved neutral grassland along road verges and in discrete, less intensively managed locations.

The Northdale Road Study Area was largely made up of improved grassland. There were also habitats that were consistent with those described in the Satellite Launch Facility Study Area including dry dwarf shrub heath and acid grassland. There were some small patches of neutral grassland most of which were mapped as a mosaic with the acid grassland and improved grassland.

Study Area	Phase 1 Habitats	Area (ha)	% of Study Area
Saxa Vord	Improved grassland	8.9	51.1
	Buildings and roads	5.5	31.5
	Amenity grassland	1.8	10.4
	Neutral grassland	1.2	7.0
	Total	**17.4**	**100**
Northdale Road	Improved grassland	6.6	41.4
	Acid grassland	3.4	21.3
	Dry dwarf shrub heath	3.2	20.3
	Acid grassland: neutral grassland	1.7	10.4
	Buildings and roads	0.5	3.2
	Neutral grassland	0.4	2.3
	Dry heath: acid grassland	0.1	0.7
	Neutral grassland: scrub	0.1	0.4
	Total	***16.0***	***100***

Table 4: The area of each of the Phase 1 Habitats found in the Saxa Vord Study Area and the Northdale Road Study Area.

[2] Drawings are provided within this document for ease of reference and higher resolution versions are provided separately as PDFs.

Habitat and Community Descriptions

Buildings and roads

The building and roads category includes the buildings and their gardens, roads, tracks, carparks and play courts. In the Saxa Vord Study Area the buildings included Saxa Vord Resort with restaurants, accommodation, a youth hostel and distillery. In the Northdale Road Study Area there were small sections of the existing road and some buildings. There is no associated NVC community.

Amenity grassland

Amenity grassland incudes intensively managed grassland which is regularly mown. It is typical of lawns and playing fields. Amenity grassland was common at Saxa Vord Resort. It contained a usual assemblage of species including perennial rye grass with daisy, white clover and creeping buttercup. There were occasional records of common sorrel (*Rumex acetosa*), red clover (*Trifolium pratense*), hogweed (*Heracleum sphondylium*), selfheal, bird's-foot trefoil and rarely heath spotted orchid.

The associated NVC community for this habitat is **MG7e *Lolium perenne – Plantago lanceolata* community** which is characteristic of verges and lawns which are regularly mown.

Amenity grassland is not considered to be a wetland and MG7 is not considered to be a GWDTE in SEPA's guidance.

Improved grassland

There was much improved grassland in the Saxa Vord Study Area and the Northdale Road Study Area which experienced a range of grazing intensity from sheep. Perennial rye grass was dominant in much of the improved grassland. In species poor fields the improved grassland was restricted to perennial rye grass, white clover with some Yorkshire fog, common sorrel and occasional bent grasses. In other fields a greater variety of grasses could be more prominent including Yorkshire fog, bent grasses and fescues. Sheep's sorrel, white clover and creeping buttercup were common forbs. In the fields surrounding the Northdale Road Study Area autumn hawkbit was prominent.

The associated NVC community for this habitat is **MG7 *Lolium perenne* leys**. Sub-communities ***MG7a Lolium perenne - Trifolium repens*** leys and **MG7b *Lolium perenne – Poa trivialis*** were both represented in the Saxa Vord and Northdale Road Study Areas. The MG7b could be fairly forb rich with red clover, white clover, autumn hawkbit, tormentil and lesser stitchwort all frequent in some stands, indicating that these fields receive light, or minimal, improvement.

There were occasional patches of creeping thistle in the improved grassland.

Improved grassland is not considered to be a wetland and MG7 is not considered to be a GWDTE in SEPA's guidance.

Neutral grassland

The Phase 1 Habitat category neutral grassland includes grasslands dominated by false oat-grass (*Arrhenatherum elatius*) and species-poor wet grasslands where soft rush and Yorkshire

fog are abundant. The neutral grassland within the Saxa Vord Study Area and Northdale Road Study Area included three NVC communities **MG1a *Arrhenatherum elatius* grassland, *Festuca rubra* sub-community, MG9 *Holcus lanatus – Deschampsia cespitosa* grassland** and **MG10a *Holcus lanatus – Juncus effusus* rush-pasture, typical sub-community.**

MG1a was recorded along some road verges and in discrete patches within Saxa Vord Resort. False oat-grass was generally overwhelmingly dominant.

A small, rough grassland in the Northdale Road Study Area was dominated by creeping soft-grass (*Holcus mollis*) with red fescue and sweet vernal grass. Pignut was the most common forb, with common sorrel and creeping buttercup. This was a very poor fit to the MG9 community.

There were occasional small patches of MG10a in the damp, hollows of grassland field where soft rush stood out amongst the other grassland and heath vegetation.

There was a patch of semi-improved neutral grassland in the northwest of the Saxa Vord Study Area which was covered in a thick thatch of senesced plant material. Between the thatch red fescue was abundant with bent grasses. Tormentil was the most common forb. It was difficult to place this into an NVC community due to the thick thatch. It was considered best to include it in the MG1a community, but lacked the false oat-grass, which is an early stage of this community type.

Marshy grassland, as described by the FWT, includes vegetation dominated by tussock forming grasses and rushes in damp soils. This includes the Phase 1 Habitat neutral grassland and NVC community MG10. The NVC communities MG10 is considered potentially moderately groundwater dependant depending on the hydrological setting (SEPA, 2017).

Unimproved acid grassland

The mat grass dominated acid grassland in the Northdale Road Study Area was consistent with that of the Satellite Launch Facility Study Area and descriptions are not repeated here. The associated NVC community was **U5b *Nardus stricta – Galium saxatile* grassland, *Agrostis canina – Polytrichum commune* sub-community**. This acid grassland is also defined as a montane grassland in the FWT. U5 is not considered a potential GWDTE.

Where the existing footpath goes between farmland fields, there was a mosaic of dry dwarf shrub heath and acid grassland. This was similar to the **U4b *Festuca ovina – Agrostis capillaris – Galium saxatile* grassland, *Holcus lanatus – Trifolium repens* sub-community** descriptions form the Satellite Launch Facility Study Area descriptions, although was not grazed. Common bent, red fescue, sweet vernal grass and Yorkshire fog were frequent to dominant. There were a variety of forbs including creeping buttercup, autumn hawkbit, white clover and tormentil (NVC community U4b).

Along the current road verge, at Houlanbrindy in the north of the Northdale Road Study Area there was an abundance of wild flowers in the U4b grassland, including thyme, bird's-foot trefoil, selfheal, autumn hawkwbit and sheep's-bit. These were usually 1-3m along the road verge, too small to map and were generally present with exposed bedrock showing though. This likely best fit the **U4b** grassland NVC community, although with some base enrichment from the exposed bedrock.

Dry dwarf shrub heath

The heather dominated dry dwarf shrub heath in the Northdale Road Study Area was consistent with that of the Satellite Launch Facility Study Area and descriptions. The associated NVC community was ***H10b Calluna vulgaris – Erica cinerea heath, Racomitrium lanuginosum sub-community***. The H10b community was of short heather with crowberry, bell heather and tormentil. Wavy hair-grass, sweet vernal grass, mat grass and common sedge were occasional to frequent. Several field gentian (*Gentianella campestris*) were recorded along the trackway at the transition of dry heath and semi-improved grassland

Dry heath communities are not considered to be wetland habitats in the FWT and are not potential GWDTE.

Scrub

There was a small patch of Japanese rose (*Rosa rugosa*) in the Northdale Road Study Area. It was ca. 2m tall and was found along the existing road edge and in old, ruined buildings.

Evaluation

Habitat evaluation

No parts of the three Study Areas formed part of a site designated for biological features. There are several designated sites on Unst with features that are nationally or internationally important. The closest nationally designated site is Norwick SSSI which is adjacent to the Satellite Launch Facility Study Area to the southwest. It is designated for its geological features (NatureScot, 2020). A section of ca. 85m of this geological SSSI is within the Study Area, at the cliffs in southwestern edge (Appendix 7.2 Drawing 12).

Norwick Meadows SSSI is also very close to the Northdale Road Study Area (ca. 60m south) and relatively near to the Satellite Launch Facility Study Area (ca. 600m south) (Appendix 7.2 Drawing 12). Norwick Meadows SSSI is designated for its valley fen wetlands and sand dunes (NatureScot, 2020). The Northdale Road Study Area is particularly close to the Norwick Meadows SSSI. Improved grassland is the main habitat type between the road and the SSSI, with a small area mapped as marshy grassland and acid grassland mosaic. These communities do not form part of the designated feature of the SSSI.

The other designated sites on Unst are designated for bird species and/or for calaminarian grassland and serpentine heath (e.g. Keen of Hamar SSSI and SAC and Crussa Field and the Heogs SSSI) (NatureScot, 2020).

There are also several Local Nature Conservation Sites on Unst. These are listed in Table 5.

Local Nature Conservation Sites on Unst	Primary Interest	Justification for Local Nature Conservation Site
Baltasound	Species	Glasswort (*Salicornia europea*) and annual sea-blite (*Suaeda maritima*).
Burn of Mailand	Species	Rare plants. Lesser tussock sedge (*Carex diandra*) and small bur-reed (*Sparganium natans*) are found nowhere else in Shetland. Rich bryophyte flora.
Haroldswick mires	Species	Schedule 1 bird species. The pool at Haroldswick is attractive to migrant birds. The base-rich mire vegetation is unusual in Shetland.
Lochs of Bordastubble and Stourhoull	Species	These water bodies are on the Unst serpentine; they are nutrient rich and support a variety of aquatic species. Breeding Schedule 1 bird species.
Skeo Taing	Species	The herb-rich turf with base-rich shell sand provides habitat for a diverse range of plants. The nationally rare autumn gentian (*Gentianella amarelle septentrionalis*) is found on site. This is the only site in Shetland where harebell (*Campanula rotundifolia*) may still occur.
Wick of Skaw	Geology	Easily identifiable exposure of a granite intrusion contact zone.
Belmont Quarry	Geology	Rock exposures across a major shear zone/ophiolite thrust. Part of the Shetland Ophiolite Suite.
Clibberswick Cross Geo	Geology	Part of the Shetland Ophiolite suite.
Hill of Clibberswick	Species	Two nationally scarce plant species are present on-site, Norwegian sandwort (*Arenaria norvegica*) and northern rock cress (*Arabis petraea*)

Table 5: The Local Nature Conservation Sites on Unst with their features of primary interest and the justification as specified in the Shetland Island Development Plan Local Nature Conservation Site guidance (SIC, 2015).

Some of the habitats described within the Satellite Launch Facility Study Area are similar to, or approaching descriptions for, Annex 1 habitats and/or SBL habitats. These include:

- Coastal grasslands;
- Saltmarsh;
- Sand dunes;
- Wet modified bog;
- Blanket bog;
- Wet modified bog/wet heath
- Fen;
- Dry dwarf shrub heath;
- Acid flush; and
- Water margin vegetation.

Dry dwarf shrub heath was also recorded in the Northdale Road Study Area and may have been similar to, or approaching, Annex 1 habitats and/or SBL habitats descriptions.

Coastal grassland

The Annex 1 habitats vegetated sea cliffs of the Atlantic and Baltic coasts are described as "*vegetated sea cliffs are steep slopes fringing hard or soft coasts, created by past or present marine erosion, and supporting a wide diversity of vegetation types with variable maritime influence*" and "*The most exposed areas support maritime vegetation dominated by a range of salt-tolerant plants*". The description of Annex 1 habitat vegetated sea cliffs includes the NVC communities MC8 and MC10 (EC, 2013). The coastal grassland communities within the Satellite Launch Facility Study Area meet these descriptions. The coastal grasslands in the Satellite Launch Facility Study Area also meet the description of the UK BAP habitat maritime cliffs and slopes which is a SBL habitat.

No clear published account of the total area of coastal grassland in Shetland was found. There is an estimated 12,000ha (120km^2) of coastal grasslands in Scotland and 22,138ha (221.38km^2) in the UK (JNCC, 2020). There was a total of 19.6ha of coastal grassland recorded within the Satellite Launch Facility Study Area (0.16% of the Scottish total). Given that Shetland has much grazed grassland around its extensive coastline it is not considered likely to be a particularly rare habitat type in Shetland, although it is considered to be potentially species rich and ecological valuable habitat (PlantLife, 2014). The sheep grazed coastal grassland within the Satellite Launch Facility Study Area was relatively species rich and contained a good assemblage of species. The area is grazed throughout the summer period, which may limit species richness (PlantLife, 2014). No particular Shetland rarities were recorded in the coastal grassland and it has not been identified as a location of particular conservation importance in Shetland, such as a SSSI or Local Nature Conservation Site nor is it near one with coastal grasslands as a citation feature (NatureScot, 2020; SIC, 2015). Following due consideration of the range of factors listed in the guidance (CIEEM, 2018) the coastal grasslands within the Satellite Launch Facility Study Area were considered to be of local importance.

Sand dune

The sand dune habitats within the Satellite Launch Facility Study Area are similar to the Annex 1 habitats descriptions for embryonic shifting dunes, which includes the NVC community SD4, and fixed dune vegetation, which includes NVC community SD8. The Annex 1 habitat description for embryonic shifting dunes states that "*Embryonic shifting dunes vegetation exists in a highly dynamic state and is dependent on the continued operation of physical processes at the dune/beach interface. It is the first type of vegetation to colonise areas of incipient dune formation at the top of a beach*." It goes on to say "*Embryonic shifting dunes are inherently species-poor and have a limited range of floristic variation. The predominant plants are strandline species such as sea rocket* Cakile maritima *and the two salt-tolerant, sand-binding grasses: lyme-grass* Leymus arenarius *and sand couch* Elytrigia juncea" (JNCC, 2020). The SD4 sand dune community described in the Satellite Launch Facility Study Area is considered to meet these descriptions.

The Annex 1 habitat description for fixed dune vegetation states that "*Fixed dune vegetation occurs mainly on the largest dune systems, being those that have the width to allow it to develop. It typically occurs inland of the zone dominated by marram* Ammophila arenaria *on*

coastal dunes, and represents the vegetation that replaces marram as the dune stabilises and the organic content of the sand increases. This description does not closely match what was seen in the Satellite Launch Facility Study Area and what habitat was present was a very small example of sand dune and dune grassland.

The sand dunes in the Satellite Launch Facility Study Area meet the description of the UK BAP Habitat coastal sand dunes which is a SBL habitat. There was a total of 0.3ha of sand dunes mapped within the Satellite Launch Facility Study Area. There is estimated to be 1,040ha (10.4km^2) of sand dune vegetation in Shetland including 3.4ha of embryonic dunes and 239.3ha of fixed dunes (Dargie, 1998a). There is an estimated 50,000ha (500km^2) of sand dunes in Scotland (70,000ha (700km^2) in the UK) (JNCC, 2020). The Scottish total for embryonic dunes is 90ha (295ha for the UK), whereas the fixed dune vegetation is much more common with an estimated 14,800ha (148km^2) in Scotland (22,400ha (224km^2) in the UK) (JNCC, 2020).

Dargie (1998b) states that "*The nature conservation interest of the site [Inner Skaw] is low due to small site area and limited range of vegetation*". This 2018 survey supports this statement, as the vegetation is sparse, generally species poor with limited examples of dune vegetation and is small in size. The embryonic dunes make up ca. 9% of the regional total and 0.3% of the Scottish total. Much of it was bare sand, and it has been considered to be of low conservation interest due to its limited size and range of vegetation. However, it is nearby to a SSSI designated for the sand dune features, namely Norwick Meadows SSSI. Therefore, on balance, the value of the sand dune vegetation within the Satellite Launch Facility Study Area is elevated and considered to be of regional importance.

Saltmarsh

Saltmarsh is included in the Annex 1 habitat Atlantic salt meadows which includes the NVC community SM16. The description of Annex 1 habitat Atlantic salt meadows states that Atlantic salt meadows "*develop when halophytic vegetation colonises soft intertidal sediments of mud and sand in areas protected from strong wave action. This vegetation forms the middle and upper reaches of saltmarshes, where tidal inundation still occurs but with decreasing frequency and duration*". The description of Annex 1 habitat Atlantic salt meadows does not include perched saltmarshes and the description does not fit closely to the type of saltmarsh community found within the Satellite Launch Facility Study Area and so does not meet this criteria. Saltmarsh habitats are on the SBL. Using the UK BAP habitat definitions saltmarsh is also restricted to intertidal areas with the upper limit being one metre above the level of highest astronomical tides (Maddock, 2011). These do not take into account perched saltmarsh as found in the Satellite Launch Facility Study Area.

Perched saltmarsh is a relatively rare (and likely under-recorded) habitat type in Scotland and across the UK (Haynes, 2016). The saltmarsh survey of Scotland describes perched saltmarshes as "*often very small or present as short saltmarsh turf on cliff tops, which makes them difficult to map. These marshes are likely recorded more frequently as part of cliff vegetation surveys and may be interpreted as being closely associated with maritime cliff vegetation, rather than saltmarsh*" (Haynes, 2016). A total of 0.4ha of perched saltmarsh was recorded within the Satellite Launch Facility Study Area with additional areas too small to map. No area metric for perched saltmarsh is given in the saltmarsh survey of Scotland.

Nevertheless, the saltmarsh recorded in this 2018 survey appears to be the most northerly recorded in the UK. However, it was generally species poor with saltmarsh rush sometimes the overwhelmingly dominant species present. The Satellite Launch Facility Study Area has not been identified as a location of particular conservation importance in Shetland, such as a SSSI or Local Nature Conservation Site. Baltasound, which is ca. 6km away is a Local Conservation Site with the saltmarsh species glasswort (*Salicornia europea*) and annual sea-blite (*Suaeda maritima*) a justification citation feature. (SIC, 2015). These species were not found in the Satellite Launch Facility Study Area and the type of saltmarsh, specifically perched saltmarsh, is not a feature of designated sites.

The perched saltmarsh in the Satellite Launch Facility Study Area could be considered to be of regional importance because it is a relatively rare habitat in the UK and it appears to be the most northerly saltmarsh in the UK. However, the area of perched saltmarsh in the Satellite Launch Facility Study Area is tiny and species poor. It is not an Annex 1 or SBL habitat and it is likely under-recorded in the UK. Taking all these aspects into consideration the small area of perched saltmarsh is considered to be of local importance.

This survey supports Haynes (2016) who states that "*It is likely that there is more perched saltmarsh present across Scotland than is currently recorded. The vegetation is strongly associated with the 'MC' classification and further research into the vegetation of maritime cliffs is required*".

Blanket bog

The blanket bog (M18, M19), wet modified bog (M25, M3) and wet modified bog/wet heath (M15) transition are all considered within this section.

All blanket bog, regardless of condition, is listed by European legislation, under Annex 1 of the Habitats Directive (Directive on the Conservation of Natural Habitats and Wild Fauna and Flora EC/92/43). This includes wet heath, M15, but not M25 (European Commission, 2013). Active, peat forming blanket bog has a priority status. 'Active' blanket bog is defined as "*supporting a significant area of vegetation that is normally peat-forming. Typical species include the important peat-forming species, such as bog-mosses* Sphagnum *spp. and cottongrasses* Eriophorum *spp., or purple moor-grass* Molinia caerulea *in certain circumstances, together with heather* Calluna vulgaris *and other ericaceous species*. *Thus sites, particularly those at higher altitude, characterised by extensive erosion features, may still be classed as 'active' if they otherwise support extensive areas of typical bog vegetation, and especially if the erosion gullies show signs of recolonisation*" (JNCC, 2019).

Blanket bog, including degraded blanket bog with wet heath vegetation (M15) and purple-moorgrass (M25) is listed as a SBL habitat.

The blanket bog habitat in the Satellite Launch Facility Study Area had an abundance of common cottongrass with heather and other ericaceous species such as cross-leaved heath and crowberry. Bog-mosses were present, but not generally as a continuous carpet. Erosion and grazing pressures were evident.

A PCA of the blanket bog in the Satellite Launch Facility Study Area was undertaken during the Phase 1 Habitat and NVC survey. All of the blanket bog in the Satellite Launch Facility

Study Area was considered to be modified through grazing. Some of the blanket bog (degraded areas of M3) was also considered likely to be actively eroding with erosion features and bare peat present. This has been displayed in Appendix 7.2 Drawing 6. Using the 'PCA support tool' the blanket bog in the Satellite Launch Facility Study Area was considered to be of intermediate condition, with areas of bad quality where the erosion was most pronounced (areas of M3).

The blanket bog considered to be in best ecological condition, specifically for the Satellite Launch Facility Study Area, was considered to be the M18 and M19 communities.

Using the evidence provided here, and the 'PCA Support Tool', the blanket bog within the Satellite Launch Facility Study Area could be judged as inactive and likely to be an atmospheric carbon source, rather than a carbon sink. However, this is a rough, subjective tool, and doesn't take into account subtleties and variation within the bog. Certainly, the eroding blanket bog is thought to be a carbon source rather than a sink and so unlikely to be active. But, given the northern location of the Satellite Launch Facility Study Area, and the reasonable quality of at least some of the blanket bog there is a degree of uncertainty as to its activity status or not. Therefore, it is considered that the M18 blanket bog may be active/partially active and the M19 blanket bog in the Satellite Launch Facility Study Area is likely to be mostly inactive but may have some areas that are still partially active. Therefore, the blanket bog in the Satellite Launch Facility Study Area is considered to be approaching Annex 1 priority habitat definitions.

The PCA considered that the areas of wet modified bog and wet modified bog/wet heath transition in the Satellite Launch Facility Study Area to be modified through grazing with some areas drained (Appendix 7.2 Drawing 6). Using the 'PCA Support Tool' the wet modified bog and wet modified bog/wet heath transition in the Satellite Launch Facility Study Area were considered to be of intermediate condition and unlikely to be normally active.

There is an estimated 2,224,104ha (22,241km^2) of blanket bog in the UK (JNCC, 2020) and 1,759,000ha (17,590km^2) in Scotland (JNCC, 2020). Blanket bog (in a variety of conditions) is a widespread and common habitat across Shetland. There is an estimated 53,430ha (534.3km^2) of peatland (which in Shetland is considered synonymous with blanket bog as there is little e.g. fen habitat) with additional areas also mapped as a mosaic with peatland (19km^2) (The Macaulay Institute, 1993).

The Satellite Launch Facility Study Area had 2.6ha of blanket bog habitat (including matrix with bare peat). Although some of the blanket bog met UK BAP and Annex 1 habitat definitions and may have been approaching Annex 1 priority habitat definition, there is considerably less than 1% of the national and regional total (0.0001% and 0.005% respectively). Therefore, the quantity, size and condition present is not considered to be of national or regional importance.

The Satellite Launch Facility Study Area had a further 37.5ha of wet modified bog/wet heath transitional habitat (including matrixes). This is considerably less than 1% of the national and regional total of blanket bog (0.002% and 0.07% respectively). Therefore, the quantity, size and condition of wet modified bog/wet heath habitat is not considered to be of national or regional importance.

The Satellite Launch Facility Study Area had a further 24.2ha of wet modified bog habitat. Again, this is considerably less than 1% of the national and regional total of blanket bog (0.001% and 0.05% respectively). Therefore, the quantity, size and condition present is not considered to be of national or regional importance.

The Satellite Launch Facility Study Area had a combined total of 64.3ha of bog habitats (including blanket bog, wet modified bog and wet modified bog/wet heath). The total of these habitat types is considerably less than 1% of the national and regional total (0.004% and 0.1% respectively). Therefore, the quantity, size and condition present is not considered to be of national or regional importance.

Furthermore, the Satellite Launch Facility Study Area has not been identified as a location of particular conservation importance in Shetland, such as a SSSI or Local Nature Conservation Site. The area is not near site designated for conservation importance with blanket bog as a citation feature or justification feature (NatureScot, 2020; SIC, 2015), although Haroldwick mires, which are ca. 3.8km away, has base-rich mire vegetation which is unusual in Shetland (SIC, 2015). Therefore, the blanket bog within the Satellite Launch Facility Study Area does not form an important wildlife corridor or link between important designated blanket bog patches.

The carbon and peatland maps show a small section of the northwest of the Satellite Launch Facility Study Area as having peatland with peatland vegetation (Category 1), which is consistent with the location of much of the blanket bog habitat mapped in the Satellite Launch Facility Study Area and with the areas of pools in the wet modified bog/wet heath transition. Class 1 is described as "*Nationally important carbon-rich soils, deep peat and priority peatland habitat. Areas likely to be of high conservation value*" (Scotland's Soils, 2017). The areas depicted as wet modified bog is mapped as Class 5 peat soils with no peatland vegetation, and the area mapped as wet modified bog/wet heath transition is mostly mapped as Class 4 - predominantly mineral soil with some peat soil with the vegetation described as heath with some peatlands.

Following due consideration of these the size, quality and condition of the blanket bog, and considering the widespread nature of blanket bog (in various conditions) in Shetland and on Unst, the blanket bog within the Satellite Launch Facility Study Area was considered to be of local importance. The wet modified bog/wet heath transitional habitat was considered to be of local importance. The wet modified bog was considered to be, at best, of local importance.

Wet modified bog/wet heath

The wet modified bog/wet heath has been assessed as both wet heath and wet modified bog within the blanket bog evaluation.

Wet dwarf shrub heath is included in the upland heath SBL habitat. Using the UK BAP definitions for this habitat in favourable condition is defined as "*dominated by a mixture of cross-leaved heath, deergrass, heather and purple moor-grass over an understory of bog-moss*" (Maddock, 2011). Annex 1 Northern Atlantic wet heath includes M15 wet heath (JNCC, 2020). There is an estimated 467,714ha (4,677km^2) of wet dwarf shrub heath in the UK and 370,000ha (3,700km^2) in Scotland (JNCC, 2020). There is an estimated 16,500ha (165km^2) of heather moorland in Shetland, with additional areas of mosaics making a further 37,400ha (374km^2; The Macaulay Institute, 1993). There was 37.5ha of wet modified bog/wet dwarf

shrub heath within the Satellite Launch Facility Study Area, (including mosaics). The combined total is much less than 1% (0.2%) of the Shetland total.

The wet modified bog/wet heath has been subjected to current and historic management practices of grazing and draining. It was fairly species poor, with common cottongrass often a dominant component. The Satellite Launch Facility Study Area is not designated as a SSSI or Local Nature Conservation Site for wet dwarf shrub heath. There is no nearby designated site with wet dwarf shrub heath as a citation or justification feature (NatureScot, 2020; SIC, 2015). Therefore, the wet modified bog/wet heath within the Satellite Launch Facility Study Area does not form an important wildlife corridor or link between important designated blanket bog patches. The wet modified bog/wet heath in the Satellite Launch Facility Study Area was not considered to be of particularly high ecological value but may have some restoration potential. Following due consideration of these factors, and also those listed in the best practice guidance (CIEEM, 2018), the wet dwarf shrub heath was evaluated as being of local importance.

Dry heath

Dry dwarf shrub heath is included in the upland heath SBL habitat. Using the UK BAP definitions for this habitat in favourable condition it is defined as being "*dominated by dwarf shrubs such as heather, bilberry, crowberry, and bell heather*" (Maddock, 2011). Annex 1 European dry heath includes dwarf shrub dominated vegetation with heather, bilberry and bell heather (JNCC, 2020). Some of the dry dwarf shrub heath may have been approaching these definitions, but it was found in small patches, within a mosaic of blanket bog. There is an estimated 893,540ha (8,935km^2) of dry dwarf shrub heath in the UK and 479,000ha (4,790km^2) in Scotland (JNCC, 2020). There is an estimated 16,500ha (165km^2) of heather moorland in Shetland, with additional areas of mosaics making a further 37,400ha (374km^2; The Macaulay Institute, 1993). There was 0.7ha of dry dwarf shrub heath within the Satellite Launch Facility Study Area with an additional 6.5ha mapped as a mosaic. There was a further 3.3ha (including mosaics) mapped within the Northdale Road Study Area. The combined total is considerably less than 1% (0.06%) of the total in Shetland. The Satellite Launch Facility Study Area has not been identified as a location of particular conservation importance in Shetland, such as a SSSI or Local Nature Conservation Site nor is it near one with dry dwarf shrub heath as a citation feature or justification feature (NatureScot, 2020; SIC, 2015). Therefore, the dry heath within the Satellite Launch Facility Study Area does not form an important wildlife corridor or link between important designated dry heath patches. Consequently, the dry dwarf shrub heath was not considered to be of sufficient quantity or quality to be nationally or regionally important and was evaluated as being of local importance.

Acid flush

Acid flush is listed as a SBL habitat categorised. Using the UK BAP habitat definitions upland flush is defined as 'peat or mineral-based terrestrial wetlands in upland situations, which receive water and nutrients from surface and/or groundwater sources as well as rainfall. It is a varied habitat category but is typically dominated by sedges and their allies, rushes, grasses and occasionally wetland herbs and/or a carpet of bryophytes' (Maddock, 2011). The flush habitat (NVC community M6) within the Satellite Launch Facility Study Area is equivalent to this definition. Upland flush UK BAP habitat is widespread but local throughout the uplands of Scotland (Maddock, 2011). The extent has not been recorded as it has not been

comprehensively surveyed in many areas and tends to occur in small, sometimes numerous stands (Maddock, 2011). There was a single flush habitat in the Satellite Launch Facility Study Area making up just 0.3ha of acid flush recorded (including mosaics). This habitat type is widespread across Scotland. The quantity of this habitat within the Satellite Launch Facility Study Area was small and unconnected to other areas of this habitat type. The Satellite Launch Facility Study Area has not been identified as a location of particular conservation importance in Shetland, such as a SSSI or Local Nature Conservation Site nor is it near one with acid flush as a citation feature or justification feature (NatureScot, 2020; SIC, 2015). Following due consideration of not only these factors, but also others listed in the guidance (CIEEM, 2018), the upland flush habitat was considered to be of local importance (but see GWDTE evaluation).

Water margin vegetation

The Annex 1 habitat oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*) is described as "*This type of waterbody is restricted to sandy plains that are acidic and low in nutrients, and are therefore very scarce. The water is typically very clear and moderately acid*". The description goes on to say "*The habitat type is characterised by the presence of Littorelletalia-type vegetation. Such vegetation is characterised by the presence of water lobelia* Lobelia dortmanna, *shoreweed* Littorella uniflora, *or quillwort* Isoetes lacustris. *Only one species needs to be present to conform with the definition of this Annex I type and typically the vegetation consists of zones in which the individual species form submerged, monospecific lawns*" (JNCC, 2020). This habitat type is considered rare (JNCC, 2020). The SBL habitat oligotrophic and dystrophic lakes also includes the shoreweed community A22 (Maddock, 2011). The shoreweed community A22 within the Study Area is similar to these descriptions, particularly the pool which was on a peaty-sandy soil and species poor with shoreweed forming a carpet around the edge of a pool, although the pool was smelly with thick algae growth at the time of the survey. The pool in the Satellite Launch Facility Study Area was very small, with a small patch of the community on one edge. The Study Area has not been identified as a location of particular conservation importance in Shetland, such as a SSSI or Local Nature Conservation Site nor is it near one with acid flush as a citation feature or justification feature (NatureScot, 2020; SIC, 2015). Following due consideration of not only these factors, but also others listed in the guidance (CIEEM, 2018), the marginal vegetation habitat, specifically the NVC community A22, was considered to be of potentially regional importance due to its relative rarity.

Upland grassland

The upland grassland communities *Juncus squarrosus – Festuca ovina* grassland and *Nardus stricta – Galium saxatile* grassland are on the SBL. There are no descriptions for these in the UK BAP habitat descriptions (as they were not UK BAP habitats), but they correspond to the NVC communities U5 and U6. These are widespread community types in Scotland and Shetland (Scottish Government, 2013). They are also considered to require a '*watching brief only*' within the SBL. The Satellite Launch Facility Study Area has not been identified as a location of particular conservation importance in Shetland, such as a SSSI or Local Nature Conservation Site nor is it near one with upland grasslands as a citation feature or justification feature (NatureScot, 2020; SIC, 2015). Following due consideration of not only these factors, but also others listed in the guidance (CIEEM, 2018), these upland grassland communities are considered to be of local importance.

Fen

A variety of fens are Annex 1 habitats and SBL habitats. The small amount of common sedge dominated community did not correspond well to these descriptions. Consequently the ‘fen’ habitat was considered to be of site importance.

Species evaluation

Only one of the plant species recorded during field surveys in 2018 was identified as being on the SBL. This was field gentian which was recorded along the trackway in the Northdale Road Study Area.

Oysterplant, which was recorded in the fore-dune community, is an LBAP species and considered Near Threatened and Nationally Scarce and scarce in Shetland.

No other vascular species recorded during field surveys of the three Study Areas in 2018 were identified as an LBAP species or in the lists of rare and scarce species for Shetland (Scott *et al.,* 2002). Considerations of previous records within and near the three Study Areas are provided separately within the Shetland Space Centre Natural Heritage Desk Study.

There was no evidence of any notifiable non-native invasive species (e.g. Japanese knotweed) within the three Study Areas during walkover surveys. It should be noted that species distribution varies temporarily and spatially. The non-native invasive species Japanese knotweed is known to occur on Unst, including near Saxa Vord Resort (NBN Atlas, 2020) and so a watching brief should be kept for this species.

Groundwater dependant terrestrial ecosystems evaluation

GWDTE are defined as '*A terrestrial ecosystem of importance [at Member State level] that are directly dependent on the water level in or flow of water from a groundwater body (that is, in or from the saturated zone)*' (UKTAG, 2003). UKTAG defines pressures on GWDTE as '*being important when there is, or likely to be, significant damage on a GWDTE*' (UKTAG, 2005). Significant damage is defined as:

- '*the degree of damage occurring to a GWDTE (caused by groundwater related factors); and*
- the significance or conservation value of the ecosystem.' (UKTAG, 2005).

It has been suggested that non-statutory sites should be judged as significantly damaged if any groundwater-dependent ecosystem which is a UK BAP priority habitat is judged as damaged or declining for reasons of inadequate groundwater quality or quantity (UKTAG 2005).

SEPA's Guidance Note (2017) recommends that the listed NVC communities should be treated as GWDTE unless information can be provided to demonstrate they are not dependent on groundwater. SEPA (2017) does recognise that some of these communities are common across Scotland and that these communities may be considered GWDTEs only in certain hydrogeological settings or may have limited dependency on groundwater in certain hydrogeological settings.

NVC communities recorded in the three Study Areas that are considered in the guidance (SEPA, 2017) to be potentially groundwater dependent include:

- M6 *Carex echinata – Sphagnum fallax* mire;
- M15 *Trichophorum cespitosum – Erica tetralix* wet dwarf shrub heath;
- M25 *Molinia caerulea – Potentilla erecta* mire;
- MG9 *Holcus lanatus – Deschampsia cespitosa* grassland;
- MG10 *Holcus lanatus – Juncus effusus* rush-pasture;
- MG11 *Festuca rubra – Agrostis stolonifera – Potentilla anserine* grassland community; and
- U6 *Juncus squarrosus – Festuca ovina* grassland.

One NVC community that is not in the SEPA guidance, which was considered to be a potentially GWDTE (due to the association with similar/related communities that are listed as a potentially GWDTE), is:

- Mxd *Carex nigra* provisional fen, *Molinia caerulea* sub-community; and

Of these, only M6 is considered to be potentially highly groundwater dependent, depending on the hydrological setting (SEPA, 2017). All the other communities are considered potentially moderately groundwater dependent, depending on the hydrological setting (SEPA, 2017). All mosaics of habitat were allocated their GWDTE category according to the NVC community with the highest potentially GWDTE.

The bedrock for the majority of the Satellite Launch Facility Study Area was the Skaw Intrusion which was describe as a "*Low productivity aquifer*" with "*small amounts of groundwater in near surface weathered zone and secondary fractures; rare springs*" (BGS, 2020b). To the far west of the Satellite Launch Facility Study Area the bedrock is *Hevda Phyllite Formation which was also* described a "*Low productivity aquifer*" with "*small amounts of groundwater in near surface weathered zone and secondary fractures*" (BGS, 2020b). Therefore, the majority of the potentially GWDTE are considered most likely to be present due to waterlogged conditions sustained by high rainfall in the region, rather than groundwater for their maintenance.

The M6 community was located at the transition between the two bedrock types in the Satellite Launch Facility Study Area. This can be a source location for GWDTE, where groundwater is released at a spring or seepage line (McMullen, 2020). It is, therefore, considered that the M6 community may be an actual GWDTE.

In the Saxa Vord and Northdale Road Study Areas there were some habitats that were mapped as mosaics with MG10 and MG9, which are considered potentially moderately groundwater dependent depending upon the hydrological setting. The bedrock was Gruting Greenschist Formation for the Saxa Vord Study Area and Norwick Phyllite Formation for Northdale Road Study Area. Both of which were described as a "*Low productivity aquifer*" with "*small amounts of groundwater in near surface weathered zone and secondary fractures*" (BGS, 2020b). These areas of MG9 and MG10 may also be sustained by high rainfall in the region, rather than groundwater for their maintenance. However, the sensitive, nationally important, SSSI wetland habitats downhill of these potential GWDTEs should be considered in relation to the Saxa Vord and Northdale Road development, particularly as there may be some interconnection through ground or surface water.

A qualified hydrologist should be consulted to determine if the potential GWDTEs identified within this report are actual GWDTEs.

Table 6 displays the relationship between NVC communities, Phase 1 Habitats, FWT categories and the groundwater dependency as stated by SEPA (2017).

Phase 1 Habitat	NVC Community	FWT Category	Guidance potential GWDTE	Setting	Comment on setting	Comment on potential GWDTE
Wet modified bog/wet heath	M15	Peat bog	Potentially moderately GWDTE	Lower slopes and westward side of the Satellite Launch Facility Study Area	Set on peat with the bedrock classed as a low productive aquifer	Potentially low GWDTE, but likely that most influence is from the heavy rainfall in the region
Wet modified bog	M25	Peat bog	Potentially moderately GWDTE	Centre of Lamba Ness peninsula	Set on peat with the bedrock classed as a low productive aquifer	Potentially low GWDTE, but likely that most influence is from the heavy rainfall in the region
Fen	Mxd	Fen	Not included	Centre of Lamba Ness peninsula	In seepage lines and hollow	Potentially GWDTE, but likely that most influence is from the heavy rainfall and surface water movement – assigned moderate
Blanket bog	M19,	Peat bog	Not a GWDTE	Peat bog	Ombrotrophic	Not a GWDTE
Bare peat	M3	Peat bog	Not a GWDTE	Peat bog	Ombrotrophic	Not a GWDTE
Dry dwarf shrub heath	H10	Not a wetland	Not a GWDTE			Not a GWDTE
Acid flush	M6	Flush	Potentially highly GWDTE	Hill slope	Located at/near a change in the bedrock type	Potentially highly GWDTE
Acid grassland	U5 U6	Montane grassland Montane grassland	Not a GWDTE Potentially Moderately GWDTE	 With wet heath and other acid grasslands	 Set on peaty-sandy soils with the bedrock classed as a low productive aquifer	Not a GWDTE Potentially low GWDTE, but likely that most influence is from the heavy rainfall in the region
Coastal grassland	MC8, MC10 MG11	Not a wetland Wet grassland	Not a GWDTE	 Lamba Ness peninsula		

Phase 1 Habitat	NVC Community	FWT Category	Guidance potential GWDTE	Setting	Comment on setting	Comment on potential GWDTE
			Potentially Moderately GWDTE		Set on thin peaty-sandy soils with the bedrock classed as a low productive aquifer	Potentially low GWDTE, but likely that most influence is from the heavy rainfall in the region
Saltmarsh	SM16	Saltmarsh	Not a GWDTE			Not a GWDTE
Sand dunes	SD4, SD8		Not a GWDTE			Not a GWDTE
Neutral grassland	MG9 and MG10	Marshy grassland	Potentially Moderately GWDTE	In ditches and as part of a mosaic within acid grasslands MG9 and mosaic of MG10 with acid and improved grassland in the Northdale Road Study Area	The MG10 community found in ditches is likely to be influenced mostly from the surface water rather than groundwater. Where it was associated with other grassland it was on thin peaty-sandy soils with the bedrock classed as a low productive aquifer Some was uphill of SSSI designated wetland habitats	Potentially low GWDTE, but likely that most influence is from the heavy rainfall in the region Potential for connection with SSSI habitats
Water margins and inundation	S19 A22 A24 OV28	Swamp Not a wetland (standing water) Not a wetland (standing water) Not a wetland	None classed as GWDTE			None classed as GWDTE

Table 6: The relationship between Phase 1 Habitats, NVC communities, FWT categories and the GWDTE category defined by SEPA (2017).

Discussion

Satellite Launch Facility Study Area

There were a wide variety of habitat and plant communities described within the relatively small Satellite Launch Facility Study Area, with a total of 18 Phase 1 Habitats mapped and described using standard methods, plus a further three Phase 1 Habitat mapped as mosaics. A total of 28 NVC communities were found and described using standard survey methods. Many of these habitats were typical of Shetland, including wet modified bog, wet modified bog/wet heath, blanket bog, coastal grassland and acid grassland. There were also areas of sand dunes and pools with marginal vegetation.

Of the habitats present in the Satellite Launch Facility Study Area wet modified bog/wet heath was the most common (26% of the Satellite Launch Facility Study Area) closely followed by wet modified bog (24% of the Satellite Launch Facility Study Area) and coastal grassland (17% of the Satellite Launch Facility Study Area).

The dry dwarf shrub heath, blanket bog, wet modified bog, wet modified bog/wet heath, dune grassland, coastal grassland, acid flush and water margin vegetation habitats were evaluated as being approaching or equivalent to the descriptions of the SBL habitat and/or Annex 1 habitat descriptions, with blanket bog approaching Annex 1 priority habitat descriptions. The sand dune habitat and a water margin habitat were assessed as being of regional importance. The other habitats were evaluated as being of local importance due to a combination of factors including condition, size and the widespread nature of the habitat in Shetland.

Several habitats in the Satellite Launch Facility Study Area, including wet modified bog and neutral grassland, were assessed as being potentially moderately groundwater dependent. The acid flush habitat (NVC community M6) was assessed as potentially highly GWDTE.

When assessing the potential impact of the proposed development, the presence and importance of the habitats present should be considered and special attention paid to the sand dune and the water margin (specifically the A22 community) habitats in the Satellite Launch Facility Study Area, as well as the potentially GWDTE, particularly the potentially highly GWDTE acid flush (NVC community M6).

Saxa Vord Study Area

The Saxa Vord Study Area held a small number of habitats and communities, all of which are common in and around built-up areas and agricultural land. These included frequently mown amenity grassland, improved grassland, buildings and roads and small patches of neutral grassland along road verges and in discrete, less intensively managed locations.

None of these habitats were considered to have particular ecological importance or sensitivities. The non-native invasive species Japanese knotweed is known to be present on Unst, including a patch near the Saxa Vord Study Area and so a watching brief should be kept for this species.

The MG10 grassland in the Saxa Vord Study Area, was assessed as being potentially moderately groundwater dependent. It was assessed as potentially being hydrologically connected to the nationally important, designated wetland habitats in Norwick Meadows SSSI. Care should be taken to ensure there are no direct or indirect impacts on these potentially sensitive habitats and the adjacent designated site.

When assessing the potential impact of the proposed development, the presence and importance of the habitats present should be considered.

Northdale Road Study Area

The Northdale Road Study Area had a small number of habitats present, which were considered to be typical of Shetland. These included dry dwarf shrub heath, acid grassland, improved grassland and small patches of neutral grassland most of which were mapped as a mosaic with the acid grassland and improved grassland.

The dry dwarf shrub heath was evaluated as being approaching the descriptions of the SBL habitat and Annex 1 habitat descriptions. It was assessed as being of local importance.

The MG9 and MG10 grassland in the Northdale Road Study Area, was assessed as being potentially moderately groundwater dependent. It was assessed as potentially being hydrologically connected to the nationally important, SSSI designated wetland habitats in Norwick Meadows. Care should be taken to ensure there are no direct or indirect impacts on these potentially sensitive habitats and the adjacent designated site.

When assessing the potential impact of the proposed development, the presence and importance of the habitats present should be considered and special attention paid to the nearby SSSI designated site and the potential for hydrological connectivity of wetland habitats within the Northdale Road Study Area.

References

Athliserton, I., Bosanquet, S. and Lawley, M. 2010. *Moss and liverworts of Britain and Ireland: a field guide*. British Bryological Society, Plymouth.

Averis, A., Averis, B., Birks, J., Horsfield, D., Thompson, D. and Yeo, M. 2004. *An illustrated guide to British upland vegetation*. JNCC, Peterborough.

Botanæco. 2019. GWDTE decision tool. https://drive.google.com/file/d/1LOKvFmt1UOpd9DvXlGQoMbzxOY1rSHNl/view.

British Geology Society (BGS). 2020a. Geology of Britain Viewer. http://mapapps.bgs.ac.uk/geologyofbritain/home.html. Accessed April and May 2020.

BGS. 2020b. GeoIndex Onshore. http://mapapps2.bgs.ac.uk/geoindex/home.html?layer=BGSHydroMap. Accessed April and May 2020.

Chartered Institute of Ecology and Environmental Management (CIEEM), 2017. Guidelines for Preliminary Ecological Appraisal. CIEEM Guidance.

CIEEM. 2018. *Guidelines for Ecological Impact Assessment in the United Kingdom and Ireland, Terrestrial, freshwater, coastal and marine*, 3rd Edition. Version 1.1 (2019).

CIEEM. 2019. *On the lifespan of ecological reports and surveys*. CIEEM Guidance.

Cooper, E.A. 1997. *Summary descriptions of national vegetation classification grassland and montane communities*. JNCC, Peterborough.

Dargie, T. 1998a. *Sand dune vegetation survey of Scotland: Shetland*. *Volume 1: Main report*. Scottish Natural Heritage (SNH) Research, Survey and Monitoring Report No. 122 (Volume 1 of 3).

Dargie, T. 1998b. *Sand dune vegetation survey of Scotland: Shetland*. *Volume 2: Site report*. SNH Research, Survey and Monitoring Report No. 122 (Volume 2 of 3).

Dargie, T. 1998c. *Sand dune vegetation survey of Scotland: Shetland*. *Volume 3: NVC maps*. SNH Research, Survey and Monitoring Report No. 122 (Volume 3 of 3).

Dargie, T. 1998d. *Sand dune vegetation survey of Scotland: Western Isles*. *Volume 1: Main report*. SNH Research, Survey and Monitoring Report No. 122 (Volume 1 of 3).

Elkington, Dayton, N., Jackson, D.L. and Strachan, I.M. 2001. *National vegetation classification field guide to mires and heaths*. JNCC, Peterborough.

European Commission. 2013. *Interpretation Manual of European Union Habitats. European Commission DG Environment*. https://ec.europa.eu/environment/nature/legislation/habitatsdirective/docs/Int_Manual_EU28.pdf.

Fennell, M., Jones, L. and Wade, M. 2018. *Practical management of invasive non-native weeds in Britain and Ireland*. Property Care association.

Glenk, K., Martin-Ortega, J., Byg, A. 2017. *Online Condition Assessment Support Tool. Peatland Action*, SNH Commissioned Report.

Harvey, P. 2004. *Grouped Species Action Plan 'Arable associated* plants'. Living Shetland Biodiversity Action Plan.

Haynes, T.A. 2016. *Scottish saltmarsh survey national report*. SNH Commissioned Report No. 786.

Hearn, S. M.; Healey, J. R.; McDonald, M. A.; Turner, A. J.; Wong, J. L. G.; Stewart, G. B. 2011. The repeatability of vegetation classification and mapping. Journal of Environmental Management 92, pp. 1174-1184.

Joint Nature Conservation Committee (JNCC). 2010. *Handbook for Phase 1 habitat survey – a technique for environmental audit*, JNCC, Peterborough, Revised 2016.

JNCC. 2012. *Handbook for Phase 1 Habitat Survey, a technique for environmental audit Field Manual*. Revised Reprint.

JNCC. 2020. Joint Nature Conservancy Council. www.jncc.gov.uk Accessed April 2020.

Maddock, A. (ed.) 2011. *UK Biodiversity Action Plan; Priority Habitat Descriptions*. Updated from 2008. BRIG.

Marrs, R.H., Smart, S.M, Jones, M. and Hill, M.O. 2020. *TABLEFIT v. 3.0 & v.4, programs for the identification of vegetation types according to the British National Vegetation Classification*. Tablefit version 4.

McMullen, A. 2020. *GWDTE: Go With the Flow on Surveys*. https://botanaeco.co.uk/botan%C3%A6co-blog/f/gwdte-i-go-with-the-flow-on-survey?blogcategory=GWDTE.

National Biodiversity Network (NBN) Atlas, 2020. https://nbnatlas.org/. Accessed April and May 2020.

Peatland Action, 2016. Peatland Condition Assessment Guide. https://www.nature.scot/sites/default/files/2017-10/Guidance-Peatland-Action-Peatland-Condition-Assessment-Guide-A1916874.pdf.

PlantLife. 2014. *Coastal grasslands, a management guide*. https://www.plantlife.org.uk/application/files/4714/8155/7847/Coastal_grasslands_FINAL.pdf

Rodwell, J.S. (ed.) 1991. *British Plant Communities volume 2 Mires and Heaths*. Cambridge University Press, Cambridge.

Rodwell, J.S. (ed.) 1992. *British Plant Communities volume 3 Grassland and Montane Communities*. Cambridge University Press, Cambridge.

Rodwell, J.S. (ed.) 1995. *British Plant Communities volume 4 Aquatic Communities, Swamps and Tall-herb Fens*. Cambridge University Press, Cambridge.

Rodwell, J.S. (ed.) 2001. *British Plant Communities volume 5 Maritime communities and vegetation of open habitats*. Cambridge University Press, Cambridge.

Rodwell, J.S. 2006. *National Vegetation Classification Users' Handbook*. JNCC, Peterborough.

Scotland's Soils. 2017. *Carbon and Peatland Maps 2016*. https://soils.environment.gov.scot/maps/thematic-maps/carbon-and-peatland-2016-map/ Last updated May 2017. Accessd April 2020.

Scott, W., Harvey, P., Riddington, R. and Fisher, M. 2002. Rare Plants of Shetland. Shetland Amenity Trust.

Scottish Environment Protection Agency (SEPA), 2017. *Land-use planning system SEPA guidance note 31: Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems*. LUPG-GU31 Version 3.

Scottish Government. 2013. Scottish Biodiversity List. https://www.webarchive.org.uk/wayback/archive/20160402063428/http://www.gov.scot/Topics/Environment/Wildlife-Habitats/16118/Biodiversitylist/SBL.

Shetland Island Council (SIC). 2015. *Shetland Local Development Plan, Supplementary Guidance Local Nature Conservation Sites*, 2014, Adopted 2015.

NatureScot. 2020. Sitelink. https://sitelink.nature.scot/home Accessed in April 2020.

SNIFFER. 2009a. WFD95: *A Functional Wetland Typology for Scotland – Project Report.*

SNIFFER. 2009b. WFD95: *A Functional Wetland Typology for Scotland – Field Survey Manual*. Version 1.

Streeter, D., Hart-Davis, C., Hardcastle, A., Cole, F. and Harper, L. 2016. *Collins Flower Guide* 2nd Edition. Collins.

The Macaulay Institute. 1993. *The Land Use of Scotland, 1988, Executive Summary*. The Macaulay Landuse Research Institute.

UK Technical Advisory Group (TAG). 2005. *Draft protocol for determining 'significant damage' to a groundwater dependent terrestrial ecosystem v9.6 PR1 4-10-05*. http://www.wfduk.org/sites/default/files/Media/Characterisation%20of%20the%20water%20environment/Determining%20significant%20damage%20to%20a%20groundwater%20dependent%20terrestrial%20ecosystem_Draft_011205.pdf.

Annex 1: Target Notes

TG no.	Grid reference	Note
1	HP 66382 15287	An example of coastal grassland (NVC community MC8d) dominated by red fescue with white clover and thrift.
2	HP 66457 15310	An example of a hollow within the MC8d grassland where sheep lie and fertilise. There was sheep's fescue, common chickweed and rough meadow-grass.
3	HP 66480 15304	An exposed profile of soil demonstrating a thin richer (peaty soil) layer at the top, followed by a sandy-humus layer quickly changing into a thin gravel layer then a layer of finer sand below. The sheep clearly use this for shelter as there is evidence of dunging and wool left on the edge.
4	HP 66549 15241	An example of coastal grassland (NVC community MC10b), which had an abundance of sedges.
5	HP 66570 15314	There was a small flow of water running to the cliff edge and an old, dry ditch channel which was dominated by saltmarsh rush with lesser spearwort (NVC community SM16b).
6	HP 66572 15335	Part of an old ditch which was dominated by common cottongrass (NVC community M3x).
7	HP 66568 15362	There was a ca. 8m×5m area dominated by common spike-rush (NVC community S19a).
8	HP 66557 15361	A patch of sedge dominated coastal grassland (NVC community MC10d) where common sedge and carnation sedge were of very high abundance.
9	HP 66573 15407	Drainage ditches were present across the entre of Lamba Ness, within the wet modified bog (NVC community M25b). This target note is an example of a ditch which was approximately 50cm deep and 75cm wide. It was dry during the survey. There was occasionally Pyrenean scurvygrass (*Cochlearia pyrenaica*) in the ditches.
10	HP 66525 15384	An example of wet modified bog (NVC community M25b), a common habitat in the centre of Lamba Ness. It was dominated purple moor-grass, with common cottongrass and mat grass.
11	HP 66526 15384	Heath spotted orchids were found within the wet modified bog at this location.
12	HP 66843 15475	There were bright green patches of grassland (NVC community MG11) surrounding the old military buildings. These areas were nutrient rich and heavily grazed from sheep congregating around them for shelter.
13	HP 66856 15414	There were a series of dry pools, bare peat cracked and poached by sheep. There was approximately 50% bare peat and 50% bulbous rush, with some velvet bent also present. These areas were likely to be water filled at certain times of the year. There was a ditch than went to the road, which had the same dried pool community (NVC community A24).
14	HP 66863 15341	There was a wide, open water pool at this location. Clearly an area where peaty soils had been removed. The pool had several large rocks, peat stained water and was smelly with algae growth. At the edges there were mats of shoreweed (NVC community A22a).
15	HP 66863 15341	An example of improved coastal grassland, (NVC community MG11) around a military building. There was about 3m wide strip of this nutrient enriched grassland. It was dominated by perennial rye grass with buttercup and common chickweed.
16	HP 66876 15345	An example of coastal grassland (NVC community MC8d) with thrift and plantains abundant.
17	HP 66706 15298	An example of a sheep laying area with the coastal grassland. There was an increased abundance of common chickweed.
18	HP 66675 15311	An old ditch channel which was dominated by saltmarsh rush (NVC community SM16b).
19	HP 66653 15368	An example of vegetation dominated by common spiked-rush (NVC community S19a). There was bare peat around it at the time of the survey, with bulbous rush and velvet bent. The common spiked-rush was in deeper channels.
20	HP 66595 15370	Shoreweed and velvet bent dominated area (NVC community A22a) on damp peaty soil on an old building foundation. At the time of survey it was damp, but likely to be a pool during wetter times of year.

TG no.	Grid reference	Note
21	HP 66581 15366	There was an old embankment/wall going northwards across Lamba Ness. The vegetation was coastal grassland (NVC community MC10d), but the graminoids were taller than the surrounding grassland.
22	HP 66593 15298	There was an abundance of silverweed within the coastal grassland (NVC community MC8d) at this location.
23	HP 66642 15297	There was a 50cm×50cm ditch at this location 50% filled with vegetation. There was a combination of velvet bent, sea plantain, ribwort plantain, buckhorn plantain, red fescue, thrift, saltmarsh rush and arrowgrass.
24	HP 66719 15383	There were a series of dried out pools within the wet modified bog (NVC community M25b). They were either bulbous rush dominated (NVC community A24) or common spike-rush dominated, with velvet bent common (NVC community S19a). The area was mapped as a matrix of M25b:A24:S19a at a ratio of approximately 80:10:10.
25	HP 66749 15306	There was a 2-3m wide patch, within a seepage line, with abundant sea arrowgrass. Red fescue, common cottongrass and purple moor-grass were all abundant with frequent sea plantain, and occasional chickweed, and Yorkshire fog. The surrounding part of this seepage line was made up of NVC community M3x, S19a, SM16 and A24.
26	HP 66857 15481	An example of a small shallow pool (dry at the time of survey) within the wet modified bog (NVC community M25) habitat. The dominant species in this pool was velvet bent.
27	HP 66892 15511	An example of the community S19a, dominated by common spike-rush. Marsh pennywort was common was abundant in this stand.
28	HP 66894 15518	There was a little red bog-moss in the wet modified bog (NVC community M25b) at this location. It was with some heather on the side of a ditch.
29	HP 66896 15601	An embankment around a military building had maritime grassland (NVC community MC10a) with the more nutrient rich maritime grassland (NVC community MG11a) surrounding the base.
30	HP 66896 15601	There was a patch of maritime grassland (NVC community MC8d) which appeared to be over a concrete of gravel surface. Thrift and daisy were more common in this patch.
31	HP 66838 15556	There was a dry ditch at this location with a spoil pile beside it. The ditch was straight, 1m wide and 60cm deep. There was a little velvet bent along the base. The spoil line was 1.5m wide and was drier than the surrounding vegetation.
32	HP 66836 15576	There was a wet ditch at this location with a little bog pondweed within it. There was also lesser spearwort, velvet bent, common cottongrass and bulbous rush occasionally present.
33	HP 66782 15567	There were two, man-made, circular pools at this location. They were made up of common spiked rush (NVC community S19a) with a bog pondweed surrounding it. Other species located here were marsh willowherb, marsh cinquefoil, cuckooflower and bog asphodel.
34	HP 66783 15574	There was a small patch of soft rush dominated area within the wet modified bog (NVC community M25b). It had an increase of some wetland species such as marsh marigold, marsh pennywort and marsh willowherb, and was moving towards an M23 community, although the abundance of purple moor-grass and common cottongrass resulted in it being part of the M25b community.
35	HP 67178 15407	There was a mostly dried out, un-vegetated, pool at this location. The base was of gravel and sands with some cobbles.
36	HP 67166 15350	There was a small (1m×3m) patch of saltmarsh rush dominated habitat (NVC community SM16b) in this location on a sandy substrate.
37	HP 67216 15375	An example of less species rich coastal grassland (NVC community MC10a).
38	HP 67249 15419	A small (5m×5m) dry, un-vegetated area with gravel and sand substrate. This may well be a pool at wetter times of year.
39	HP 67360 15396	A small wet pool, 4m×4m in size, with boulders and a sand/gravel substrate. There were some very small patches of saltmarsh rush (NVC community SM16b) around it.
40	HP 67487 15500	The coastal grassland (NVC community MC10b) at this location was more species poor than previously noted with fewer forbs. Sedges were still common in the grassland (giving the MC10b sub-community).

TG no.	Grid reference	Note
41	HP 67457 15500	The improved coastal grassland (NVC community MG11) at this location lacked any perennial rye grass.
42	HP 67433 15500	The improved coastal grassland (NVC community MG11) at this location included marsh thistle, and silverweed was highly abundant.
43	HP 67407 15600	An example of the coastal grassland (NVC community MC10a) where sea plantain was the dominant species.
44	HP 67167 15497	There was a steep cliff edge at this location that had been used as a rubbish dump. There was a large pile of glass, metal, plastic debris.
52	HP 67096 15536	There was a small, shallow, draining channel at this location, dominated by salt-marsh rush (NVC community SM16b) with an orangey brown muddy substrate below.
53	HP 67070 15528	There was a small bowl, shaped hollow dug out of the rock at this location. It was mostly grassed over with coastal grassland (NVC communities MC10a and MC10b). There was also a small dug out dry pool next to this location which had a sand and mud base.
54	HP 66600 15411	There were many dug out ditches within the wet modified bog (NVC community M25b) along this location with the fresh spoil along the side, which appeared sandy.
55	HP 66719 15547	There was an area dominated by well-established common cottongrass (NVC community M3x) either side of a ditch. The ditch had pondweed and marsh pennywort within it.
56	HP 66727 15563	A patch of fen (NVC community Mxd) where common sedge was dominant.
57	HP 66764 15760	There was a patch of mat grass dominated unimproved acid grassland (NVC community U5a) at this location.
58	HP 66755 15749	A patch of fen (NVC community Mxd) where common sedge was dominant.
59	HP 66664 15758	There was a patch of heath rush dominated U6 vegetation at this location.
60	HP 66615 15716	There was a historic wall or dyke at this location, located under the vegetation, but slightly raised within the wet modified bog (NVC community M25b). The vegetation on top was drier as the ground was free draining. It was about 2m across.
61	HP 66505 15701	The semi-improved acid grassland (NVC community U4b) at this location was highly grazed and quite tussocky. There were signs of a historic enclosure or terracing.
62	HP 66425 15416	There was a dried, scorched area of grassland (unidentified NVC community) at this location which had grown over an old tarmac road.
63	HP 66311 15732	There was fore-dune vegetation (NVC community SD4) at this location going to a small, sheltered beach.
64	HP 66309 15763	There was a narrow section of dune grassland (NVC community SD8d) at this location.
65	HP 66307 15754	There was a small, sheltered beach at this location.
66	HP 66305 15773	There was a flush of vegetation (NVC community OV28) at this location with running water meeting the sea.
67	HP 66281 15712	The semi-improved acid grassland (NVC community U4b) at this location was heavily sheep grazed. Daisy and perennial rye grass was abundant showing a strong affinity with more improved grassland types (MG7).
68	HP 66289 15549	There was a small seepage line of NVC community Mxd at this location, draining downhill towards the beach. It was dominated by common sedge with marsh pennywort, lesser spearwort and marsh willowherb.
69	HP 66090 15491	There was a 0.5-2m wide stripe of semi-improved acid grassland (NVC community U4b). There were a variety of forbs along the road verge and there were small patches where species such as silverweed were prominent.
70	HP 66063 15465	There was a dug out area at this location, with an old foundation. There were rock faces. The vegetation was fairly nutrient enriched with a combination of improved coastal grassland (NVC community MG11) and semi-improved acid grassland (NVC community U4b) and some small patches of nettle (NVC community OV25).
71	HP 66047 15400	There were large areas of wet modified bog/wet heath (NVC community M15d) in this location.
72	HP 65968 15301	There were a series of retaining walls with common sedge the most abundant species in the wet modified bog (NVC community M25b) along the top. These appeared to be holding back water with bog pools present behind it.

TG no.	Grid reference	Note
73	HP 65877 15277	There were several bog pools at this location. They were relatively wet, and filled with bog-moss, common sedge and common cottongrass (NVC community M2b).
74	HP 65877 15272	There were some large areas around this location which were mapped as the NVC community M3x. They had 100% cover of vegetation, with common cottongrass making up 80-90% of the vegetation. Dwarf shrubs were generally absent.
75	HP 65851 15328	There were small patches of NVC community M15d within the NVC community M3x vegetation. These were usually small (5m×5m) It was slightly raised and distinguished by the dwarf shrubs and heath rush.
76	HP 65826 15372	There were areas of wet modified bog that were between NVC communities M3x and M15d where common cottongrass were highly abundant, but dwarf shrubs were present below. Tormentil was highly abundant in these stands.
77	HP 65840 15385	There was a ca. 2m deep, 8m wide hole at this location. Heath rush dominated acid grassland (NVC community U6) was along the sides and there was semi-improved acid grassland (NVC community U4b) at the base.
78	HP 65835 15464	There was often a mixture of communities within the wet modified bog/wet heath with acid grassland habitats present in low proportions. (NVC communities M15, M3x, M15b and U6. At this location it was in a ratio of 60:20:10:10).
79	HP 65776 15549	This perennial rye grass and daisy semi-improved acid grassland (NVC community U4b with affinities to MG7) had patches of marsh, spear and creeping thistle. There were occasional tussocks of soft rush and heath rush.
80	HP 65919 15580	There was a mixture of highly grazed semi-improved acid grassland (NVC community U4b) with perennial rye grass and daisy, patches of mat grass dominated unimproved acid grassland (NVC community U5b) and patches of neutral grassland (NVC community MG10a) where soft rush was the dominant species.
81	HP 65824 15703	There were lots of small patches of soft rush dominated neutral grassland (NVC community MG10a) within the semi-improved acid grassland (NVC community U4b). It was dominated by soft rush, with Yorkshire fog.
82	HP 65792 15665	There was a dense patch of marsh thistle at this location around the foundations of an old military building.
83	HP 65827 15789	An example of wet modified bog/wet heath (NVC community M15d).
84	HP 65906 15865	There was round-leaved sundew within the wet modified bog/wet heath (NVC community M15d) at this location.
85	HP 65917 15876	There was a circular hole in the ground here (borrow pit perhaps), approximately 8m in diameter and 2m deep. There was a mixture of semi improved acid grassland and neutral grassland (NVC communities U4b and MG10a) within it. It was used as shelter by sheep. Thyme was recorded here. A drystone wall was nearby.
86	HP 66172 15782	There was a cutting at this location through the wet modified bog/wet heath (NVC community M15d). It was a straight line, 2-3m wide and long. It was vegetated down the sides and there was no water in it at the time of the survey.
87	HP 66150 15731	The acid grassland (NVC community U6) at this location had patches in which heath rush was highly abundant.
88	HP65457 15176	There was semi-improved acid grassland (NVC community U4b) at this location with patches of heath rush dominated acid grassland (NVC community U6).
89	HP 65532 15169	At the fence to the sea cliffs there was a 2-5m wide stripe of ungrazed semi-improved acid grassland (NVC community U4b). It was tall with fescues and bent-grasses, sheep's sorrel, tormentil and creeping buttercup.
90	HP 65598 15221	There was a flushed area rich in common sedge and lesser spearwort.
91	HP 65600 15267	The blanket bog (M18) at this location was dominated by common cottongrass over a patchy layer of papillose and red bog-moss. Cross-leaved heath, heather and crowberry were all evident under the common cottongrass layer.
92	HP 65447 15317	The wet modified bog/wet heath (NVC community M15d) around this location was characterised by an undulating ground. On the drier tops heather, deergrass, common cottongrass and heath rush were common. In the hollows red bog-moss, common cottongrass, bog asphodel and tormentil were more common.

TG no.	Grid reference	Note
93	HP 65495 15517	There was a patch of semi-improved acid grassland (NVC community U4b) with perennial rye grass and daisy. Clearly frequented by sheep and consequently enriched. There were also patches of soft rush, marsh thistle and nettles.
94	HP 65479 15502	There was a large borrow pit at this location, ca. 5m deep. It was filled with semi-improved acid grassland (NVC community U4b) with small patches of soft rush and heath rush.
95	HP 65545 15487	There was a common sedge dominated flush (NVC community Mxd) at this location with an area of exposed peat with common cottongrass the main species present (NVC community M3).
96	HP 65631 15538	The wet modified bog/wet heath (NVC community M15d) at this location was highly grazed and trampled. Red bog-moss was hummocky at this location.
97	HP 65582 15546	There was a small area beside a ditch that was dominated by common sedge with tormentil (NVC community Mxd).
98	HP 65418 15898	There were extensive areas of hagging in the blanket bog (NVC community M19) with bog pools (NVC communities M2a and M3) and areas of bare peat.
99	HP 65393 15896	There was a complex within the blanket bog habitat with blanket bog (NVC community M19), bog pools (mostly NVC community M3) and dry dwarf shrub heath (NVC community H10b). The ratio was approximately 50:40:10. There were extensive areas of hagging in the blanket bog. An M2 pool was located here with common sedge and flat-topped bog-moss.
100	HP 65400 15901	The blanket bog (NVC community M19) at this location was relatively wet, with the water table just below the surface.
101	HP 65402 15903	The blanket bog complex included areas of dry dwarf shrub heath (NVC community H10b), these were on drier hummocks within the blanket bog.
102	HP 65504 15722	There was another complex of bog pools (including NVC communities M3 and M2a) and bare peat within the wet modified bog/wet heath (NVC community M15d) at this location. There was some chickweed, floating sweet-grass and bent-grasses with the blunt-leaved bog-moss and common sedge. Bulbous rush was also present.
103	HP 65522 15721	There were large bog pools at this location (30m×40m). They were mostly exposed bare peat at the time of survey, but likely to be water filled in wetter months.
104	HP 65476 15653	There was an area of blanket bog (NVC community M19) at this location, with hare's-tail cottongrass was prominent.
105	HP 65296 15707	There was a patch of acid grassland (NVC community U6) along a steep bank near a military building at this location.
106	HP 65300 15687	There was a view of the Satellite Launch Facility Study Area at this location.
107	HP 65212 15751	Potential GWDTE. There was a bog-moss dominated flush (NVC community M6) running downhill at this location. Bog-mosses dominated with occasional common sedge and bulbous rush over the bog-moss layer. On slightly raised ground heath rush dominated acid grassland (NVC community U6).
108	HP 65342 15461	An example of heath rush dominated acid grassland (NVC community U6).
109	HP 65396 15464	There was a borrow pit cut into the rock besides the road. It as vegetated with a white clover rich form of semi-improved acid grassland (NVC community U4b).
110	HP 65413 15464	In the semi-improved acid grassland (NVC community U4b) at this location, within a borrow pit, the grassland was short (<5cm), with a variety of forbs including selfheal and daisy. Thyme was occasional on drier patches. Yorkshire fog was abundant here. Wavy hair-grass was more common on the slopes of the borrow pit.
111	HP 65175 15324	The dry dwarf shrub heath (NVC community H10b) here had abundant crowberry and woolly fringe moss.
112	HP 65251 15326	There was a patch of highly grazed heath rush dominated acid grassland (NVC community U6). Heath rush was dominant throughout, but in wetter areas, in hollows common cottongrass and bog asphodel were abundant, in drier areas mat grass and tormentil were more abundant.
113	HP 64359 13300	Amenity grassland was very common within the Saxa Vord Study Area. It was dominated by perennial rye grass, with daisy and white clover. Regularly mown.
114	HP 64362 13304	There was a very small patch of neutral grassland at this location within the Saxa Vord Study Area which had not been cut but left for wildflowers. Oxeye

TG no.	Grid reference	Note
		daisy was particularly common with large scabious, hogweed, ribwort plantain, clover, bird's-foot trefoil, soft meadow grass and false oat-grass.
115	HP 64479 13433	The regularly mown amenity grassland at this location included fescues and occasional selfheal and hogweed.
116	HP 64502 13473	False oat-grass dominated the road verges.
117	HP 64519 13423	The improved grassland at this location included perennial rye grass, with creeping buttercup and white clover.
118	HP 64483 13502	The neutral grassland at this location was covered in a thick thatch of senesced plant material. Red fescue was the dominate grass between the thatch.
119	HP 64122 13405	The improved grassland at this location included perennial rye grass, creeping buttercup, white clover, common sorrel, hogweed, Yorkshire fog and occasionally yellow rattle.
120	HP 64115 13388	There was a dense stand of creeping thistle at this location.
121	HP 64436 13557	Creeping thistle was common at this location.
122	HP 64433 13495	Nettles were common at this location.
123	HP 64401 13136	Japanese knotweed was located here.
124	HP 64317 14267	This was an area of dry dwarf shrub heath dominated by short heather with crowberry, bell heather and tormentil. Wavy hair-grass, sweet vernal grass and mat grass were occasional.
125	HP 64316 14329	The road verge along here was forb rich with sheep's-bit, thyme, bird's-foot trefoil. The grasses included red fescue, common bent and sweet vernal grass.
126	HP 64327 14337	The improved grassland field was dominated by sweet vernal grass and Yorkshire fog. There was occasional cock's-foot, bent grasses, perennial rye grass and Timothy. It was fairly forb rich, particularly noticeable was autumn hawkbit. There was also white clover, red clover, tormentil, lesser stitchwort and more rarely eyebright. The improved grassland field is likely to have had relatively little improvement in recent times.
127	HP 64349 14230	There was a ruderal area at this location with pineapple weed and broad-leaved dock.
128	HP 64424 14193	There was an overgrown dyke, or boundary wall, within the grassland at this location. There were occasional patches of soft rush in the grazed field.
129	HP 64396 14180	The improved grassland at this location included Yorkshire fog and sweet vernal grass. Daisy was very abundant. There was also heath wood-rush and autumn hawkbit. It was heavily grazed by sheep.
130	HP 64400 14184	The road verge was species rich, with autumn hawkbit, sheep's-bit, thyme, heather, bird's-foot trefoil, selfheal and eyebright.
131	HP 64328 14232	There was a ruderal area at this location, including a spoil heap with silverweed growing on it.
132	HP 64326 14218	Around the gate of this improved grassland field pineapple weed was dominant.
133	HP 64321 14211	Dry dwarf shrub heath made up the vegetation on one side of the trackway whilst semi-improved grassland U4b made up the other side of the trackway. The dry heath similar to other areas (NVC community H10b). The grassland appeared unmanaged, with common bent, red fescue, sweet vernal grass and a variety of forbs (NVC community U4b).
134	HP 64328 14201	The field on the east side of the track was heavily grazed with white cover and daisy prominent.
135	HP 64323 14148	The west side of the track the grassland was grazed but was dominated by mat grass with tormentil, Autumn hawkbit as prominent. There were several orchid spikes, but they had senesced. They were likely to be heath-spotted orchid or a marsh orchid.
136	HP 64324 14056	There were several field gentians at this location, at the transition of dry heath and semi-improved grassland.
137	HP 64298 14021	The dry heath at this location was on flatter ground than the surrounding dry heath. It was fairly grassy with wavy hair-grass and common bent.
138	HP 64269 14021	Bird's foot-trefoil was common on the track at this location. The surrounding dry heath included common sedge, woolly fringe moss and lichens.
139	HP 64197 13945	This MG7b field was recently grazed by sheep. It included sweet vernal grass, Yorkshire fog, perennial rye grass white clover and autumn hawkbit.
140	HP 64166 13918	This field was similar to other rich MG7b, with no recent improvements, and grazing low at during this season. Yorkshire fog and sweet vernal grass were dominant. White clover and mouse ear were frequent.

TG no.	Grid reference	Note
141	HP 64171 13901	This area of rough grassland was made up of soft meadow grass, sweet vernal grass, red fescue and pignut. Common sorrel was also frequent. There was much senesced material below, indicating that it was not grazed recently.
142	HP 64118 13912	The road verges along here were dominated by false oat-grass (NVC community MG1).
143	HP 64119 13913	The improved grassland fields along this area were recently cut. They appeared to have been dominated by perennial rye-grass with Timothy (MG7a).
144	HP 64114 13960	There was Japanese rose scrub along the roadside here, besides a tumbled down wall. There was also honey suckle, elder and false oat-grass.
145	HP 64111 13986	The Japanese rose scrub along the side of the road at this location. False oat-grass was dominant along the verge. There was a garden escapee at this location too.
146	HP 64105 13992	There was a strip of semi-improved neutral grassland (NVC community MG1) at this location rich in dock, common sorrel and creeping buttercup.
147	HP 64118 13872	The road verges were semi-improved neutral grassland (NVC community MG1) at this location.

Annex 2: Photographs



Photo 1: MC8d Red fescue – thrift grassland (TG1).



Photo 2: MC10b Red fescue – plantain spp. grassland (TG4).



Photo 3: Saltmarsh rush (SM16b) in an old, peaty, ditch/cutting (TG5).



Photo 4: M3x dominated by common cottongrass on Lamba Ness (TG6).



Photo 5: An example of a dry ditch on Lamba Ness at OS grid reference HP 66573 15407 (TG9).



Photo 6: Wet modified bog (M25b) on Lamba Ness (TG10).



Photo 7: Bright green improved coastal grassland (MG11) around old military buildings (TG12).



Photo 8: An example of a seasonally dry pool on Lamba Ness (TG13).



Photo 9: Shoreweed (A22a) growing as a mat on the edge of a man-made pool (TG14).



Photo 10: Common spiked-rush (S19a) within a channel on Lamba Ness (TG19).



Photo 11: Shoreweed dominated community (A22a) growing in in the foundations of an old building (TG20).



Photo 12: An example of MC10a maritime grassland (TG37). It was dominated by sea plantain with thrift and fescues.



Photo 13: An example of MG11 around military buildings. Silverweed is prominent at this location (TG42).



Photo 14: A rubbish dump over the edge of the cliff at Lamba Ness (TG44).



Photo 15: A recently dug ditch with the fresh sandy spoil on the side (TG54).



Photo 16: Well-established M3x common cottongrass dominated vegetation beside ditch. (TG 55).



Photo 17: Sand dune vegetation at a sheltered beach (TG63-65).



Photo 18: Perennial rye grass and daisy were abundant in the highly grazed U4b grassland at this location. (TG 67).



Photo 19: Common cottongrass was dominant, with few shrub shrubs present in the M3x community (TG 74).



Photo 20: Common cottongrass was dominant over heather in the wet modified bog/wet heath (NVC community M15) (TG 76).



Photo 21: Soft rush was dominant in the MG10a neutral grassland (TG 81).



Photo 22: Round-leaved sundew in wet dwarf shrub heath (NVC community M15d) (TG 84).



Photo 23: The blanekt bog at this location was rich in pappilose bog-moss (NVC community M18) (TG 91).



Photo 24: There were extensive areas of hagging in the blanket bog (NVC community M19) *(TG 98).*



Photo 25: The blanket bog complex included areas of dry dwarf shrub heath (NVC community H10b), these were on drier hummocks within the blanket bog (TG101).



Photo 26: There were large bog pools at this location (30m×40m). They were mostly exposed bare peat at the time of survey, but likely to be water filled in wetter months (TG103).



Photo 27: A view of an extensive area of wet modified bog/wet heath (TG106).



Photo 28: A Potential GWDTE. There was a bog-moss dominated flush (NVC community M6) running downhill. On slightly raised ground heath rush dominated acid grassland (NVC community U6) (TG107).



Photo 29: Amenity grassland at Saxa Vord Resort (TG112).



Photo 30: A patch of neutral grassland where oxeye daisy was abundant (TG113).



Photo 31: Road verges were dominated by false oat-grass (TG116).



Photo 32: There was a thick thatch of senesced plant material at this location (TG118).



Photo 33: Improved grassland in the Saxa Vord Study Area (TG119).



Photo 34: Japenses knotweed just outside Saxa Vord Study Area (TG123).



Photo 35: Species rich imporved grassland in the Northdale Road Study Area (TG126).



Photo 36: The road verge was species rich with thyme, sheep's-bit, autumn hawkbit and bird's-foot trefoil (TG130).



Photo 37: The track way was made up of dry dwarf shrub heath and acid grassland (TG133).



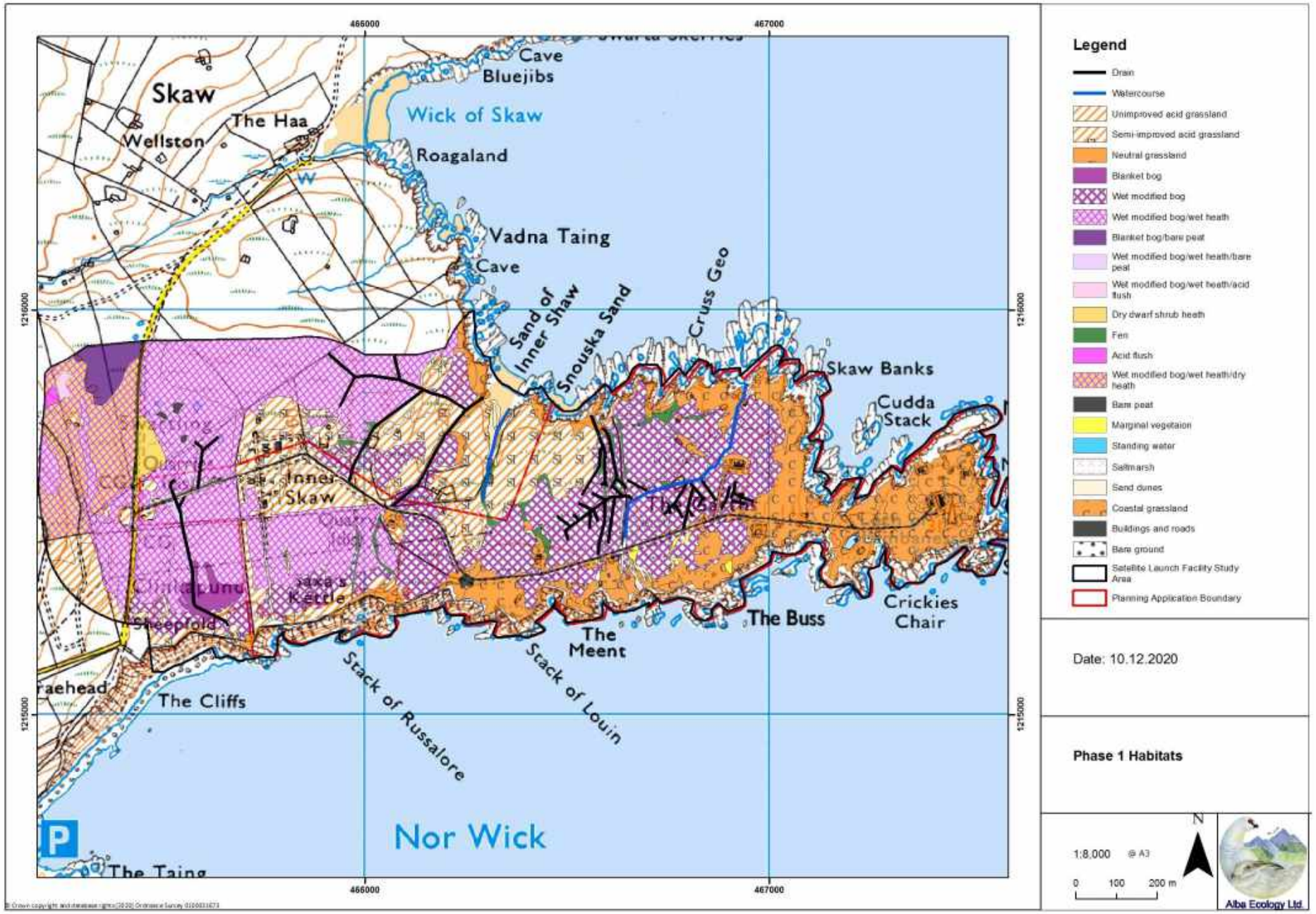
Photo 38: Field gentian (TG136).



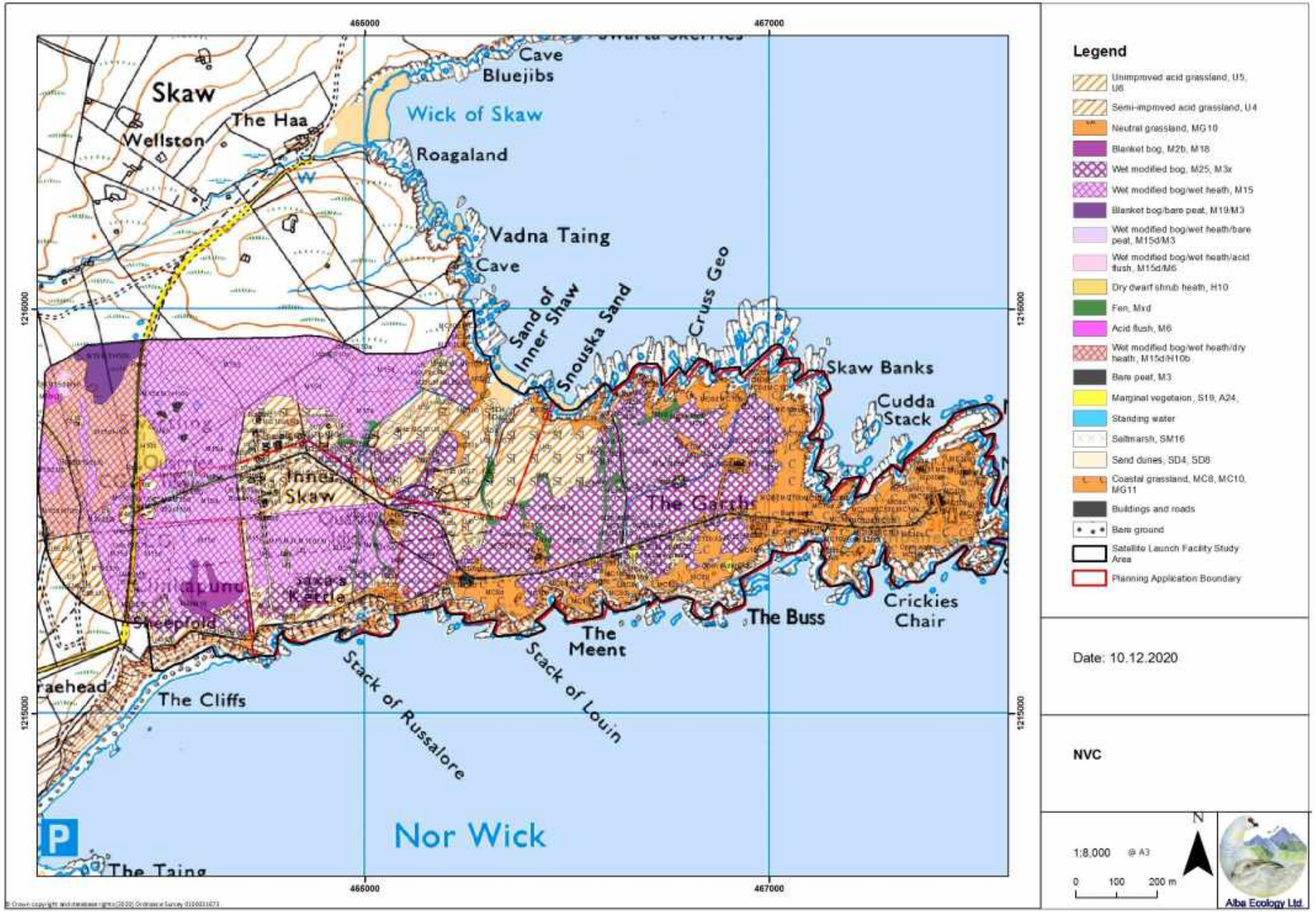
Photo 39: The track way goes across dry dwarf shrub heath.



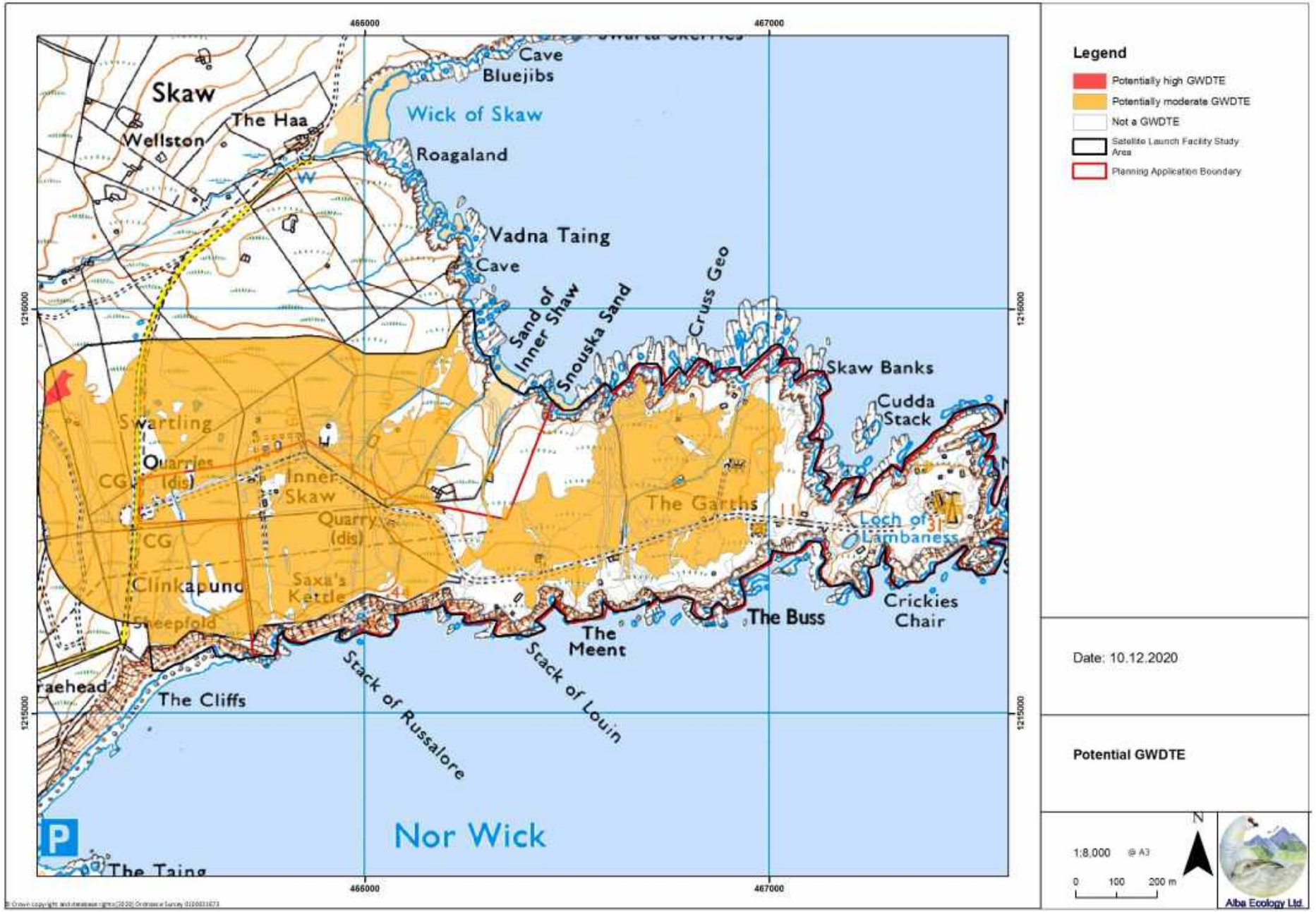
Photo 40: A rough neutral grassland within the Northdale Road Study Area.



Appendix 7.2 Drawing 3: Phase 1 Habitat Survey at the Satellite Launch Facility Study Area



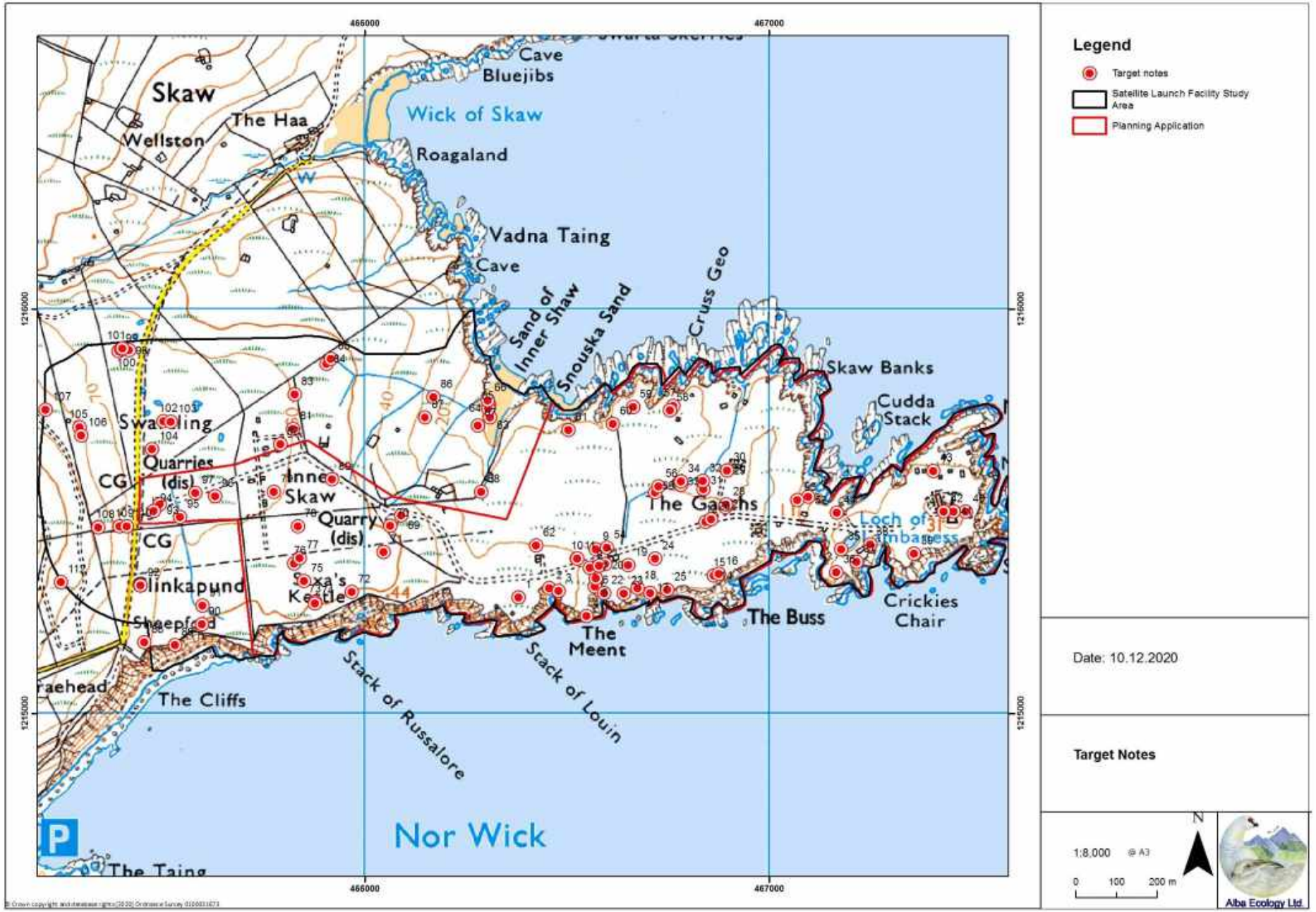
Appendix 7.2 Drawing 4: NVC communities at the Satellite Launch Facility Study Area



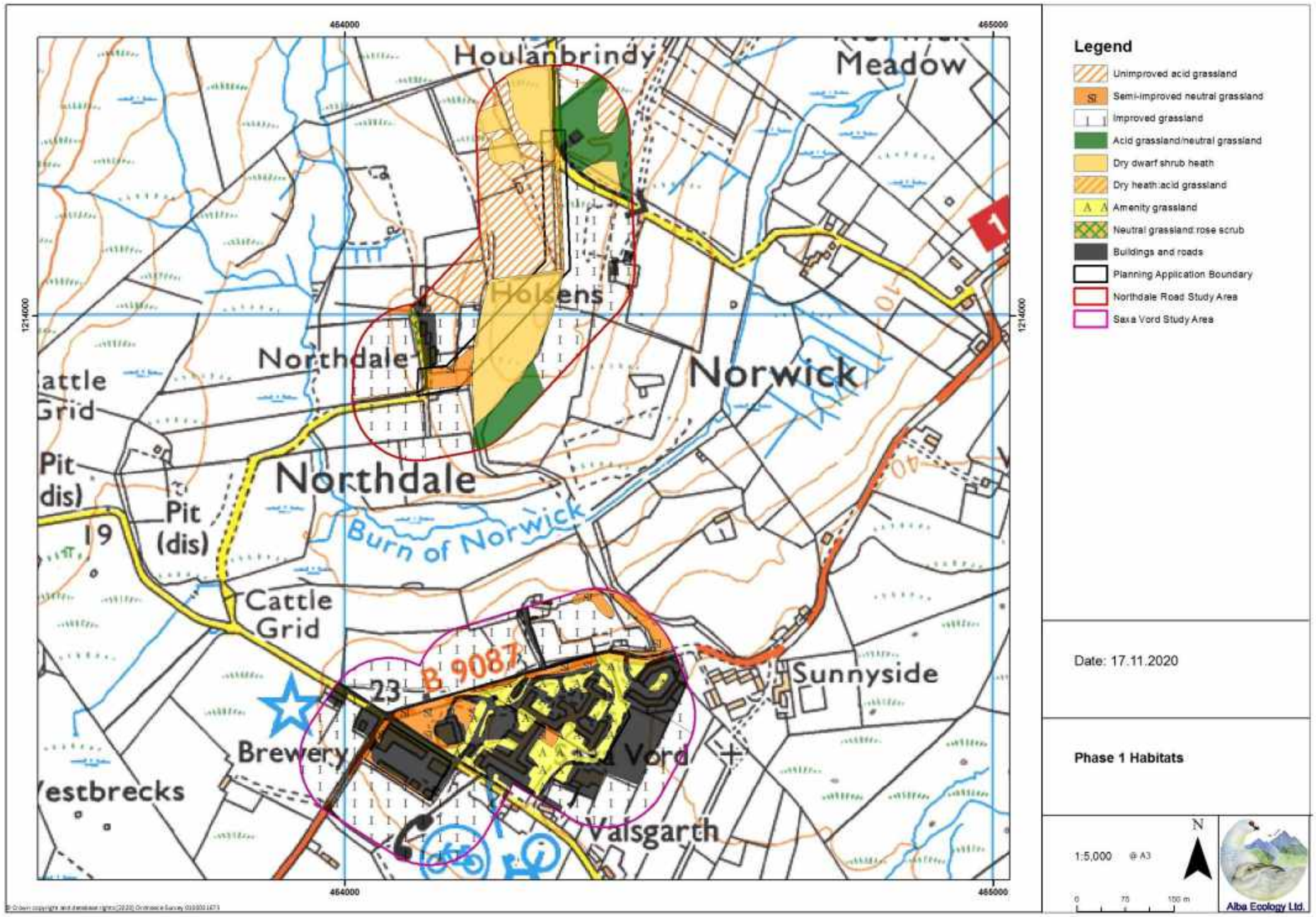
Appendix 7.2 Drawing 5: Potential GWDTEs at the Satellite Launch Facility Study Area



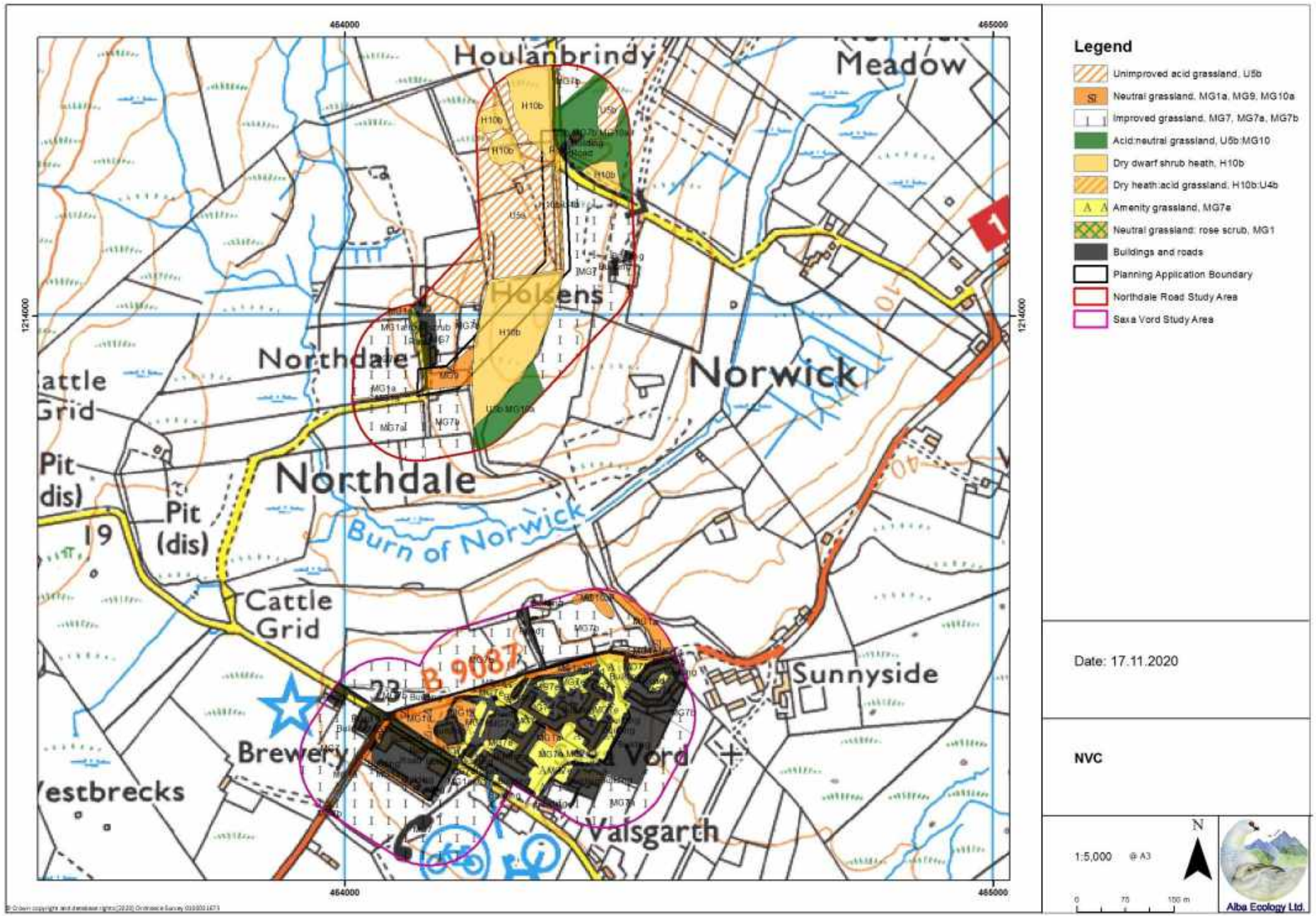
Appendix 7.2 Drawing 6: Peatland Condition at the Satellite Launch Facility Study Area



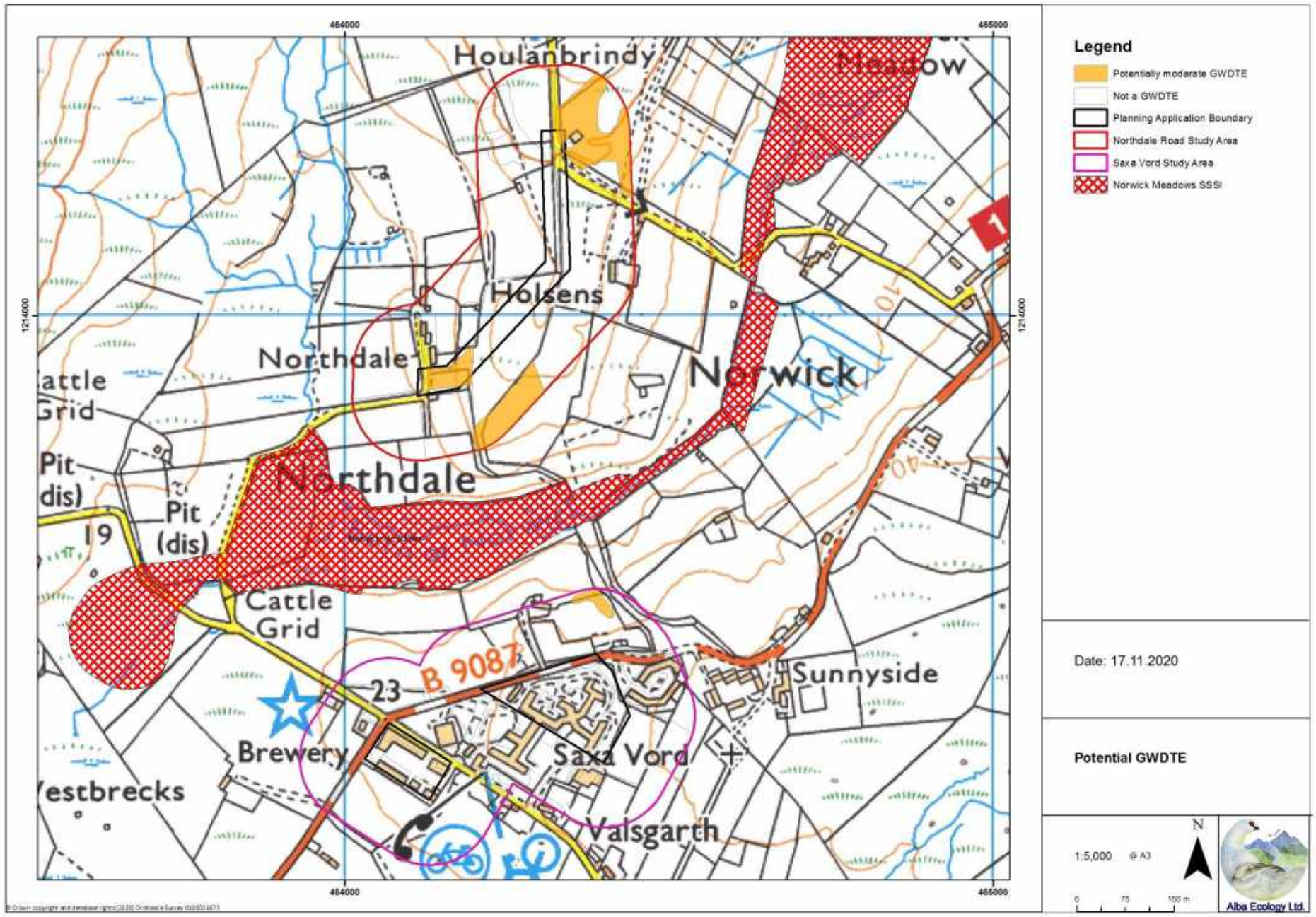
Appendix 7.2 Drawing 7: Target Note Locations at the Satellite Launch Facility Study Area



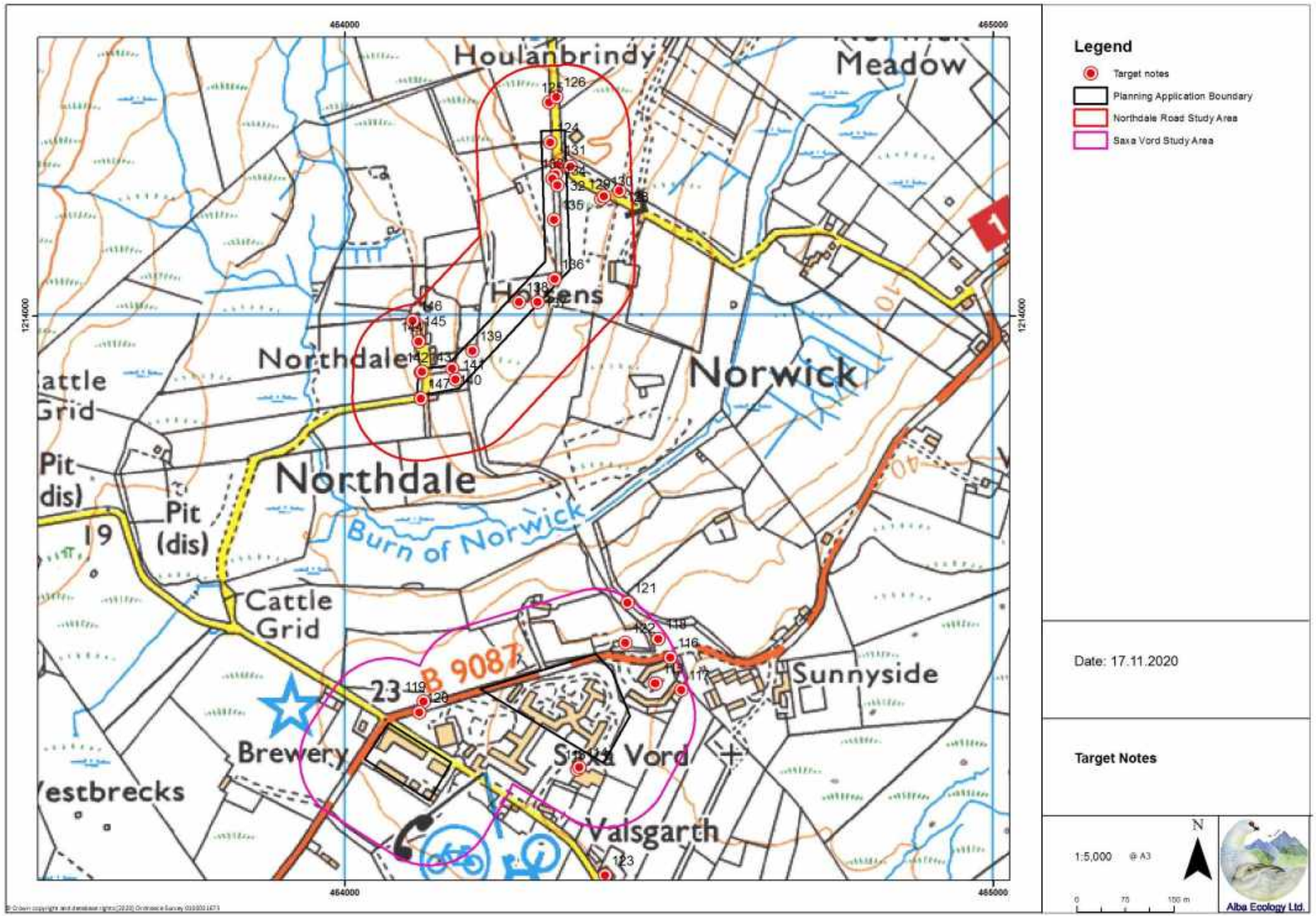
Appendix 7.2 Drawing 8: Phase 1 Habitat Survey at the Saxa Vord Study Area and Northdale Road Study Area



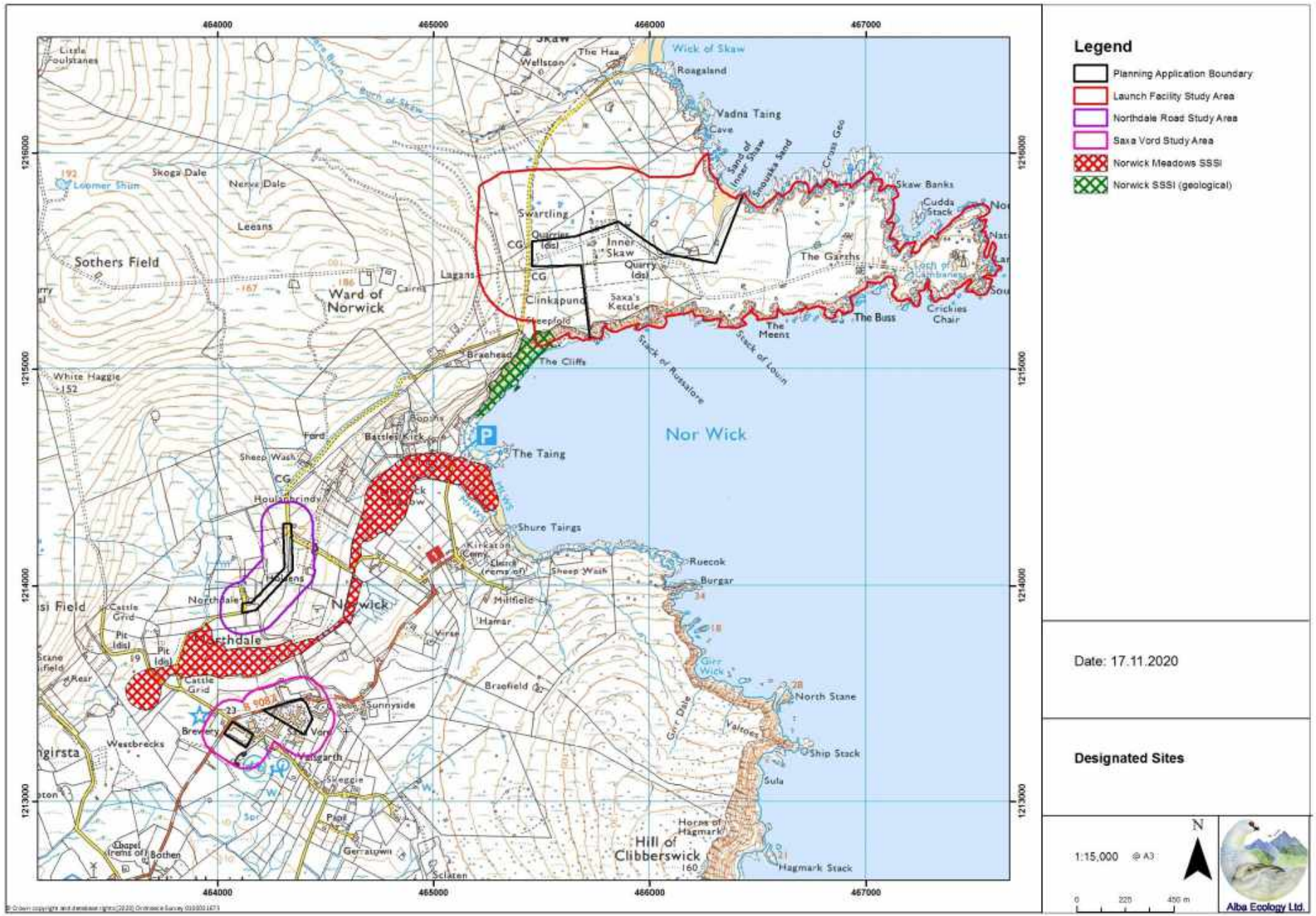
Appendix 7.2 Drawing 9: NVC communities at the Saxa Vord Study Area and Northdale Road Study Area



Appendix 7.2 Drawing 10: Potential GWDTEs at the Saxa Vord Study Area and Northdale Road Study Area



Appendix 7.2 Drawing 11: Target Note Locations at the Saxa Vord Study Area and Northdale Road Study Area



Appendix 7.2 Drawing 12: The location of the designated site, Norwick SSSI (geological) and Norwick Meadows SSSI in relation to the Study Areas

Appendix 6.3a Otter Species Protection Plan March 2022

SaxaVord Spaceport Otter Protection Plan

Alba Ecology Ltd.

February 2022, Updated March 2022

This report should be quoted as '*Alba Ecology Ltd. (2022). Unst Space Port Otter Protection Plan*'.

Registered Office: Coilintra House, High Street, Grantown on Spey, Moray PH26 3EN Tel: 01479 870238. *enquires@albaecology.co.uk*

INTRODUCTION

A proposal for a satellite launch facility has been made by the Applicant in north Unst, Shetland - known as the '*SaxaVord Spaceport'*. As part of the proposal, Alba Ecology Ltd. was commissioned to produce this Otter Protection Plan as part of pre-commencement planning.

Otters are known to be present within the Planning Application Boundary area, which was surveyed in detail for otters in both 2018 and 2020. The survey methods involved a systematic survey of terrestrial, aquatic and riparian habitats within the Study Areas looking for places otters use for shelter, resting and protection (such as couches, lying-up sites and holts), or for signs of activity (such as spraints, feeding remains, runs or footprints).

Legal protection

Otters are classed as European Protected Species (EPS) under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended).

According to NatureScot's standing guidance on otters (accessed 24/11/20), it is an offence to deliberately or recklessly:

- capture, injure or kill an otter;
- harass an otter or group of otters;
- disturb an otter in a holt or any other structure or place it uses for shelter or protection;
- disturb an otter while it is rearing or otherwise caring for its young;
- obstruct access to a holt or other structure or place otters use for shelter or protection, or otherwise deny the animal use of that place;
- disturb an otter in a manner or in circumstances likely to significantly affect the local distribution or abundance of the species; and
- disturb an otter in a manner or in circumstances likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young.

It is also an offence to:

- damage or destroy a breeding site or resting place of such an animal (whether or not deliberately or recklessly); and
- keep, transport, sell or exchange, or offer for sale or exchange any wild otter (or any part or derivative of one) obtained after 10 June 1994.

Otter shelters are legally protected whether or not an otter is present.

This means that if otters could be affected in these ways by a development, and no action is taken to prevent it, an offence may be committed. According to NatureScot "*Licensing allows named individuals to carry out actions that could otherwise constitute an offence. If you're planning any activities that could affect otters or the places they use, you must make sure you stay within the law*".

PREVIOUS SURVEY RESULTS

2018 data

Numerous otter field signs were recorded in the Proposed Launch Site Otter Study Area during targeted surveys in June 2018 (Table 1) and October 2018 (Table 2). Based on June 2018 survey data, there was a total of ten otter holts within the Proposed Launch Site Otter Study Area, six of which were in the Proposed Launch Site Boundary (EIAR Drawing 7.10). Based on October 2018 survey data, there was a total of eight otter holts within the Proposed Launch Site Otter Study Area with all but one of these in the Proposed Launch Site Boundary (EIAR Drawing 7.10). Based on the 2018 survey data, there were no otter holts within the Launch and Range Control Centre and New Section of Access Road at Northdale Otter Study Area (EIAR Drawing 7.11). Only spraints and footprints were recorded within the Launch and Range Control Centre and New Section of Access Road at Northdale Otter Study Area and these were adjacent to the Burn of Norwick.

Table 1. Otter signs June 2018

O/S grid reference	Type of otter sign	Note
HP6580215203	Holt	Obvious holt site with spraint at foot of cliff amongst boulder scree
HP6604915254	Holt	Obvious holt amongst boulder scree at foot of high cliff - located from top
HP6649615366	Spraint/print	Small amount spraint but many fresh paw prints inside old concrete bunker
HP6667215410	Spraint	Spraint site with drying green by concrete found of old bunker and run leading to flash pool
HP6694415371	Holt	Active holts in boulder scree at foot of cliffs
HP6705015430	Holt	Recently active holt at top of cliff in boulder scree
HP6709915521	Spraint	Spraint site at old bunker
HP6718515489	Spraint	Active spraint site at bottom of cliff on boulder scree
HP6720315508	Spraint/run	Run leading from spraint point at foot of cliff across headland through underpass to the other side.
HP6762115529	Holt	Active boulder scree holt at foot day of cliff
HP6720815622	Spraint	Freshwater bathing pool active spraint site run from one side of headland to other
HP6707815936	Spraint	Active spraint site
HP6704215811	Spraint	Stream side spraint site, inactive
HP6702915769	Spraint	Stream side spraint site
HP6701415731	Spraint	Stream side spraint point active
HP6682215819	Holt	Active holt at foot of cliff boulder scree
HP6666915820	Run	Run up and down cliff from small geo leading up to small ditch
HP6630416163	Holt	Active boulder scree holt at foot of cliff
HP6634616188	Holt	Run across small headland provable holt below cliff top
HP6628316222	Holt, inactive	Clifftop holt, not recently active
HP6626616261	Holt, inactive	Clifftop holt, not recently active
HP6624416270	Spraint	Stream side spraint site
HP6475316325	Spraint	Stream side spraint point, just outside buffer zone
HP6451216235	Spraint	Stream side spraint site
HP6471814142	Spraint	Spraint point, bridge

HP6477814289	Spraint	Stream side spraint site
HP6483414368	Spraint	Stream side spraint site
HP6495114419	Spraint	Stream-side spraint point
HP6538914686	Spraint	Inactive spraint site
HP6524614816	Spraint	Inactive spraint site

Table 2. Otter signs, October 2018.

O/S grid reference	Type of otter sign	Note
HP6604915254	Holt	Obvious holt amongst boulder scree at foot of high cliff- located from top
HP6647715340	Spraint/print	Currently inactive- spraint/paw prints in old bunker
HP6668815436	Spraint	Active spraint site
HP6696015377	Holt	Active holt in boulder scree bottom of cliffs
HP6705115430	Holt	Relatively active holt at top of cliff
HP6762115529	Holt	Active boulder scree holt at foot day of cliff
HP6754015606	Holt	Bunker used as holt v active
HP6754715719	Spraint	Active bunker spraint site
HP6724715610	Holt/lay-up	Boulder scree holt/lay-up
HP6720615630	Spraint	Active spraint site by stream and run across headland
HP6713915851	Spraint	Spraint at clifftop
HP6708915930	Spraint/lay-up	Active spraint site, lay-up
HP6701615730	Spraint	Active stream Spraint site
HP6681515845	Holt	Active hots in boulder scree foot of cliffs
HP6628416216	Print	Paw prints aside fresh dug holts but no spraint point (previously active) along clifftop
HP6623916259	Holt/spraint	Active spraint site by stream, relatively active holt on clifftop
HP6534214469	Tracks/spraint	Tracks and spraint on sand and at stream
HP6526314527	Spraint/print	Spraint site and paw prints along stream and beach
HP6521114661	Spraint	Very active spraint site by underpass - cub spraint noted confirming mother with family
HP6502514580	Spraint/print	Spraint and paw prints in mud by stream
HP6497714508	Spraint/print	Paw prints and spraint along stream- mum and cub sets together
HP6495214421	Spraint/print	Spraint and paw prints along stream- again cub prints with adult
HP6472914171	Spraint	Spraint site at underpass
HP6352014285	Spraint	Fresh spraint at roadside underpass
HP6385913627	Spraint	Fresh spraint site at underpass
HP6391513674	Spraint	Spraint site at underpass

2020 data

In July 2020, additional otter surveys were undertaken at the Proposed Launch Site Boundary. Numerous otter signs were recorded (EIAR Drawing 7.12, Table 3). This included eight holts located within boulder scree, below the cliff tops but above the high tide mark within the Proposed Launch Site Boundary. The holts were in inaccessible locations, between boulders or going into rock caves/crevices and were viewed from the cliff tops with binoculars (Photo 1). Scats and regularly used runs were recorded near and at the holt sites, and otters were occasionally seen/heard. One particular holt on Lamba Ness, which had a large build-up of scats, was clearly being used by a female and her young cubs in July 2020 (Photo 2).

Scats and footprints, including those of adults and young, were also recorded in the abandoned buildings across Lamba Ness (Photo 3). It was considered likely that some of the buildings were used as lay-ups during poor weather conditions, when holts at the base of cliffs would potentially be inundated with sea water.

Otter use of the existing track underpass at HP 671 154 was particularly noticeable. It was considered likely that otters use this underpass as a regular route to cross from the north to south side of Lamba Ness. The route was well delimitated on the grassland and rocks showing a well-established run (Photo 4). These data indicated that there was one female, with dependent young, using Lamba Ness as their core home territory. Regular sightings of a male indicated that Lamba Ness also formed part of at least one dog otter territory.

Table 3. Otter signs July 2020

O/S grid reference	Type of sign	Note
HP 66032 15254	Holt	Inaccessible holt within boulders of cliff face.
HP 66033 15255	Holt	Inaccessible holt within boulders of cliff face.
HP 66367 15253	Prints	Fresh footprints located within the small, abandoned building at this location.
HP 66764 15296	Holt	This holt was inactive in July 2020.
HP 66832 15296	Holt	This holt may have been active in July 2020. There were old & more recent spraints visible.
HP 66854 15291	Lay-up	The lay-up was in the boulder scree at this location.
HP 67046 15425	Holt	There was a holt at this location, within the boulder scree.
HP 67091 15465	Run	The underpass showed signs of frequent use by otters. There was a clear run from the rocks to the underpass.
HP 67510 15446	Lay-up & run	A commonly used lay-up & run within the rocks of the edge of the cliff.
HP 67530 15451	Holt	Potential holt site. Appears inactive this season.
HP 67431 15532	Spraint/print	This abandoned building had many signs of otter use including spraints & footprints. It is likely used as a couch.
HP 67439 15637	Prints	There were otter footprints in this abandoned building. The prints were of two different sizes, indicating a female & young.
HP 67136 15532	Holt	This was the most active holt in 2020. There was a large pile of spraints which included crab remains. Crabs are easy kills for young otters. This holt was likely to have a female with young.
HP 66740 15785	Holt	Potential holt. Spraints recorded here.

Example photos (from 2020 and 2022)

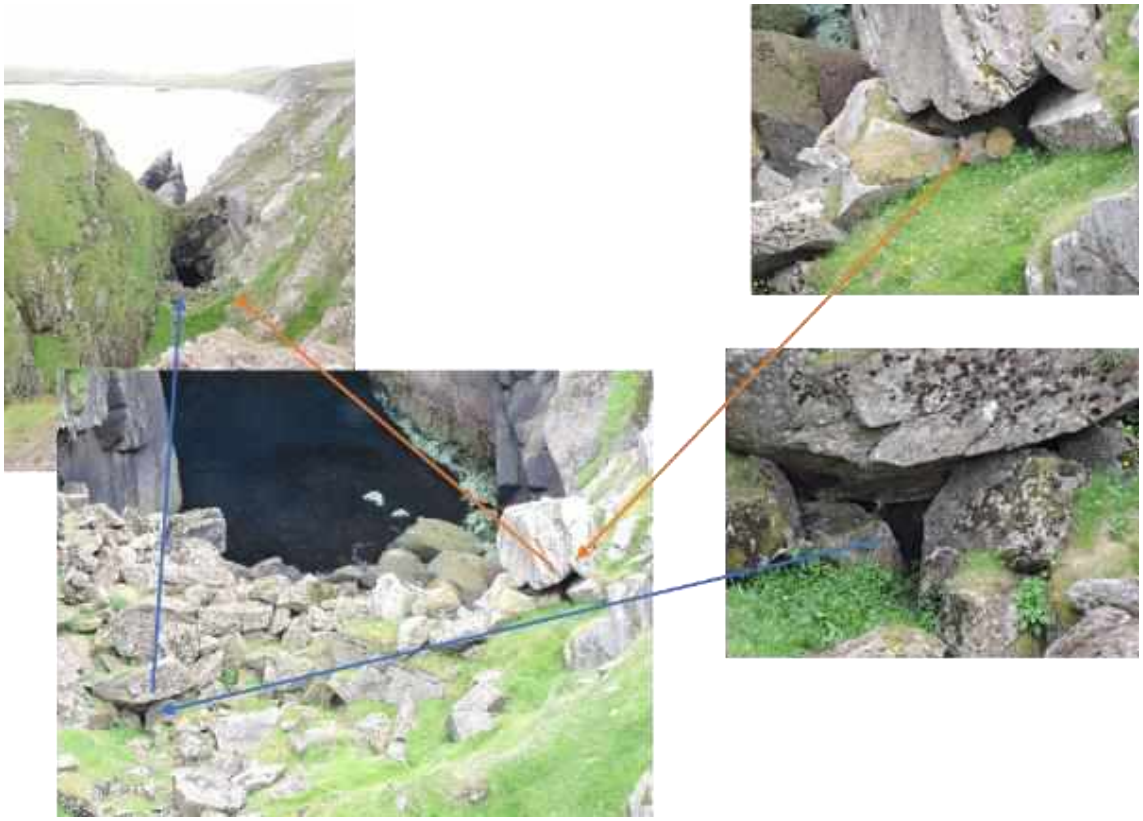


Photo 1: Two inaccessible otter holts were viewed from the cliff top. They were located within boulder scree. Spraint marks around the entrances were evident (OS grid reference HP 66032 15254), as was flattened vegetation.



Photo 2: The most active holt location was likely used by a female with young. The spraint pile nearby was very fresh and included crab remains (OS grid reference HP 67136 15532).



Photo 3: Fresh otter prints, of two different sizes, were clear within this abandoned military building (OS grid reference HP 67439 15637).



Photo 4: A clearly defined otter run (slightly dark coloured curved area of grass in the foreground) going towards and through the track underpass (OS grid reference HP 67091 15465).



Photo 5. Clearly defined otter run on the north side of track underpass (OS grid reference HP 67091 15465) to a small freshwater pool. Based on field signs, this pool is regularly used by otters to clean themselves after leaving saltwater.

There is evidence that the Proposed Launch Site Boundary is regularly and indeed heavily used by otters (e.g. EIAR Drawing 7.10 and 7.12). The presence of multiple holts and lay-up sites within the Application Boundary and other signs means that otters could potentially be directly affected by the proposed development.

Based on the indicative planned site layout and the most up to date (July 2020) otter survey data, the main sensitivities are considered to be:

- The access road bend by the Satellite Tracking Station is relatively close to an otter holt (ca. 240m separation).
- Launch Pad 1 is close to an otter holt (ca. 30m separation).

- The access road between Launch Pad 2 and Launch Pad 3 is close to two otter holts (ca. 55m south and 80m north separation) and crosses the otter run.
- Launch Pad 3 is situated on buildings used by otters and is close to an otter holt at the end of Lamba Ness (ca. 100m separation).

There is no evidence that the proposed development at the proposed Launch and Range Control Centre and proposed New Section of Access Road would impact on any otter breeding site or resting place (e.g. EIAR Drawing 7.11). Otter use of this area appears occasional and is focussed along the Burn of Norwick. Consequently, it is unlikely that proposed development in the Launch and Range Control Centre and New Section of Access Road Otter Study Area would kill, injure, capture or disturb an otter whilst it is occupying a holt or other places of rest/shelter. This assumes that best practice construction methods are employed under the supervision of an Ecological Clerk of Works.

The EIAR recognises that otters could be directly affected by the Proposed Launch Site (i.e. the planned work could potentially kill, injure, capture or disturb an otter whilst it is occupying a holt or other places of rest/shelter) and so an Otter Species Protection Plan is necessary. Figure 1 illustrates the known legally protected otter features across the Site based on 2018-2020 data.



Figure 1. Known Otter Constraints 2018-2020.

MINIMISING IMPACTS

There is a good understanding of how otters at Lamba Ness use the habitats present with many holts at the base of sea cliffs and used during suitable weather (e.g. Photos 1-2). During inclement weather (e.g. winter storms), some of these holts would potentially be inundated with sea water. At such times, the otters probably make regular use of the old abandoned open military buildings which become *de faco* holts/resting places (e.g. Photo 3). Any development related work on these buildings must therefore be considered as potentially affecting resting/holt sites. It should be noted that fresh otter footprints inside buildings were recorded in July 2020 during a period of good weather, suggesting the building may also offer shelter outwith adverse weather conditions. It may be that natural resting/holt sites in the Proposed Launch Site Boundary (away from the base of cliffs) are limited and are therefore perhaps used year-round.

The track underpass (Photo 4) is also an important feature for otters, allowing them to cross from one side of Lamba Ness to the other, (bathing/cleaning in the freshwater pool - Photo 5) without having to swim around the point or cross a large area of open ground and an access track. This feature might be extremely important functionally, particularly during inclement weather and it should be treated as such in construction plans (e.g. CEMP).

The measures within this Otter Protection Plan follow the well-established hierarchy of avoidance, mitigation and compensation as outlined in the actions in Table 4. It is important to recognise that otter use of the Site may vary over time and planned actions will need to account for this. Consequently, the Otter Protection Plan Actions (Table 4) should be regularly reviewed to ensure they are fit for purpose and this document should remain 'live' and be updated by the ECoW when necessary.

Table 4. Otter Protection Plan Actions

Action	Location	Comments
Tool-box talk & construction site materials.	Site Office	Construction workers & site staff must be given a tool-box talk (provided by the ECoW) which covers otter species protection issues. Sensitive & legally protected otter features must be marked-up on relevant construction plans & updated in light of new information.
Create otter sensitive zones.	Holts, couches & underpass/ pool area	Physically mark sensitive areas on the ground using coloured pegs & possibly rope/line marker chalk paint. It should be recognised that standard canes & marker tape typically used to mark-up sensitive areas might get damaged & blown away by strong winds. Therefore, strong, low markers, fixed securely into the ground or marked directly onto the ground with line marker chalk paint will likely be most resilient to adverse weather conditions.
Pre-construction survey	Site wide	Pre-construction surveys for signs of otters was undertaken in march 2022 prior to any works commencing on the Proposed Development.
All construction work must avoid damage &/or destruction of otter holts/couches unless under licence from NatureScot.	Site wide	Construction plans avoid damage &/or destruction of natural otter holts/couches, most of which lie at the base of sea cliffs & so will be unaffected (Figure 1). In the 2020 otter surveys one existing building, in the east of the Site at proposed Launch Pad 3, had evidence of use

		by otters and was identified as being directly lost by the construction of the Proposed Development. At the single, known otter resting place, where avoidance is not possible, a pre-construction survey was carried out. In the pre-construction otter survey all the existing buildings on Lamba Ness were surveyed. One existing building, in the east of the Site at proposed Launch Pad 3, had evidence of use by otters in March 2022 and will be directly lost by the construction of the Proposed Development.  *Footprints of an individual otter were recorded in a building within the development footprint at HP6743915639.* This area was identified as a couch. Couches are daytime resting places for otters. Therefore, the destruction/modification of this building will require a licence from NatureScot. While no other resting places will be destroyed given current information, the ECoW will provide regular inspections/surveys of the buildings and note any change in use of the buildings by otters. Artificial holts/shelter will be used to replace the lost spaces in the building at a very similar nearby location providing alternative resting sites.
Retain the established and well used run, underpass & freshwater pool (Photos 4 & 5).	HP 671 154	The vehicle track running on top of the underpass will need strengthening & widening. As a consequence, the existing underpass will be extended & an additional tunnel added to facilitate crossings if the existing tunnel is inundated during wet weather. The well-used run & freshwater pool will be retained to maintain important connectivity between the north & south sides of Lamba Ness. Every effort will be made to ensure the underpass and runs to and from the underpass are not destroyed or obstructed though the construction period. This will be achieved by:

		• The underpass will remain open during the construction phase, as far as possible. • The route of the run will be avoided, with exclusion zones marked and not entered unnecessarily. • Either side of the underpasses will have an artificial holt/shelter designed into it, so otters can use them for refuge.
Avoid working in vicinity of otter holts/couches in the hours darkness.	Site wide	Unlike on the mainland, otters using coastal habitats on Unst are diurnal & so not limited to nocturnal or crepuscular hunting/feeding.
Avoid disturbance to otter holts/couches.	Site wide	Mark work exclusion zones around any holts & shelters. If otters are breeding, the disturbance-free zone should be at least 200m. However, it could be reduced to 100m depending on the nature of the works, topography & natural screening. This will require judgement from an experienced ecologist. For holts & shelters where otters are not breeding, the exclusion zone should be 30m. Where exclusion zones of the required size are not possible, works will require a licence from NatureScot before they can proceed. 30m exclusion zones will be maintained around the three active holt locations identified in March 2022. These are shown in Figure 3. The proposed works are all outwith 30m. The holts were located within inaccessible boulder scree at the base of sea cliff. They were viewed with binoculars from safe locations from the top of the cliffs. Therefore, some of the grid references are indicative, and are likely further away than shown. As the Lamba Ness peninsula is actively used by otters, the construction team and the Ecological Clerk of Works should be aware of, and keep a watching brief for their presence, especially when working in and around the old military buildings and at/around the underpass.
Cap exposed pipes when not in use.	Site wide	All exposed pipes must be capped to prevent otters from entering them & potentially getting injured/killed. See example photo below.

		
Enforce safe-working vehicle speed limit.	Site wide	Vehicle speed limit of 10 mph across the Site to reduce possibility of otter traffic mortality/injury.
Awareness raising for drivers.	Entrance & main track	Otter crossing road signs will be located at the Site entrance & at other strategic locations along the main track, including either side of bridge with the otter underpass.
Construct ten artificial holts to replace any natural holts/couches that have to be destroyed or damaged.	Site wide	None of the natural holt sites will be directly lost due to construction as they were all recorded in inaccessible locations in the boulder scree and caves at the foot of cliffs which are deliberately avoided by the design layout. The construction of the Proposed Development will result in the direct loss of ten abandoned military buildings/ruined infrastructure, including one that is known to be used by otters (and considered above) and an additional nine abandoned military buildings/ruined infrastructure. There is no evidence that these nine locations have been used as resting places by otters from previous surveys. However, otters are mobile and so occasional use cannot be ruled out. Therefore, pre-construction otter surveys will be required. To mitigate for the loss of potentially occasionally used shelter a series of artificial otter holts will be built as identified in Figure 2 to provide additional resting places away from the coast.

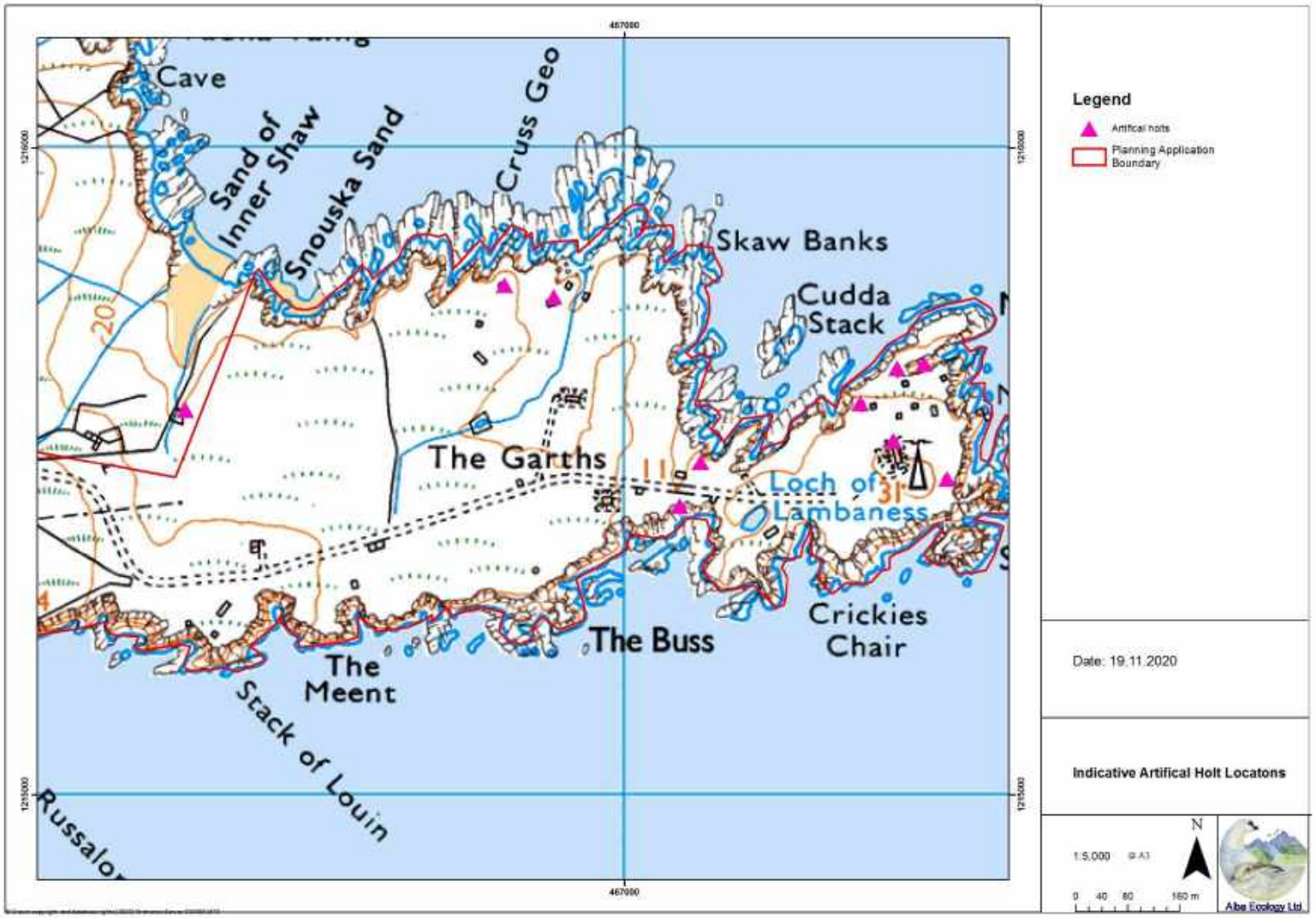


Figure 2. Artificial Otter Holt Locations.

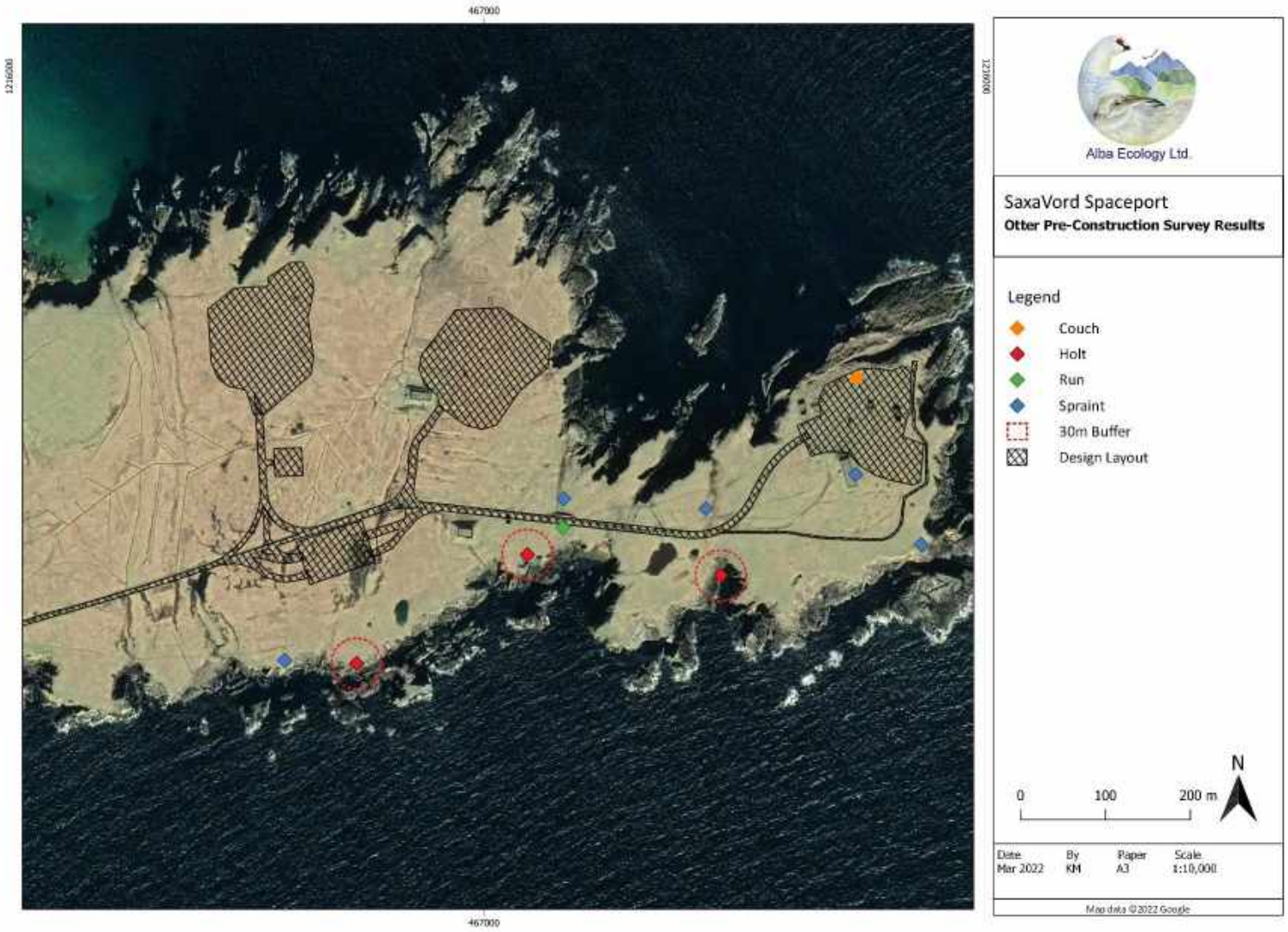


Figure 3. 30m buffer around holt locations.

Licensing development works affecting otters

Licences for development works that would otherwise result in an offence with respect to EPS such as otters, can only be issued if it can be demonstrated that the following three tests are all met:

- Test 1 - that the purpose of the licence is to preserve public health or public safety or for other imperative reasons of overriding public interest, including those of a social or economic nature and beneficial consequences of primary importance for the environment.
- Test 2 - that there is no satisfactory alternative.
- Test 3 – that the proposed action will not be detrimental to the maintenance of the population of the species at a favourable conservation status in their natural range.

There is a presumption against licensing disturbance to breeding otters and damage or destruction of an otter holt while being used for breeding. Nevertheless, according to the NatureScot standing advice "*developers can apply for a licence to allow proposed development works that might affect otters to proceed legally*". An example of the type of information likely to be require for licencing is provided in Annex 1.

For all development proposals where otters are a consideration, pre-construction surveys should be timetabled into project plans. This is to enable checks for any new holts or resting places that may have become occupied after the original surveys, and to ensure the measures proposed to minimise impacts on otters remain appropriate. Consequently, a pre-construction otter survey will need to take place within 4-6 weeks of constructions works commencing.

REFERENCES

Chanin P. (2003) Monitoring the otter *Lutra lutra*. Conserving Natura 2000 Rivers Monitoring Series No.10. English Nature, Peterborough.

NatureScot (no date) Standing Advice for Planning Consultants. Protected Species: Otter. Otters: licences for development | NatureScot [accessed February 2022].

ANNEX 1. Example of Likely Otter Licensing Requirements

Introduction

A proposal for a satellite launch facility has been made by the Applicant in north Unst, Shetland - known as the 'Unst Space Port'. Targeted otter surveys (2018-2020) demonstrated that the Proposed Launch Site Boundary is regularly used by otters. Chapter 7 of the Environmental Impact Assessment Report (EIAR), identified that the proposals would potentially result in the destruction of a single occasionally used otter resting place within an abandoned military building on Lamba Ness. The destruction of the resting place of an EPS, such as an otter, is an offence unless licensed. Construction work on this military building will therefore require a licence from NatureScot to destroy this shelter if it is still used being otters.

This Annex provides an outline of the likely licensing requirements and obligations and the information required for the licence application.

Legal protection

The Eurasian otter (*Lutra lutra*) is an EPS under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended). According to NatureScot's standing guidance on otters, it is an offence to deliberately or recklessly:

- capture, injure or kill an otter;
- harass an otter or group of otters;
- disturb an otter in a holt or any other structure or place it uses for shelter or protection;
- disturb an otter while it is rearing or otherwise caring for its young;
- obstruct access to a holt or other structure or place otters use for shelter or protection, or otherwise deny the animal use of that place;
- disturb an otter in a manner or in circumstances likely to significantly affect the local distribution or abundance of the species; and
- disturb an otter in a manner or in circumstances likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young.

It is also an offence to:

- damage or destroy a breeding site or resting place of such an animal (whether or not deliberately or recklessly); and
- keep, transport, sell or exchange, or offer for sale or exchange any wild otter (or any part or derivative of one) obtained after 10 June 1994.

Otter shelters are legally protected whether or not an otter is present.

Licencing

NatureScot is responsible for considering and issuing licences to permit actions related to developments that might affect EPS, such as otters. A licence allows activities to be carried out which would otherwise be unlawful. Licences are granted subject to conditions and licence holders are responsible for ensuring compliance with conditions. Failure to comply with conditions is an offence.

Applications for a licence should be made to NatureScot for work that could otherwise result in an offence in relation to otters. The Application form and accompanying guidance is on the NatureScot webpage at: Otters: licences for development | NatureScot [accessed February 2022].

Avoiding the Need for a Licence

When considering activities that could affect otters the primary aim is to avoid impacts in the first place. Given that otter use of an area changes over time, it is important that up to date information (in the form of a pre-construction otter survey and report) is available and used to inform whether a licence is needed or not.

Offences and impacts can be avoided in a number of ways, such as;

- modifying the location of a proposed action/piece of work;
- timing operations to avoid times when the species is likely to be present;
- protecting important features from disturbance by creating ‘no disturbance zones’;
- retaining certain areas/structures used by the species;
- modifying working practices; and
- look at alternative solutions to problems.

If there are no satisfactory alternatives to avoiding an impact/offence, a licence may be necessary. If this is the case the applicant will need to clearly demonstrate the alternatives that have been considered and why they are not satisfactory.

Tests for Granting a Licence

A licence can only be granted if the three strict EPS licensing tests are met.

- Test 1 - that the purpose of the licence is to preserve public health or public safety or for other imperative reasons of overriding public interest, including those of a social or economic nature and beneficial consequences of primary importance for the environment.
- Test 2 - that there is no satisfactory alternative.
- Test 3 – that the proposed action will not be detrimental to the maintenance of the population of the species at a favourable conservation status in their natural range.

Supporting Information

In order to apply for a licence, supporting information must be provided by the Applicant to the licensing authority (NatureScot in this instance). NatureScot provides guidance on the supporting information needed (*Guidance notes on providing supporting information for a licence for European protected species*).

The supporting information includes:

- Survey and site assessment (in the form of an up-to-date pre-construction survey report);
- Impact assessment, mitigation and compensation;
- Method statement; and
- Appropriate maps.

It is the responsibility of the Applicant to demonstrate (and provide supporting evidence where necessary) why the proposal (in its submitted form) is necessary. The Applicant should explain any alternatives that were considered and justify why these were discounted. The application should provide objective evidence of a lack of satisfactory alternatives. Applicants will need to provide detailed proposals of all the mitigation and compensation measures that they will undertake to ensure that impacts on the species concerned are minimised.

The Species Protection Plan should outline the measurers that planned to mitigate/compensate for the otter feature(s) that may be lost through construction and be provided to NatureScot. The Species Protection Plan should allow NatureScot to consider the merits and potential efficacy of the measures proposed to reduce impacts on otters.

Outline rationale for the Licence Application

Based on existing information, the construction of the Unst Space Port has the potential to adversely impact otters in one way; through the destruction of a single known resting place (an old abandoned military building). This activity is likely to require an agreement with, and a licence from, NatureScot.

Avoidance

Avoidance of impacts on otters was achieved through in-built design in several ways. For example:

- The cliffs and their bases (where most otter holts were identified) have been avoided by the design layout, therefore the majority of the otter holt locations will not be directly impacted by any land-take.
- Two out of three of the old military buildings known to be used by otters have been avoided by the design layout.

- An important under-road culvert, which is regularly used by otters crossing overland from one side of Lamba Ness to the other will be retained (and extended).

Additional Mitigation in Relation to Otters

To further avoid and minimise impacts on otters additional mitigation will be undertaken in relation to the Proposed Development:

- An Ecological Clark of Works (ECoW) will ensure that pipes etc. are stored correctly reducing likelihood of otters using them and being present in potentially 'high risk' areas during construction.
- Enforced low vehicle speed limits (10mph) would greatly reduce the likelihood of injury or death from vehicle collisions happening during construction. Similarly, low enforced vehicle speed limits (10mph) during operation would greatly reduce the likelihood of any operational mortality.
- Otter crossing road signs will be located at the Site entrance and at the frequently used otter run to further help prevent mortality caused by vehicle traffic during construction and operation.
- The frequently used otter run, crossing from the north to south of Lamba Ness and using the underpass at HP 671 154 has the potential to be damaged or destroyed during construction. The road will be reinforced and widened at this location for access. However, the design will deliberately be otter friendly. The current underpass will remain and will be extended on either side. As the road will be reinforced and widened at this location an additional underpass will also be created, slightly above and along from the current location. This will provide an alternative, easy route for otter if, for example there is any period of heavy rain causing flooding/puddling of the current underpass or if it gets blocked for any reason. Either side of the underpasses will have an artificial holt/shelter built (Figure 2), so otters can use them for refuge.
- Fencing around the Proposed Development has the potential to impede otter movements to and from the buildings. It is also possible that otters may want to occasionally cross the site during construction and operation at other locations. To avoid blocking potential routes, and as part of embedded mitigation, permeable (otter friendly) boundary fences will be used during construction and operation. They will be otter friendly in-so-far as they will have regular small gaps for otter to move through. The spacing of gaps along the fence will be agreed with NatureScot and will form part of the otter licencing/planning conditions.

Predicted Impacts of the Proposed Development and Mitigation

Despite the avoidance and mitigation outlined above, the construction of the Unst Space Port would likely result in the unavoidable destruction/modification of a resting place/holt within a single abandoned military building around the area of Launch Pad 3 (EIAR Chapter 7). Targeted otter surveys showed that this building has been occasionally used in the past as a resting place by otters. Assuming pre-construction surveys demonstrate that the building is still used, the destruction/modification of this building will require a licence from NatureScot.

While no other resting places will be destroyed given current information, pre-construction surveys will assess whether any of the other areas or buildings which will be lost during construction are used by otters.

Nine artificial holts/shelters (Figure 2) will be created across the top of the Lamba Ness area (in which the current use by otters appears limited). These include two at either side of the regularly used underpass. These should provide appropriate multiple alternative resting sites in lieu of the old military building. This mitigation will be embedded within the planning conditions and will be constructed prior to the works on the military buildings commencing.

Application and Supporting Information for Licence Application

To apply for a NatureScot otter licence the Applicant will provide an application form detailing:

- That the purpose of the licence is of a social/economic nature;
- That there were no satisfactory alternatives; and
- That the proposed action will not be detrimental to the maintenance of the population of the species at a favourable conservation status in their natural range.

To support the licence application the Applicant will provide:

- Appendix 7.3: Otter Survey Report;
- EIAR Chapter 7: Ecology;
- Appendix 6.4 OHMP;
- An up to date pre-construction otter survey of the abandoned military buildings; and
- A method statement outlining details of the works and associated mitigation.

The methods statement and pre-construction otter survey will be written post-consent and submitted as part of the licence application.

Appendix 6.3b Pre-Construction Otter Survey Report

SaxaVord Spaceport Pre-construction Otter Survey Report

March 2022

This report should be quoted as '*Alba Ecology (2022). SaxaVord Spaceport Pre-construction Otter Survey Report 2022*'.

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Introduction

An application for a satellite launch facility has been made by SaxaVord Spaceport in north Unst, Shetland (formerly known as the Shetland Space Centre). Planning permission was granted in March 2022.

Previous surveys of the area in support of the initial application (Alba Ecology, 2020a) found numerous otter signs, and use of some of the buildings present on the Lamba Ness peninsula. As part of the planning conditions, Alba Ecology Ltd. was commissioned to conduct a pre-construction otter survey targeted around the site works of the launch facilities at Lamba Ness. This was to provide up-to-date information of the current use of the area by otters.

Aim

The aim of the SaxaVord Spaceport pre-construction otter survey was:

- To provide up-to-date information and inform the SaxaVord Spaceport development on the current use of the area by otters; and
- To provide advice in regard to the requirement of a licence from NatureScot to undertake construction work.

Legal protection

Otters are classed as European Protected Species (EPS) under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended). It is therefore an offence to deliberately or recklessly:

- Kill, injure, capture or harass an otter;
- Disturb an otter whilst it is occupying a holt (underground den) or other place it uses for shelter or protection, or while it is rearing or otherwise caring for its young, or in any way that impairs its ability to survive or breed, or significantly affects the local distribution or abundance of otters; and
- Obstruct access to an otter breeding site or resting place, or otherwise prevent their use.

And whether or not deliberate or reckless:

- To damage or destroy an otter breeding site or resting place.

This means that if otters could be affected in these ways by a development, and no action is taken to prevent it, an offence may be committed.

Methods

Surveyor

According to the NatureScot otter standing guidance "*surveys should be done by persons with the appropriate knowledge of otter ecology and practical experience of otter survey work*"(NatureScot, 2020). The Study Area was surveyed for otters in March 2022 by Mr Donald Shields MCIEEM, a highly experienced mammal surveyor and ecologist. Mr Donald Shields has the knowledge, skills and experience required to survey, disturb and/or to carry out research works on otter in accordance with the CIEEM (2013) '*Competencies for Species Survey: Eurasian Otter*'.

Study Area

The Study Area was based on two factors: The first was the design layout of the development at Lamba Ness (Figure 1), and the second, where otter signs were recorded in previous surveys.

NatureScot's standing guidance (2020) states that "*Surveys should be done by persons with the appropriate knowledge of otter ecology and practical experience of otter survey work. All suitable otter habitat within 200m of the proposed works should be surveyed, including a systematic search for spraints, paw prints, otter paths, slides, food remains, holts and places used for shelter*". This is in accordance with general best practice guidance e.g. Chanin (2003). As a consequence of this guidance, outwith the footprint of the design layout, a 200m buffer was also surveyed for signs of otter, and termed the Study Area.



Figure 1: *Lamba Ness with SaxaVord Spaceport (Shetland Space Centre) design layout*

Survey methodology

As a pre-construction survey, this was conducted just prior to the planned commencement of construction works on the project.

The survey methods involved a systematic survey of terrestrial, aquatic and riparian habitats within the Study Area looking for places otters use for shelter, resting and protection (such as couches, lying-up sites and holts), or for signs of activity (such as spraints, feeding remains, runs or footprints) (Chanin, 2003).

Where signs were located, a grid reference was recorded along with notes on the types of signs present and a photograph taken. Many of the otter signs were located within inaccessible boulder scree at the base of cliff faces at Lamba Ness. They were viewed with binoculars from safe locations from the top of the cliffs. Therefore, some of the grid references are indicative. Additionally, some of the clifftop edges were deemed to be too dangerous to survey during high winds that were ongoing during the survey period.

The otter surveys took place during suitably dry weather conditions, so that otter field signs (spraints, slides, sheltering or resting places etc.) would have had time to build up, be relatively visible and would not have been degraded/washed away e.g. after heavy rain.

Results

Numerous otter field signs were recorded during targeted surveys in March 2022 (Table 1). Three otter holts were recorded during surveys, though none were recorded within the design layout itself.

One building within the design layout was recorded as being used as a couch. Couches are daytime resting places for otters.

Several sprainting sites were recorded around the design layout during the survey, with the most active one recorded near an underpass below the main track across Lamba Ness which also had an otter runway through it.

O/S grid reference	Type of otter sign	Note
HP6743915639	Couch	Small building occasionally used by otters during survey. Footprints and spraint recorded.
HP6744115528	Spraint	Old spraint, area not recently used.
HP6751315453	Spraint	Fresh spraint.
HP6726915424	Holt	Holt site at foot of cliffs. Not visited directly due to access issues and high winds.
HP6725815487	Spraint	Fresh spraint.
HP6709015483	Runway	Clear runway through underpass.
HP6708915502	Spraint	Regularly and heavily used sprainting site.
HP6704815435	Holt	Holt site in boulder field at foot of cliffs.
HP6684315302	Holt	Holt site at base of cliff in scree slope.
HP6675915307	Spraint	Old spraint, not recently used.

Table 1: *Study Area otter signs March 2022*



Photo 1: *Footprints of an individual otter were recorded in a building within the development footprint at HP6743915639.*



Photo 2: *Fresh spraint was also recorded in the doorway of this building at HP6743915639.*



Photo 3: *Several of the old military buildings were partially if not fully submerged in water during the survey.*



Photo 4: *Underpass still showing signs of use, with trails leading through and sprainting site used recently (HP6709015483).*



Photo 5: *Spraining site by lochan near underpass showing signs of recent use (HP6708915502).*



Photo 6: *Spraining site near entrance to main bunker at HP6744115528. This was not a recent spraint and no further evidence of use of the bunker was recorded.*



Photo 7: *Spraints and holts were recorded as in previous surveys outwith the design layout (often along the cliff edge and down scree areas).*



Photo 8: *Additional areas within the design layout which could potentially be used as resting sites or couches were surveyed. None showed any evidence of regular use by otters.*

Discussion

The survey recorded evidence of use of parts of the design layout by otters. Following on from previous surveys, Lamba Ness remains important for otters. While some of the buildings were noted as being used by otters during the previous survey, only one had any evidence of recent activity during this pre-construction survey. This building was within the design layout (Figure 2) and in use as an otter couch/resting place.

The track underpass remains an important feature for otters, with a large and active sprainting site recorded near it. This appears to allow them to cross from one side of Lamba Ness to the other without having to swim around the headland. Also, the freshwater lochan on the north side of the underpass is considered likely to be an important place for otters to wash.

As a result, any changes to or demolition of the building being used as a couch at HP6743915639 will require a licence from NatureScot (as outlined in Alba Ecology, 2020b) before any works can commence on this building. Works across the remainder of the Study Area will be unaffected and do not require licensing. Finally, as the Lamba Ness peninsula is actively used by otters, the construction team and the Ecological Clerk of Works should be aware of, and keep a watching brief for their presence, especially when working in and around the old military buildings and at/around the underpass.

References

Alba Ecology (2020a) Shetland Space Centre Otter Survey Report 2018 and 2020.

Alba Ecology (2020b) Shetland Space Centre Otter Licensing Requirements.

Chanin P. (2003) Monitoring the otter *Lutra lutra*. Conserving Natura 2000 Rivers Monitoring Series No.10. English Nature, Peterborough.

CIEEM (2013). Competencies for Species Survey: Eurasian Otter.

NatureScot (2020) Standing Advice for Planning Consultants. Protected Species: Otter. Standing advice for planning consultations - Otters | NatureScot [accessed March 2022].



Figure 2: *Results of SaxaVord Spaceport Pre-construction Otter Survey*

Appendix 6.4 Freshwater Pearl Mussel Survey Report

Shetland Space Centre Freshwater Pearl Mussel Survey



April 2020

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Summary

Background

Scotland is a global stronghold for the freshwater pearl mussel (*Margaritifera margaritifera*), a species now fully protected under the Wildlife and Countryside Act (1981) (as amended) of Great Britain. It is also listed on Annexes II and V of the EC Habitats Directive (Council Directive 92/43/EEC) and Appendix III of the Bern Convention. Estimates suggest that Scotland holds a large proportion of the world's remaining viable populations, with several sites of national and international importance in the north of Scotland, including Shetland.

A proposal for a space centre has been made by the Applicant in north Unst, Shetland. As part of this proposal, Alba Ecology Ltd. was commissioned to conduct a freshwater pearl mussel survey in a watercourse immediately adjacent and downslope to the proposed planning application boundary on Unst. The proposal comprises of work in three discrete areas: (i) a proposed New Section of Access Road at Northdale, (ii) a proposed Launch and Range Control Centre Site, and (iii) a proposed Launch Site. The first of these areas had running water (the Burn of Norwick) downslope and so was considered further in relation to potential freshwater pearl mussel sensitivities.

Main Findings

- The Burn of Norwick was surveyed by Dr Peter Cosgrove, an experienced and licensed freshwater pearl mussel surveyor in September 2018.
- No evidence of freshwater pearl mussels was found in the Burn of Norwick survey reach.
- No patches of suitable or potentially suitable substrate habitat were recorded in the Burn of Norwick survey reach.
- This report provides survey evidence that no freshwater pearl mussels were present within the Burn of Norwick survey reach. Consequently, the survey evidence suggests that there are no special freshwater pearl mussel sensitivities that need to be considered. Nevertheless, freshwater pearl mussels are highly sensitive to changes in water quality, and if present and undetected (and there is no evidence for this) it will be important to avoid any sources of pollution or runoff from the site during proposed works by following best practice measures when working around watercourses.

Introduction

Aim

To provide information to inform the proposed Shetland Space Centre (SSC) development in Unst, Shetland a freshwater pearl mussel (*Margaritifera margaritifera*) survey with three main stages was considered necessary.

- Watercourse survey site selection;
- Freshwater pearl mussel survey of all potentially affected watercourses; and
- Report and recommendations.

Species background

During the past 100 years, the freshwater pearl mussel has declined throughout its Holarctic range to such an extent that it is now listed as an endangered species (IUCN, 1991). Scotland is a global stronghold for the freshwater pearl mussel, a species which is now fully protected under the Wildlife and Countryside Act (1981) (as amended) of Great Britain. It is also listed on the Annexes II and V of the EC Habitats Directive (Council Directive 92/43/EEC) and Appendix III of the Bern Convention.

Recent estimates suggest that Scotland holds an important proportion of the world's known remaining viable populations (e.g. Cosgrove *et al.* 2000a; Cosgrove *et al.* 2016). However, the species has declined in Scotland, with gross industrial and agricultural pollution, over-exploitation by pearl fishers, decline in salmonid host stocks (the short parasitic larval stage of freshwater pearl mussels is entirely dependent upon salmon and trout fry) and physical river bed habitat degradation due to hydro-electric operations and small-scale river engineering works (Cosgrove *et al.* 2000a; Cosgrove *et al.* 2016).

Every year, new undiscovered pearl mussel populations are found in Scotland during targeted surveys. Freshwater pearl mussels were rediscovered in Shetland in 2002 (Cosgrove and Harvey, 2003; Cosgrove and Harvey, 2005) and so surveys of watercourses holding potentially suitable freshwater pearl mussel habitats in Shetland are required to account for this legally protected species within the SSC Study Area.

Habitat requirements

Freshwater pearl mussels are found in fast flowing rivers and streams, with detailed studies on Scottish freshwater pearl mussel populations suggesting that optimum water depths of 0.3 - 0.4m and optimum current velocities of 0.25 - 0.75ms-1 at intermediate water levels are most suitable (Hastie *et al.* 2000). River bed substratum characteristics appear to be the best physical parameters for describing freshwater pearl mussel habitat. Freshwater pearl mussels prefer stable cobble/boulder dominated substrate with some fine substrate that allows the mussels to burrow (Cosgrove *et al.* 2000b). Adult and juvenile mussels tend to have similar habitat 'preferences', although adults are found over a wider range of physical conditions and juveniles appear to be more exacting in their requirements and sensitivity to environmental disturbance (Hastie *et al.* 2000). Juvenile mussels prefer finer stable sediments than adults, particularly clean sand and gravel.

Freshwater pearl mussels live buried or partly buried in the beds of clean, fast-flowing unpolluted streams and rivers and subsist by inhaling and filtering for the minute organic particles on which they feed (Cosgrove *et al*. 2000b). Of specific importance to freshwater pearl mussel survival are detrimental levels of silt, algae, suspended solids, calcium and chemical compounds generally associated with enrichment (eutrophication) i.e. nitrate, phosphate and biological oxygen demand (Bauer 1983). Various types of river engineering work can detrimentally impact the habitat of freshwater pearl mussels (Cosgrove and Hastie, 2001).

Freshwater pearl mussels have a short parasitic larval phase on the gills of suitable host fish. The larvae (glochidia) are very host-specific and can only complete their development on Atlantic salmon *Salmo salar* or brown trout *Salmo trutta*. Usually juvenile fish (fry and parr) are utilised (Young and Williams 1984). The presence of freshwater pearl mussels in any river therefore depends on salmonid host fish availability. It is usually considered necessary for migratory salmonids to be present within a catchment for freshwater pearl mussels to be present.

Methods

Survey site selection

A proposal for a space centre has been made by the Applicant in north Unst, Shetland. As part of this proposal, Alba Ecology Ltd. was commissioned to conduct a freshwater pearl mussel survey in watercourse immediately adjacent to the proposed planning application boundary on Unst. The proposal comprises of work in three discrete areas: (i) a proposed New Section of Access Road at Northdale, (ii) a proposed Launch and Range Control Centre Site, and (iii) a proposed Launch Site. The first of these areas had running water (the Burn of Norwick) downslope and so was considered further in relation to potential freshwater pearl mussel sensitivities.

On the basis that there are no known historical records of freshwater pearl mussels within the Planning Application boundary, survey site selection was directed towards establishing the status (presence or absence) of freshwater pearl mussels and habitat suitability within potentially suitable watercourses in (or immediately adjacent to) the proposed planning application boundary.

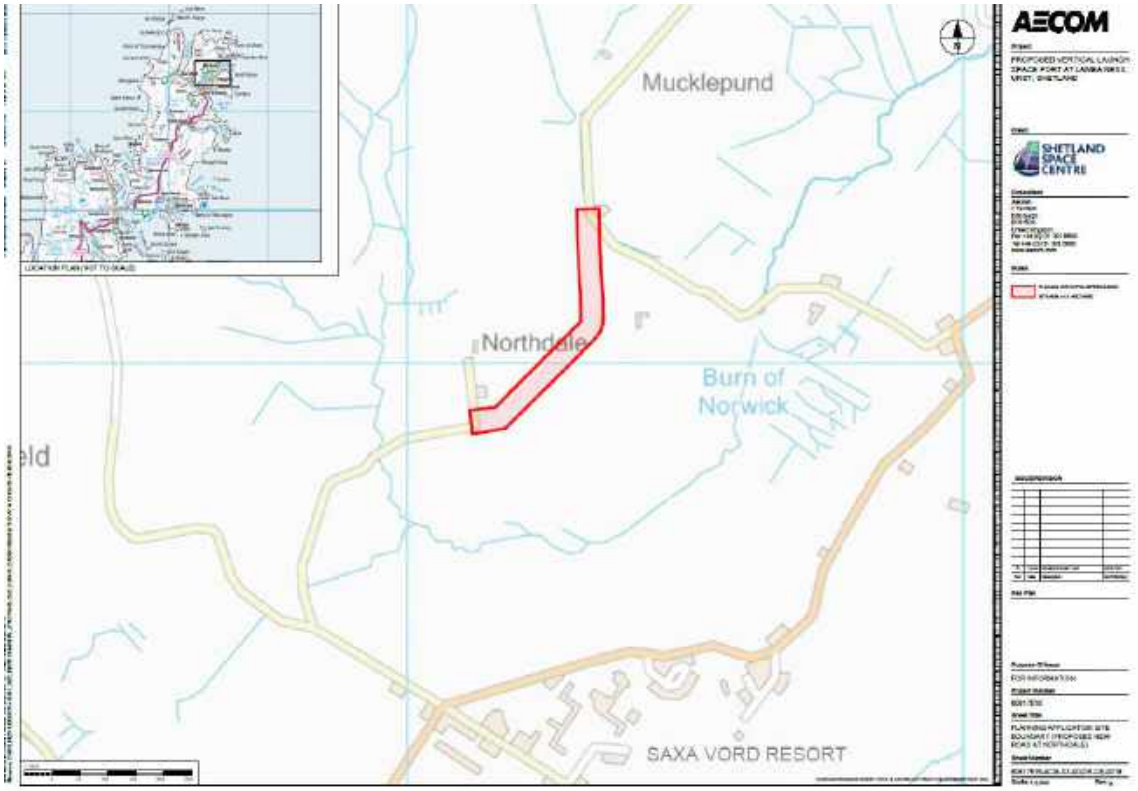

Figure 1. Proposed New Section of Access Road Boundary (red line) and the Burn of Norwick.

Survey site selection was based around knowledge of the species' habitat, host fish requirements, the Study Area and standard SNH guidance for shallow-water freshwater pearl mussel surveys (SNH, 2008). Whilst the proposed New Section of Access Road does not cross the Burn of Norwick, access from the west to and from this new road does and so it was considered important to establish presence or absence of freshwater pearl mussels (as well as habitat suitability) around this existing bridge crossing.

Survey methodology

The watercourse was entered and searched for freshwater pearl mussels, where Health and Safety conditions allowed, using an adapted version of the standardised shallow-water survey methodology (SNH, 2008).

A general survey was made of the Burn of Norwick and its substrate types within the survey reaches; defined as 100m upstream and 500m downstream of the existing bridge crossing at Northdale. This was carried out by walking along the bank and/or by wading in the water using thigh waders. The aim was to identify specific areas that were most likely to harbour mussels using information on their habitat preferences from previous studies and experience. Once an apparently suitable area was found, the watercourse was entered at the nearest point and search conducted, concentrated in the most favourable substrate types so as to optimise search efficiency. The searches were conducted in the following manner to ensure compatibility with other surveys and the standard SNH recommended methodology (SNH, 2008):

- Searches were made using a glass-bottomed viewing bucket;

- Viewing was conducted under favourable conditions i.e. bright light, clear water, low flow regime;
- Searches were made in water sufficiently shallow for safe wading;
- Searches were made in an upstream direction, checking favourable sites e.g. in the shelter of cobbles, boulders or overhanging banks;
- Loose debris and trailing weed were moved gently aside but no disturbance of the river bed was required; and
- The substrate in each transect was recorded and classified using the standard Wentworth Scale (1922).

Mussel abundance categories

For conservation reporting purposes, standard criteria were used for describing the abundance and status of the pearl mussels in 50m x 1m transects, based on counts of visible mussels (Cosgrove *et al.* 2000a). Any description of the conservation status of a mussel population must refer to the current ability of that population to recruit juveniles. The relative abundance and status terms used in this report (Table 2) match those used in previous survey work are therefore based on the recommended SNH terminology and, importantly, are directly comparable to those used on all other Scottish pearl mussel Site Condition Monitoring assessments.

Table 2. Standard relative abundance terms and codes for 50m x 1m transect counts.

Visible mussels per 50m x 1m transect	**Terminology**	**Abundance code**
0	Absent	E
1-49	Rare	D
50-499	Scarce	C
500-999	Common	B
1000+	Abundant	A

Results

The Burn of Norwick was surveyed under SNH licence (No 33634) for freshwater pearl mussels in September 2018 by Dr Peter Cosgrove, a highly experienced freshwater pearl mussel surveyor. The water levels were low and clear and the weather was bright and clear providing ideal conditions throughout surveying. No live mussels or empty/dead freshwater pearl mussel shells were found within the 600m survey reach.

The Burn of Norwick is small, recently dredged permanent watercourse. It has a gentle gradient within the 600m survey reach. Sometime after 2010, the survey reach on the Burn of Norwick at Northdale was dredged. The resultant instream substrate habitat is dominated with fine sized silt/peat sediment (Table 3). The catchment lies within an area dominated by sheep grazing and degraded blanket bog on upslope hillsides. No host fish were recorded present during surveys.

Table 3. Typical Burn of Norwick typical habitat summary

Location surveyed			**Substrate stability**			**Width**	**Depth**	**Land use/riparian vegetation**
600m around bridge @ Northdale			Unstable			2m	0.25m	Grazing pasture
	Bedrock	**Boulder**	**Cobble**	**Pebble**	**Granule**	**C sand**	**F sand**	**Silt/ Peat**
Substrate					5%	5%	+	90%
Comments: Muddy, silty and dredged channel. Wholly unsuitable for freshwater pearl mussels.								

+ = present, but less than 5%.

Photo 1. Burn of Norwick, Northdale @ HP639138, September 2018.



DISCUSSION

Summary of results

The Burn of Norwick was surveyed using SNH recommended standard shallow-water methodologies under ideal survey conditions. The relative abundance and status of the watercourse was classified as E 'Absent'. The sample based survey methodology used does not search every square metre of stream bed, so it is conceivable that a small number of freshwater pearl mussels may have remained undetected somewhere within the survey reaches. However, the use of an experienced surveyor meant that all potentially suitable habitats were thoroughly searched. It is highly unlikely (although hypothetically possible) that freshwater pearl mussels occur in the surveyed reaches where no mussels were found.

These limitations would apply to any freshwater pearl mussel survey carried out using the standard methodologies because it is a sample-based survey and not a complete census. Such a census would require the destructive searching of all loose substrate, including all

potentially suitable habitats to search for hidden mussels. Census work of this nature is not carried out in Scotland due to the endangered status of the species and its legal protection, as well as Health and Safety considerations.

Implications of results

There is no evidence that freshwater pearl mussels are present within the section of the Burn of Norwick surveyed. Consequently, there are no particular freshwater pearl mussel sensitivities that need to be considered further. Nevertheless, freshwater pearl mussels are highly sensitive to changes in water quality, and if present and undetected (and there is no evidence for this) it will be important to avoid any sources of pollution or runoff from the site during proposed works by following best practice pollution prevention measures when working around watercourses.

REFERENCES

Bauer, G. 1983. Age structure, age specific mortality rates and population trend of the freshwater pearl mussel (*M. margaritifera*) in North Bavaria. Archiv für Hydrobiologie 98: 523-532.

Cosgrove, P. J. and Hastie, L. C. 2001. Conservation of threatened freshwater pearl mussels populations: river management, mussel translocation and conflict resolution. *Biological Conservation* 99: 183-190.

Cosgrove, P. J. Young, M. R. Hastie, L. C. Gaywood, M. and Boon, P. J. 2000a. The status of the freshwater pearl mussels *M. margaritifera* Linn. in Scotland. *Aquatic Conservation: Marine and Freshwater Ecosystems* 10: 197-208.

Cosgrove, P. J. Hastie, L. C. and Young, M. R. 2000b. Freshwater pearl mussels in peril. *British Wildlife* 11: 340-347.

Cosgrove, P. and Harvey, P. 2003. An unusual freshwater pearl mussel *Margaritifera margaritifera* (L.) population in Scotland*. Journal of Conchology* 38: 139-146.

Cosgrove, P.J. and Harvey, P.V. 2005. The rediscovery of freshwater pearl mussels *Margaritifera margaritifera* (L.) in Shetland. *Shetland Naturalist* 2:2 pp 57-64.

Cosgrove, P., Watt, J., Hastie, L., Sime, I., Shields, D., Cosgrove, C., Brown, L. Isherwood, I. and Bao, M. 2016. The status of the freshwater pearl mussel *Margaritifera margaritifera* (L.) in Scotland: extent of change since 1990s, threats and management implications. *Biodiversity and Conservation* 25: 2093-2112.

Hastie, L. C. Boon, P. J. and Young, M. R. 2000. Physical microhabitat requirements of freshwater pearl mussels *M. margaritifera* (L). *Hydrobiologia* 429: 59-71.

IUCN. 1991. Invertebrate Red List. *International Union for the Conservation of Nature*.

SNH (2008). Freshwater pearl mussel survey protocol. https://www.nature.scot/freshwater-pearl-mussel-survey-protocol-use-site-specific-projects.

Wentworth, C. K. 1922. A scale of grade and class terms for clastic sediments. *Journal of Geology* 30: 377-392.

Young, M. R. and Williams, J. C. 1984. The reproductive biology of the freshwater pearl mussel *Margaritifera margaritifera* (Linn.) in Scotland I. Field Studies. *Archive für Hydrobiologie* 99: 405-422.

Appendix 6.5 SaxaVord Spaceport Chapter 9 Water

9. Water

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9. Water

9.1 Introduction

9.1.1 This chapter provides an assessment of the effects of the Proposed Project on hydrological and hydrogeological resources.

9.1.2 The Proposed Project comprises a launch area at Lamba Ness comprising three launch pad complexes, a satellite tracking station, launch vehicle integration buildings, roadways (largely re-using existing roads), fuel storage and ancillary infrastructure.

9.1.3 The Proposed Project will be operated to launch sub-orbital and orbital launch vehicles. Orbital launches will enter either polar or sun-synchronous, low-earth orbits. The layout of the spaceport allows for launches by multiple Launch Operators using a range of different launch vehicle types and is designed to accommodate launch vehicles up to 30 m in height. Launch vehicle widths are anticipated to be between 1–2 m and will not have additional boosters at the sides. Full details of the Proposed Project are provided in Chapter 3.

9.1.4 An assessment of the potential significant effects of the operation of the Proposed Project on the water environment has been undertaken, together with an assessment of the potential for any long-term or permanent alterations to the hydrological and hydrogeological regime.

9.1.5 For the purposes of this assessment, watercourses have been identified as those which appear on 1:25,000 scale Ordnance Survey mapping (Volume III Drawing 9.1). However, reconnaissance and survey work by the project civil engineers and ecologists has been also been undertaken and observations of watercourses and field drains made and taken into account.

9.2 Legislation, Policy and Guidelines

Legislation

Space Industry Act

9.2.1 The Space Industry Act (2018) regulates all spaceflight activities carried out in the United Kingdom, and associated activities. The Act requires any person or organisation to obtain the relevant licence to:

- launch a launch vehicle from the UK;
- return a launch vehicle launched elsewhere than the UK to the UK landmass or the UK's territorial waters;
- operate a satellite from the UK;
- conduct sub-orbital activities from the UK;
- operate a spaceport in the UK; or
- provide range control services from the UK.

9.2.2 As the Applicant wishes to operate a vertical launch spaceport (the SaxaVord Spaceport) and provide range control services (at the Launch and Range Control Centre, LRCC) they are required to apply for a both a spaceport licence and a range control licence. However, AEE is only relevant to applications for spaceport licences.

Space Industry Regulations 2021

9.2.3 The Space Industry Regulations 2021 (the Regulations) set out in more detail the requirements for each licence the Regulators Licensing rules, which specify what information the UK Civil Aviation Authority (CAA), the regulator, requires in support of an application.

Additional Legislation

9.2.4 With regard to hydrology, management of water-borne pollution and protection of natural heritage areas, the Scottish Environment Protection Agency (SEPA) has statutory obligations in terms of the management and control of pollution into water resources in Scotland. Where careful design has avoided sensitive receptors, it is reasonable to assume that the adoption of the SEPA's Good Practice Guidelines will, in general, prevent pollution to acceptable standards and make the majority of any 'significant' effects unlikely.

9.2.5 There is a range of environmental legislation that the Proposed Project must adhere to throughout its life cycle. Relevant legislation and guidance documents have been reviewed and taken into account as part of this hydrogeological and hydrological assessment. Key legislative drivers relating to the water environment which have been considered within this assessment are listed below:

- Control of Pollution Act 1974;
- Environmental Protection Act 1990;
- Environment Act 1995;
- Water Framework Directive 2000/60/EC;
- Groundwater Daughter Directive 2006/118/EC;
- Water Environment and Water Services (Scotland) Act (WEWSA) 2003;
- Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended in 2018) (CAR);
- The Water Intended for Human Consumption (Private Supplies) (Scotland) Regulations 2017 (amends and revokes the Private Water Supplies (Scotland) Regulations 2006);
- The Flood Risk Management (Scotland) Act 2009; and,
- The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017.

9.2.6 The Water Framework Directive has been implemented in Scotland through WESWA and CAR. The primary objective of the Directive is for all surface and coastal water bodies to achieve good chemical and ecological status, and ground water bodies to achieve good quantitative and chemical status, by 2015 or 2021. This required assessment of a much wider set of water quality parameters than had previously been used. SEPA has published River Basin Management Plans (RBMPs) which detail the current and target status of water bodies, and the means of achieving these targets.

Policy

9.2.7 Scottish Planning Policy (SPP) (Scottish Government, 2014) identifies the range of considerations likely to be relevant to the determination of developments of the nature of the Proposed Project. These include effects on hydrology, the water environment and flood risk.

9.2.8 It also states that the planning system should '*promote protection and improvement of the water environment, including rivers, lochs, estuaries, wetlands, coastal waters and groundwater, in a sustainable and co-ordinated way*' (paragraph 194); and '*Development management decisions should take account of potential effects on landscapes and the natural and water environment, including cumulative effects*' (paragraph 202).

9.2.9 With respect to flooding, SPP paragraph 255 promotes a precautionary approach to flood risk from all sources and states that the planning system should prevent development which would have a significant probability of being affected by flooding or would increase the probability of flooding elsewhere. Paragraph 264 sets out aspects to be taken account for development management, in respect of flood risk. This includes consideration of the design and use of the Proposed Project. Paragraph 266 notes that Flood Risk Assessments should be required for development in the medium to high category of flood risk (annual probability of coastal or watercourse flooding is greater than 0.5% or 1:200 years).

9.2.10 The following Planning Advice Notes, issued by the then Scottish Executive, are also relevant to the assessments made in this chapter:

- Planning Advice Note 61: Planning and Sustainable Urban Drainage Systems, 2001; and,
- Planning Advice Note 79: Water and Drainage, 2006.

9.2.11 The Shetland Local Development Plan (Shetland Islands Council, 2014), identifies considerations relevant to the Proposed Project including:

- WD1 Flooding Avoidance;
- WD2 Waste Water;
- WD3 Sustainable Drainage Systems;
- NH1 International and National Designations; and
- NH7 Water Environment.

Guidance

Guidance to the regulator on environmental objectives relating to the exercise of its functions under the Space Industry Act 2018

9.2.12 The Department for Transport issued its document '*Guidance to the regulator on environmental objectives relating to the exercise of its function under the Space Industry Act 2018*' in 2021, clarifying the government's environmental objectives relating to spaceflight and associated activities in the UK:

The environmental objectives for spaceflight are:

- *Minimise emissions contributing to climate change resulting from spaceflight activities;*
- *Protect human health and the environment from the impacts of emissions on local air quality arising from spaceflight activities;*
- *Protect people and wildlife from the impacts of noise from spaceflight activities;*
- *Protect the marine environment from the impact of spaceflight activities.*

Guidance for the Assessment of Environmental Effects

9.2.13 The CAA (July 2021) document Guidance for the Assessment of Environmental Effects (AEE) explains the process for completing an assessment of environmental effects as part of a licence application under the Space Industry Act.

9.2.14 The AEE Guidance requires that potential direct and indirect significant effects of proposed spaceflight activities on environmental features, including water, are considered. The guidance further requires that:

- Specific potential effects are identified and, where possible, quantified;

- The focus of the AEE should be on significant effects arising from the proposed activities;
- Applicants for a spaceport licence set an environmental budget, comprising a maximum number of launches per launch vehicle type which can take place over the course of a year that can be carried out in an environmentally sustainable manner, taking into account the cumulative effect of all launches; and
- The AEE must address a range of environmental topics, including water.

Pollution Prevention Guidance documents

9.2.15 A review plan for Pollution Prevention Guidance documents (PPGs) is currently underway by Natural Resources Wales (NRW), the Northern Ireland Environment Agency (NIEA) and the Scottish Environment Protection Agency (SEPA), replacing them with a replacement guidance series: Guidance for Pollution Prevention (GPPs). GPPs provide environmental good practice guidance for the whole UK, and environmental regulatory guidance directly to Northern Ireland, Scotland and Wales only.

9.2.16 The PPGs and GPPs include the documents referred to below, which are the principal documents used for guidance on preventing contamination of surface water. Those relevant to the Proposed Project include:

- PPG1: General guide to the prevention of pollution (EA, SEPA & EHSNI, 2013);
- GPP2: Above ground oil storage tanks (EA, SEPA & EHSNI, January 2018);
- GPP21: Pollution incidence response planning (EA, SEPA & EHSNI, 2017).

9.2.17 The following SEPA Guidelines are also relevant:

- Flood Risk and Planning Briefing Note (SEPA, 2014);
- Position Statement: The role of SEPA in natural flood management (SEPA, Feb, 2012);
- Technical flood risk guidance for stakeholders, version 12 (SEPA, May 2019);
- Land Use Planning System Guidance Note 31 (LUPS-GU31) - Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems (SEPA, October 2014);
- The Water Environment (Controlled Activities) (Scotland) Regulations 2011 as amended in 2018 - A practical guide (SEPA, 2011 as amended in 2019);
- Environmental Quality Standards and Standards for Discharges to Surface Waters, Supporting Guidance (WAT-SG-53) (SEPA, 2020);
- Development of a groundwater vulnerability screening methodology for the Water Framework Directive, Project WFD28 Final Report (SEPA 2004); and,
- The River Basin Planning Strategy for the Scotland River Basin District (SEPA, 2009/2015).

9.2.18 Other relevant guidance includes:

- Private Water Supplies: Technical Manual, Scottish Executive, 2006; and
- UK Technical Advisory Group on the WFD (Water Transport Directive), UK Environmental Standards and Conditions Final Report, November 2013.

9.3 Consultation

9.3.1 Extensive statutory consultation in relation to the water environment was carried out during preparation and determination of the planning application for the SaxaVord Spaceport, where the Proposed Project will be operated. Where directly relevant to this AEE, consultation responses

received during the SaxaVord Spaceport planning application period have been summarised in Table 9.1.

Table 9.1 Consultation Relevant to AEE

Consultee	Notes
Shetland Islands Council Environmental Health	Shetland Islands Council Environmental Health was consulted for information on any known private water supplies within 1 km of any of the Proposed Project boundaries. Shetland Islands Council confirmed that it holds no records of any private water supplies within this study area.
SEPA	SEPA was not directly consulted, however a database of regulatory information including water quality classifications, flood risk, historical landfill sites, waste sites, and authorised industrial process was obtained by AECOM (the project civil engineer) and has been reviewed.

9.4 Assessment Methodology and Significance Criteria

9.4.1 The following section sets out the approach that was followed to collect relevant baseline information and the methodology for assessing impacts and the significance of effects.

Environmental Zone of Influence

9.4.2 The hydrology study area incorporates the areas within the Proposed Project boundary, alongside consideration of hydrological effects up to one kilometre away. Consideration has also been given to the presence of any known private water supplies within one kilometre of the Proposed Project.

9.4.3 The criteria for defining the EZI with regard to hydrological resources have been established based on professional judgement and experience with regard to likely access and working areas, reference to SEPA guidance, and with due consideration to other relevant guidance on hydrological assessment. The extent of the hydrology study area or EZI is shown on Drawing 9.1.

Desk Study

9.4.4 Baseline conditions have been established primarily via desk-based research and has included the following:

- consultation with relevant regulatory authorities as described in Table 9.1 above;
- identification of the locations and characteristics of catchments and principal watercourses and waterbodies as shown on 1:25,000 scale OS mapping which may be affected by the Proposed Project;
- identification of SEPA/WFD watercourse and water body classifications;
- review of online SEPA flood mapping;
- review and collation of pertinent information on surface hydrology, flooding, climate etc.;
- review of geological mapping of the area, British Geological Survey, Geology of Britain Viewer, 1:50,000 scale;
- review of hydrogeological characteristics and groundwater resource;
- review of Private Water Supply records held by the Drinking Water Quality Regulator for Scotland (DWQR) and Shetland Islands Council;

- AECOM project drawing 0065 – Existing Watercourses & Drainage Ditches; and,
- AECOM report *Shetland Space Centre, Desk Study and Site Appraisal* (AECOM, 2019), which is included as Volume IV Technical Appendix 9.1 to this AEE Report.

9.4.5 Details of the Proposed Project relevant to the water environment have been provided by the project team, principally AECOM as the project civil engineer. Specifically, this includes the following:

- AECOM project drawings:
  - 0037(S) – Launch Site Layout
  - 0054(B) – Launch Pad 1 Drainage Strategy
  - 0056(C) – Transport Holding Building Drainage Strategy
  - 0057(C) – Assembly & Storage Area Proposed Drainage Strategy
  - 0060(C) – Launch Pad 3 Drainage Strategy
  - 0066(A) – Satellite Tracking Area Drainage Strategy
- AECOM report *Shetland Space Centre, Drainage Strategy Rev.4* (AECOM, 2020a), which is included as Volume IV Technical Appendix 9.2 to this AEE Report.

Site Visit and Surveys

9.4.6 As part of AECOM's site appraisal (as reported in the above-noted desk study and site appraisal report), AECOM staff undertook a detailed site walkover of the Proposed Project in November 2019. Photographs were taken and are included in the report with descriptions. Observations were made of extant buildings, other relic infrastructure, and former quarries. Ground conditions were also observed where possible, including along the sea cliffs and at the quarries, where the soil profile was reported to be clearly exposed. The presence and nature of watercourses and drainage ditches was also noted.

9.4.7 Subsequently, in October and November 2020, AECOM undertook a preliminary ground investigation at the Proposed Project, to determine the depth of peat, where present, and the nature of underlying deposits and depth to bedrock. This investigation comprised excavation of 42 trial pits and advancing 304 peat probes. Information from this investigation is included and referred to as appropriate within this chapter. Full details are provided in the AECOM report *Shetland Space Centre, Preliminary Ground Investigation – Factual Report* (AECOM, 2020b) which is included as Volume IV Technical Appendix 9.3 to this AEE Report.

9.4.8 As part of the ecological assessment for the Proposed Project, Alba Ecology undertook field surveys in July 2018, updated in July 2020. These included an extended Phase 1 Habitat survey, a National Vegetation Classification (NVC) survey, and protected species surveys. Alba undertook an assessment of potential Groundwater Dependent Terrestrial Ecosystems (GWDTE) as part of this work, as reported in Appendix 6.2.

9.4.9 No water quality monitoring has been undertaken, although this is not considered to be warranted at this stage and is not considered to materially affect the impact assessment.

Assessment of Potential Effect Significance

9.4.10 The characterisation of hydrological and hydrogeological sensitivities has been guided by the matrix presented in Table 9.2 below which lists the characterisation criteria.

Table 9.2 Hydrological and Hydrogeological Sensitivity

Sensitivity	Description
High	Areas containing hydrological features considered to be of international or national interest, for example Aquatic Natura 2000 sites, SACs (Special Areas of Conservation), SSSIs (Site of Special Scientific Interest). Highly permeable superficial deposits allowing free transport of contaminants to groundwater and surrounding surface waters. Wetland/watercourse of High or Good Ecological Potential. High risk of flooding.
Medium	Moderately permeable superficial deposits allowing some limited transport of contaminants to groundwater and surrounding surface waters. Wetland/watercourse of Moderate Ecological Potential. Moderate risk of flooding.
Low	Low permeability superficial deposits likely to inhibit the transport of contaminants. Wetland/watercourse of Poor or Bad Ecological Potential or no WFD classification. Low risk of flooding.

9.4.11 The criteria for sensitivity have been developed based on a hierarchy of factors relating to quality of the aquatic environment including international and national designations, water quality information, watercourse status from the WFD review work undertaken to date by SEPA, consultations, site reconnaissance and the professional judgement of the assessment team.

9.4.12 The prediction and assessment of effects on hydrology and hydrogeology has been undertaken using a series of tables to document the various potential impacts from operation of the Proposed Project. Effects have been predicted for the Proposed Project based on the guideline criteria for impact magnitudes set out in Table 9.3 below.

Table 9.3 Impact Magnitude

Impact Magnitude	Guideline Criteria
High	Total loss of, or alteration to, key features of the baseline resource such that characteristics or quality would be fundamentally and irreversibly changed e.g. watercourse realignment.
Medium	Loss of, or alteration to, key features of the baseline resource such that characteristics or quality would be partially changed e.g., instream permanent bridge supports.
Low	Small changes to the baseline resource, which are detectable, but the underlying characteristics or quality of the baseline

Impact Magnitude	Guideline Criteria
	situation would be similar e.g. culverting of very small watercourses/drains.
Negligible	A very slight change from baseline conditions, which is barely distinguishable, and approximates to the 'no-change' situation.

9.4.13 The significance of the predicted effects has been assessed in relation to the sensitivities of the baseline resource and magnitude of predicted impacts. A matrix of significance has been developed to provide a consistent framework for evaluation and is presented in Table 9.4 below. Guideline criteria for the various categories of effect are included in Table 9.5 below.

Table 9.4 Effect Significance Matrix

	Sensitivity			
Magnitude	**High**	**Medium**	**Low**	**Not Sensitive**
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Minor	Negligible
Low	Moderate	Minor	Minor	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

Table 9.5 Effect Significance Categories

Significance	Definition	Guideline Criteria
Major	A fundamental change to the environment.	Changes in water quality or quantity affecting widespread catchments or groundwater reserves of strategic significance.
Moderate	A larger, but non-fundamental change to the environment.	Changes in water quality or quantity affecting part of a catchment or groundwaters of moderate vulnerability.
Minor	A small but detectable change to the environment.	Localised changes resulting in minor and reversible effects on surface and groundwater quality or habitats.
Negligible	No detectable change to the environment.	No effects on drainage patterns, surface and groundwater quality or aquatic habitat.

9.4.14 In the above classification, fundamental changes are those which are permanent, either adverse or beneficial, and would result in widespread change to the baseline environment. For the purposes of this assessment, those effects identified as being major or moderate have been evaluated as significant environmental effects.

9.4.15 These matrices have been used to guide the assessment, although they have been applied with a degree of flexibility, since the evaluation of effects will always be subject to location-specific characteristics which must be taken into account. For this reason, the evaluation of the significance of effects in particular will not always correlate exactly with the cells in the relevant matrix, especially where professional judgement and knowledge of local conditions may result in a slightly

different interpretation of the impact concerned. Additionally, effects may be assessed as having a significance level between those noted above, i.e., Minor to Moderate, or Moderate to Major.

9.4.16 Cumulative effects have been accounted for through the prediction and evaluation of effects cumulatively with those which could arise as a result of operation of other developments (operational, consented or in planning) within the EZI.

Requirements for Mitigation

9.4.17 Proposed mitigation measures are presented within this chapter where the potential to affect sensitive hydrological or hydrogeological receptors has been predicted.

Assessment of Residual Effect Significance

9.4.18 An assessment of any predicted significant residual effects on sensitive hydrological or hydrogeological receptors, taking account of committed mitigation measures, is presented within this chapter.

9.5 Baseline Conditions

Geography and Topography

9.5.1 The Proposed Project is located on the peninsula known as Lamba Ness, on the north-east coast of the Island of Unst. The coastline which forms the north, east and south boundaries comprises high, rocky cliffs, rising from sea level to approximately 10 to 20 m Above Ordnance Datum (AOD) along the north and east of the site, and as high as 50 m AOD in the south.

9.5.2 The Proposed Project site is generally flat, with a very gentle overall rise towards the west across the main body, steepening towards the west end (the western edge being at approximately 65 m AOD). A small, low hill feature (31 m AOD) is located towards the east end of the peninsula.

Designated Sites

9.5.3 There are no statutorily designated sites relevant to hydrology or hydrogeology within the boundaries of the Proposed Project.

9.5.4 No internationally designated sites relevant to hydrology or hydrogeology (i.e. Special Areas of Conservation) are located within the EZI.

9.5.5 There is one relevant nationally designated site within the EZI:

- The Norwick Meadows SSSI is approximately 800 m south-west of the Proposed Project and is designated for sand dunes and valley fen.

9.5.6 There is no hydrological continuity between the Proposed Project and the Norwick Meadows SSSI, therefore potential impacts on this designated site arising from operation are scoped out of further assessment.

Hydrology

9.5.7 There are no major surface watercourses within the Proposed Project boundary.

9.5.8 A minor, unnamed watercourse rises in the central part of the Proposed Project site (west of The Garths) and flows north/north-east to the sea west of Skaw Banks. A small pond feature appears to be present along the course of this burn.

9.5.9 Three further drains/minor burns flow from the western part of the northern boundary, north/north-east to the sea at Sand of Inner Shaw. Another drain flows north to south across the far west end of the site. Several small ponds are located off-site to the north of the far west end, with map markings indicating these may be water-filled former quarries.

9.5.10 A small water body is present in the south-east of the Proposed Project site, called Loch of Lamba Ness. A second, unnamed pond is located approximately 300 m west of this. These ponds have no evident connection with any surface watercourses, so may be rainwater fed.

9.5.11 In addition to the above watercourses and water bodies identified from 1:25,000 scale OS mapping (as shown on Drawing 9.1), AECOM identifies a number of drainage ditches cut into the Proposed Project site, as shown in Figure 9-1 below. These are largely in the central part of the site, draining from south to north, with a small number draining southward to the sea.

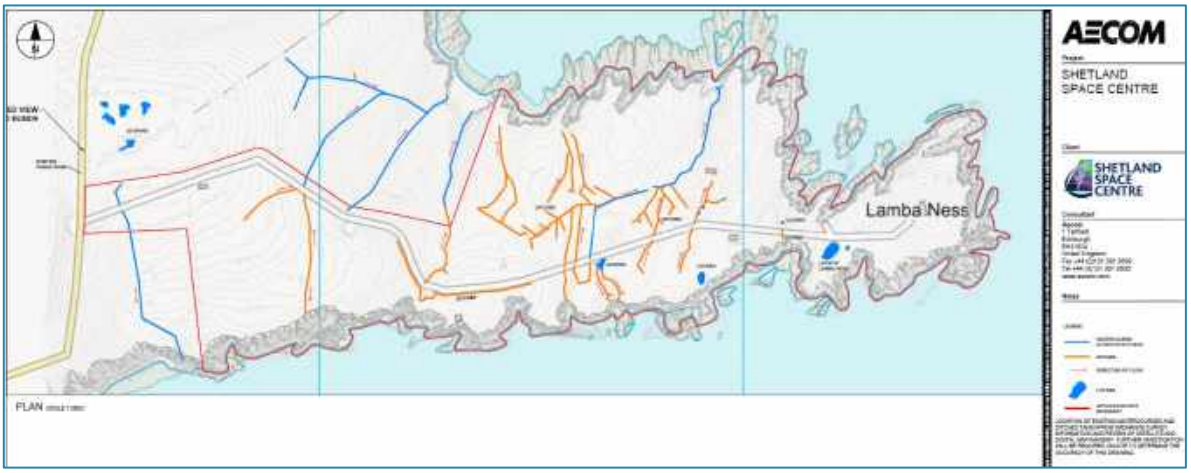


Figure 9-1 Existing watercourses and drainage ditches

9.5.12 Figure 9-1 also shows several additional small lochans, in the south-central part of the Proposed Project site.

9.5.13 Additional watercourses within 1 km of the Proposed Project are all up-stream/up-gradient and are therefore unlikely to be impacted by operation of the Proposed Project.

9.5.14 None of the above-noted watercourses have WFD classifications.

Summary

9.5.15 Although there are a number of drains and small watercourses within and near to the Proposed Project, these are all minor watercourses with no WFD classifications. Furthermore, they all drain to the sea, therefore the potential for any localised impact on surface water is minimal given the scale of the receiving coastal water body. The overall sensitivity of the hydrological (surface water) resource in the Proposed Project EZI is assessed as low.

Hydrogeology

Aquifer Status

9.5.16 The Hydrogeology Map of the UK indicates that the rock formations underlying the Proposed Project are classified as a low productivity aquifer, with flow virtually all through fractures and other discontinuities. Small amounts of groundwater may be present in the near-surface weathered zone.

9.5.17 SEPA identifies the groundwater body at the Proposed Project site as the Unst Groundwater (ID 150594), designated an overall status of '*Good*' in 2018.

Private Water Supplies

9.5.18 No springs or wells are marked on OS mapping within the boundary of the Proposed Project. A well is shown at the mouth of the Burn of Skaw, approximately 650 m north of the western part of the Proposed Project.

9.5.19 The DWQR online map shows no recorded private water supplies within 1 km of the Proposed Project. Shetland Islands Council has been consulted for any information it holds on private water supplies within 1 km of the Proposed Project. A response was received during the planning application stage indicating that Shetland Islands Council holds no records of private water supplies within the EZI.

Groundwater Dependent Terrestrial Ecosystems (GWDTE)

9.5.20 National Vegetation Classification (NVC) survey work undertaken by Alba Ecology (refer to Chapter 5) recorded several NVC communities indicative of potential groundwater dependence. Much of the Proposed Project area was recorded as wet modified bog and wet modified bog/wet heath transitional habitat, suggesting potentially moderate groundwater dependence.

9.5.21 Bedrock across the Proposed Project site comprises a low productivity aquifer (Skaw Intrusion), considered unlikely to contain any substantial groundwater at shallow depth. Groundwater is indicated to flow virtually all through fractures and other discontinuities. Therefore, the pattern of modified bog/wet heath being widespread across much of the site area is not indicative of potential groundwater presence along fissures or discontinuities. Rather, it is considered likely that these habitats are fed by rainwater forming waterlogged ground conditions.

9.5.22 An area of acid flush observed by Alba Ecology to the west of the Proposed Project site was identified as being potentially highly groundwater dependent. This area is within the Saxa Vord Pelite Formation, also a low permeability aquifer with minimal groundwater anticipated to be present at shallow depth. The localised occurrence of this habitat, near the edge of the Skaw Intrusion, suggests potential for it to be at a fissure or spring feature, and fed by groundwater. However, this location is up-gradient, and more than 250 m from any proposed infrastructure (the distance identified by SEPA as being a suitable buffer between GWDTE and even deep excavations).

Summary

9.5.23 Superficial geological deposits in the area are likely to be variable and potentially conducive to transmission of groundwater at least locally. However, the regional bedrock has low permeability and is likely to inhibit migration of groundwater and reduce its susceptibility to impact beyond a limited zone of influence. The only area of potential GWDTE considered to be actually fed by groundwater is more than 250 m from any proposed infrastructure.

9.5.24 The sensitivity of groundwater at the Proposed Project site is assessed as low.

Flood Risk

9.5.25 SEPA online flood risk mapping identifies no risk of fluvial or coastal flooding at the Proposed Project site. Potential surface water flood risk areas are limited to actual water bodies i.e., the Loch of Lamba Ness.

9.5.26 Given the absence of identified flood risk, the sensitivity of the Proposed Project to flood risk is assessed as low.

9.6 Receptors Brought Forward for Assessment

9.6.1 Following review and analysis of the hydrological and hydrogeological baseline as reported above, the following features/receptors have been taken forward for assessment:

- Local surface water including watercourses within the Proposed Project boundary.

9.7 Standard Mitigation

9.7.1 The following embedded mitigation measures, as detailed at project planning and design stage, are applicable to operation of the Proposed Project.

9.7.2 The AECOM Drainage Strategy report and associated drawings provide full details of the proposed arrangements for the management of drainage throughout the Proposed Project.

Surface Water

9.7.3 Each launch pad will comprise a concrete slab with a launch pit sunk into it, and a flame deflection culvert. The concrete slab will be surrounded on three sides by a wall to contain any deluge water, if required. The slab will fall towards the launch pit, such that any surface and deluge water will run-off into the launch pit. The launch pit is connected to a culvert via a manhole with a penstock valve permitting water to be diverted to an interceptor/storage tank (for collection and removal for off-site treatment) during fuelling and launch activities.

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

9.7.5 Launch pad fuel storage areas 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.

Foul Drainage

9.7.6 Permanent welfare facilities will be provided at the Proposed Project. Foul drainage from these facilities will be collected through a small drainage network into a sewerage storage tank which will be emptied as required. Given the relatively infrequent use of the facilities (only during launch cycles and in preparation for them), AECOM notes that it is not considered feasible to use septic tanks or small treatment works. In future, as and when launch frequency increases such that there are consistent foul drainage flows, a septic tank is proposed to be added, with filter distribution pipework and final discharge to existing drainage ditches.

9.7.7 Temporary welfare facilities will be provided at each launch pad when in use (i.e., portable cabins, with tanks emptied as required).

Fuel Storage

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

9.7.9 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.

Water Abstraction

9.7.10 No new on-site water abstraction is proposed. The volumes of water required for site operation are approximately 5,000 litres per launch/test, and it is proposed that water will be either sourced from a nearby MoD reservoir west/north-west of the Proposed Project site (subject to further assessment and appropriate authorisation), or tankered onto site as required. Rainwater harvesting is also being considered and will be used where available but is unlikely to reliably provide the volumes required for all functions. Very little potable water will be required for site operation, and due to the intermittent requirement, bottled water will be used.

9.8 Potential Effects

9.8.1 New structures and hardstanding at the Proposed Project have the potential to result in increased and concentrated surface water run-off, impacting on the water quality and flow rate of local drainage ditches and watercourses; however, these structures have all been assessed as part of the construction phase during the planning application and are therefore not required to be considered further for AEE.

9.8.2 Taking account of the embedded mitigation included in the design of the Proposed Project during the planning stages, the potential impact magnitude of operation of the Proposed Project is considered to be low, on a low sensitivity receptor. Therefore, there are **no significant effects** predicted.

9.9 Additional Mitigation

9.9.1 Potential effects have been assessed as not significant, with no additional mitigation therefore required.

9.10 Cumulative Assessment

9.10.1 Cumulative effects can be either inter-project or intra-project effects.

9.10.2 Inter-project cumulative effects are those where an environmental topic/receptor is affected by impacts from more than one project at the same time and the impacts act together. No consented or proposed developments with the potential to create cumulative effects on water have been identified in the EZI.

9.10.3 Intra-project cumulative effects are those where an environmental topic/receptor is affected by more than one impact from the same Proposed Project and the impacts act together. Given that none of the other environmental topics considered impact directly on water and the fact that containment will be in place during launches, it is considered that there is no potential for additive or intra-project cumulative effects.

9.11 Residual Effects

9.11.1 No additional mitigation is proposed therefore, residual effects are as per the potential effects described in Section 9.8 above. All residual effects considered in this assessment are assessed as being minor adverse and therefore there are considered to be **no significant effects**.

9.12 Summary

9.12.1 The Proposed Project comprises three launch pads and ancillary buildings and access infrastructure. The site is a relatively flat area on the Lamba Ness peninsula with high, rocky cliffs forming the north, east and south boundaries.

9.12.2 There are no statutorily designated sites relevant to hydrology or hydrogeology within Proposed Project boundary. The Norwick Meadows SSSI is approximately 800 m south-west of the Proposed Project and is designated for sand dunes and valley fen.

9.12.3 There is no hydrological continuity between the Proposed Project and the Norwick Meadows SSSI.

9.12.4 There are a number of drains and small watercourses within and near to the Proposed Project site, all of which drain into the sea.

9.12.5 Habitats indicative of potential moderate groundwater dependency have been identified across much of the Proposed Project site, although based on the site geology and the distribution of these habitats, they are interpreted as being surface water or rainwater fed. The only area of potential

GWDTE considered to be actually fed by groundwater is more than 250 m from any proposed infrastructure.

9.12.6 Likely operational effects include sedimentation or pollution of the water environment from surface runoff and fuel/chemical leaks and spills, and effects on the local groundwater quality and flow regime.

9.12.7 Embedded mitigation measures included in the design of the Proposed Project and operational control measures include no bulk storage of fuels at the Proposed Project and provision of appropriate spill control procedures alongside a suitable Drainage Strategy to control and treat surface and foul drainage.

9.12.8 No new on-site water abstraction is proposed. Water required for site operation will be sourced from a nearby MoD reservoir or tankered onto site as required.

9.12.9 The likely effects on hydrological and hydrogeological receptors, taking account of the embedded mitigation measures committed to during the planning stage, have been assessed as minor and **no significant effects**.

9.12.10 The significance of residual effects on hydrological and hydrogeological receptors is considered to be minor and **no significant effects**.

9.12.11 No cumulative effects on hydrology or hydrogeology are predicted.

9.13 References

CIRIA (2015). *SUDS Manual C753*. Available at: https://www.ciria.org/

CIRIA (2010). *Environmental good practice on site C650*. Available at: https://www.ciria.org/

CIRIA (2016). *Groundwater Control – design and practice C515*. Available at: https://www.ciria.org/

DWQR. (2019). *Private Water Supply map*. Available at: https://dwqr.scot/private-supply/pws-location-map/

EA, SEPA & EHSNI (2011): *PPG26: Storage and handling of drums and intermediate bulk containers*. Available at: https://www.gov.uk/government/publications/storing-and-handling-drums-and-intermediate-bulk-containers-ppg26

EA, SEPA & EHSNI (2013). *PPG1: General guide to the prevention of pollution*. Available at: https://www.gov.uk/government/publications/basic-good-environmental-practices-ppg1-prevent-pollution

EA, SEPA & EHSNI (2017). *GPP21: Pollution incidence response planning*. Available at: http://www.netregs.org.uk/environmental-topics/pollution-prevention-guidelines-ppgs-and-replacement-series/guidance-for-pollution-prevention-gpps-full-list/

EA, SEPA & EHSNI (January 2017). *GPP5: Works and maintenance in or near water*. Available at: http://www.netregs.org.uk/environmental-topics/pollution-prevention-guidelines-ppgs-and-replacement-series/guidance-for-pollution-prevention-gpps-full-list/

EA, SEPA & EHSNI (January 2018). *GPP2: Above ground oil storage tanks*. Available at: http://www.netregs.org.uk/environmental-topics/pollution-prevention-guidelines-ppgs-and-replacement-series/guidance-for-pollution-prevention-gpps-full-list/

EA, SEPA & EHSNI (November 2017). *GPP4: Treatment and disposal of sewage where no foul sewer is available*. Available at: http://www.netregs.org.uk/environmental-topics/pollution-prevention-guidelines-ppgs-and-replacement-series/guidance-for-pollution-prevention-gpps-full-list/

EC (1979). *Groundwater Directive 80/68/EEC*. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31980L0068

EC (2000). *Water Framework Directive 2000/60/EC (WFD) 2000*. Available at: http://ec.europa.eu/environment/water/water-framework/index_en.html

EC (2006). *Groundwater Daughter Directive 2006/118/EC*. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32006L0118

NERC. (2012). *Geology of Britain*. Available at: http://mapapps.bgs.ac.uk/geologyofbritain/home.html Accessed in July and October 2020.

Scottish Executive (2006). *Private Water Supplies: Technical Manual*. Available at: http://www.privatewatersupplies.gov.uk/private_water/files/Full%20Doc.pdf

Scottish Executive (2007). *Flood Prevention and Land Drainage (Scotland) Act 1997*. Available at: http://www.legislation.gov.uk/ukpga/1997/36/section/3/enacted

Scottish Government (2001). *Planning Advice Note 61: Planning and SUDS, 2001*. Available at: https://www.gov.scot/publications/pan-61-sustainable-urban-drainage-systems/

Scottish Government (2003). *Water Environment and Water Services (Scotland) Act (WEWS Act) 2003*. Available at: http://www.legislation.gov.uk/asp/2003/3/contents

Scottish Government (2006). *Planning Advice Note 79: Water and Drainage, 2006*. Available at: https://www.gov.scot/publications/planning-advice-note-pan-79-water-drainage/

Scottish Government (2009). *The Flood Risk Management (Scotland) Act 2009*. Available at: http://www.legislation.gov.uk/asp/2009/6/contents

Scottish Government (2011). *Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended in 2018 (CAR)*. Available at: http://www.legislation.gov.uk/ssi/2011/209/contents/made

Scottish Government (2014). *Scottish Planning Policy (SPP) June 2014*. Available at: https://www.gov.scot/publications/scottish-planning-policy/

Scottish Government (2015). *The Environmental Liability (Scotland) Regulations 2015*. Available at: http://www.legislation.gov.uk/ssi/2015/214/contents/made

Scottish Government (2017). *The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017*. Available at: http://www.legislation.gov.uk/ssi/2017/102/contents/made

Scottish Government (2017). *The Water Intended for Human Consumption (Private Supplies) (Scotland) Regulations 2017*. Available at: http://www.legislation.gov.uk/ssi/2017/282/contents/made

SEPA (2004). *Methodology for the Water Framework Directive, Scotland and Northern Ireland Forum for Environmental Research, Project WFD 28 Final Report*.

SEPA (2006). *Special Requirements for Civil Engineering Contracts for the Prevention of Pollution, Version 2*. Available at: https://www.sepa.org.uk/media/152220/wat_sg_31.pdf

SEPA (2008). *Regulatory Position Statement: Waste Water Drainage*.

SEPA (2009/2015). *The River Basin Planning Strategy for the Scotland River Basin District*. Available at: https://www.sepa.org.uk/media/37453/rbmp_planning-strategy_scotland.pdf

SEPA (2011 as amended in 2018). *The Water Environment (Controlled Activities) (Scotland) Regulations 2011 as amended in 2018 - A practical guide*. Available at: https://www.sepa.org.uk/media/34761/car_a_practical_guide.pdf

SEPA (2014). *Flood Risk and Planning Briefing Note*. Available at: https://www.sepa.org.uk/media/143403/sepa-briefing-note-to-planning-authorities-on-the-flood-risk-management-scotland-act-2009.pdf

SEPA (2014). *Land Use Planning System Guidance Note 31 (LUPS-GU31)- Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems*. Available at: https://www.sepa.org.uk/media/144266/lups-gu31-guidance-on-assessing-the-impacts-of-development-proposals-on-groundwater-abstractions-and-groundwater-dependent-terrestrial-ecosystems.pdf

SEPA (Feb 2012). *Position Statement: The role of SEPA in natural flood management*. Available at: https://www.sepa.org.uk/media/42133/sepa-04-12-position_statement_the_role_of_sepa_in_natural_flood_management.pdf

SEPA (January 2014, updated April 2018). *Indicative River & Coastal Flood Map (Scotland)*. Available at: *http://map.sepa.org.uk/floodmap/map.htm*

SEPA (July 2019). *Technical flood risk guidance for stakeholders, version 12*. Available at: *https://www.sepa.org.uk/media/162602/ss-nfr-p-002-technical-flood-risk-guidance-for-stakeholders.pdf*

Shetland Islands Council (2014). Shetland Local Development Plan. Available at: https://sfd.shetland.gov.uk/sfd/Planning/DevelopmentPlans/ShetlandLocalDevelopmentPlanAdopted26_09_2014.pdf

SNH (2018). *A Handbook of Environmental Impact Assessment, 5th Edition*. Available at: *https://www.nature.scot/handbook-environmental-impact-assessment-guidance-competent-authorities-consultees-and-others*

UK Government (1974). *Control of Pollution Act 1974*. Available at: *https://www.legislation.gov.uk/ukpga/1974/40*

UK Government (1990). *Environmental Protection Act 1990*. Available at: *https://www.legislation.gov.uk/ukpga/1990/43/contents*

UK Government (1995). *Environment Act 1995*. Available at: *https://www.legislation.gov.uk/ukpga/1995/25/contents*

UK Government (1998). *Groundwater Regulations 1998*. Available at: *http://www.legislation.gov.uk/uksi/1998/2746/contents/made*

UK Technical Advisory Group on the WFD (2013). *UK Environmental Standards and Conditions Final Report*, November 2013.

Appendix 7.1 Traffic Emissions Assessment

Operational Phase Traffic Data

During development of the AEE for the SaxaVord Spaceport, operational phase traffic generation data were supplied by AECOM for each week of a typical five-week launch cycle as shown in Table 1. The applicant has confirmed that the duration of each Skyrora XL launch event is expected to run for around four weeks, starting with delivery of the Skyrora XL Launch Vehicle approximately 21 days before the launch and ending with demobilisation of equipment within seven days thereafter. As such the data provided for the Spaceport AEE are considered to be a precautionary representation of the Skyrora XL launch events.

The maximum number of development-generated movement is in week one which corresponds to a launch event and is due to the extra launch support vehicles and site visitors.

The data have been processed to calculate the maximum daily and maximum hourly light goods vehicles (LGVs) and heavy goods vehicles (HGVs) in order to predict the magnitude of change at sensitive receptors adjacent to any of the road links.

The modelled concentrations of NO_x, PM_{10} and $PM_{2.5}$ attributable to the development-generated operational phase traffic was added to the 2022 background concentrations of each pollutant.

The results of the assessment are summarised in Tables 3 - 7.

Table 1 Operational Phase Traffic Movements-Per Launch

Operational Phase Traffic Data													
Event	**Assumptions**	**Wk 4**		**Wk 3**		**Wk 2**		**Wk 1**		**Wk +1**		**Maximum Daily for Wk 1**	
		HGV	**Car**	**HGV**	**Car**	**HGV**	**Car**	**HGV**	**Car**	**HGV**	**Car**	**HGV**	**Car**
PL arrival (1)	One truck	2											
PL prop/pyros (2)	Separate to PL arrival? One truck	2											
LV arrival (3)	Three trucks. One truck PL+LV recovery wk+1			6						2			
LV commodities arrival (5)	Two LO2 tankers. One gases (He, N2) truck					6							
LV RP-1 arrival (7)	One tanker					2							
LV commodities return (5)	One LO2 tanker									2			
LV RP-1 return (7)	One tanker									2			
PL support staff	10 in 2 vehicles 7 days a week one shift		28		28		28		28				4
LV support staff	40 in 8 vehicles 7 days a week one shift				112		112		112		112		16
Site general deliveries	One per week	2		2		2		2		2		2	
Site diesel / water deliveries	One truck each per launch							4				4	
Site staff	Eleven staff M-F travelling independently (Jobs for Launch 002)		110		110		110		110		110		22
Security staff	Two staff. One vehicle 7 days a week 2 shifts		28		28		28		28		28		4
Range staff	Three staff 7 days a week one shift travelling together (Jobs for Launch 002)				14		14		14		14		2
Emergency vehicles	One fire, one ambulance for 3 days (LV fuelling, static and launch) one day (PL fuelling)			4				12				3	
Mobile launch support vehicle	One vehicle for 5 days (eg RF/ tracking off site)							10				2	
Site visitors - launch	20 in 10 vehicles for 2 days								40				20
Site Visitors - commercial	One per week		2		2		2		2		2		2
Weekly movements total		6	168	12	294	10	294	28	334	8	266	11	70
	Notes (11):											Max Daily	Max Daily
1	Based on 4 week launch cycle + 1 week recovery												
2	Working week 7 days											0.5	2.9
3	Number of vehicle movements per week											Max Hourly	Max Hourly
4	**Vehicle to/from site = 2 movements (vehicle numbers = half total)**												
5	Event number as per SSC typical 30 day launch schedule												
6	All deliveries = HGV												
7	Excludes tourist visitors												
8	Excludes IT/Electrician/Maintenance/Fuelling crew/Met/Environmental as per Jobs for Launch 002												
9	Use SSC electric shuttle vehicles to move customers on/off site?												
10	Site deliveries may not follow launch cycle if concurrent launch cycles ie per calendar week for site												
11	LV RP-1 and He N2 deliveries may not follow launch cycle for commercial reasons												

Table 2 – Modelled Operational Phase Traffic Data – Per Launch

SUMMARY OF OPERATIONAL PHASE TRAFFIC DATA

Scenario: **WITH DEVELOPMENT**

Link	Street Name	Development	AADT	AADT LDV Flow	Hourly LDV Flow	LDV Speed (Kmh)	AADT HGV Flow	Hourly HGV Flow	HGV Speed (Kmh)	Canyon	Road / Canyon Width (m)	Canyon height (m)
B9087 Through Saxa Vord and Norwick												
1	B9087 from south of Saxa Vord to Village of Norwick	81	70	3	32.0	11	1.0	32.0	NO	5	N/A	
Holsens Road												
2	Single Lane Road from Norwick to Skaw through SSSI	81	70	3	24.0	11	1.0	24.0	NO	5	N/A	

Table 3 Summary of Predicted NO_2 Annual Mean Concentrations at Roadside Receptors with Proposed Development Operational Traffic

NO_2 CONCENTRATIONS

Receptor ID	Receptor Name	Without Scheme Concentration (µg/m^3)	With Scheme Concentration (µg/m^3)	Numerical Magnitude of change (µg/m^3)	% of change relative to AQS	Concentration as % of AQS	Impact Descriptor	
							Negligible/ Slight/ Moderate/ Substantial	Adverse/ Beneficial
1	SAXA VORD Resi	1.64	1.69	0.05	0.13%	4.2%	Negligible	-
2	NORWISK RESI	1.64	1.69	0.05	0.13%	4.2%	Negligible	-
3	NORWICK MEADOWS SSSI	1.68	1.74	0.06	0.15%	4.4%	Negligible	-

Table 4 NO_x to NO_2 Annual Mean Concentrations at Roadside Receptors with Proposed Development Operational Traffic

Local Authority:	Shetland Islands					Year:	2022		
						Traffic Mix:	All non-urban UK traffic		
Receptor ID	Easting,m	Northing, m	Road increment NO_x µg m^{-3}	Background µg m^{-3}		User defined local traffic mix fraction emitted as NO_2 (fNO_2)	Total NO_2 µg m^{-3}	Road NO_2 µg m^{-3}	Notes
				NO_x	NO_2				
SAXAVORD	464493	1213474	0.0859	1.99	1.64		1.69	0.05	
NORWICK RES	464988	1213954	0.0966	1.99	1.64		1.69	0.05	
NORWICK SSS	464634	1214095	0.1061	2.04	1.68		1.74	0.06	

Table 5 Summary of Predicted PM_{10} Annual Mean Concentrations at Roadside Receptors with Proposed Development Operational Traffic

ITPENERGISED

PM_{10} CONCENTRATIONS

Receptor ID	Receptor Name	Without Scheme Concentration (µg/m^3)	With Scheme Concentration (µg/m^3)	Numerical Magnitude of change (µg/m^3)	% of change relative to AQS	Concentration as % of AQS	Impact Descriptor	
							Negligible/ Slight/ Moderate/ Substantial	Adverse/ Beneficial
1	SAXA VORD Resi	4.80	4.81	0.01	0.04%	26.7%	Negligible	-
2	NORWISK RESI	4.80	4.81	0.01	0.05%	26.7%	Negligible	-
3	NORWICK MEADOWS SSSI	5.11	5.12	0.01	0.05%	28.4%	Negligible	-

Table 6 Summary of Predicted $PM_{2.5}$ Annual Mean Concentrations at Roadside Receptors with Proposed Development Operational Traffic

ITPENERGISED

$PM_{2.5}$ CONCENTRATIONS

Receptor ID	Receptor Name	Without Scheme Concentration (µg/m^3)	With Scheme Concentration (µg/m^3)	Numerical Magnitude of change (µg/m^3)	% of change relative to AQS	Concentration as % of AQS	Impact Descriptor	
							Negligible/ Slight/ Moderate/ Substantial	Adverse/ Beneficial
1	SAXA VORD Resi	2.88	2.88	0.00	0.05%	28.8%	Negligible	-
2	NORWISK RESI	2.88	2.89	0.01	0.05%	28.9%	Negligible	-
3	NORWICK MEADOWS SSSI	2.98	2.99	0.01	0.05%	29.9%	Negligible	-

Table 7 Summary of Predicted NO_x Annual Mean Concentrations at Norwick Meadows SSSI with Proposed Development Operational Traffic

NOx CONCENTRATIONS

Receptor ID	Receptor Name	Without Scheme Concentration ($\mu g/m^3$)	With Scheme Concentration ($\mu g/m^3$)	Numerical Magnitude of change ($\mu g/m^3$)	% of change relative to AQS	Concentration as % of AQS	Impact Descriptor	
							Negligible/ Slight/ Moderate/ Substantial	Adverse/ Beneficial
3	NORWICK MEADOWS SSSI	2.04	2.15	0.06	0.2%	7.2%	Negligible	-

Impact at Receptors

The assessment of operational phase traffic emissions concludes that:

- The magnitude of change in concentration of each pollutant is significantly below 0.5 % of the relevant annual mean AQS at all receptors.
- The maximum predicted total concentration of NO_2 at a sensitive receptor is less than 4.5 % of the annual mean AQS.
- The maximum predicted concentration of PM_{10} at a sensitive receptor is less than 28.5 % of the annual mean AQS.
- The maximum predicted concentration of $PM_{2.5}$ at a sensitive receptor is less than 30 % of the annual mean AQS.
- There is no predicted risk of exceedance of the annual mean or short-term AQSs at any residential receptor due to the emissions from the forecast peak number of operational vehicles during a launch event.
- The magnitude of change in concentration of each NO_x is significantly below 1 % of the relevant annual mean AQS for the protection of vegetation and ecosystems.
- The maximum predicted annual mean NO_x concentration at the Norwick Meadows SSSI is 7.2 % of the annual mean AQS (or critical level).
- There is no predicted risk of exceedance of the critical level threshold at a roadside ecological receptor.

Significance of Effect of Operational Phase Vehicle Emissions

The effect of operational phase vehicle emissions at all identified receptors is therefore predicted to be of **negligible** significance**.**

Appendix 7.2 Launch Emissions Assessment

Scope of assessment

The scope of the assessment has included the following:

- Application of the method of assessment agreed in consultation with Shetland Islands Council during preparation and determination of the planning application for the SaxaVord Spaceport, where the Proposed Project will be operated;
- Identification of environmental zone of influence (EZI) and air quality sensitive receptors;
- Collection of baseline Carbon Monoxide (CO) concentrations at the Proposed Project;
- Collection of emissions data from Skyrora for the launch emissions from an approximately 24 m long Skyrora XL launch vehicle;
- Development of representative modelled scenario from launch pad 1 (closest to receptors);
- Development of a time-dependant puff model (duration up to 18s) of a jet release using ADMS 5 (Atmospheric Dispersion Modelling System) in a range of meteorological conditions and wind directions in typical UK and Shetland-specific wind speeds;
- Development of a time-integrated dose model to predict total concentration at the closest residential receptor during the lifetime of the puff release (calculated at 1-minute intervals) using ADMS 5 in a range of meteorological conditions and wind directions;
- Conversion of total dose concentrations to 8-hour running mean concentrations and comparison with the relevant air quality standard (AQS) for carbon monoxide (CO) for the protection of human health, presented in tables;
- Contour maps demonstrating the puff concentration at 5-minute intervals after release for the worst case meteorological condition; and
- Reporting.

Environmental Zone of Influence and Air Quality Sensitive Receptors

The closest air quality sensitive receptors in each direction from launch pad 1 were identified, and an EZI up to 5 km was defined to track the concentration of the puff release from launch until concentrations returned to normal ambient background levels under a range of meteorological conditions. The closest occupied sensitive receptor is Banks Cottage at Norwick which is 1840 m from launch pad 1. This is shown as R1 on Drawing 7.2.

Method of Assessment

Consultation with Shetland Islands Council

A Shetlands Islands Council Environmental Health officer was consulted on the proposed scope and approach of the air quality assessment for candidate launch vehicles during the preparation and determination of the planning application for the SaxaVord Spaceport, where the Proposed Project will be operated. Confirmation that the approach for the modelling of launches was appropriate was received from a Senior Environmental Health Officer on 26th June 2020. The same approach has been adopted and revised to account for the specific emissions and time to reach 1000 ft of the Skyrora XL Launch Vehicle.

Baseline CO Concentrations

There are no local monitoring stations measuring background concentrations of CO in the Shetland Islands. The background concentration of CO for the EZI was therefore downloaded from the Defra background concentration maps (Defra, 2021) for Shetland based on 1 km x 1 km grid square values. The maximum background concentration of 0.05 mg/m^3 from the grid squares covering a 25 km^2 EZI around the Proposed Project (NGR 462500,1211500-NGR 467500, 1216500) was used as a representative value for all receptors in the assessment.

Launch Scenarios

The Proposed Project comprises the preparation and launch of the Skyrora XL Launch Vehicle from any of three terrestrial vertical launch pads at the SaxaVord Spaceport situated at Lamba Ness on Unst, Shetland. The applicant is applying for a maximum environmental budget of 16 Skyrora XL launches per year, which will make up just over one half of SaxaVord Spaceport's own environmental budget of 30 launches per year.

Launches will take place in a northerly direction over the sea. Launches will not occur simultaneously from more than one launch pad.

The Skyrora XL Launch Vehicles will use a propellent mixture of High Test Peroxide (HTP) (90%) and a Jet A-1 kerosene. The majority of emissions from burning this propellent are water vapour (H_20) alongside much smaller quantities of carbon dioxide (CO_2) and CO. Emissions are via nine identical nozzles directed towards a flame deflector.

Greenhouse gas emissions (including CO_2) from launches are quantified in Chapter 9.

The only pollutant that requires assessment with respect to air quality for potential effects on human health is CO.

There are no airborne pollutants considered likely to have any significant adverse effects on important local ecology.

In order to determine the maximum potential effects of emission from a launch at a sensitive receptor, the assessment considers the effects of emissions from launch pad 1 at receptor R1, Banks Cottage, the closest emission-receptor relationship.

The Civil Aviation Authority (CAA) guidance document CAP1616 *"Airspace Change – Guidance on the regulatory process for changing the notified airspace design and planned and permanent redistribution of air traffic, and on providing airspace information",* states that assessment of emissions on local air quality is required for any airspace change less than 1000 feet in altitude. It is therefore only necessary for the AQIA to consider emissions from LVs during Stage 1 as subsequent stages occur at significantly higher altitudes. This has been estimated to take a maximum of 18 seconds for the Skyrora XL Launch Vehicle.

Emissions Data

Preliminary emissions data for the Skyrora XL launches were confirmed by the applicant and are summarised in Table 1.

Table 1 Preliminary Emissions Data (Stage 1)

Parameter	Skyrora XL
Temperature (◦K)	1450
Exit Diameter of each nozzle (m)	0.276
Exit diameter of flame deflector (m) (assumed – component in final design stage)	3

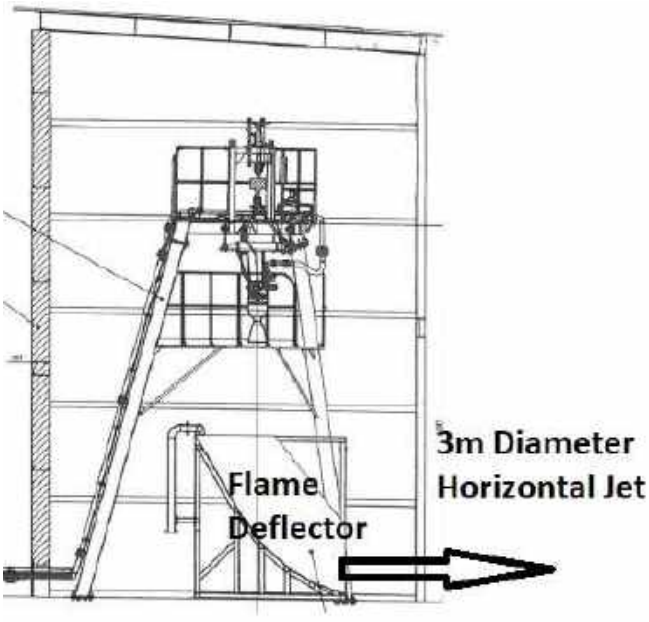
Parameter	Skyrora XL
Exit area of flame deflector (m^2)	7.065
Exhaust gas density (kg/m^3)	0.9
Mass flow rate of CO emitted per nozzle at Stage 1 launch (kg)	1.15
Ignition to 1000 ft altitude (seconds)	18
Total Mass of CO emitted from nine nozzles per Stage 1 launch (kg)	186.3
Volume of gas emitted in Stage 1 launch (m^3)	207
Volume Flow Rate (m^3/s)	11.5
Emissions Area (m^2)	7.065
Jet Velocity at flame deflector (m/s)	1.62

Modelling Assumptions

The launch rig has a flame deflector underneath the Skyrora XL Launch Vehicle exhaust jet which will direct the jet from the vertical to the horizontal plane. The width of the flame detector chute is 3 m. ADMS 5 has been used to model a horizontal jet release based at ground level with a diameter equivalent to the width of the flame deflector. The height of the centre of the jet release is the therefore 1.5 m above ground level. The duration of the release is 18 seconds with the exhaust gas volume flow rate, temperature and mass emissions of CO as specified in Table 1.

A diagram of the test rig demonstrating the model setup is shown in Figure 1.

Figure 1 Schematic of Launch Rig



Meteorological Conditions used in the Assessment

It is not possible to predict exact meteorological conditions during future launches. As such, the ADMS 5 puff model has been run for a set of seven different meteorological conditions that roughly correspond to seven atmospheric stability classes known as Pasquill-Gifford Stability Classes A-G.

Stability is the tendency of the atmosphere to resist or enhance vertical motion and thus turbulence and potential dispersion of pollutants released within it. Stability is related to both the change of temperature with height (influenced by cloud cover and solar radiation) and mechanical friction influenced by the wind speed together with surface characteristics (roughness). The stability class conditions range from very convective (turbulent) conditions with a high surface solar heat flux, low winds and cloudless skies, (A), through to neutral conditions which are prevailing for approximately 40-50% of the time in the UK with moderate wind speeds and partially cloudy skies, (D), to very stable (calm) conditions with low temperatures and low wind speeds typically associated with night time or winter conditions (G).

It is recognised that the wind speeds on Unst can be considerably higher than the average UK conditions, therefore a detailed analysis of available meteorological data from Baltasound Airport in Unst from 2015-2019 has been undertaken in order to determine the average wind speed in each of eight compass directions and the prevailing wind speed across all directions locally. This is summarised in Tables 2 and 3. The wind roses for each year are shown in Drawing 7.3.

Table 2 Analysis of Baltasound Wind Speed and Direction 2015-2019

Wind Direction (sector °)	Humber of Hours per annum	Percentage of hours per annum	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)	Minimum Wind Speed (m/s)
2015					
North (337.5-22.5°)	675	7.7 %	6.8	16.5	0.0
North-East (22.5-67.5°)	313	3.6 %	5.6	14.4	0.5
East (67.5-112.5°)	441	5.0 %	5.7	14.4	0.5
South-East (112.5-157.5°)	961	11.0 %	7.9	21.6	0.5
South (157.5-202.5°)	1765	20.1 %	7.7	20.6	0.5
South-West (202.5-247.5°)	1578	18.0 %	7.3	23.7	0.5
West (247.5-292.5°)	2022	23.1 %	8.5	26.8	0.5
North-West (292.5-337.5°)	969	11.1 %	6.8	24.7	0.5
Missing	36	0.4 %			
Total	8760	100.0%	7.5	26.8	0.0

Wind Direction (sector °)	Humber of Hours per annum	Percentage of hours per annum	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)	Minimum Wind Speed (m/s)
2016					
North (337.5-22.5°)	946	10.8 %	6.1	16.5	0.0
North-East (22.5-67.5°)	780	8.9 %	6.7	17.5	0.5
East (67.5-112.5°)	719	8.2 %	5.7	17.0	0.5
South-East (112.5-157.5°)	841	9.6 %	7.2	19.1	0.5
South (157.5-202.5°)	1682	19.1 %	7.4	19.1	0.5
South-West (202.5-247.5°)	1216	13.8 %	6.5	29.4	0.5
West (247.5-292.5°)	1612	18.4 %	7.1	29.4	0.5
North-West (292.5-337.5°)	926	10.5 %	6.5	22.7	0.5
Missing	62	0.7 %			
Total	8784	100.0%	6.8	29.4	0.0
2017					
North (337.5-22.5°)	835	9.5 %	6.8	21.1	0.0
North-East (22.5-67.5°)	514	5.9 %	6.3	17.0	0.5
East (67.5-112.5°)	597	6.8 %	5.5	18.6	0.5
South-East (112.5-157.5°)	1144	13.1%	8.4	20.1	0.5
South (157.5-202.5°)	1332	15.2 %	7.6	17.5	0.5
South-West (202.5-247.5°)	1029	11.7 %	6.8	15.5	0.5
West (247.5-292.5°)	1711	19.5 %	8.5	21.1	0.5
North-West (292.5-337.5°)	1174	13.4 %	8.0	26.3	0.5
Missing	424	4.8 %	6.8	21.1	0.0
Total	8760	100.0%	7.5	26.3	0.0

Wind Direction (sector °)	Humber of Hours per annum	Percentage of hours per annum	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)	Minimum Wind Speed (m/s)
2018					
North (337.5-22.5°)	561	6.4 %	4.7	14.9	0.0
North-East (22.5-67.5°)	545	6.2 %	5.7	12.4	0.5
East (67.5-112.5°)	626	7.1 %	5.3	14.9	0.5
South-East (112.5-157.5°)	1136	13.0 %	8.7	23.2	0.5
South (157.5-202.5°)	1989	22.7 %	7.7	21.1	0.5
South-West (202.5-247.5°)	1188	13.6 %	6.5	20.1	0.5
West (247.5-292.5°)	1476	16.8 %	7.4	22.7	0.5
North-West (292.5-337.5°)	697	8.0 %	6.4	20.6	0.5
Missing	542	6.2 %			
Total	8760	100.0%	7.0	23.2	0.0
2019					
North (337.5-22.5°)	955	10.9 %	6.6	16.0	0.0
North-East (22.5-67.5°)	761	8.7 %	6.9	16.5	0.5
East (67.5-112.5°)	761	8.7 %	5.7	15.5	0.5
South-East (112.5-157.5°)	1244	14.2 %	7.0	16.0	0.5
South (157.5-202.5°)	1553	17.7 %	6.9	18.6	0.5
South-West (202.5-247.5°)	1127	12.9 %	6.6	19.1	0.5
West (247.5-292.5°)	1350	15.4 %	6.9	20.6	0.5
North-West (292.5-337.5°)	1005	11.5 %	6.0	21.1	0.5
Missing	4	0.0 %			
Total	8760	100.0%	6.7	21.1	0.0

Table 1- Average Unst Wind Speed per Direction

Wind Direction (sector °)	Average Wind Speed 2015-2019 (m/s)
North (337.5-22.5°)	6.2
North-East (22.5-67.5°)	6.3
East (67.5-112.5°)	5.6
South-East (112.5-157.5°)	7.8
South (157.5-202.5°)	7.5
South-West (202.5-247.5°)	6.8
West (247.5-292.5°)	7.7
North-West (292.5-337.5°)	6.7

The number of hours that the wind speed was greater than 5 m/s was between 54 % and 73 % of each year.

The prevailing wind direction is from the south to the west, and Unst wind speeds are higher than UK averages, therefore the emissions from any launch will most likely be directed out towards the sea, rapidly dispersed and pose no risk to any onshore sensitive receptors, however the potential effects at the closest onshore receptor have been assessed in all seven stability meteorological conditions A-G for each of the eight main 45° compass sectors in order to model the dispersion of the jet puff release in a range of meteorological conditions and determine the worst case impact at the nearest sensitive receptor R1.

The meteorological conditions used in the modelling assessment for each wind direction in Table 2 are summarised for the UK and Unst Average wind speeds in Table 4.

Table 4 Modelled Meteorological Conditions for Eight Compass Wind Directions

Stability Class	UK Average Wind Speed (m/s)	Unst Average Wind Speed (m/s)	Surface Solar Heat Flux (W/m²)	Atmospheric Boundary Layer Height (m)
A	1	0° = 6.2 45° = 6.3 90° = 5.6 135° = 7.8 180° = 7.5 225° = 6.8 270° = 7.7 315° = 6.7	113	1300
B	2		84	900
C	5		74	850
D	5		0	800
E	3		-10	400
F	2		-6	100
G	1		-6	100

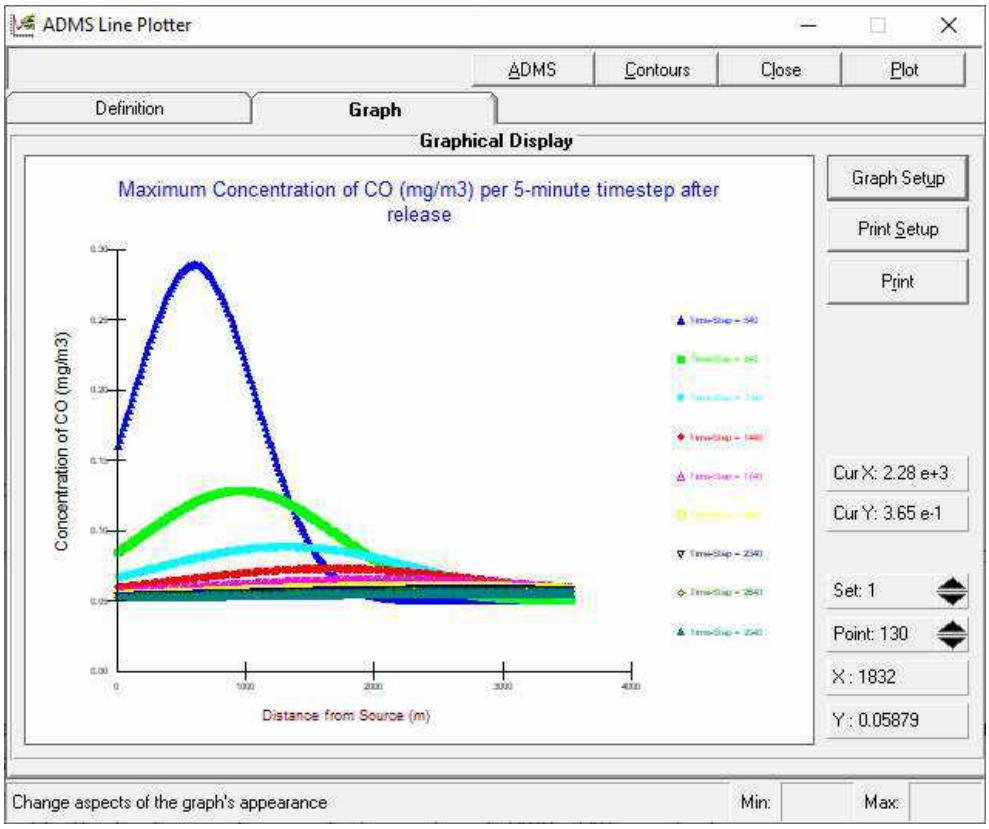
Results

Calculation of Exposure Time to Release at Receptor R1

The closest identified receptor to the launch pads is Banks Cottage at Norwick which is 1840 m from launch pad 1. This is shown as R1 in Drawing 7.2. The total dose due to emissions from a launch from launch pad 1 was calculated at R1 for the seven stability classes (A-G) and eight wind directions in both UK and Unst average wind speeds.

The maximum period when the CO concentration was predicted to be detectible above background levels (a minimum increase of 0.005 mg/m^3 – 10% of background levels) at receptor R1 was 37 minutes in UK average wind speed Stability Class A conditions. This is shown in Figure 2 where the concentration at just under 1840 m downwind of the launch site is first above the background concentration of 0.05 mg/m^3 at 540 s (nine-minutes) after the release and returned to the background concentration value at 2760 s (46 minutes).

Figure 2 Timestep Concentrations after Release of the Skyrora XL from Launch Pad 1



Each line in Figure 2 shows the predicted concentration with distance downstream at a particular period of time after the launch.

The start time and end time after launch of concentrations above 0.055 mg/m^3 at 1840m is shown in Table 5.

Table 2 – Duration of Concentration above Background at R1

Stability Class	Time First above 0.055mg/m^3	Time Last above 0.055mg/m^3	Puff Lifetime Duration (seconds)	Puff Lifetime Duration (minutes)	Fraction of 1-hour
UK Average Wind Speeds					
A	540	2760	2220	37	0.62
B	420	1560	1140	19	0.32
C	240	480	240	4	0.07
D	240	540	300	5	0.08

E	300	1020	720	12	0.20
F	360	660	300	5	0.08
G	720	840	120	2	0.03
Unst Average Wind Speeds					
A	180	360	180	3	0.05
B	180	480	300	5	0.08
C	180	480	300	5	0.08
D	180	420	240	4	0.07
E	180	480	300	5	0.08
F	180	840	660	11	0.18
G	240	720	480	8	0.13

Calculation of 1-hour Average Concentration at Receptor R1

The ADMS 5 model was then used to calculate a total dose of CO at receptor R1, i.e., the total dose that an individual would be exposed to over the lifetime of the puff (as detailed in Table 5) before it dispersed and ambient concentrations returned to normal background levels.

For each stability, the dose in mg.s/m^3 was divided by the puff lifetime (s) to calculate the average ambient concentration during the exposure period. Over one hour, the total concentration was calculated as the average puff lifetime concentration plus existing background for the duration of the puff i.e., for a fraction of 1 hour; and normal background concentration of 0.05 mg/m^3 for the remaining fraction of the hour.

For Stability A in average UK wind speed conditions, the puff lifetime was 37 minutes (0.62 of 1 hour). The hourly mean was therefore calculated from the following equation:

Hourly ave. concentrations = ((average puff lifetime concentration + 0.05) x 0.62) + (0.05 x 0.38))

Calculation of 8-hour Average Concentration at Receptor R1

To calculate the running 8-hour average, the concentration will be as background for the seven hours before release. Therefore, the maximum 8-hour average can be calculated from the following equation:

8-Hour average = (hourly average during release + (7 x 0.05))/8

There will be no more than one launch in any 24-hour period so the maximum 8-hour running mean can only be as above.

The results are summarised in Tables 6 and 7.

Table 3 Calculated Dose and 8-Hour Average CO Concentrations at Receptor R1 – UK Average Wind Speeds

Stability Class	Maximum Dose at R1 (mg.s/m^3) UK average	Average Concentration over Exposure Period (mg/m^3)	Background Concentration (mg/m^3)	Maximum Hourly Average Concentration (mg/m^3)	Maximum 8-Hour Average Concentration (mg/m^3)	Percentage of the AQS
Wind = 0 NORTH						
A	3.90	0.002	0.05	0.05	0.05	0.51%
B	0.0002	0.00	0.05	0.05	0.05	0.51%
C	0.0000	0.00	0.05	0.05	0.05	0.51%
D	0.0000	0.00	0.05	0.05	0.05	0.51%
E	0.0000	0.00	0.05	0.05	0.05	0.51%
F	0.0000	0.00	0.05	0.05	0.05	0.51%
G	0.0000	0.00	0.05	0.05	0.05	0.51%
Wind = 45 NORTH EAST						
A	66.06	0.03	0.05	0.07	0.055	0.55%
B	91.04	0.08	0.05	0.08	0.054	0.54%
C	66.04	0.28	0.05	0.07	0.053	0.53%
D	43.12	0.14	0.05	0.06	0.052	0.52%
E	74.61	0.10	0.05	0.07	0.053	0.53%
F	24.93	0.08	0.05	0.06	0.052	0.52%
G	3.79	0.03	0.05	0.05	0.051	0.51%
Wind = 90 EAST						
A	42.63	0.02	0.05	0.06	0.05	0.54%

Stability Class	Maximum Dose at R1 (mg.s/m^3) UK average	Average Concentration over Exposure Period (mg/m^3)	Background Concentration (mg/m^3)	Maximum Hourly Average Concentration (mg/m^3)	Maximum 8-Hour Average Concentration (mg/m^3)	Percentage of the AQS
B	12.03	0.01	0.05	0.05	0.05	0.51%
C	0.13	0.00	0.05	0.05	0.05	0.51%
D	0.00	0.00	0.05	0.05	0.05	0.51%
E	0.00	0.00	0.05	0.05	0.05	0.51%
F	0.00	0.00	0.05	0.05	0.05	0.51%
G	0.00	0.00	0.05	0.05	0.05	0.51%
Wind = 135 SOUTH EAST						
A	0.00	0.00	0.05	0.05	0.05	0.51%
B	0.00	0.00	0.05	0.05	0.05	0.51%
C	0.00	0.00	0.05	0.05	0.05	0.51%
D	0.00	0.00	0.05	0.05	0.05	0.51%
E	0.00	0.00	0.05	0.05	0.05	0.51%
F	0.00	0.00	0.05	0.05	0.05	0.51%
G	0.00	0.00	0.05	0.05	0.05	0.51%
Wind = 180 SOUTH						
A	0.00	0.00	0.05	0.05	0.05	0.51%
B	0.00	0.00	0.05	0.05	0.05	0.51%
C	0.00	0.00	0.05	0.05	0.05	0.51%
D	0.00	0.00	0.05	0.05	0.05	0.51%

Stability Class	Maximum Dose at R1 (mg.s/m³) UK average	Average Concentration over Exposure Period (mg/m³)	Background Concentration (mg/m³)	Maximum Hourly Average Concentration (mg/m³)	Maximum 8-Hour Average Concentration (mg/m³)	Percentage of the AQS
E	0.00	0.00	0.05	0.05	0.05	0.51%
F	0.00	0.00	0.05	0.05	0.05	0.51%
G	0.00	0.00	0.05	0.05	0.05	0.51%
Wind = 225 SOUTH WEST						
A	0.00	0.00	0.05	0.05	0.05	0.51%
B	0.00	0.00	0.05	0.05	0.05	0.51%
C	0.00	0.00	0.05	0.05	0.05	0.51%
D	0.00	0.00	0.05	0.05	0.05	0.51%
E	0.00	0.00	0.05	0.05	0.05	0.51%
F	0.00	0.00	0.05	0.05	0.05	0.51%
G	0.00	0.00	0.05	0.05	0.05	0.51%
Wind = 270 WEST						
A	0.00	0.00	0.05	0.05	0.05	0.51%
B	0.00	0.00	0.05	0.05	0.05	0.51%
C	0.00	0.00	0.05	0.05	0.05	0.51%
D	0.00	0.00	0.05	0.05	0.05	0.51%
E	0.00	0.00	0.05	0.05	0.05	0.51%
F	0.00	0.00	0.05	0.05	0.05	0.51%
G	0.00	0.00	0.05	0.05	0.05	0.51%

Stability Class	Maximum Dose at R1 (mg.s/m³) UK average	Average Concentration over Exposure Period (mg/m³)	Background Concentration (mg/m³)	Maximum Hourly Average Concentration (mg/m³)	Maximum 8-Hour Average Concentration (mg/m³)	Percentage of the AQS
Wind = 315 NORTH WEST						
A	0.00	0.00	0.05	0.05	0.05	0.51%
B	0.00	0.00	0.05	0.05	0.05	0.51%
C	0.00	0.00	0.05	0.05	0.05	0.51%
D	0.00	0.00	0.05	0.05	0.05	0.51%
E	0.00	0.00	0.05	0.05	0.05	0.51%
F	0.00	0.00	0.05	0.05	0.05	0.51%
G	0.00	0.00	0.05	0.05	0.05	0.51%

Table 4 Calculated Dose and 8-Hour Average CO Concentrations at Receptor R1 – Unst Average Wind Speeds

Stability Class	Maximum Dose at R1 (mg.s/m³) UK average	Average Concentration over Exposure Period (mg/m³)	Background Concentration (mg/m³)	Maximum Hourly Average Concentration (mg/m³)	Maximum 8-Hour Average Concentration (mg/m³)	Percentage of the AQS
Wind = 0 NORTH						
A	0.00	0.00	0.05	0.05	0.05	0.51%
B	0.00	0.00	0.05	0.05	0.05	0.51%
C	0.00	0.00	0.05	0.05	0.05	0.51%
D	0.00	0.00	0.05	0.05	0.05	0.51%
E	0.00	0.00	0.05	0.05	0.05	0.51%

Stability Class	Maximum Dose at R1 (mg.s/m^3) UK average	Average Concentration over Exposure Period (mg/m^3)	Background Concentration (mg/m^3)	Maximum Hourly Average Concentration (mg/m^3)	Maximum 8-Hour Average Concentration (mg/m^3)	Percentage of the AQS
F	0.00	0.00	0.05	0.05	0.05	0.51%
G	0.00	0.00	0.05	0.05	0.05	0.51%
Wind = 45 NORTH EAST						
A	60.14	0.33	0.05	0.07	0.05	0.53%
B	60.5570	0.20	0.05	0.07	0.05	0.53%
C	60.1435	0.20	0.05	0.07	0.05	0.53%
D	40.5208	0.17	0.05	0.06	0.05	0.52%
E	25.7967	0.09	0.05	0.06	0.05	0.52%
F	5.3353	0.01	0.05	0.05	0.05	0.51%
G	5.6317	0.01	0.05	0.05	0.05	0.51%
Wind = 90 EAST						
A	0.49	0.00	0.05	0.05	0.05	0.51%
B	0.1046	0.00	0.05	0.05	0.05	0.51%
C	0.0699	0.00	0.05	0.05	0.05	0.51%
D	0.0003	0.00	0.05	0.05	0.05	0.51%
E	0.0000	0.00	0.05	0.05	0.05	0.51%
F	0.0000	0.00	0.05	0.05	0.05	0.51%
G	0.0000	0.00	0.05	0.05	0.05	0.51%
Wind = 135 SOUTH EAST						

Stability Class	Maximum Dose at R1 (mg.s/m^3) UK average	Average Concentration over Exposure Period (mg/m^3)	Background Concentration (mg/m^3)	Maximum Hourly Average Concentration (mg/m^3)	Maximum 8-Hour Average Concentration (mg/m^3)	Percentage of the AQS
A	0.00	0.00	0.05	0.05	0.05	0.51%
B	0.00	0.00	0.05	0.05	0.05	0.51%
C	0.00	0.00	0.05	0.05	0.05	0.51%
D	0.00	0.00	0.05	0.05	0.05	0.51%
E	0.00	0.00	0.05	0.05	0.05	0.51%
F	0.00	0.00	0.05	0.05	0.05	0.51%
G	0.00	0.00	0.05	0.05	0.05	0.51%
Wind = 180 SOUTH						
A	0.00	0.00	0.05	0.05	0.05	0.51%
B	0.00	0.00	0.05	0.05	0.05	0.51%
C	0.00	0.00	0.05	0.05	0.05	0.51%
D	0.00	0.00	0.05	0.05	0.05	0.51%
E	0.00	0.00	0.05	0.05	0.05	0.51%
F	0.00	0.00	0.05	0.05	0.05	0.51%
G	0.00	0.00	0.05	0.05	0.05	0.51%
Wind = 225 SOUTH WEST						
A	0.00	0.00	0.05	0.05	0.05	0.51%
B	0.00	0.00	0.05	0.05	0.05	0.51%
C	0.00	0.00	0.05	0.05	0.05	0.51%

Stability Class	Maximum Dose at R1 (mg.s/m^3) UK average	Average Concentration over Exposure Period (mg/m^3)	Background Concentration (mg/m^3)	Maximum Hourly Average Concentration (mg/m^3)	Maximum 8-Hour Average Concentration (mg/m^3)	Percentage of the AQS
D	0.00	0.00	0.05	0.05	0.05	0.51%
E	0.00	0.00	0.05	0.05	0.05	0.51%
F	0.00	0.00	0.05	0.05	0.05	0.51%
G	0.00	0.00	0.05	0.05	0.05	0.51%
Wind = 270 WEST						
A	0.00	0.00	0.05	0.05	0.05	0.51%
B	0.00	0.00	0.05	0.05	0.05	0.51%
C	0.00	0.00	0.05	0.05	0.05	0.51%
D	0.00	0.00	0.05	0.05	0.05	0.51%
E	0.00	0.00	0.05	0.05	0.05	0.51%
F	0.00	0.00	0.05	0.05	0.05	0.51%
G	0.00	0.00	0.05	0.05	0.05	0.51%
Wind = 315 NORTH WEST						
A	0.00	0.00	0.05	0.05	0.05	0.51%
B	0.00	0.00	0.05	0.05	0.05	0.51%
C	0.00	0.00	0.05	0.05	0.05	0.51%
D	0.00	0.00	0.05	0.05	0.05	0.51%
E	0.00	0.00	0.05	0.05	0.05	0.51%
F	0.00	0.00	0.05	0.05	0.05	0.51%

Stability Class	Maximum Dose at R1 (mg.s/m^3) UK average	Average Concentration over Exposure Period (mg/m^3)	Background Concentration (mg/m^3)	Maximum Hourly Average Concentration (mg/m^3)	Maximum 8-Hour Average Concentration (mg/m^3)	Percentage of the AQS
G	0.00	0.00	0.05	0.05	0.05	0.51%

The maximum predicted doses and 8-hour concentrations at R1 are due to the UK average meteorological data for stability classes A-G. When repeated with the Unt average wind speeds, the puff is diluted and dispersed more rapidly giving lower predictions at R1.

It is possible for launch events to occur in substantially higher wind speeds than the Unst averages that have been modelled. The calculated 8-hour average concentrations for comparison with the AQS are therefore conservative worse-case results.

The maximum predicted dose at R1 was 91.04 mg/m^3 CO over 19 minutes. This is equivalent to a total dose over the lifetime of the jet release of 79.5 parts per million (ppm). There are no health effects of this level of exposure to CO over periods of 19 minutes. A person would have to be exposed to this dose for six to eight hours of constant exposure to experience headache or dizziness (Goldstein, 2008). For a health effect to arise from around 20 minutes of exposure, the dose would need to be around 1600 ppm.

The maximum predicted 8-hour concentration at R1 was 0.55 mg/m^3, 0.55 % of the AQS, when modelled using UK average convective (Stability A) meteorological conditions with wind from the north east (45°). This reduced to 0.53% of the AQS when average Unst wind speed conditions were modelled for this direction.

On analysis of the meteorological data, a north east (45°) wind only occurs for approximately 9 % of the year on Unst. Drawings 7.4 to 7.8 show the concentration contour plots of the puff as it moves downwind in ten-minute timesteps from after the start of the release for the worst case meteorological conditions. The concentration scale demonstrates how quickly the puff dilutes and disperses after release, with no concentrations above background levels from 40 minutes after release. The concentrations returns to background levels within 12 minutes over all the stability classes and Unst average wind speed conditions.

Summary

The assessment has calculated the CO concentrations at the closest residential receptor (R1) to the launch pad 1 at the SaxaVord Spaceport at 1-minute intervals after a launch of a Skyrora XL Launch Vehicle.

With UK average wind speeds, the modelling identified that the downwind concentration was slightly detectible above background levels following launch for a period of up to 37 minutes depending on atmospheric stability conditions, after which time, concentrations reverted to background levels.

The maximum predicted dose at R1 was 91.04 mg/m^3 CO over 19 minutes. This is equivalent to a total dose over the lifetime of the jet release of 79.5 parts per million (ppm). There are no health effects of this level of exposure to CO over periods of 19 minutes. A person would have to be exposed to this dose for six to eight hours of constant exposure to experience headache or dizziness (Goldstein, 2008). For a health effect to arise from around 20 minutes of exposure, the dose would need to be around 1600 ppm

The maximum predicted 8-hour concentration at R1 was 0.55 mg/m^3, 0.55 % of the AQS, when modelled using UK average convective (Stability A) meteorological conditions with wind from the north east (45°). This reduced to 0.53% of the AQS when average Unst wind speed conditions were modelled for this direction.

On analysis of the meteorological data, a north east (45°) wind only occurs for approximately 9 % of the year on Unst. There is therefore a high probability that launches will take place under the local prevailing wind condition which, over the period 2015-2019, was southerly to westerly. Under prevailing conditions, there is no detectible impact at the closest receptor R1.

The assessment has demonstrated that there is no risk of exceedance of the 8-hour AQS for CO at any sensitive receptor in the vicinity of the Proposed Project irrespective of the prevailing weather conditions during a launch of the Skyrora XL Launch Vehicle and there are no health effects associated with the maximum predicted dose over 19 minutes.

Appendix 8.1 Blue Ridge Noise Modelling Assessment

Blue Ridge Research and Consulting, LLC

Technical Report

Noise Study for Launch Vehicle Operations at Shetland Space Centre

October 2, 2020 (Final)

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Acronyms and Abbreviations

The following acronyms and abbreviations are used in the report:

ASEL	A-Weighted Sound Exposure Level in Decibels
BRRC	Blue Ridge Research and Consulting, LLC
dB	Decibel
dBA	A-weighted Decibel Level
dBC	C-weighted Decibel Level
CDNL	C-weighted Day Night Average Sound Level
DI	Directivity Indices
DNL	Day Night Average Sound Level
DSM-1	Distributed Source Method 1
EIA	Environmental Impact Assessment
Hz	Hertz
km	Kilometers
$L_{A,max}$	Maximum A-weighted OASPL in Decibels
L_{den}	A-weighted Day-Evening-Night Sound Level in Decibels
L_{max}	Maximum Unweighted OASPL in Decibels
L_{pk}	Peak Sound Pressure Level in Decibels
N	Newtons
NIHL	Noise-Induced Hearing Loss
NIOSH	National Institute for Occupational Safety and Health
OASPL	Overall Sound Pressure Level in Decibels
OSHA	Occupational Safety and Health Administration
Pa	Pascal
psf	Pounds per Square Foot
RUMBLE	The Launch Vehicle Acoustic and Emissions Simulation Model
SEL	Sound Exposure Level
SCLV	Small Class Launch Vehicles
S.L.	Sea Level
TA	Time Above
UK	United Kingdom

1 Introduction

This report documents the noise study performed as part of efforts on the Environmental Impact Assessment (EIA) for proposed launch operations at Shetland Space Centre (SSC). SSC plans to conduct launch and static operations of various launch vehicles from three pads. Although a number of small class launch vehicles (SCLV) could operate from the proposed launch sites, this noise study examines a single nominal launch vehicle representing the largest SCLV (in terms of thrust) projected to be launched from SSC. The potential impacts from propulsion noise and sonic booms are evaluated in relation to human annoyance, hearing conservation, and structural damage.

This noise study describes the environmental noise associated with proposed operations. Section 2 describes the proposed operations at SSC; Section 3 summarizes the basics of sound and describes the noise metrics and impact criteria discussed throughout this report; Section 4 describes the general methodology of the propulsion noise and sonic boom modeling; and Section 5 presents the propulsion noise and sonic boom modeling results. A summary is provided in Section 6 to document the notable findings of this noise study.



Figure 1. Image of SSC launch site (credit: Shetland Space Centre Ltd)

2 Launch and Static Operations

SSC plans to conduct up to 30 launch and 30 static fire operations of various small class launch vehicles per year. The annual operations are presented in Table 1 in terms of acoustic time of day.

The representative SCLV length, diameter, weight, and sea level (S.L.) thrust are presented in Table 2. The noise and sonic boom modeling use the time varying weight and thrust profiles, with the first stage reaching a maximum thrust of 736,200 N.

Launch trajectories departing from SSC will be unique to the vehicle, mission, and environmental conditions. For the purposes of this study, the noise modeling utilized a nominal launch trajectory

provided by the SCLV manufacturer with an azimuth of 343°, relative to true north. An overview of the facility and nominal trajectory from each pad is shown in Figure 2.

Table 1. Proposed SCLV operations

				Annual Operations			
				Daytime	Evening	Nighttime	
Pad	**Coordinates**	**Event**	**Duration**	0700 – 1900	1900 – 2300	2300 – 0700	Total
Pad 1	60.8188° N	Launch	--	6	2	2	10
(Eastern)	0.7751° W	Static Fire	5 seconds	6	2	2	10
Pad 2	60.8184° N	Launch	--	6	2	2	10
(Central)	0.7700° W	Static Fire	5 seconds	6	2	2	10
Pad 3	60.8178° N	Launch	--	6	2	2	10
(Western)	0.7613° W	Static Fire	5 seconds	6	2	2	10

Table 2. SCLV modeling parameters

Modeling Parameters	Values
Length	29 m
Diameter	1.8 m
Gross Mass	10,049 kg
Propellant Description	LOX/RP-1
S.L. Thrust	633,658 N (158,415 N/engine x Qty. 4 engines)

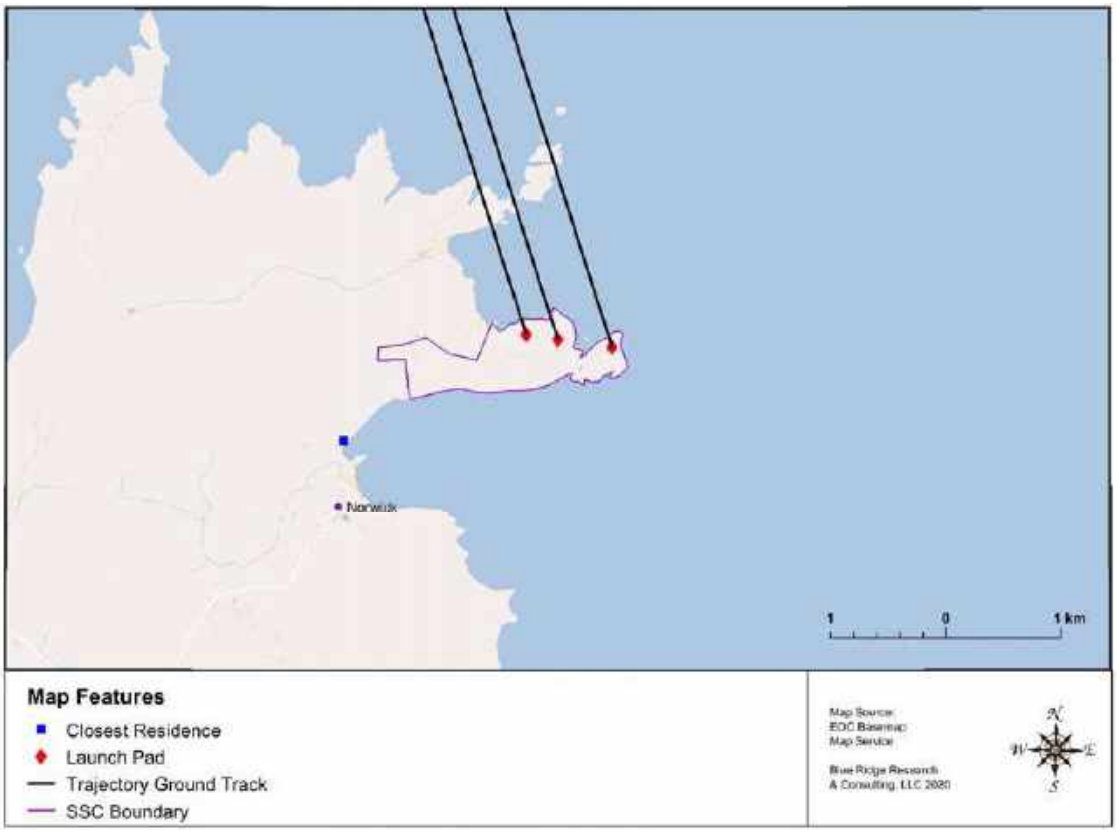


Figure 2. SSC facility boundary, launch pads, and trajectory ground tracks from each pad.

3 Acoustics Overview

An overview of sound-related terms, metrics, and effects, which are pertinent to this study, is provided to assist the reader in understanding the terminology used in this noise study.

3.1 Fundamentals of Sound

Any unwanted sound that interferes with normal activities or the natural environment is defined as noise. Three principal physical characteristics are involved in the measurement and human perception of sound: intensity, frequency, and duration [1].

- **Intensity** is a measure of a sound's acoustic energy and is related to sound pressure. The greater the sound pressure, the more energy is carried by the sound and the louder the perception of that sound.
- **Frequency** determines how the pitch of the sound is perceived. Low-frequency sounds are characterized as rumbles or roars, while high-frequency sounds are typified by sirens or screeches.
- **Duration** is the length of time the sound can be detected.

3.1.1 Intensity

The loudest sounds that can be comfortably detected by the human ear have intensities a trillion times higher than those of sounds barely audible. Because of this vast range, using a linear scale to represent the intensity of sound can become cumbersome. As a result, a logarithmic unit known as the decibel (abbreviated dB) is used to represent sound levels. A sound level of 0 dB approximates the threshold of human hearing and is barely audible under extremely quiet listening conditions. Normal speech has a sound level around 60 dB. Sound levels above 120 dB begin to be felt inside the human ear as discomfort. Sound levels between 130 and 140 dB are experienced as pain [2].

Because of the logarithmic nature of the decibel unit, sound levels cannot be simply added or subtracted and are somewhat cumbersome to handle mathematically. However, some useful rules help when dealing with sound levels. First, if a sound's intensity is doubled, the sound level increases by 3 dB, regardless of the initial sound level. For example:

$$50\ \text{dB} + 50\ \text{dB} = 53\ \text{dB}, \text{ and } 70\ \text{dB} + 70\ \text{dB} = 73\ \text{dB}.$$

Second, the total sound level produced by two sounds with different levels is usually only slightly more than the higher of the two. For example:

$$50.0\ \text{dB} + 60.0\ \text{dB} = 60.4\ \text{dB}.$$

On average, a person perceives a change in sound level of about 10 dB as a doubling (or halving) of a sound's loudness. This relation holds true for both loud and quiet sounds. A decrease in sound level of 10 dB represents a 90% decrease in sound intensity but only a 50% decrease in perceived loudness because the human ear does not respond linearly [1]. In the community, "it is unlikely that the average listener would be able to correctly identify at a better than chance level the louder of two otherwise similar events which differed in maximum sound level by < 3 dB" [3].

The intensity of sonic booms is quantified with physical pressure units rather than levels. Intensities of sonic booms are traditionally described by the amplitude of the front shock wave, referred to as the peak overpressure. The peak overpressure is normally described in units of pounds per square foot (psf). The

amplitude is particularly relevant when assessing structural effects as opposed to loudness or cumulative community response. In this study, sonic booms are quantified by either dB or psf, as appropriate for the particular impact being assessed [4].

3.1.2 Frequency

Sound frequency is measured in terms of cycles per second or hertz (Hz). Human hearing ranges in frequency from 20 Hz to 20,000 Hz, although perception of these frequencies is not equivalent across this range. Human hearing is most sensitive to frequencies in the 1,000 to 4,000 Hz range. Most sounds are not simple pure tones, but contain a mix, or spectrum, of many frequencies. Sounds with different spectra are perceived differently by humans even if the sound levels are the same. Weighting curves have been developed to correspond to the sensitivity and perception of different types of sound. A-weighting and C-weighting are the two most common weightings. These two curves, shown in Figure 3, are adequate to quantify most environmental noises. A-weighting puts emphasis on the 1,000 to 4,000 Hz range to match the reduced sensitivity of human hearing for moderate sound levels. For this reason, the A-weighted decibel level (dBA) is commonly used to assess community sound.

Very loud or impulsive sounds, such as explosions or sonic booms, can sometimes be felt, and they can cause secondary effects, such as shaking of a structure or rattling of windows. These types of sounds can add to annoyance and are best measured by C-weighted sound levels, denoted dBC. C-weighting is nearly flat throughout the audible frequency range and includes low frequencies that may not be heard but cause shaking or rattling. C-weighting approximates the human ear's sensitivity to higher intensity sounds. Note, "unweighted" sound levels refer to levels in which no weighting curve has been applied to the spectra. Unweighted levels are appropriate for use in examining the potential for noise impacts on structures.

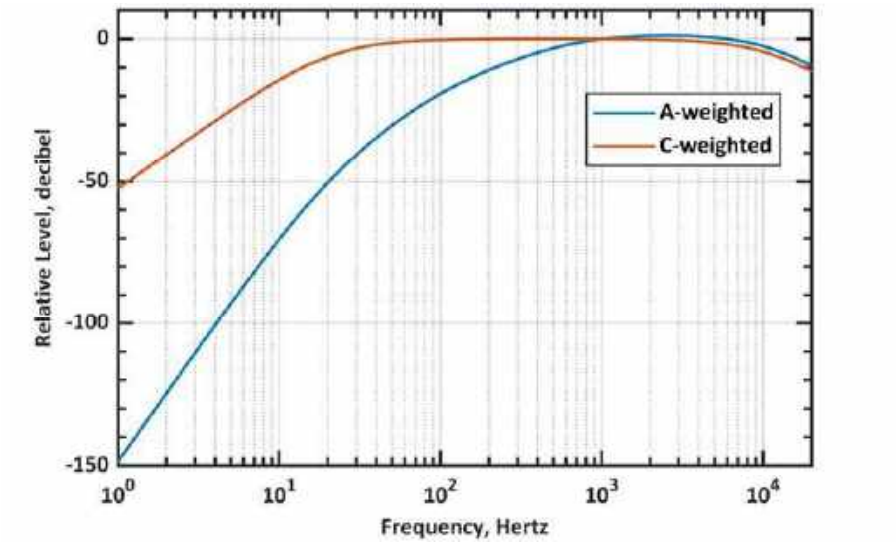


Figure 3. Frequency adjustments for A-weighting and C-weighting [5]

3.1.3 Duration

The third principal physical characteristic involved in the measurement and human perception of sound is duration, which is the length of time the sound can be detected. Sound sources can vary from short durations to continuous, such as back-up alarms and ventilation systems, respectively. Sonic booms are

considered low-frequency impulsive noise events with durations lasting a fraction of a second. A variety of noise metrics have been developed to describe noise over different time periods. These are discussed in detail in Section 3.2.

3.1.4 Common Sounds

Common sources of noise and their associated levels are provided for comparison to the noise levels from the proposed action.

A chart of A-weighted sound levels from everyday sound sources [6] is shown in Figure 4. Some sources, like the air conditioners and lawn mower, are continuous sounds whose levels are constant for a given duration. Some sources, like the ambulance siren and motorcycle, are the maximum sound during an intermittent event like a vehicle pass-by. Other sources like "urban daytime" and "urban nighttime" (not shown in Figure 4) are averages over extended periods [7]. Per the US Environmental Protection Agency, "Ambient noise in urban areas typically varies from 60 to 70 dB but can be as high as 80 dB in the center of a large city. Quiet suburban neighborhoods experience ambient noise levels around 45-50 dB" [8].

A chart of typical impulsive events along with their corresponding peak overpressures in terms of psf and peak dB values are shown in Figure 5. For example, thunder overpressure resulting from lightning strikes at a distance of one kilometer is estimated to be near two psf, which is equivalent to 134 dB [9].

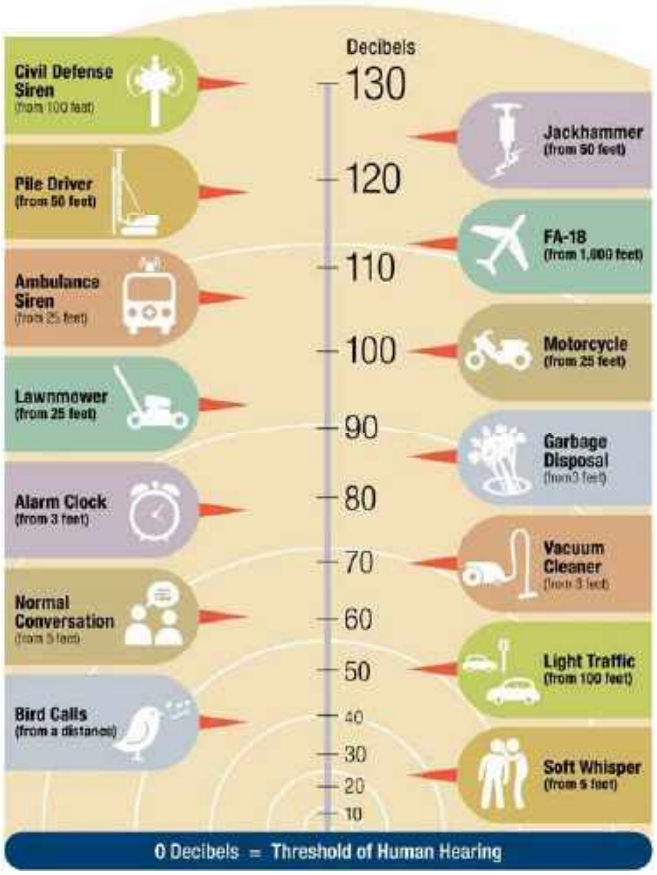


Figure 4. Typical A-weighted levels of common sounds [10]

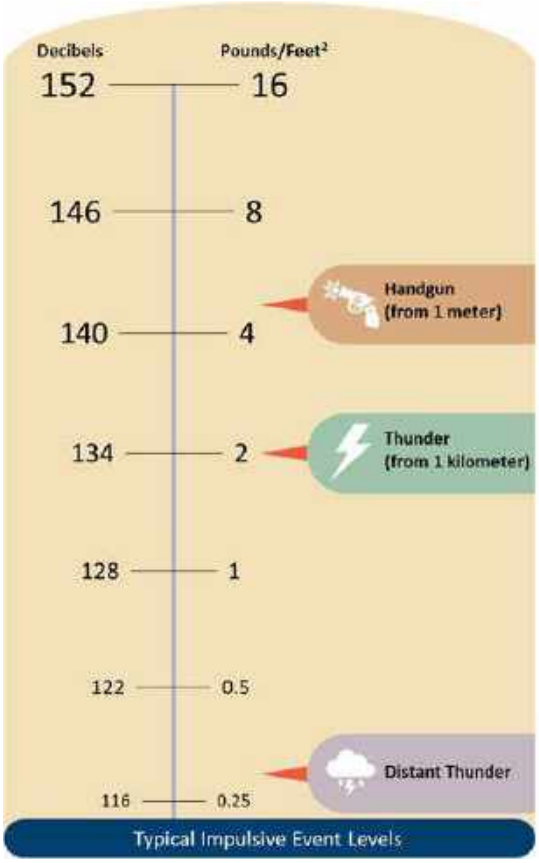


Figure 5. Typical impulsive event levels [9]

3.2 Noise Metrics

A variety of acoustical metrics have been developed to describe sound events and to identify any potential impacts to receptors within the environment. These metrics are based on the nature of the event and who or what is affected by the sound. A brief description of the noise metrics used in this noise study are provided below.

3.2.1 Maximum Sound Level (L_{max})

The highest unweighted sound level measured during a single event, in which the sound changes with time, is called the Maximum Sound Level (abbreviated as L_{max}). The highest A-weighted sound level measured during a single event is called the Maximum A-weighted Sound Level (abbreviated as $L_{A,max}$). Although it provides some measure of the event, L_{max} (or $L_{A,max}$) does not fully describe the sound because it does not account for how long the sound is heard.

3.2.2 Peak Overpressure (L_{pk})

For impulsive sounds, the true instantaneous peak sound pressure level, which lasts for only a fraction of a second, is important in determining impacts. The peak overpressure of the front shock wave is used to describe sonic booms, and it is usually presented in psf. Peak sound levels are not frequency weighted.

3.2.3 Day-Night Average Sound Level (DNL) and Day-Evening-Night Average Sound Level (L_{den})

Day-Night Average Sound Level is a cumulative metric that accounts for all noise events in a 24-hour period. To account for increased sensitivity to noise at night, DNL applies an additional 10 dB adjustment to events during the acoustical nighttime period, defined as 10:00 PM to 7:00 AM. DNL represents the average sound level exposure for annual average daily events.

The United Kingdom (UK) uses the Day-Evening-Night Average Sound Level (L_{den}), a variant of the DNL. In addition to a 10 dB (i.e. 10 times weighting) adjustment during the acoustical nighttime period (11:00 pm to 7:00 am), the L_{den} includes a 5 dB adjustment (i.e. 3 times weighting) to events during the acoustical evening period (7:00 PM to 11:00 PM) to account for decreased community noise during this period. DNL and L_{den} do not represent a level heard at any given time but represent long term exposure to noise.

3.2.4 Sound Exposure Level (SEL)

Sound exposure level is a composite metric that represents both the intensity of a sound and its duration. Individual time-varying noise events have two main characteristics: a sound level that changes throughout the event and a period of time during which the event is heard. SEL provides a measure of the net impact of the entire acoustic event, but it does not directly represent the sound level heard at any given time. Mathematically, it represents the sound level of a constant sound that would generate the same acoustical energy in one second as the actual time-varying noise event. For sounds that typically last more than one second, the SEL is usually greater than the L_{max} because a single event takes seconds and the maximum sound level (L_{max}) occurs instantaneously. A-weighted sound exposure level is abbreviated as ASEL.

3.2.5 Time Above (TA)

The Time Above a threshold level is a measure of the total time the noise level exceeds the A-weighted threshold level during a defined time period. TA is expressed in seconds and describes the time noise levels are elevated above a level. For example, TA66 represents the time that the noise levels are above 66 dBA. However, it does not describe the magnitude of the elevated noise levels.

3.3 Noise Effects

Noise criteria have been developed to protect the public health and welfare of the surrounding communities. The impacts of launch vehicle noise and sonic booms are evaluated on a cumulative basis in terms of human annoyance. In addition, potential impacts are evaluated on a single-event basis in relation to hearing conservation, sleep disturbance, speech interference, and structural damage.

3.3.1 Human Annoyance

DNL is based on long-term cumulative noise exposure and has been found to correlate well with long-term community annoyance for regularly occurring events including aircraft, rail, and road noise [11, 12]. Noise studies used in the development of the DNL metric did not include rockets, which are historically irregularly occurring events. Thus, it is acknowledged that the suitability of DNL for infrequent rocket noise events is uncertain. Additionally, it has been noted that the DNL "threshold does not adequately address the effects of noise on visitors to areas within a national park or national wildlife refuge where other noise is very low and a quiet setting is a generally recognized purpose and attribute" [13]. However, DNL is the most widely accepted metric to estimate the potential changes in long-term community annoyance. For launch propulsion noise, A-weighted DNL is used to assess the community impacts with regards to human annoyance. For impulsive noise sources with significant low-frequency content such as sonic booms, C-weighted DNL (CDNL) is preferred over A-weighted DNL [14]. In terms of percent highly annoyed, DNL 65 dBA is equivalent to CDNL 60 dBC [15]. Within the UK, the potential for community impacts with regards to human annoyance are assessed using L_{den} (see Section 3.2), a variant of DNL. Given that there are no formal thresholds incorporated into UK guidelines or legislation, the present study uses a criterion of 55 dBA L_{den} based on guidance from EU Directive 2002/49/EC [16].

3.3.2 Hearing Conservation

Launch Vehicle Noise

National agencies have provided guidelines on permissible noise exposure limits. These documented guidelines are in place to protect human hearing from long-term continuous daily exposures to high noise levels and aid in the prevention of noise-induced hearing loss (NIHL). A number of agencies have set exposure limits on non-impulsive noise levels, including the Occupational Safety and Health Administration (OSHA) [17], National Institute for Occupational Safety and Health (NIOSH) [18], and UK Legislation [19]. The most conservative of these upper noise level limits has been set by OSHA at 115 dBA. At 115 dBA, the allowable exposure duration is 15 minutes for OSHA and 28 seconds for NIOSH. $L_{A,max}$ contours are used to identify potential locations where hearing protection should be considered for rocket operations.

Sonic Booms

Multiple national agencies have provided guidelines on permissible noise exposure limits on impulsive noise such as sonic booms. In terms of upper limits on impulsive or impact noise levels, NIOSH [18], OSHA [20], and UK Legislation [19] have stated that levels should not exceed 140 dB peak sound pressure level, which equates to a sonic boom level of approximately 4 psf.

3.3.3 Sleep Disturbance

Launch Vehicle Noise

Sleep disturbance is a major concern for communities exposed to launch vehicle noise at night. A number of studies have attempted to quantify the effects of noise on sleep. Although no scientific evidence directly relates nighttime aircraft noise and irreversible long-term health effects such as stress-induced illnesses, sleep disturbance is a major cause of annoyance for the community.

The relationship between noise levels and sleep disturbance is complex and not fully understood. The disturbance depends not only on the depth of sleep, but also on the previous exposure to launch vehicle noise, familiarity with the surroundings, the physiological and psychological condition of the recipient, and a host of other situational factors. The most readily measurable effect of noise on sleep is the number of arousals or awakenings, and so the body of scientific literature has focused on predicting the percentage of the population that will be awakened at various single event noise levels, expressed in terms of SEL, and or the probability of awakening during the night from nighttime operations.

A UK study [21] concluded that "below outdoor event levels of 90 dB ASEL, aircraft noise events are most unlikely to cause any measurable increase in the overall rates of sleep disturbance experienced during normal sleep." An SEL of 90 dBA is used to identify potential locations where sleep disturbance may occur.

3.3.4 Speech Interference

Launch Vehicle Noise

Speech interference from noise is a primary cause of annoyance for communities. Disruption of routine activities such as radio or television listening, telephone use, or conversation leads to frustration and annoyance. The quality of speech communication is important in classrooms and offices. In the workplace, speech interference from noise can cause fatigue and vocal strain in those who attempt to talk over the noise. In schools it can impair learning.

There are two measures of speech comprehension:

1. Word Intelligibility - the percent of words spoken and understood. This might be important for students in the lower grades who are learning the English language, and particularly for students who have English as a Second Language.
2. Sentence Intelligibility – the percent of sentences spoken and understood. This might be important for high-school students and adults who are familiar with the language, and who do not necessarily have to understand each word in order to understand sentences.

A sentence intelligibility of 95% usually permits reliable communication because of the redundancy in normal conversation. Levels must remain below 66 dBA to maintain a speech intelligibility of 95% for two people standing outside, approximately 1 m apart [8].

3.3.5 Structural Damage

Launch Vehicle Noise

Typically, the most sensitive components of a structure to launch vehicle noise are windows, and infrequently, the plastered walls and ceilings. The potential for damage to a structure is unique interaction among the incident sound, the condition of the structure, and the material of each element and its respective boundary conditions. A report from the National Research Council on the "Guidelines for Preparing Environmental Impact Statements on Noise" [22] states that one may conservatively consider all sound lasting more than one second with levels exceeding 130 dB (unweighted) as potentially damaging to structures.

A NASA technical memo examined the relationship between structural damage claims and overall sound pressure level and concluded "the probability of structural damage [was] proportional to the intensity of the low frequency sound" [23]. This relationship estimated that one damage claim in 100 households exposed is expected at an average continuous sound level of 120 dB (unweighted), and one in 1,000 households at 111 dB (unweighted). The study was based on community responses to 45 ground tests of the first and second stages of the Saturn V rocket system conducted in Southern Mississippi over a period of five years. The sound levels used to develop the criteria were modeled mean sound levels.

It is important to highlight the difference between the static ground tests on which the rate of structural damage claims is based and the dynamic events modeled in this noise study. During ground tests, the engine/motor remains in one position, which results in a longer-duration exposure to continuous levels as opposed to the transient noise occurring from the moving vehicle during a launch event. Regardless of this difference, Guest and Slone's [23] damage claim criteria represents the best available dataset regarding the potential for structural damage resulting from rocket noise. Thus, L_{max} values of 120 dB (unweighted) and 111 dB (unweighted) are used in this report as conservative thresholds for potential risk of structural damage claims.

Sonic Booms

High-level sonic booms are also associated with structural damage. Most damage claims are for brittle objects, such as glass and plaster. Table 3 summarizes the threshold of damage that may be expected at various overpressures [24]. Additionally, Table 3 describes example impulsive events for each level range. A large degree of variability exists in damage experience, and much of the damage depends on the pre-existing condition of a structure. Breakage data for glass, for example, spans a range of two to three orders of magnitude at a given overpressure. The probability of a window breaking at 1 psf ranges from one in a billion [25] to one in a million [26]. These damage rates are associated with a combination of boom load and glass condition. At 10 psf, the probability of breakage is between one in 100 and one in 1,000. Laboratory tests involving glass [27] have shown that properly installed window glass will not break at overpressures below 10 psf, even when subjected to repeated booms. However, in the real world, glass is not always in pristine condition.

Damage to plaster occurs at similar ranges to glass damage. Plaster has a compounding issue in that it will often crack due to shrinkage while curing or from stresses as a structure settles, even in the absence of outside loads. Sonic boom damage to plaster often occurs when internal stresses are high as a result of these factors. In general, for well-maintained structures, the threshold for damage from sonic booms is 2 psf [24], below which damage is unlikely.

Table 3. Possible damage to structures from sonic booms [24]

Nominal level	Damage Type	Item Affected
0.5 – 2 psf *piledriver at construction site*	Plaster	Fine cracks; extension of existing cracks; more in ceilings; over doorframes; between some plasterboards.
	Glass	Rarely shattered; either partial or extension of existing.
	Roof	Slippage of existing loose tiles/slates; sometimes new cracking of old slates at nail hole.
	Damage to outside walls	Existing cracks in stucco extended.
	Bric-a-brac	Those carefully balanced or on edges can fall; fine glass, such as large goblets, can fall and break.
	Other	Dust falls in chimneys.
2 – 4 psf *cap gun/firecracker near ear*	Glass, plaster, roofs, ceilings	Failures show that would have been difficult to forecast in terms of their existing localized condition. Nominally in good condition.
4 – 10 psf *handgun at shooter's ear*	Glass	Regular failures within a population of well-installed glass; industrial as well as domestic greenhouses.
	Plaster	Partial ceiling collapse of good plaster; complete collapse of very new, incompletely cured, or very old plaster.
	Roofs	High probability rate of failure in nominally good state, slurry-wash; some chance of failures in tiles on modern roofs; light roofs (bungalow) or large area can move bodily.
	Walls (out)	Old, free standing, in fairly good condition can collapse.
	Walls (in)	Inside ("party") walls known to move at 10 psf.
> 10 psf *fireworks display from viewing stand*	Glass	Some good glass will fail regularly to sonic booms from the same direction. Glass with existing faults could shatter and fly. Large window frames move.
	Plaster	Most plaster affected.
	Ceilings	Plasterboards displaced by nail popping.
	Roofs	Most slate/slurry roofs affected, some badly; large roofs having good tile can be affected; some roofs bodily displaced causing gale-end and will-plate cracks; domestic chimneys dislodged if not in good condition.
	Walls	Internal party walls can move even if carrying fittings such as hand basins or taps; secondary damage due to water leakage.
	Bric-a-brac	Some nominally secure items can fall; e.g., large pictures, especially if fixed to party walls.

4 Noise Modeling

An overview of the propulsion noise and sonic boom modeling methodologies used in this noise study are presented in Section 4.1 and 4.2, respectively.

4.1 Propulsion Noise Modeling

Launch vehicle propulsion systems, such as solid rocket motors and liquid-propellant rocket engines, generate high-amplitude broadband noise. Most of the noise is created by the rocket plume interacting with the atmosphere and the combustion noise of the propellants. Although rocket noise radiates in all directions, it is highly directive, meaning that a significant portion of the source's acoustic power is concentrated in specific directions.

The Launch Vehicle Acoustic and Emissions Simulation Model (RUMBLE) 4.1, developed by Blue Ridge Research and Consulting, LLC (BRRC), is the noise model used to predict the noise associated with the proposed operations. The core components of the model are visualized in Figure 6 and are described in the following subsections.

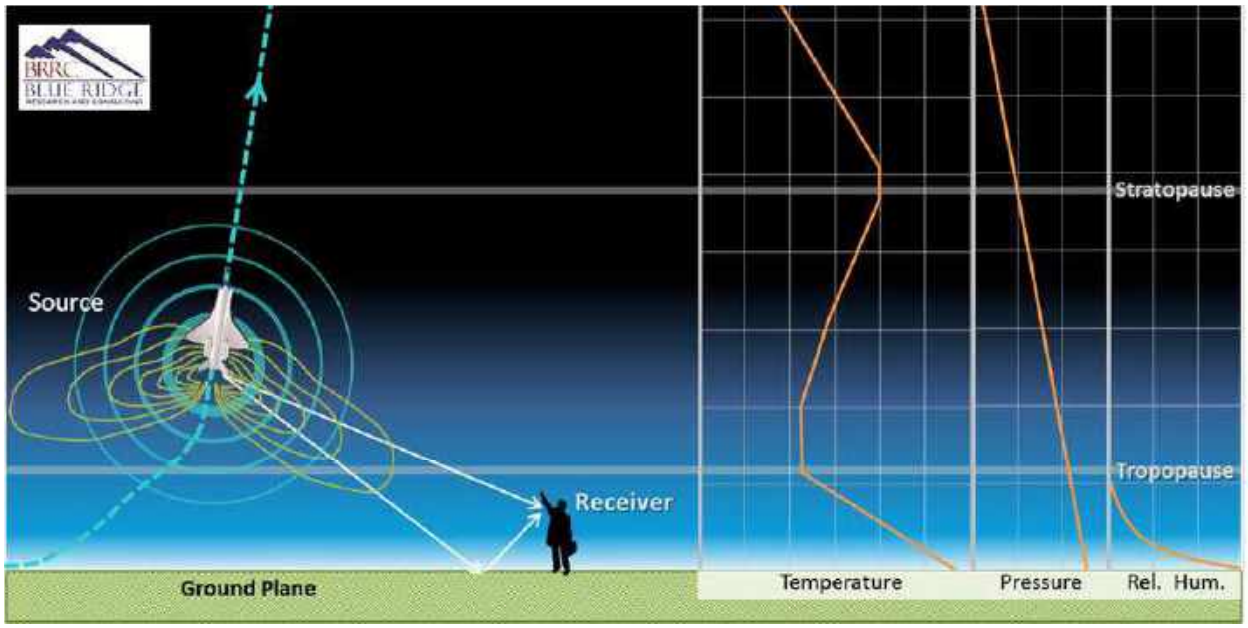


Figure 6. Conceptual overview of rocket noise prediction model methodology

4.1.1 Source

The rocket noise source definition considers the acoustic power of the rocket, forward flight effects, directivity, and the Doppler effect.

Acoustic Power

Eldred's Distributed Source Method 1 (DSM-1) [28] is utilized for the source characterization. The DSM-1 model determines the launch vehicle's total sound power based on its total thrust, exhaust velocity, and the engine/motor's acoustic efficiency. BRRC's recent validation of the DSM-1 model showed very good agreement between full-scale rocket noise measurements and the empirical source curves [29]. The acoustic efficiency of the rocket engine/motor specifies the percentage of the mechanical power

converted into acoustic power. The acoustic efficiency of the rocket engine/motor was modeled using Guest's variable acoustic efficiency [30]. Typical acoustic efficiency values range from 0.2% to 1.0% [28]. In the far-field, distributed sound sources are modeled as a single compact source located at the nozzle exit with an equivalent total sound power. Therefore, launch vehicle propulsion systems with multiple tightly clustered equivalent engines can be modeled as a single engine with an effective exit diameter and total thrust [28]. Additional boosters or cores (that are not considered to be tightly clustered) are handled by summing the noise contribution from each booster/core.

Forward Flight Effect

A rocket in forward flight radiates less noise than the same rocket in a static environment. A standard method to quantify this effect reduces overall sound levels as a function of the relative velocity between the jet plume and the outside airflow [31, 32, 33, 34]. This outside airflow travels in the same direction as the rocket exhaust. At the onset of a launch, the rocket exhaust travels at far greater speeds than the ambient airflow. Conversely, for a vertical landing, the rocket exhaust and ambient airflow travel in opposing directions, yielding an increased relative velocity differential. As the differential between the forward flight velocity and exhaust velocity decreases, jet plume mixing is reduced, which reduces the corresponding noise emission. Notably, the maximum sound levels are normally generated before the vehicle reaches the speed of sound. Thus, the modeled noise reduction is capped at a forward flight velocity of Mach 1.

Directivity

Rocket noise is highly directive, meaning the acoustic power is concentrated in specific directions, and the observed sound pressure will depend on the angle from the source to the receiver. NASA's Constellation Program has made significant improvements in determining launch vehicle directivity of the reusable solid rocket motor (RSRM) [35]. The RSRM directivity indices (DI) incorporate a larger range of frequencies and angles than previously available data. Subsequently, improvements were made to the formulation of the RSRM DI [36] accounting for the spatial extent and downstream origin of the rocket noise source. These updated DI are used for this analysis.

Doppler Effect

The Doppler effect is the change in frequency of an emitted wave from a source moving relative to a receiver. The frequency at the receiver is related to the frequency generated by the moving sound source and by the speed of the source relative to the receiver. The received frequency is higher (compared to the emitted frequency) if the source is moving towards the receiver, it is identical at the instant of passing by, and it is lower if the source is moving away from the receiver. During a rocket launch, an observer on the ground will hear a downward shift in the frequency of the sound as the distance from the source to receiver increases. The relative changes in frequency can be explained as follows: when the source of the waves is moving toward the observer, each successive wave crest is emitted from a position closer to the observer than the previous wave. Therefore, each wave takes slightly less time to reach the observer than the previous wave, and the time between the arrivals of successive wave crests at the observer is reduced, causing an increase in the frequency. While they are traveling, the distance between successive wave fronts is reduced such that the waves "bunch together." Conversely, if the source of waves is moving away

from the observer, then each wave is emitted from a position farther from the observer than the previous wave; the arrival time between successive waves is increased, reducing the frequency. Likewise, the distance between successive wave fronts increases, so the waves "spread out." Figure 7 illustrates this spreading effect for an observer in a series of images, where a) the source is stationary, b) the source is moving less than the speed of sound, c) the source is moving at the speed of sound, and d) the source is moving faster than the speed of sound. As the frequency is shifted lower, the A-weighting filtering on the spectrum results in a decreased A-weighted sound level. For unweighted overall sound levels, the Doppler effect does not change the levels since all frequencies are accounted for equally.

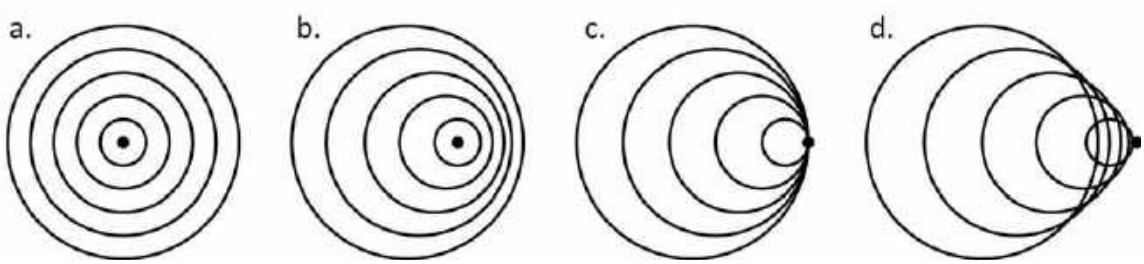


Figure 7. Effect of expanding wavefronts (decrease in frequency) that an observer would notice for higher relative speeds of the rocket relative to the observer for: a) stationary source b) source velocity < speed of sound c) source velocity = speed of sound d) source velocity > speed of sound

4.1.2 Propagation

The sound propagation from the source to receiver considers the ray path, atmospheric absorption, and ground interference.

Ray Path

The model assumes straight line propagation between the source and receiver to determine propagation effects. For straight rays, sound levels decrease as the sound wave propagates away from a source uniformly in all directions. The launch vehicle noise model components are calculated based on the specific geometry between source (launch vehicle trajectory point) to receiver (grid point). The position of the launch vehicle, described by the trajectory, is provided in latitude and longitude, defined relative to a reference system (e.g. World Geodetic System 1984) that approximates the Earth's surface by an ellipsoid. The receiver grid is also described in geodetic latitude and longitude, referenced to the same reference system as the trajectory data, ensuring greater accuracy than traditional flat earth models.

Atmospheric Absorption

Atmospheric absorption is a measure of the sound attenuation from the excitation of vibration modes of air molecules. Atmospheric absorption is a function of temperature, pressure, and relative humidity of the air. The propulsion noise model utilizes an atmospheric profile, which describes the variation of temperature, pressure, and relative humidity with respect to the altitude. Standard atmospheric data sources [37, 38, 39, 40] were used to create a composite atmospheric profile for altitudes up to 106 km. The atmospheric absorption is calculated using formulas found in ANSI Standard S1.26-1995 (R2004). The result is a sound-attenuation coefficient, which is a function of frequency, atmospheric conditions, and distance from the source. The amount of absorption depends on the parameters of the atmospheric layer and the distance that the sound travels through the layer. The total sound attenuation is the sum of the absorption experienced from each atmospheric layer.

Nonlinear propagation effects can result in distortions of high-amplitude sound waves [41] as they travel through the medium. These nonlinear effects are counter to the effect of atmospheric absorption [42, 43]. However, recent research shows that nonlinear propagation effects change the perception of the received sound [44, 45], but the standard acoustical metrics are not strongly influenced by nonlinear effects [46, 47]. The overall effects of nonlinear propagation on high-amplitude sound signatures and their perception is an ongoing area of research, and it is not currently included in the propagation model.

Ground Interference

The calculated results of the sound propagation using DSM-1 provide a free-field sound level (i.e. no reflecting surface) at the receiver. However, sound propagation near the ground is most accurately modeled as the combination of a direct wave (source to receiver) and a reflected wave (source to ground to receiver) as shown in Figure 6. The ground will reflect sound energy back toward the receiver and interfere both constructively and destructively with the direct wave. Additionally, the ground may attenuate the sound energy, causing the reflected wave to propagate a smaller portion of energy to the receiver. RUMBLE accounts for the attenuation of sound by the ground [48, 49] when estimating the received noise. The model assumes a five-foot receiver height and a homogeneous grass ground surface. However, it should be noted that noise levels may be 3 dB louder over water surfaces compared to the predicted levels over the homogeneous grass ground surfaces assumed in the modeling. To account for the random fluctuations of wind and temperature on the direct and reflected wave, the effect of atmospheric turbulence is also included [48, 50].

4.1.3 Receiver

The received noise is estimated by combining the source and propagation components. The basic received noise is modeled as overall and spectral level time histories. This approach enables a range of noise metrics relevant to environmental noise analysis to be calculated and prepared as output.

4.2 Sonic Boom Modeling

A vehicle creates sonic booms during supersonic flight. The potential for the boom to intercept the ground depends on the trajectory and speed of the vehicle as well as the atmospheric profile. The sonic boom is shaped by the physical characteristics of the vehicle and the atmospheric conditions through which it propagates. These factors affect the perception of a sonic boom. The noise is perceived as a deep boom, with most of its energy concentrated in the low frequency range. Although sonic booms generally last less than one second, their potential for impact may be considerable.

A brief sonic boom generation and propagation modeling primer is provided in Section 4.2.1 to describe relevant technical details that inform the sonic boom modeling. The primer also provides visualizations of the boom generation, propagation, and ground intercept geometry. An overview of the sonic boom modeling software used in the study, PCBoom, and a description of inputs are found in Section 4.2.2.

4.2.1 Primer

When a vehicle moves through the air, it pushes the air out of its way. At subsonic speeds, the displaced air forms a pressure wave that disperses rapidly. At supersonic speeds, the vehicle is moving too quickly for the wave to disperse, so it remains as a coherent wave. This wave is a sonic boom. When heard at ground level, a sonic boom consists of two shock waves (one associated with the forward part of the vehicle, the other with the rear part) of approximately equal strength. When plotted, this pair of shock waves and the expanding flow between them has the appearance of a capital letter “N,” so a sonic boom pressure wave is usually called an “N-wave.” An N-wave has a characteristic "bang-bang" sound that can be startling. Figure 8 shows the generation and evolution of a sonic boom N-wave under the vehicle.

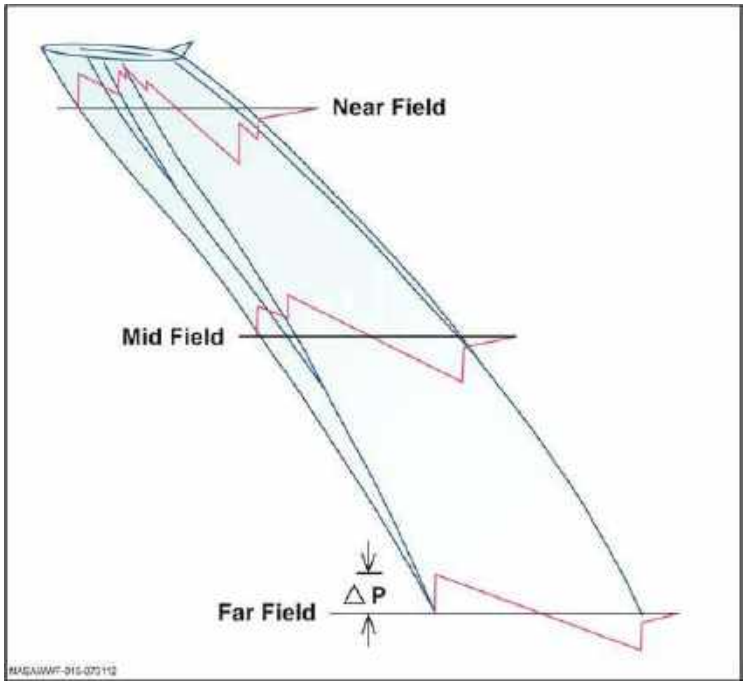


Figure 8. Sonic boom generation and evolution to N-wave [51]

For aircraft, the front and rear shock are generally the same magnitude. However, for rockets, in addition to the two shock waves generated from the vehicle body, the plume itself acts as a large supersonic body, and it generates two additional shock waves (one associated with the forward part of the plume, the other with the rear part) and extends the waveform duration to as large as one second. If the plume volume is significantly larger than the vehicle, its shocks will be stronger than the shocks generated by the vehicle.

Figure 9 shows the sonic boom wave cone generated by a vehicle in steady (non-accelerating) level supersonic flight. The wave cone extends toward the ground and is said to sweep out a "carpet" under the flight track. The boom levels vary along the lateral extent of the "carpet" with the highest levels directly underneath the flight track and decreasing levels as the lateral distance increases to the cut-off edge of the "carpet."

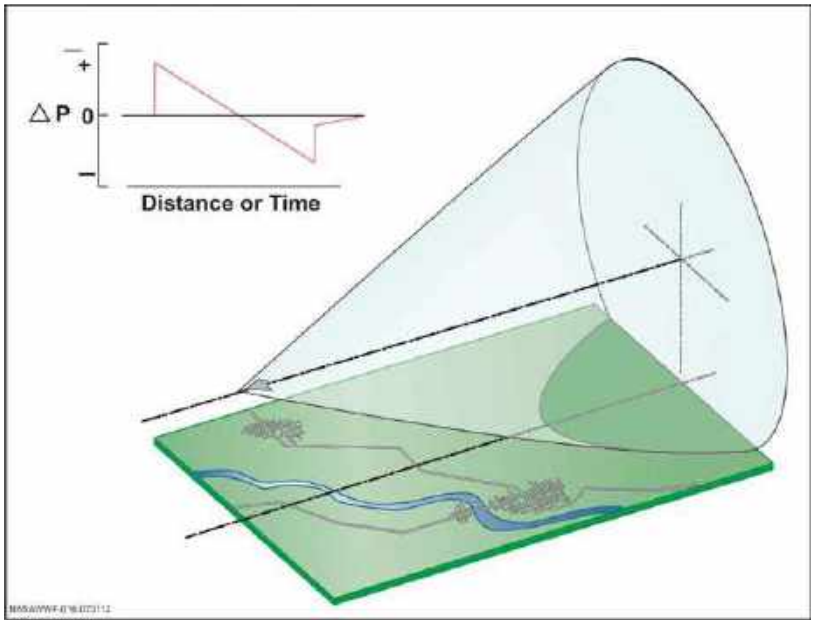


Figure 9. Sonic boom carpet for a vehicle in steady flight [52]

Although the wave cone can be calculated from an aircraft-fixed reference frame, the ray perspective is more convenient when computing sonic boom metrics in a ground-fixed observer's reference frame [53]. Both perspectives are shown in Figure 10. The difference in wave versus ray perspectives is described for level, climbing, and diving flight, in the PCBoom Sonic Boom Model User Guide [53]:

> Sonic boom wave cones are not generated fully formed at a single point in time, instead resulting from the accumulation of all previous disturbance events that occurred during the vehicle's time history. […] Unlike wave cones, ray cones are fully determined at a single point in time and are independent of future maneuvers. They are orthogonal to wave cones and represent all paths that sonic boom energy will take from the point they are generated until a later point in time when they hit the ground. The ray perspective is particularly useful when considering refraction due to atmospheric gradients or the effect of aircraft maneuvers, where rays can coalesce into high amplitude focal zones.

When the ray cone hits the ground, the resulting intersection is called an "isopemp." The isopemp is forward-facing [as shown in Figure 10] and falls a distance ahead of the vehicle called the "forward throw." At each new point in the trajectory, a new ray cone is generated, resulting in a new isopemp that strikes the ground. These isopemps are generated throughout the trajectory, sweeping out an area called the "boom footprint."

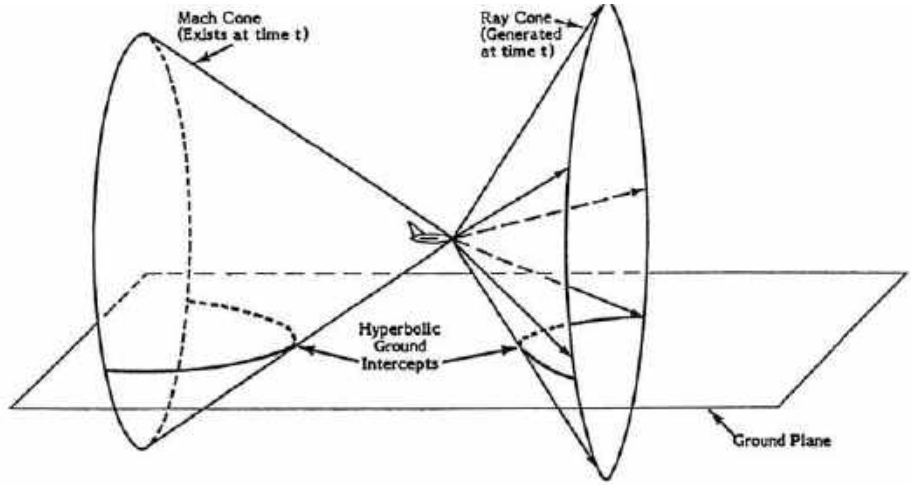


Figure 10. Mach cone vs ray cone viewpoints

Figure 9 and Figure 10 may give the impression that the boom footprint is generally associated with rays generated from the bottom of a vehicle. This is the case for vehicles at moderate climb and dive angles, or in level flight as shown in Figure 10. For a vehicle climbing at an angle steeper than the ray cone half angle, such as in the left image of Figure 11, rays from that part of its trajectory will not reach the ground. This is important for vertical launches, where the ascent stage of a launch vehicle typically begins at a steep angle. In these cases, sonic booms are not expected to reach the ground unless refracted back downwards by gradients in the atmosphere. Conversely, if a vehicle is in a sufficiently steep dive, such as in the right image of Figure 11, the entire ray cone may intersect the ground, resulting in an elliptical or even circular isopemp. This is of importance for space flight reentry analysis, where descent may be nearly vertical.

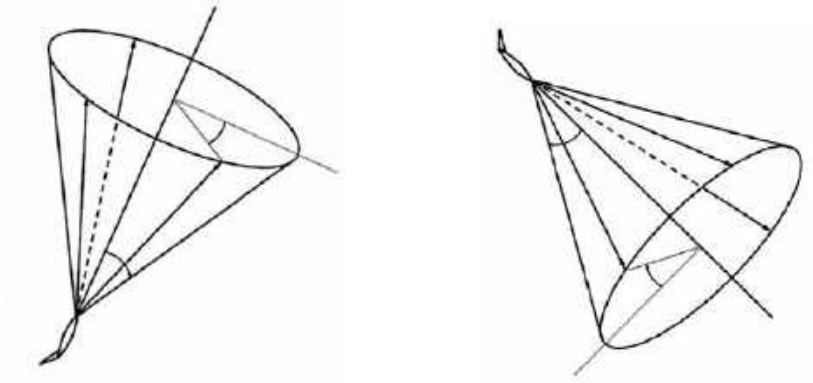


Figure 11. Ray cone in climbing (left) and diving (right) flight

4.2.2 PCBoom

The single-event prediction model, PCBoom 6.7b [54, 55, 56], is a full ray trace sonic boom program that is used to calculate the magnitude, waveform, and location of sonic boom overpressures on the ground from supersonic flight operations. Additionally, BRRC uses a custom version of PCBoom 6.7b that implements proper plume physics.

Several inputs are required to calculate the sonic boom impact, including the geometry of the vehicle, the trajectory path, and the atmospheric conditions. These parameters along with time-varying thrust, drag, and weight are used to define the PCBoom starting signatures used in the modeling. The starting signatures are propagated through a site-specific atmospheric profile that includes the mean temperature, wind speed, and wind direction [57].

5 Results

The following sections present the results of the environmental propulsion noise and sonic boom impacts associated with the proposed SCLV operations. Additionally, noise levels over water may be higher because of the acoustical hardness of the water surface. Single event propulsion noise and sonic boom noise metrics are presented in Section 5.1 and Section 5.2, respectively. Cumulative launch vehicle noise results are presented in Section 5.3.

5.1 Single Event Propulsion Noise Metrics and Effects

Single event propulsion noise events are evaluated using maximum A-weighted and unweighted levels, A-weighted sound exposure level, and time above.

5.1.1 Maximum A-weighted Sound Level ($L_{A,max}$)

The modeled $L_{A,max}$ contours associated with SCLV operations from SSC are presented in Figure 12 through Figure 17. An upper limit noise level of 115 dBA is used as a guideline to protect human hearing from long-term continuous daily exposures to high noise levels and to aid in the prevention of NIHL. There are no residences within the land area encompassed by the 115 dB noise contours resulting from SCLV operations. Thus, the potential for impacts to people in the community with regards to hearing conservation is negligible.

Launch Operations – The 115 dBA contour for SCLV launch events from Pad 1, Pad 2, and Pad 3 are shown in Figure 12, Figure 13, Figure 14, respectively. The SCLV launch event generates modeled levels at or above an $L_{A,max}$ of 115 dBA within 0.56 km of the pad nearest to the community.

Static Operations – The 115 dBA contour for SCLV static events from Pad 1, Pad 2, and Pad 3 are shown in Figure 15, Figure 16, and Figure 17, respectively. Note the difference in zoom level between the launch and static operation results. The SCLV static event noise contours are more directive than the launch event noise contours because the plume is redirected in-line with the deflector heading for the entire duration of the event. A receptor located along the peak directivity angle may experience an $L_{A,max}$ of 115 dBA at approximately 0.29 km from the pad during a static event. The levels produced by static events will remain constant over the duration of the event, whereas the levels produced by launch events will decrease as the rocket moves further away from the receptor.

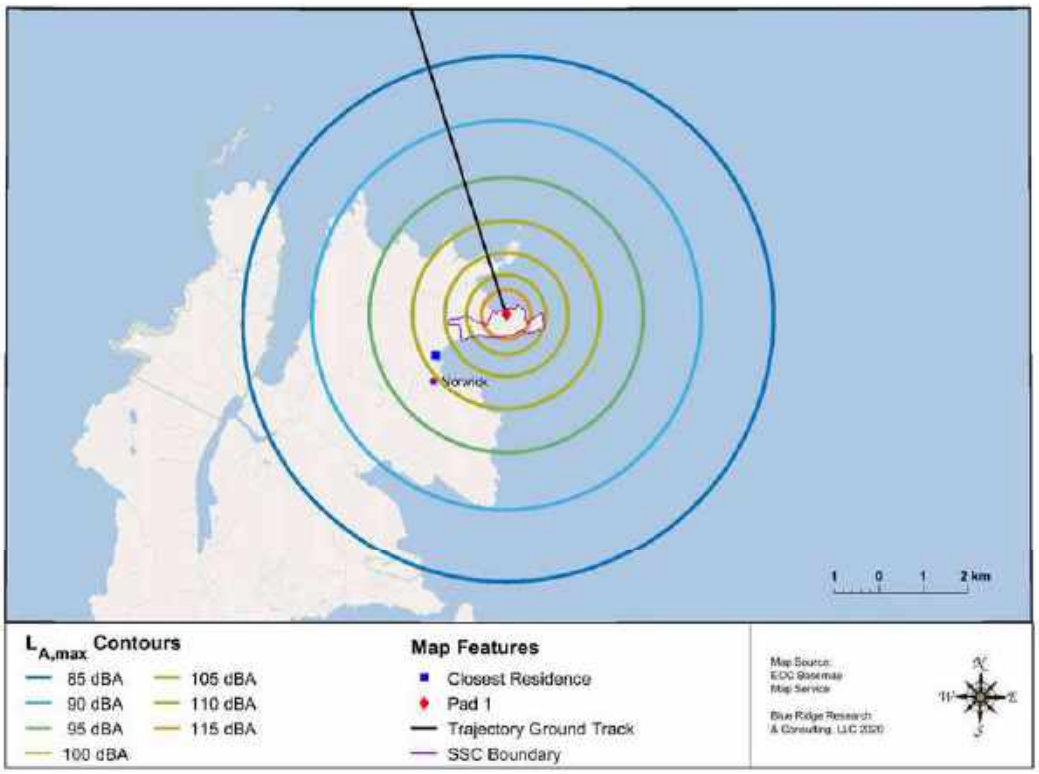


Figure 12. $L_{A,max}$ contours for a SCLV launch from SSC Pad 1

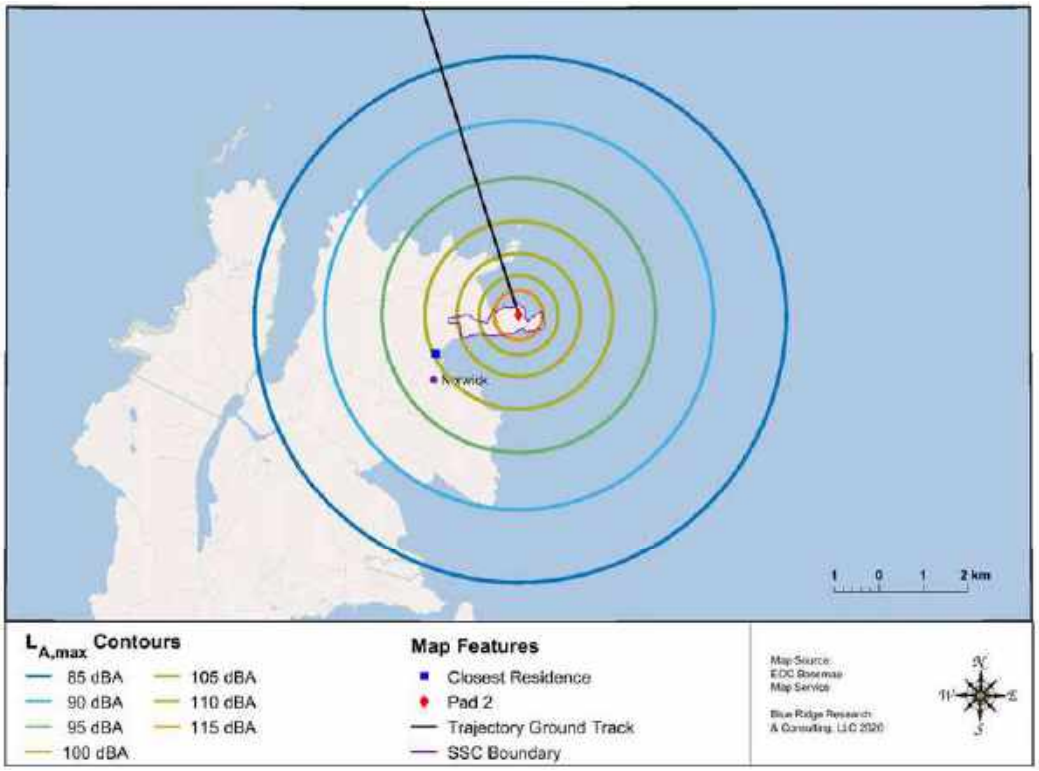


Figure 13. $L_{A,max}$ contours for a SCLV launch from SSC Pad 2

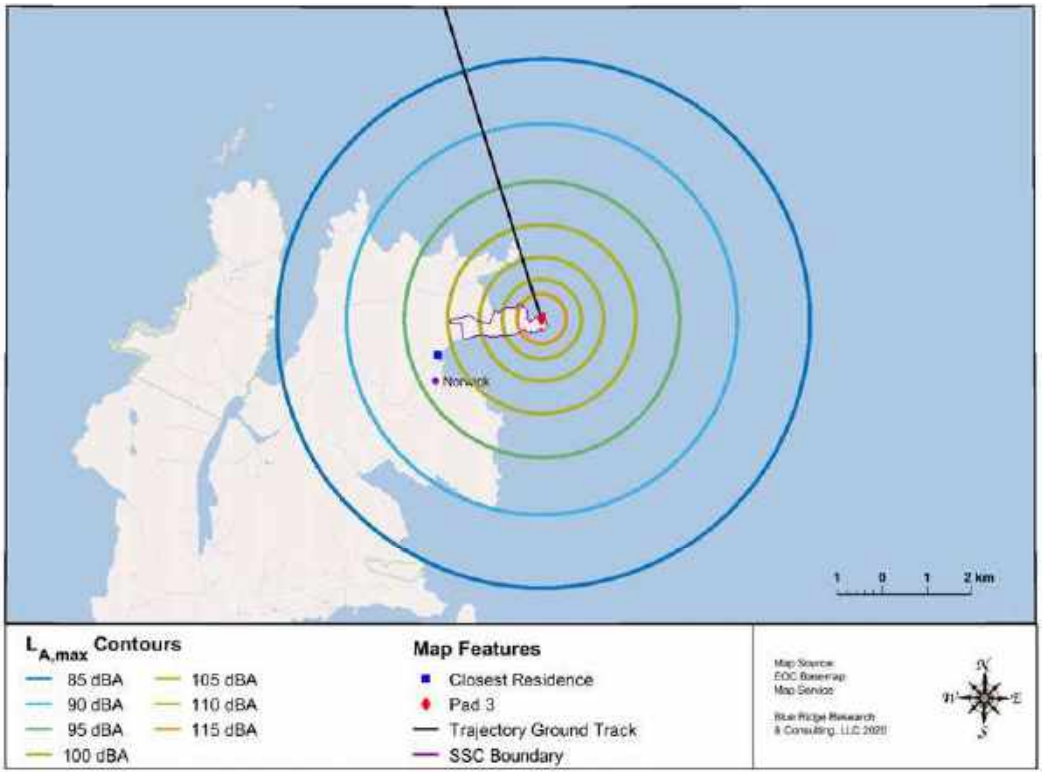


Figure 14. $L_{A,max}$ contours for a SCLV launch from SSC Pad 3

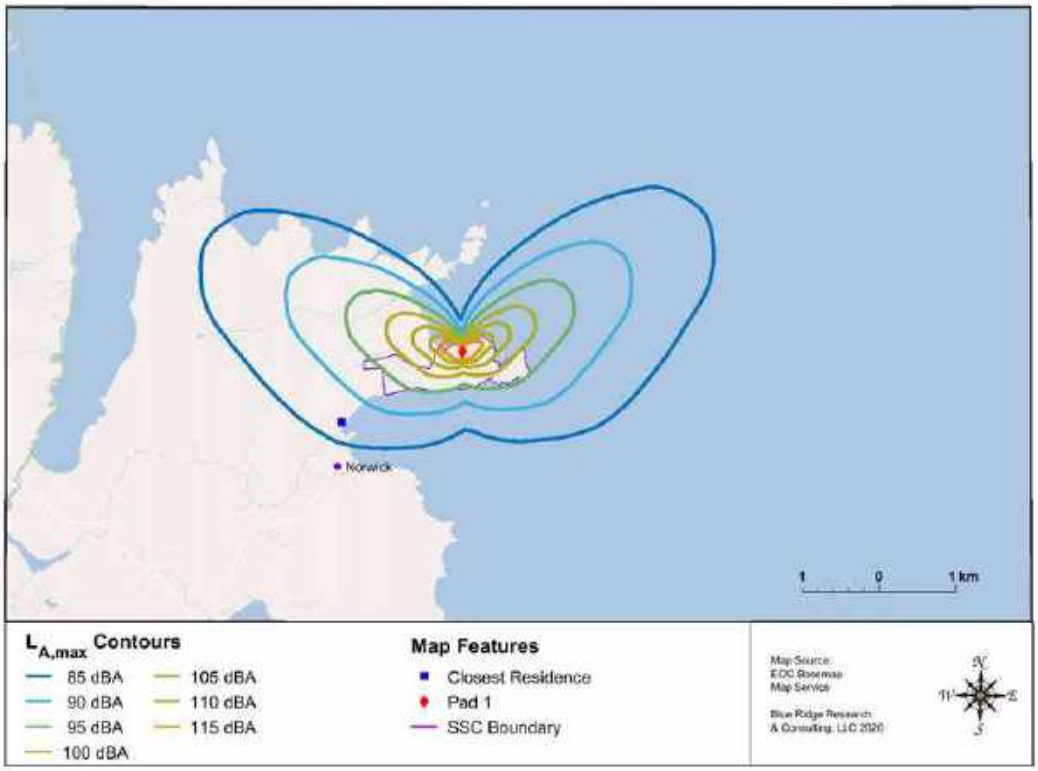


Figure 15. $L_{A,max}$ contours for a SCLV static fire from SSC Pad 1

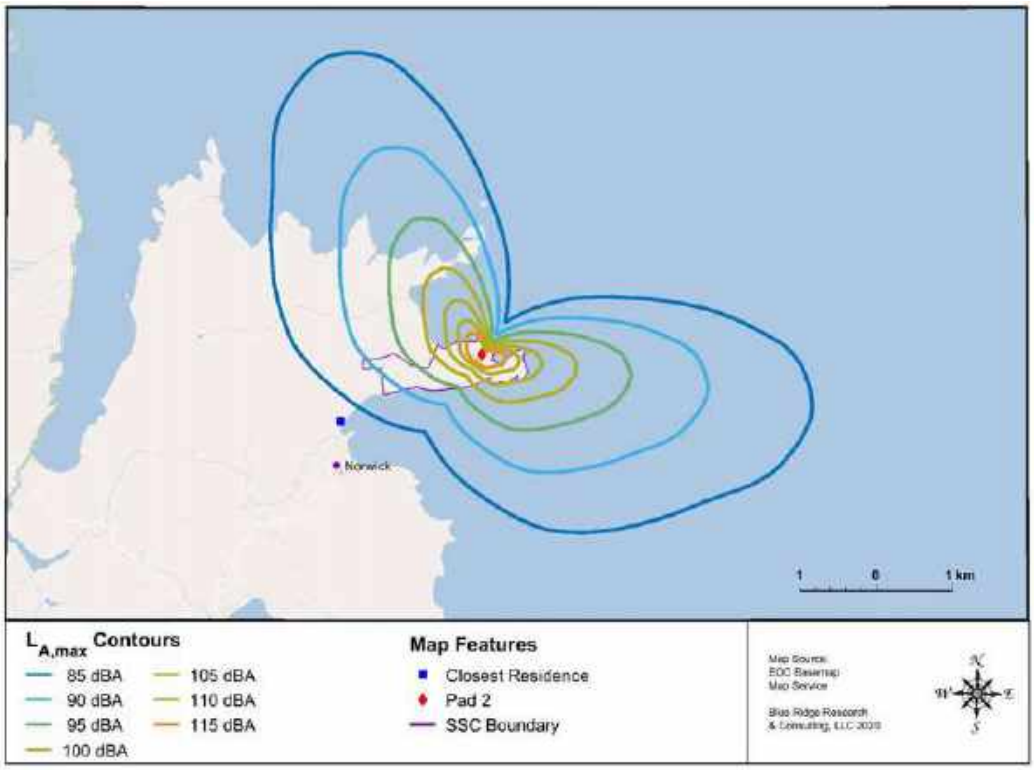


Figure 16. $L_{A,max}$ contours for a SCLV static fire from SSC Pad 2

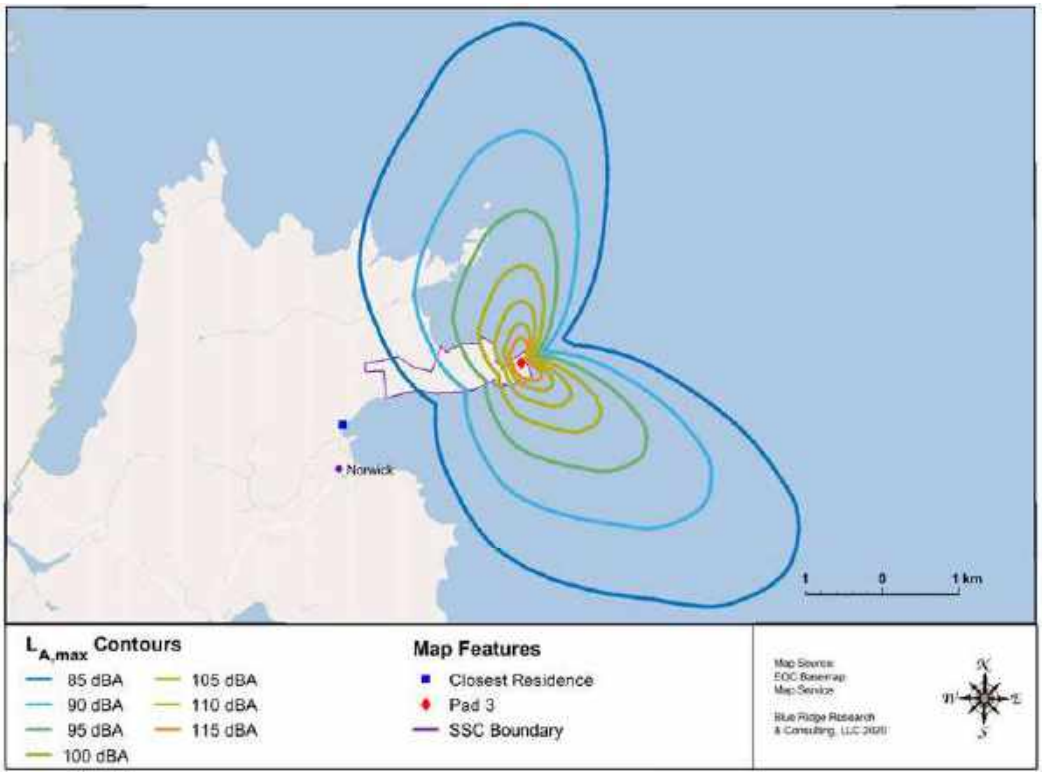


Figure 17. $L_{A,max}$ contours for a SCLV static fire from SSC Pad 3

5.1.2 Sound Exposure Level

The modeled ASEL contours associated with SCLV operations from SSC are presented in Figure 18 through Figure 23. Typically, ASEL levels in excess of 90 dBA indicate potential for sleep disturbance. Northern Unst is encompassed by the 90 dBA noise contours resulting from SCLV launch operations. Thus, the potential for sleep disturbance exists for nighttime launch operations.

Launch Operations – The 90 dBA contour for SCLV launch events from Pad 1, Pad 2, and Pad 3 are shown in Figure 18, Figure 19, and Figure 20, respectively. The SCLV launch event generates modeled levels at or above an ASEL of 90 dBA within 12.9 km of the pad nearest to the community.

Static Operations – The 90 dBA contour for SCLV static events at Pad 1, Pad 2, and Pad 3 are shown in Figure 21, Figure 22, and Figure 23, respectively. Note, the difference in zoom level between the launch and static operation results. The SCLV static event noise contours are more directive than the launch event noise contours because the plume is redirected in-line with the deflector heading for the entire duration of the event. A receptor located along the peak directivity angle may experience an ASEL of 90 dBA at approximately 4.2 km from the pad during a static event. Note, the levels produced by static events will remain constant over the duration of the event, whereas the levels produced by launch events will decrease as the rocket moves further away from the receptor.

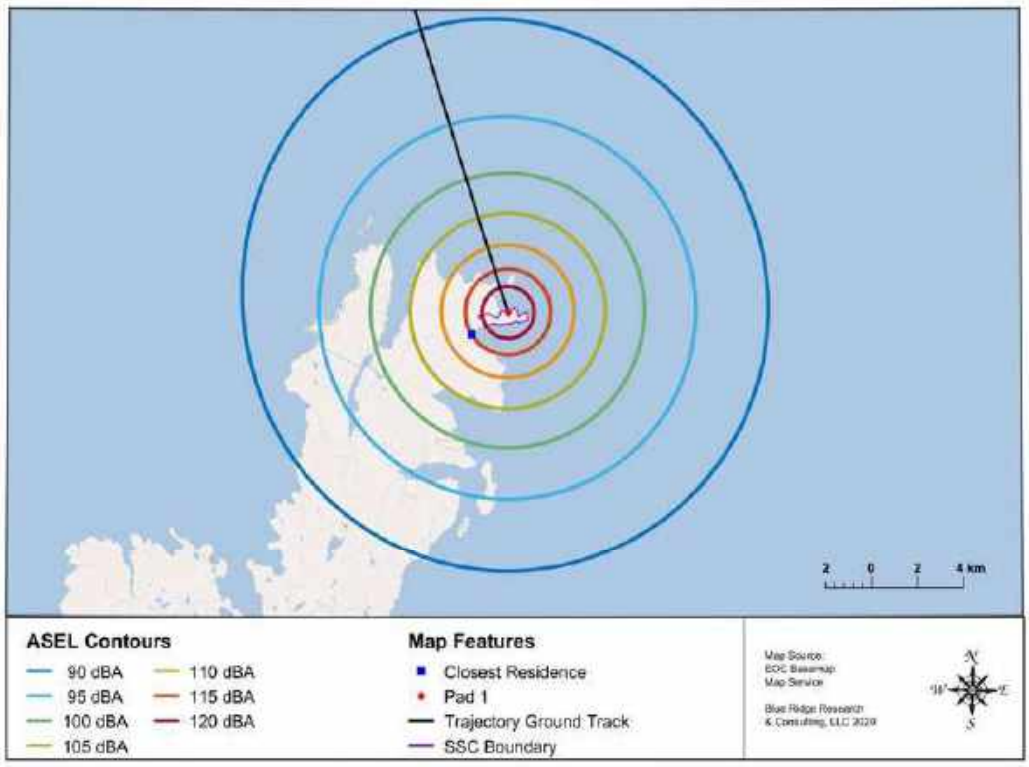


Figure 18. ASEL contours for a SCLV launch from SSC Pad 1

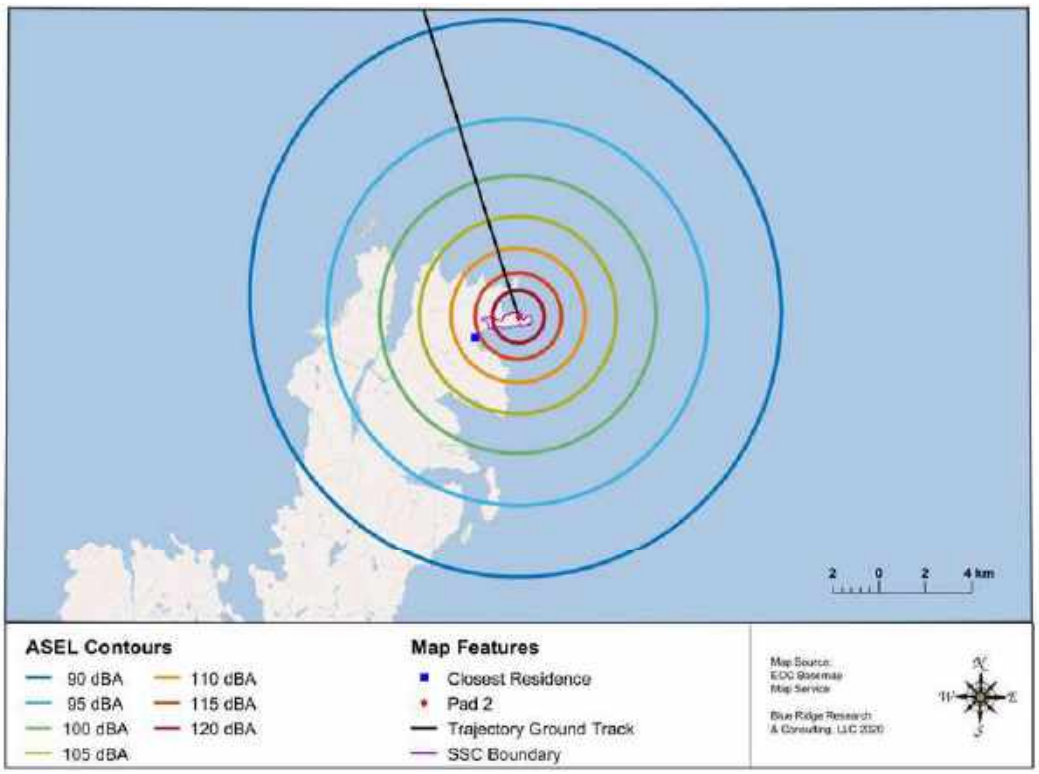


Figure 19. ASEL contours for a SCLV launch from SSC Pad 2

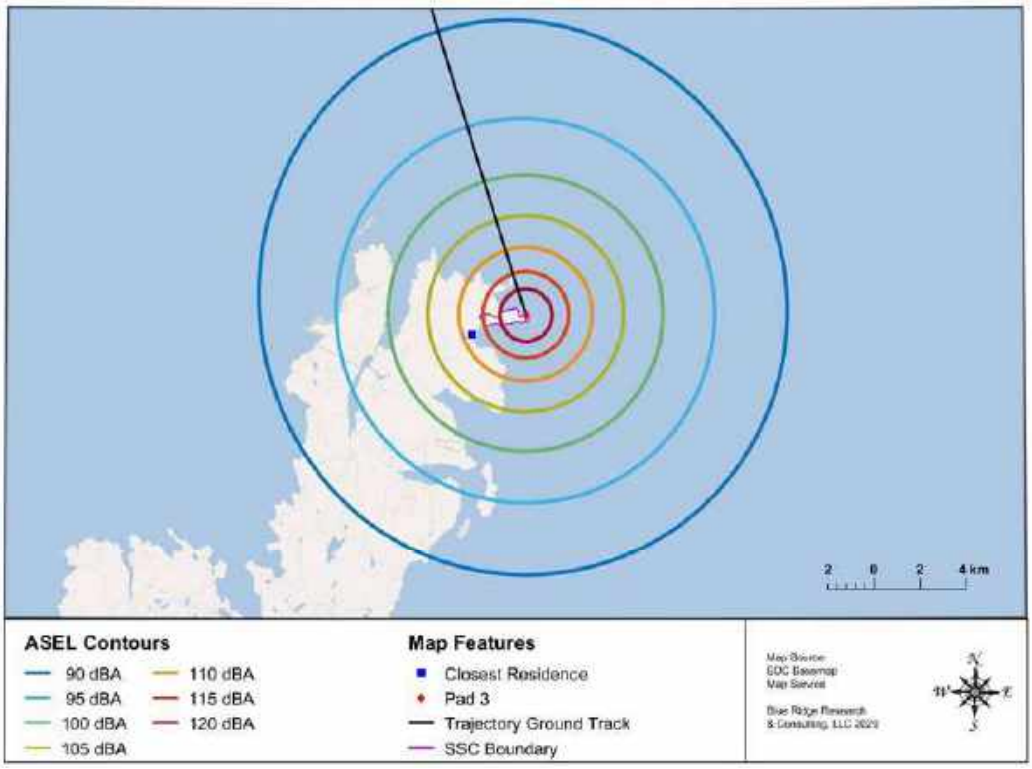


Figure 20. ASEL contours for a SCLV launch from SSC Pad 3

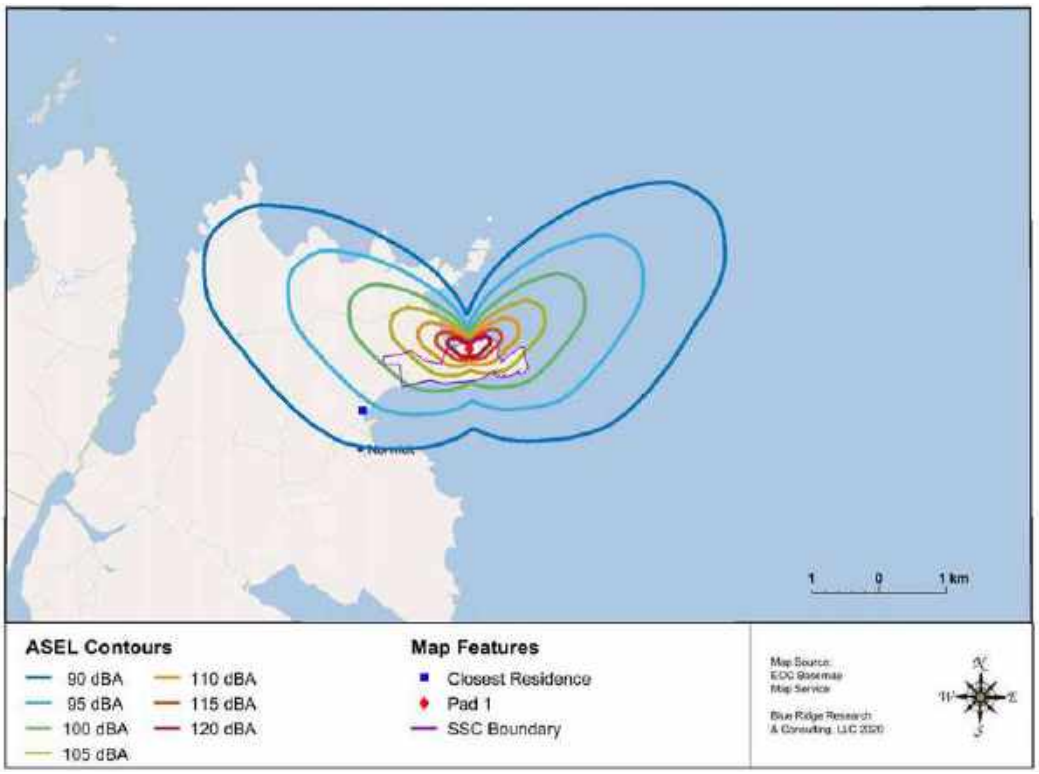


Figure 21. ASEL contours for a SCLV static fire from SSC Pad 1

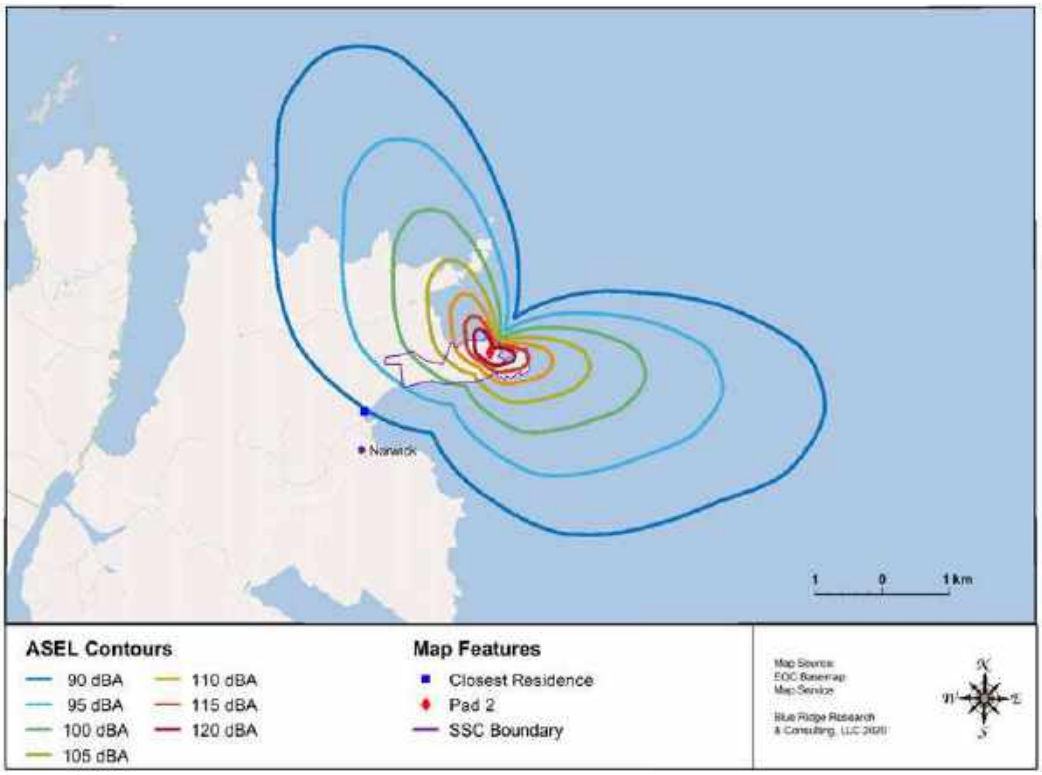


Figure 22. ASEL contours for a SCLV static fire from SSC Pad 2

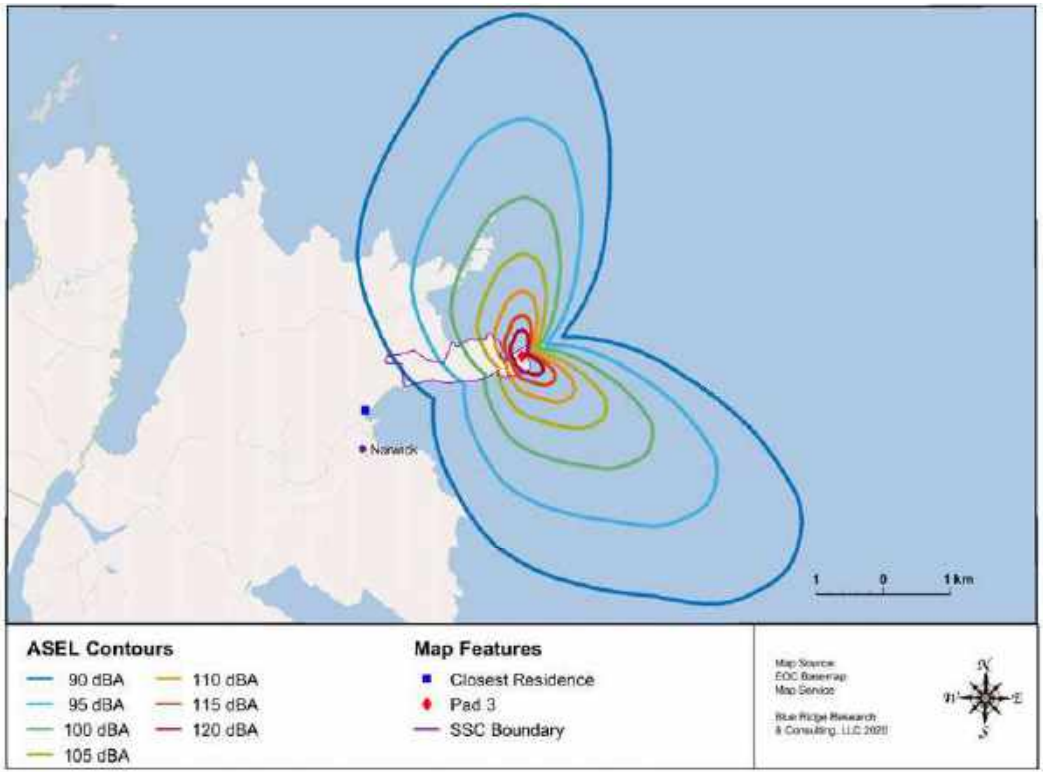


Figure 23. ASEL contours for a SCLV static fire from SSC Pad 3

5.1.3 Time Above

The modeled sound level time history for the event at the closest residence is shown in Figure 24. To provide additional context, Figure 24 displays the time above for four specified threshold levels which represent:

- A typical helicopter overflight (89 dBA);
- A speech intelligibility threshold of 95% (66 dBA);
- The average background noise level on Unst (45 dBA); and
- The background noise level on Unst that is exceeded 90% of the time (22 dBA).

To show the effect over the study region, the modeled time above contours associated with SCLV launch operations from SSC Pad 1, Pad 2, and Pad 3 are presented for 45 dBA, 66 dBA, and 89 dBA in Figure 25 to Figure 33. The shape of the contours depends on the selected time above threshold level. The TA45 contours, representing the time above the average background noise on Unst, increase from south to north over the study area and span a duration of 130-200 seconds. The TA66 contours, representing the time above the speech intelligibility threshold, shows a similar trend and span a duration of 60-95 seconds. The TA89 contours, representing the time above a typical helicopter overflight, generally decreases away from SSC and span a duration of 5-45 seconds.

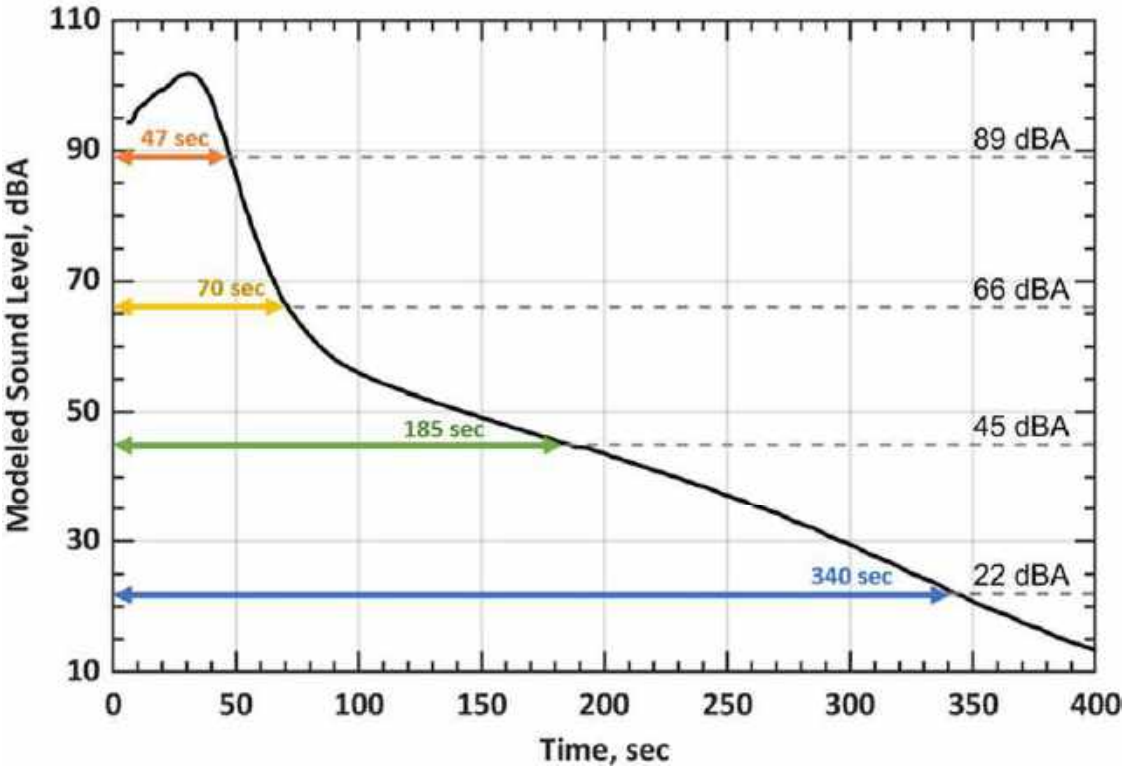


Figure 24. Modeled sound level time history at closest residence from SCLV launch operation.

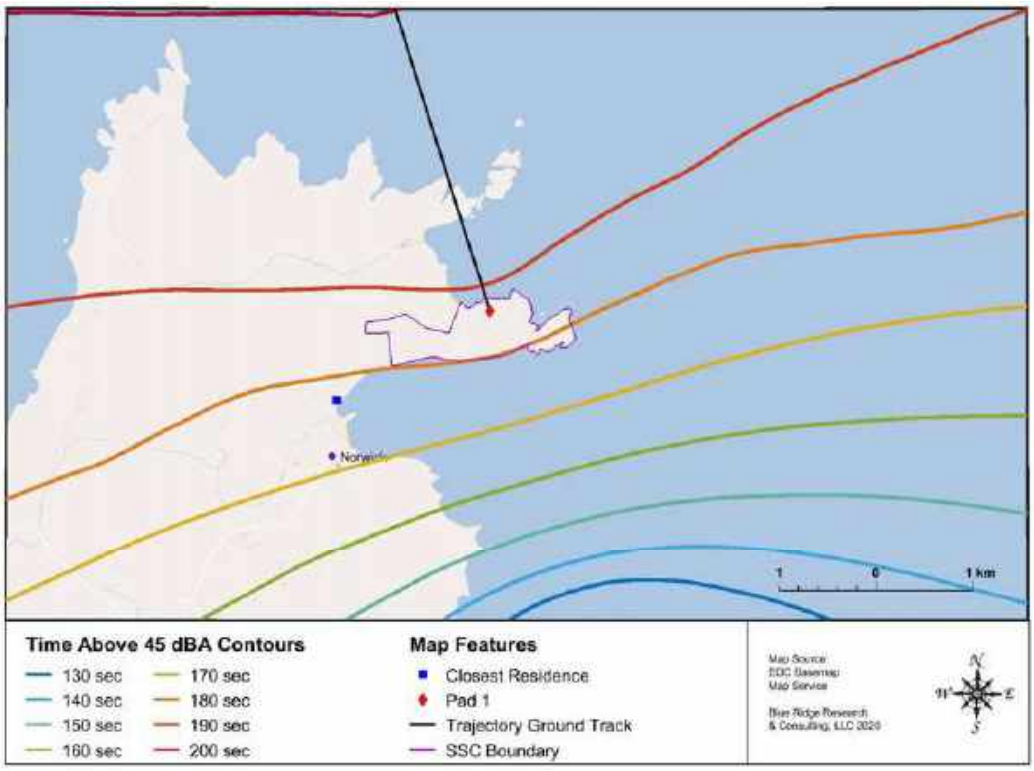


Figure 25. Time above 45 dBA contours for a SCLV launch from SSC Pad 1

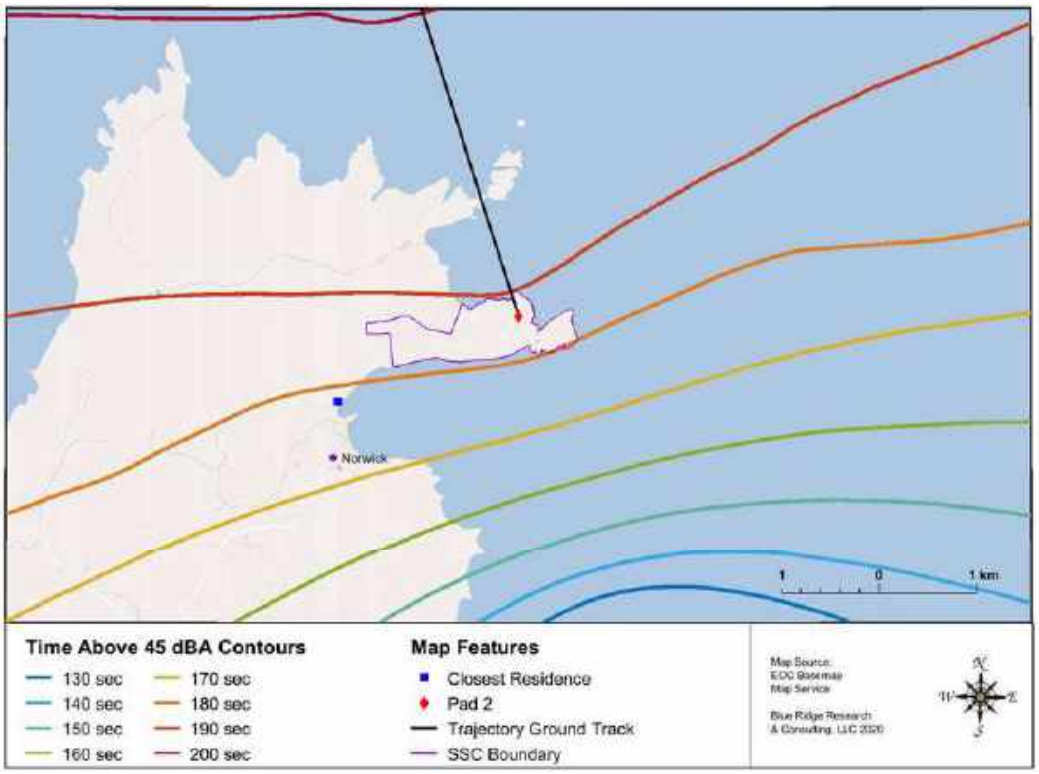


Figure 26. Time above 45 dBA contours for a SCLV launch from SSC Pad 2

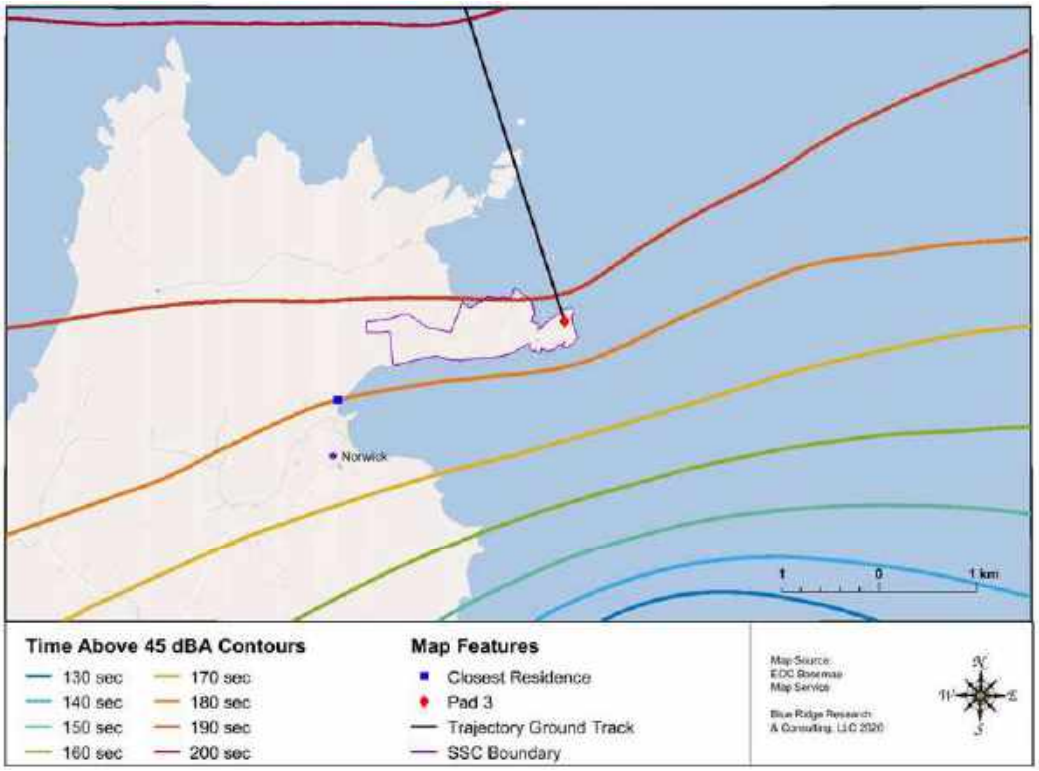


Figure 27. Time above 45 dBA contours for a SCLV launch from SSC Pad 3

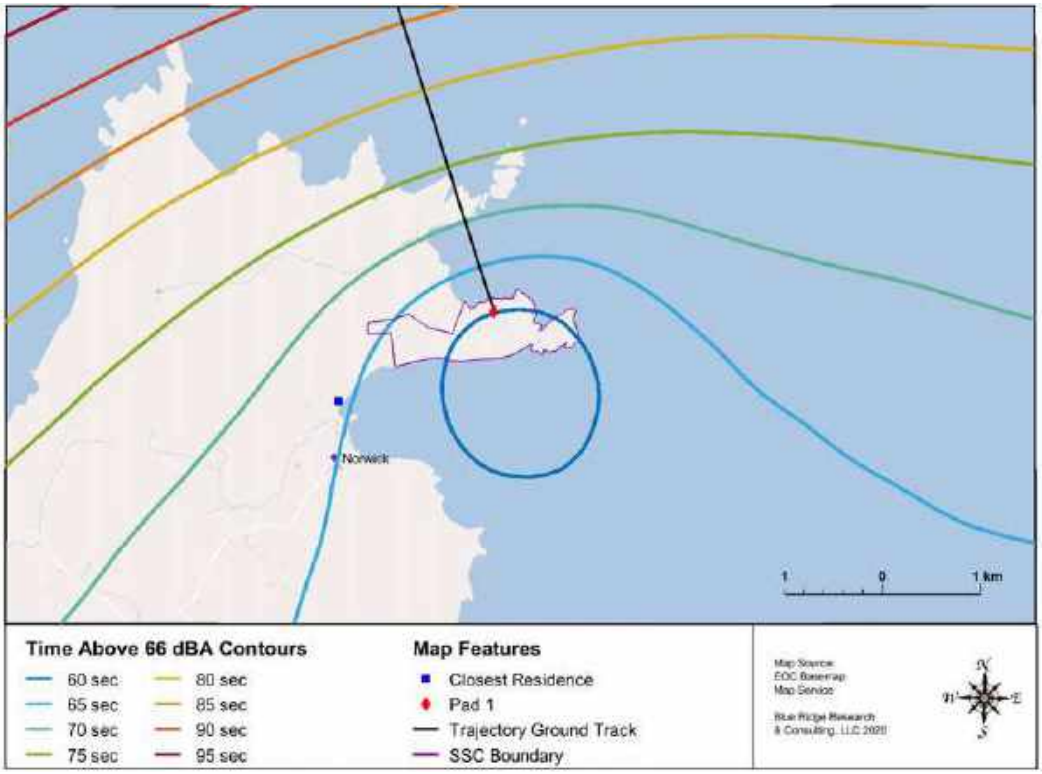


Figure 28. Time above 66 dBA contours for a SCLV launch from SSC Pad 1

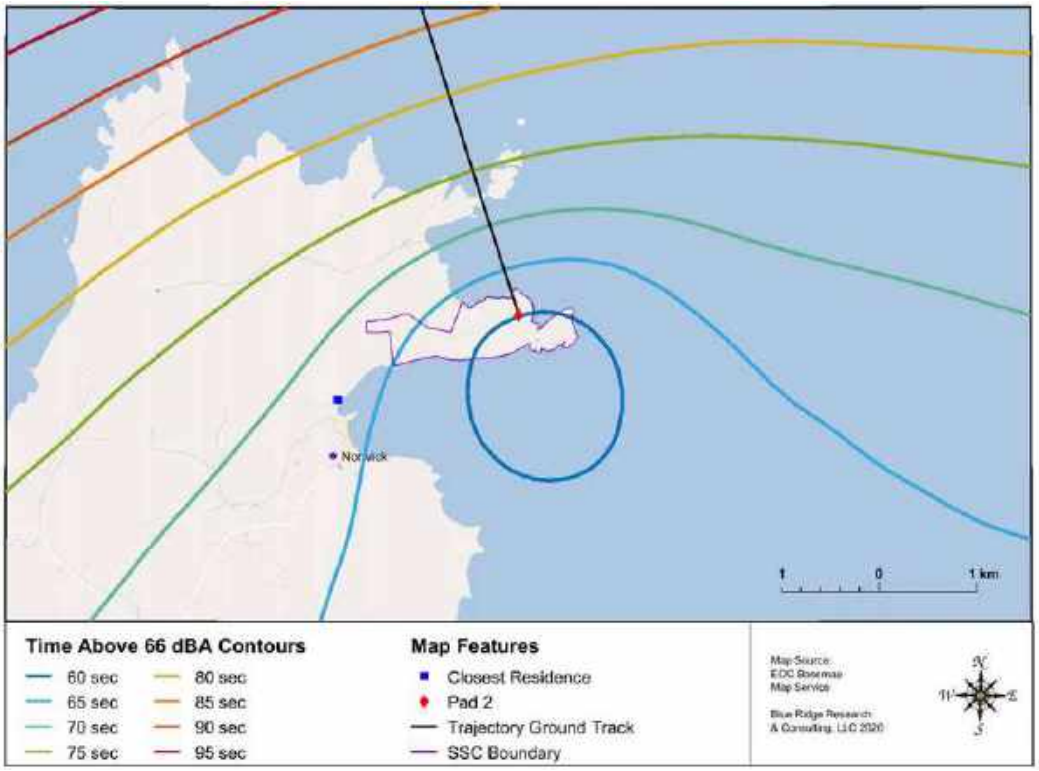


Figure 29. Time above 66 dBA contours for a SCLV launch from SSC Pad 2

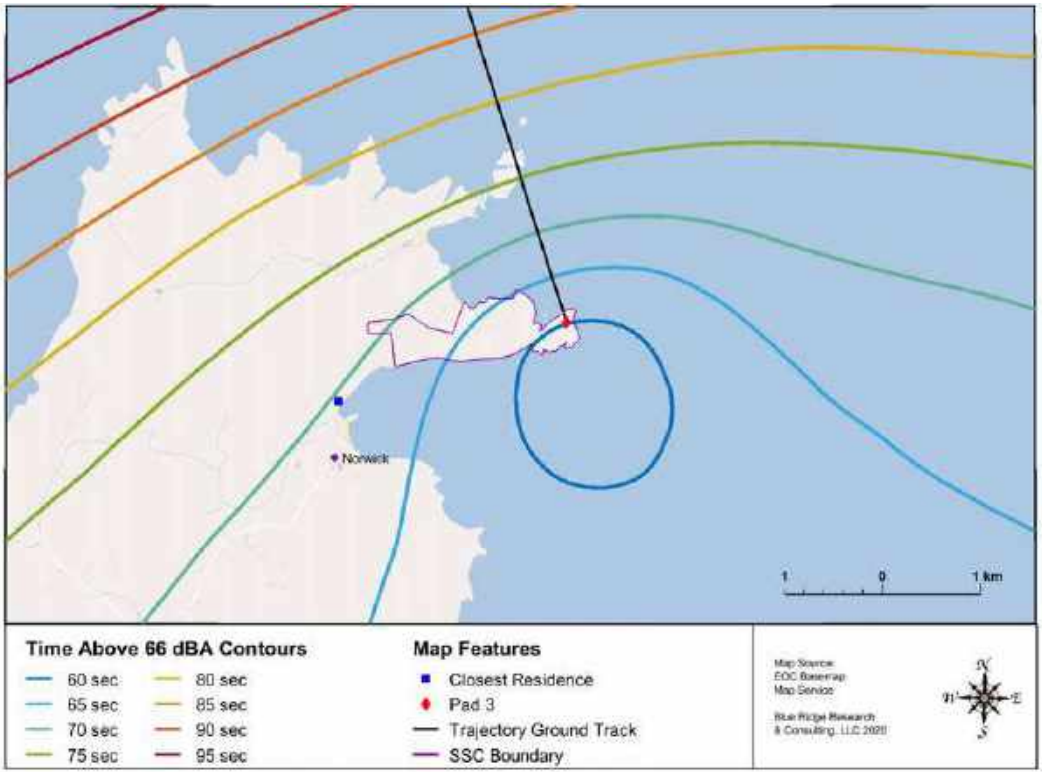


Figure 30. Time above 66 dBA contours for a SCLV launch from SSC Pad 3

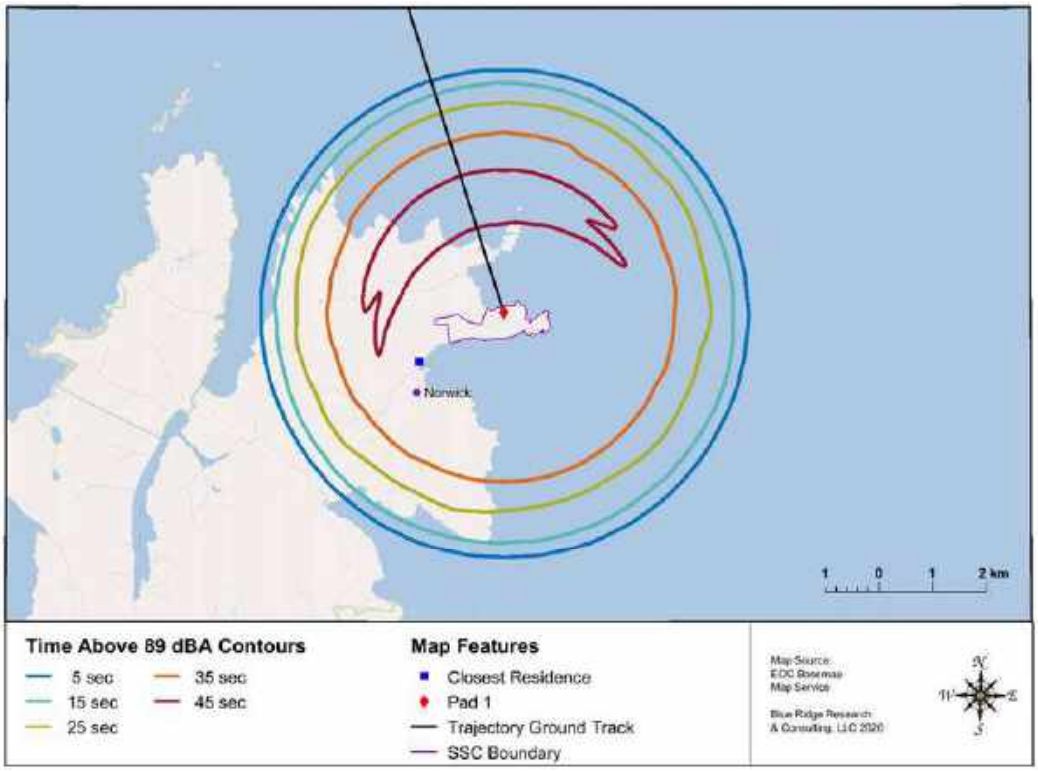


Figure 31. Time above 89 dBA contours for a SCLV launch from SSC Pad 1

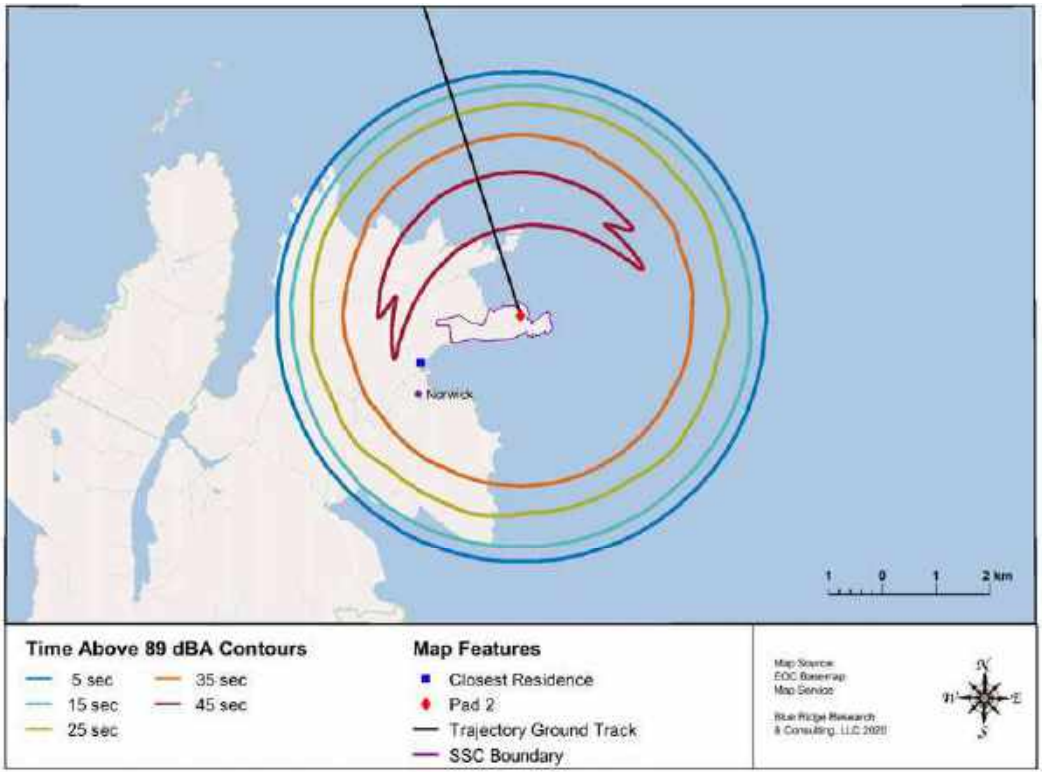


Figure 32. Time above 89 dBA contours for a SCLV launch from SSC Pad 2

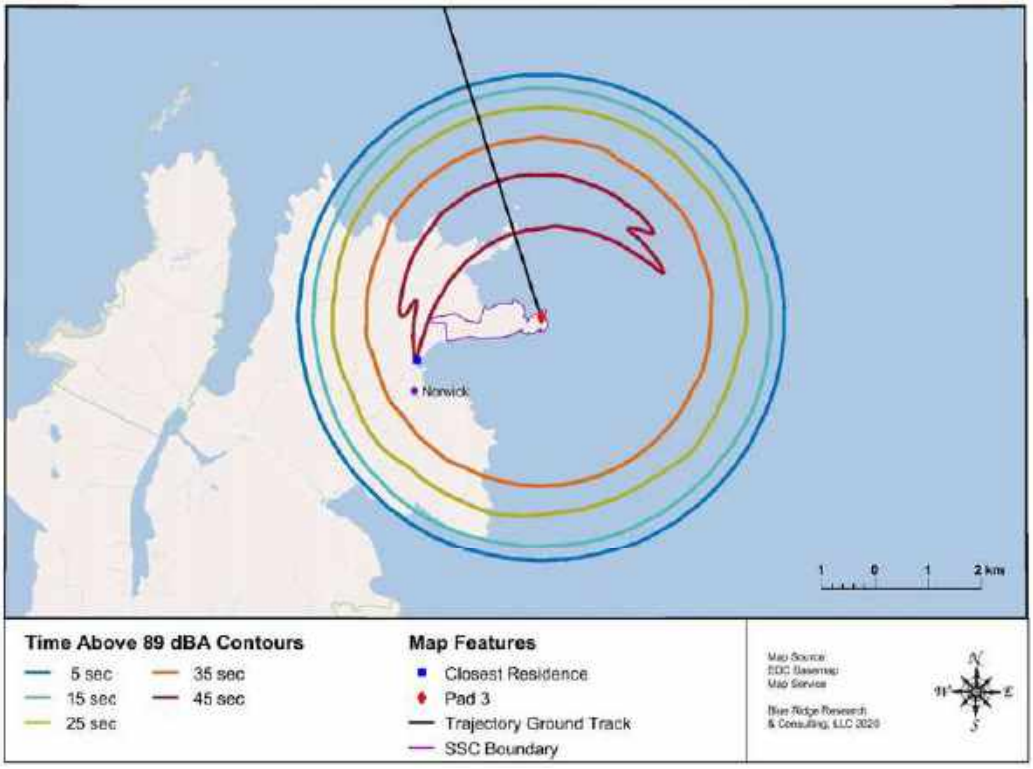


Figure 33. Time above 89 dBA contours for a SCLV launch from SSC Pad 3

5.1.4 Maximum Unweighted Sound Level (L_{max})

The modeled L_{max} contours associated with SCLV operations from SSC are presented in Figure 34 to Figure 39. For reference, the potential for structural damage claims is approximately one damage claim per 100 households exposed at 120 dB and one in 1,000 households at 111 dB [23].

Launch Operations – The 120 dB and 111 dB contours for SCLV launch events from Pad 1, Pad 2, and Pad 3 are shown in Figure 34, Figure 32, and Figure 36, respectively. The modeled 120 dB and 111 dB contours are limited to radii of 1.0 km and 2.5 km from the pad nearest the community, respectively. The closest residence and Norwick lie outside the 120 dB contour, but within the 111 dB contour.

Static Operations – The 120 dB and 111 dB contour for SCLV static events at Pad 1, Pad 2, and Pad 3 are shown in Figure 37, Figure 38, and Figure 39, respectively. For a SCLV static event, a receptor located along the peak directivity angle may experience L_{max} values of 120 dB and 111 dB at approximately 1.0 km and 2.4 km from the pad nearest the community, respectively.

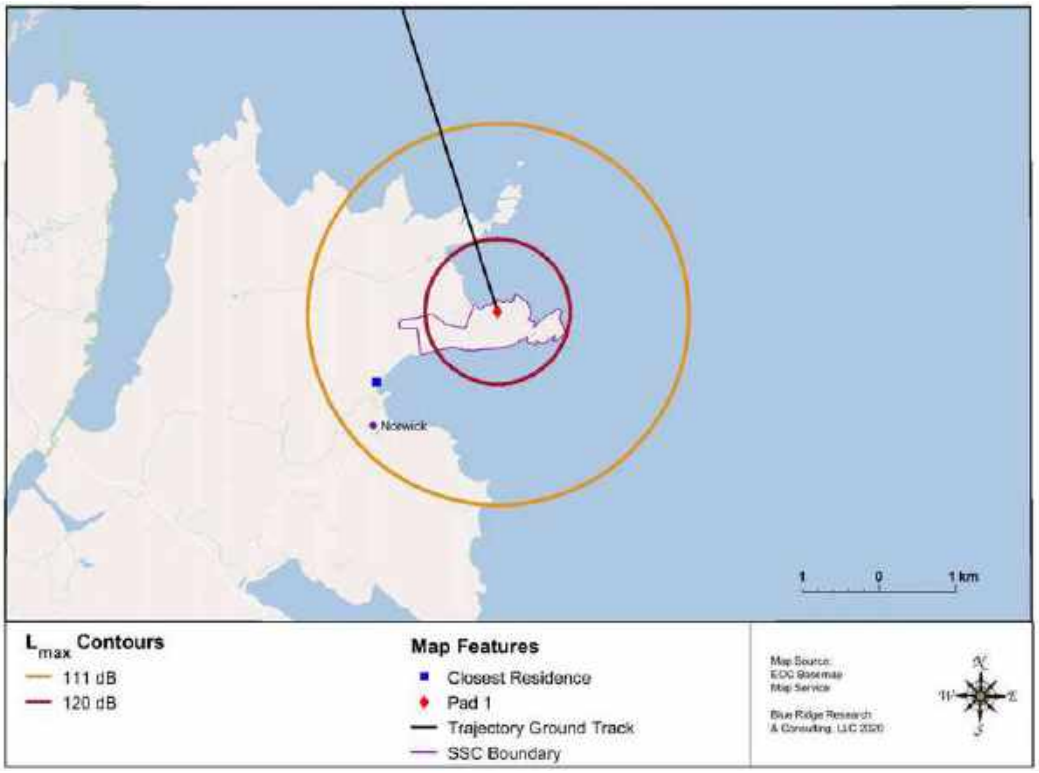


Figure 34. L_{max} contours for a SCLV launch from SSC Pad 1

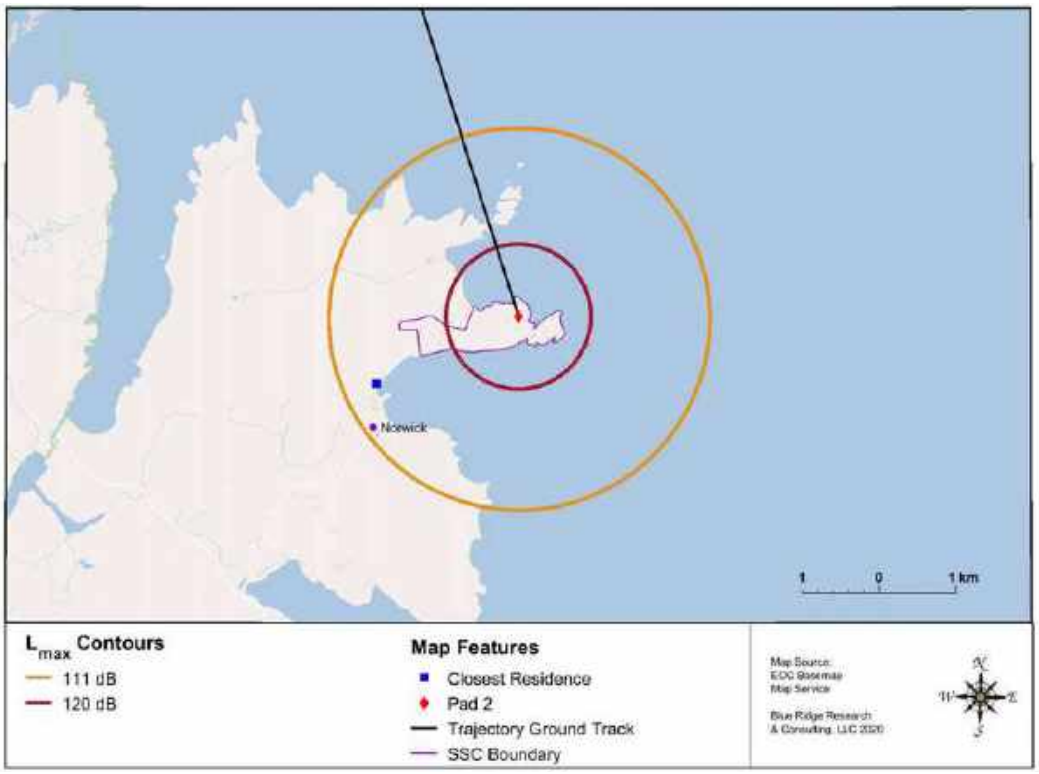


Figure 35. L_{max} contours for a SCLV launch from SSC Pad 2

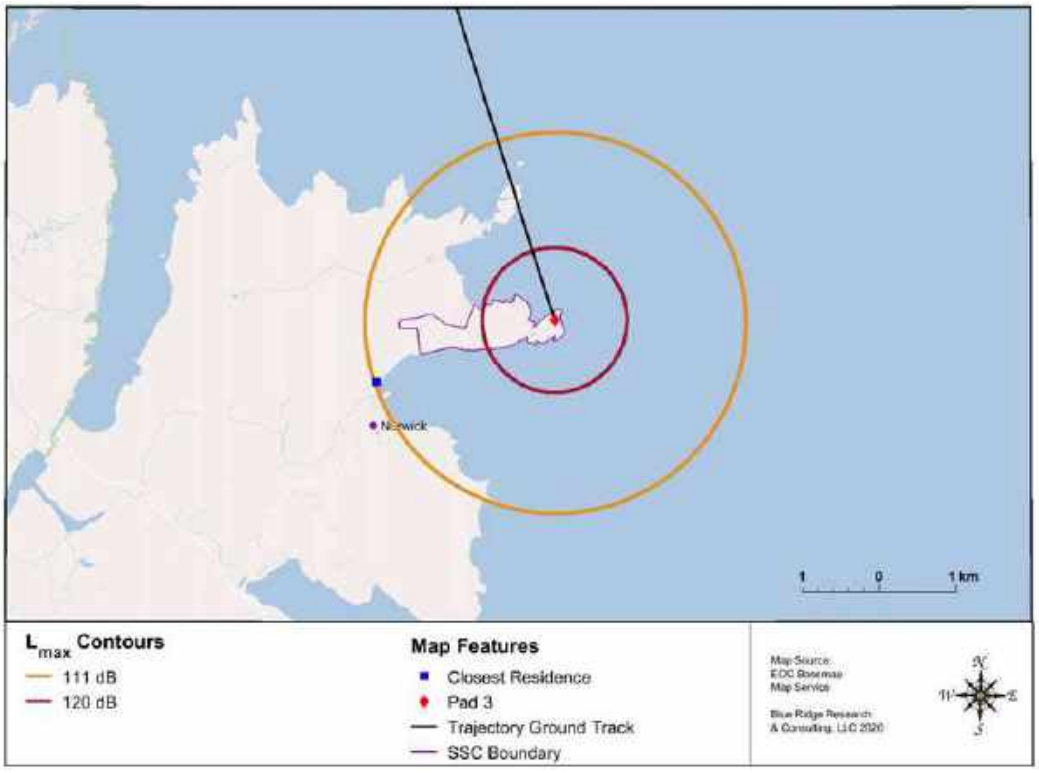


Figure 36. L_{max} contours for a SCLV launch from SSC Pad 3

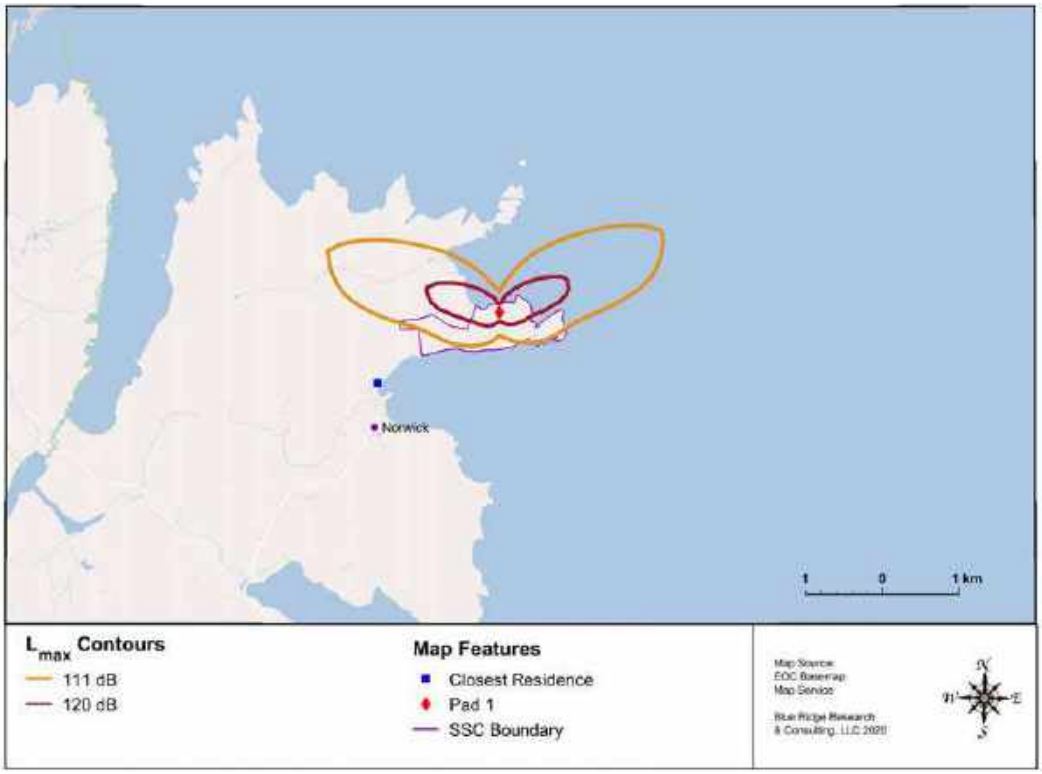


Figure 37. L_{max} contours for a SCLV static fire from SSC Pad 1

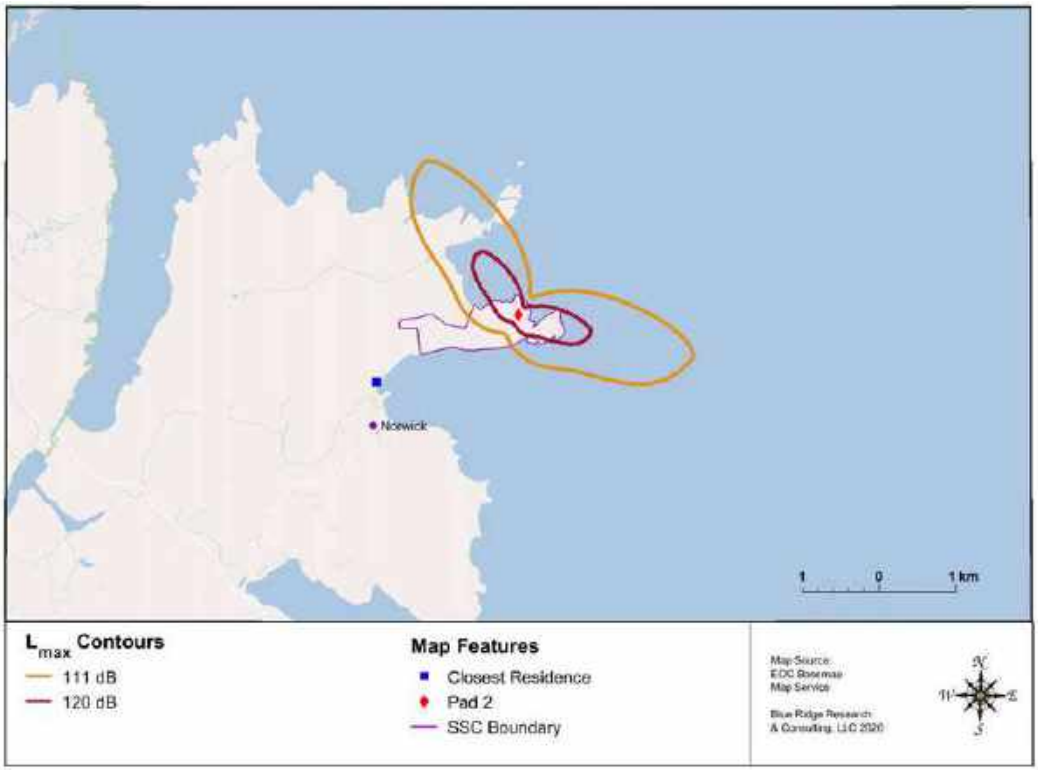


Figure 38. L_{max} contours for a SCLV static fire from SSC Pad 2

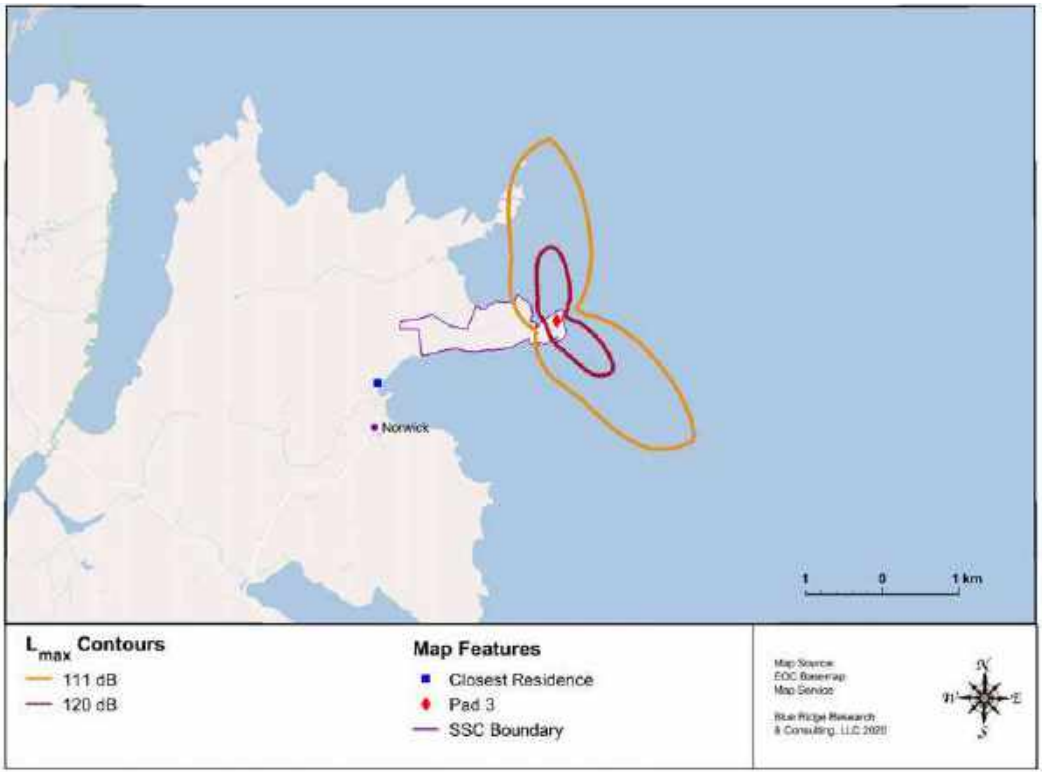


Figure 39. L_{max} contours for a SCLV static fire from SSC Pad 3

5.2 Single Event Sonic Boom Metrics and Effects

Individual launch site operations are evaluated using peak overpressure for sonic booms. To evaluate the sonic boom impacts from SSC operations, the nominal trajectory from the center launch site (Pad 2) was modeled. The resulting sonic boom footprint spans a much larger geographic area relative to the distance between adjacent pads, thus the results from Pad 1 and Pad 3 will produce similar levels with minor deviations to the precise location.

The sonic boom peak overpressure contours for the modeled SCLV launch operations are presented in Figure 40. The sonic boom footprint produced by the SCLV launch vehicle has a long, narrow, forward-facing, crescent-shaped focus boom region beginning 60 km downrange of the launch site. The focus boom region is generated because the launch vehicle continuously accelerates and pitches downward as it ascends. The maximum peak overpressure along the focus boom region is predicted to be approximately 5.4 psf. However, these high levels would only occur in extremely small areas along the focus boom region. As the rocket gains altitude, the sonic boom peak overpressure gradually decreases, and the crescent-shaped contours become slightly wider.

The sonic booms were modeled based on a single launch trajectory at a nominal azimuth of 343° relative to true north. The sonic boom peak overpressure contours for the modeled SCLV launch operation are predicted to be entirely over water. Thus, the potential for structural damage and hearing damage (with regards to humans) is not expected. The exact location of the sonic boom footprint produced by each SCLV launch operation will be highly dependent on the vehicle configuration, trajectory, and atmospheric conditions at the time of flight.

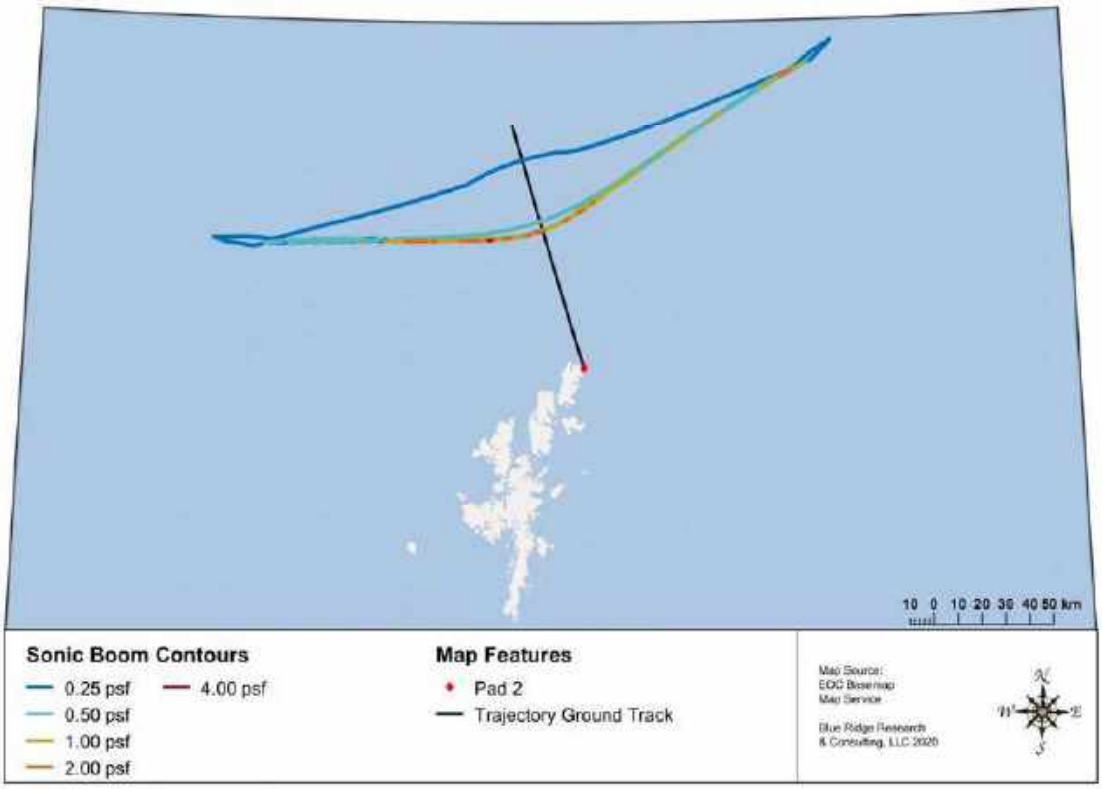


Figure 40. Sonic boom peak overpressure contours for a SCLV launch from SSC

5.3 Cumulative Noise Metrics

The potential for long-term community annoyance is assessed using A-weighted L_{den} for launch vehicle noise and C-weighted L_{den} for sonic booms.

Launch Site Operations

To assess cumulative noise impacts, a criteria of 55 dBA is used by the UK government. The L_{den} contours for all SSC launch and static operations are presented in Figure 41. The L_{den} 55 dBA contours extend approximately 3.3 km from the launch pad nearest the community. This area encompasses the closest residence, which is modeled to receive 59 dBA. Norwick is also encompassed by the 55 dBA contour.

The sonic booms resulting from the modeled launch trajectory occur entirely over the Atlantic Ocean. Therefore, with respect to human annoyance, noise impacts due to sonic booms for the launch trajectory are not expected. Thus, a quantitative L_{den} analysis was not performed.

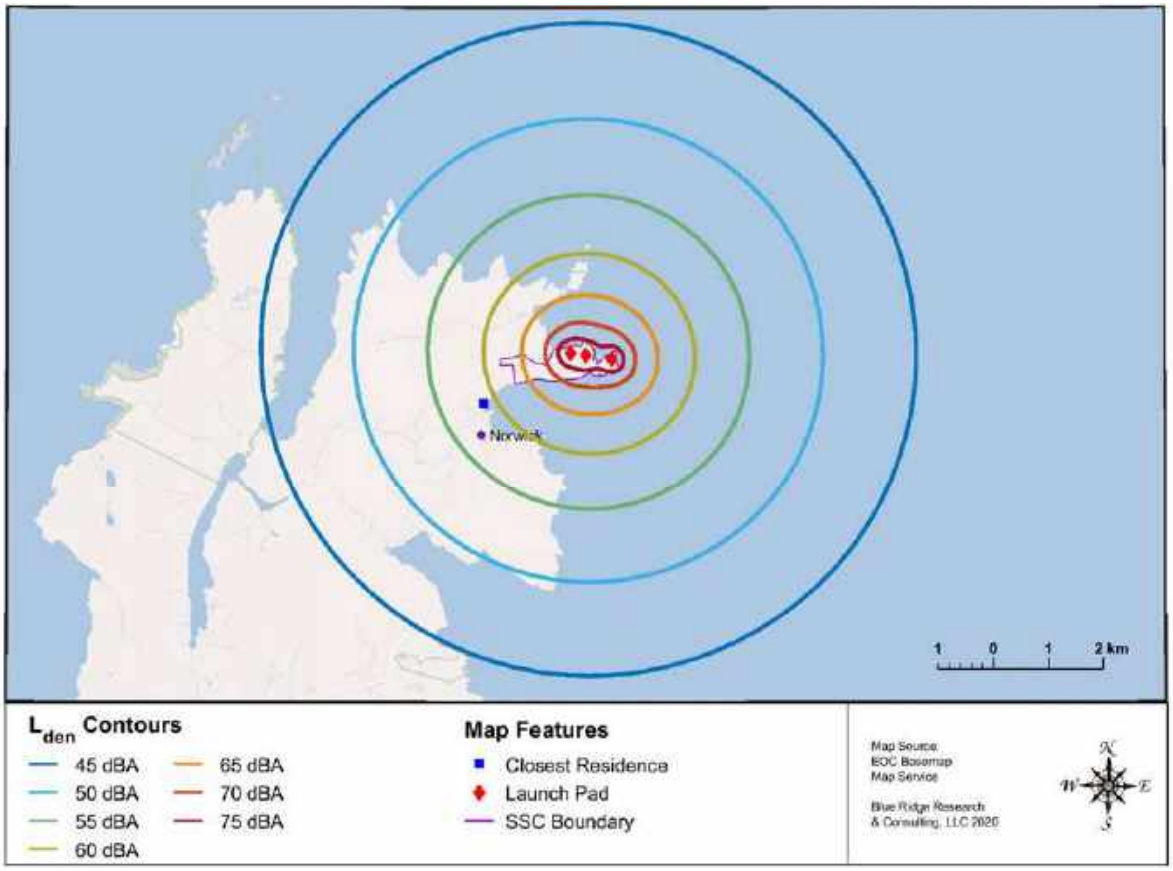


Figure 41. L_{den} contours for SCLV launch and static operations from all pads at SSC

6 Summary

This report documents the noise study performed as part of SSC's efforts on the EIA for the proposed SCLV operations. SSC plans to conduct launch and static operations of SCLV launch vehicles from three pads. The potential impacts of launch vehicle noise and sonic booms are evaluated on a cumulative basis in terms of human annoyance. In addition, potential impacts are evaluated on a single-event basis in relation to hearing conservation, sleep disturbance, speech interference, and structural damage.

Single Event Noise Results with respect to Hearing Conservation

An upper limit noise level of $L_{A,max}$ 115 dBA is used as a guideline to protect human hearing from long-term continuous daily exposures to high noise levels and to aid in the prevention of NIHL. There are no residences within the land area encompassed by the 115 dBA noise contours resulting from SCLV operations.

For impulsive noise events such as sonic booms, the potential for impacts to people in the community with regards to hearing conservation is not expected as the modeled sonic boom footprint is entirely over water.

Single Event Noise Results with respect to Sleep Disturbance

Studies have found that ASEL above 90 dBA generally leads to sleep disturbance. Northern Unst is encompassed by the 90 dBA noise contours resulting from SCLV launch operations. Thus, the potential for sleep disturbance exists for nighttime launch operations.

Single Event Noise Results with respect to Structural Damage

The potential for structural damage claims is approximately one damage claim per 100 households exposed at 120 dB and one in 1,000 households at 111 dB [23]. While there are no residences within the land area encompassed by the 120 dB noise contours resulting from SCLV operations, the closest residence and Norwick lie between the 120 dB and 111 dB contours.

For impulsive noise events such as sonic booms, noise impacts to structures are not expected as the modeled sonic boom footprint is entirely over water. Thus, the potential for structural damage is negligible.

Cumulative Noise Results

The L_{den} 55 dBA contour is used to identify the potential for significant noise impacts resulting from the propulsion noise generated by SCLV operations. The area identified within the 55 dBA contour for cumulative noise impacts includes the closest residence and Norwick.

For impulsive noise events such as sonic booms, cumulative noise impacts with respect to human annoyance are not expected as the modeled sonic boom footprint is entirely over water.

7 References

[1] US Navy, "Discussion of Noise and Its Effect on the Environment, Appendix H2," December 2016.

[2] B. Berglund and T. Lindvall, "Community Noise," Editors, Stockholm, Sweden, 1995.

[3] F. Fahy and D. Thomspon, Fundamentals of Sound and Vibration, 2nd ed., CRC Press, 2015.

[4] "F-22A Beddown Environmental Assessment," Appendix D Aircraft Noise Analysis and Airspace Operations, June 2006.

[5] ANSI S1.4A-1985, "Specification of Sound Level Meters," 1985.

[6] C. M. Harris, Handbook of Acoustical Measurements and Noise Control, 1998.

[7] US Air Force, "Supplemental Environmental Impact Statement for F-35 Beddown at Eglin Air Force Base, Florida, Draft Appendix E: Noise," September 2010.

[8] US Environmental Protection Agency (USEPA), "Protective Noise Levels," Office of Noise Abatement and Control, Washington, D.C. USEPA Report 550/9-79-100, November 1978.

[9] FAA, "Environmental Assessment for the Site, Launch, Reentry and Recovery Operations at the Kistler Launch Facility, Nevada Test Site (NTS)," April 2002.

[10] Department of the Navy, "Aircraft Noise Assessment," NAS Oceana Strike Fighter Transition: Final EA. Appendix A-53, October 2017.

[11] T. Schultz, "Synthesis of Social Surveys on Noise Annoyance," *J. Acoust. Soc. Am.,* vol. 64, no. 2, pp. 377-405, August 1978.

[12] L. Finegold, C. Harris and H. v. Gierke, "Community Annoyance and Sleep Disturbance: Updated Criteria for Assessing the Impacts of General Transportation Noise on People," *Noise Control Engineering Journal,* vol. 42, pp. 25-30, 1994.

[13] FAA, *Environmental Impacts: Policies and Procedures, Order 1050.1F,* 2015.

[14] FAA, "Order 1050.1 Desk Reference DRAFT," May 2018.

[15] Committee on Hearing, Bioacoustics, and Biomechanics (CHBB), "Assessment of community response to high-energy impulsive sounds," National Academy Press, National Research Council, Washington, D.C., 1981.

[16] European Comission, "Environmental Noise Directive 2002/49/EC," 2002.

[17] OSHA, "Federal Regulation Title 29 - Labor, Subtitle B, Capter XVII, Part 1910 - Occupational Saftey and Health Standards, Subpart G - Occupational Health and Environmental Control, 1910.95 -

Occupational noise exposure," [Online]. Available: http://www.ecfr.gov/. [Accessed December 2019].

[18] NIOSH, *Criteria for a Recommended Standard-Occupational Exposure to Noise – Revised Criteria 1998, DHHS (NIOSH) Pub. No. 98-126,* 1998.

[19] UK Statutory Instruments, "No. 1643, Regulation 4, The Control of Noise at Work Regulations," 2005.

[20] OSHA, "Federal Regulation Title 29 - Labor, Subtitle B, Capter XVII, Part 1910 - Occupational Saftey and Health Standards, Subpart G - Occupational Health and Environmental Control, 1910.95 - Occupational noise exposure," [Online]. Available: http://www.ecfr.gov/. [Accessed April 2017].

[21] J. Ollerhead and C. Jones, "Aircraft noise and sleep disturbance: a UK field study," *Proceedings Noise as a Public Health Problem,* 1993.

[22] B. a. B. Committee on Hearing, "Guidelines for Preparing Environmental Impact Statements on Noise," National Academy of Sciences, Washington DC, 1977.

[23] S. Guest and R. M. Slone Jr., *Structural Damage Claims Resulting from Acoustic Environments Developed During Static Firing of Rocket Engines,* San Antonio, Texas, April 1972.

[24] J. Haber and D. Nakaki, "Sonic Boom Damage to Conventional Structures. HSD-TR-89," 1989.

[25] L. Sutherland, *Effects of Sonic Boom on Structures, Lecture 3 of Sonic Boom: Prediction and Effects, AIAA Short Course,* 1990.

[26] R. L. Hershey and T. H. Higgins, *Statistical Model of Sonic Boom Structural Damage. FAA RD-76-87,* 1976.

[27] R. White, *Effects of Repetitive Sonic Booms on Glass Breakage,* 1972.

[28] K. M. Eldred, *NASA SP-8072: Acoustic Loads Generated By the Propulsion Systems,* NASA, 1971.

[29] M. M. James, A. R. Salton, K. L. Gee, T. B. Neilsen and S. A. McInerny, *Full-scale rocket motor acoustic tests and comparisons with empirical source models,* vol. 18, J. Acoust. Soc. Am., 2014.

[30] S. H. Guest, *NASA TN D-1999: Acoustic Efficiency Trends for High Thrust Boosters,* NASA Marshall Space Flight Center: NASA, 1964.

[31] K. Viswanathan and M. J. Czech, *Measurements and Modeling of Effect of Forward Flight on Jet Noise,* vol. 49, AIAA, 2011.

[32] S. Saxena and P. Morris, *Noise Predictions for High Subsonic Single and Dual-Stream Jets in Flight,* Colorado Springs, CO, 2012.

[33] R. Buckley and C. L. Morfey, *Flight Effects on Jet Mixing Noise: Scaling Laws Predicted for Single Jets from Flight Simulation Data,* Atlanta, GA: AIAA, 1983.

[34] R. Buckley and C. L. Morfey, *Scaling Laws for Jet Mixing Noise in Simulated Flight and the Prediction Scheme Associated,* Williamsburg, VA: AIAA, 1984.

[35] J. Haynes and J. R. Kenny, *Modifications to the NASA SP-8072 Distributed Source Method II,* Miami, Florida: AIAA, 2009.

[36] M. M. James, A. R. Salton, K. L. Gee, T. B. Neilsen, S. A. McInerny and R. J. Kenny, *Modification of directivity curves for a rocket noise model,* vol. 18, J. Acoust. Soc. Am., 2014.

[37] NASA, "Terrestrial Envrionment (Climatic) Criteria Gudelines for use in Aerospace Vehicle Devlopment," NASA TM-4511, 1993.

[38] Handbook of Astronautical Engineering, McGraw-Hill, 1961.

[39] NOAA, NASA, USAF, "U.S. Standard Atmosphere, 1976," U.S. Government Priting Office, Washington, D.C..

[40] National Climatic Data Center, "Global gridded upper air statistics, 1980-1995," National Climatic Data Center, Asheville, NC, 1996.

[41] S. A. McInerny, K. L. Gee, J. M. Downing and M. M. James, *Acoustical Nonlinearities in Aircraft Flyover Data,* Rome, Italy: AIAA, 2007.

[42] S. A. McInerny and S. M. Ölçmen, *High-Intensity Rocket Noise: Nonlinear Propagation, Atmospheric Absorption, and Characterization,* vol. 117, J. Acoust. Soc. Am., 2005, pp. 578-591.

[43] D. F. Pernet and R. C. Payne, *Non-linear propagation of signals in airs,* vol. 17, Journal of Sound and Vibration, 1971, pp. 383-396.

[44] K. L. Gee, V. W. Sparrow, A. A. Atchley and T. B. Gabrielson, *On the Perception of Crackle in High Amplitude Jet Noise,* vol. 45, AIAA, 2007, pp. 593-598.

[45] J. E. Ffowcs, J. Simson and V. J. Virchis, *Crackle: an annoying component of jet noise,* vol. 71, Journal of Fluid Mechanics, 1975, pp. 251-271.

[46] K. L. Gee, V. W. Sparrow, M. M. James, J. M. Downing, C. M. Hobbs, T. B. Gabrielson and A. A. Atchley, *The role of nonlinear effects in the propagation of noise from high-power jet aircraft,* vol. 123, J. Acoust. Soc. Am., 2008, pp. 4082-4093.

[47] K. L. Gee, V. W. Sparrow, M. M. James, J. M. Downing, C. M. Hobbs, T. B. Gabrielson and A. A. Atchley, *Measurement and Prediction of Noise Propagation from a High-Power Jet Aircraft,* Cambridge, Massachusetts: AIAA, 2006.

[48] C. Chessel, *Propagation of noise along a finite impedance boundary,* vol. 62, J. Acoust. Soc. Am., 1977, pp. 825-834.

[49] T. Embleton, J. Piercy and G. Daigie, *Effective flow resistivity of ground surfaces determined by acoustical measurements,* vol. 74, J. Acoust. Soc. Am., 1983, pp. 1239-1244.

[50] G. A. Daigle, *Effects of atmospheric turbulence on the interference sound waves above a finite impedance boundary,* vol. 65, J. Acoust. Soc. Am., 1979.

[51] H. W. Carlson, *NASA SP-147: Experimental and Analytical Research on Sonic Boom Generation at NASA,* NASA Langley Research Center: NASA, 1967, p. 10.

[52] K. J. Plotkin and L. C. Sutherland, *Sonic Boom: Prediction and Effects,* Tallahassee, FL, Florida: AIAA, 1990, pp. 1-7.

[53] K. A. Bradley, C. Wilmer and V. S. Miguel, "PCBoom: Sonic Boom Model for Space Operations, Version 4.99 User Guide," Wyle Laboratories, Inc., Arlington, VA, 2018.

[54] K. Plotkin, "Review of Sonic Boom Theory," *AIAA,* pp. 89-1105, 1989.

[55] J. A. Page, K. J. Plotkin and C. Wilmer, "PCBoom Version 6.6 Technical Reference and User Manual," December 2010.

[56] K. J. Plotkin and F. Grandi, "Computer Models for Sonic Boom Analysis: PCBoom4, CABoom, BooMap, CORBoom, Wyle Research Report WR 02-11," 2002.

[57] N. C. D. Center, "Global gridded upper air statistics, 1980-1995," National Climatic Data Center, Asheville, 1996.

[58] J. Panda, R. N. Mosher and B. J. Porter, *Identification of noise sources during rocket engine test firings and a rocket launch using a microphone phased-array, TM 216625,* NASA, 2013.

[59] NASA, "Kennedy NASA Procedural Requirements," 2013.

[60] H. W. Carlson, "NASA Technical Paper 1122: Simplified Sonic-Boom Prediction," NASA, 1978.

Appendix 8.2 Summary of Legislation and Guidance

PAN1/2011

PAN1/2011 (Scottish Government, 2011), sets out a series of noise issues for planning authorities to consider when making decisions on planning applications. A Technical Advice Note (TAN) on Assessment of Noise (Scottish Government, 2011) has been published to accompany PAN 1/2011. In Appendix 1 of the TAN are codes of practice for the assessment of various sources of noise. It also identifies British Standard BS 5228 for guidance on construction site noise control, and as a method of prediction of noise from construction sites.

The TAN recommends that the daytime period includes the hours 07:00 – 23:00 and the night-time period 23:00 – 07:00.

The TAN suggests that equivalent continuous noise level over a time period, T ($L_{Aeq,T}$), is a good general purpose index for environmental noise; this index is commonly referred to as the "ambient" noise level. It further notes that road traffic noise is commonly evaluated using the $L_{A10,18hr}$ level, and the $L_{A90,T}$ index is used to describe the "background" noise level.

Table 2.4 of the TAN (reproduced here as Table 1) provides an example method for determining the magnitude of noise impacts at proposed noise sensitive developments.

Table 1 - PAN1/2011 TAN Example of associating changes in noise levels with magnitudes of impacts for a new road in a residential area

(existing – target) Noise level, x dB $L_{A10,18hr}$ (07:00 – 23:00)	Magnitude of impact
x = 5	Major adverse
3 = x < 5	Moderate adverse
1 = x < 3	Minor adverse
0 < x < 1	Negligible adverse
x = 0	No change

Table 2.6 of the TAN (reproduced here as Table 2) provides a matrix for determining the level of impact significance dependent on the sensitivity of the receptor.

Table 2 - PAN1/2011 TAN Significance of effects

Magnitude of impact	Level of significance relative to sensitivity of receptor		
	Low	Medium	High
Major	Slight/Moderate	Moderate/Large	Large/Very Large
Moderate	Slight	Moderate	Moderate/Large
Minor	Neutral/Slight	Slight	Slight/Moderate
Negligible	Neutral/Slight	Neutral/Slight	Slight
No change	Neutral	Neutral	Neutral

Table 2.1 of the TAN (reproduced below as Table 3) provides the criteria to define levels of sensitivity for each type of NSR.

Table 3 - PAN1/2011 TAN Level of Noise Sensitivity for Different Types of NSR

Sensitivity	Description	Example of NSR
High	Receptors where people or operations are particularly susceptible to noise	• Residential, including private gardens where appropriate • Quiet outdoor areas used for recreation • Conference facilities • Theatres/Auditoria/Studios • Schools during the daytime • Hospitals/residential care homes • Places of worship
Medium	Receptors moderately sensitive to noise, where it may cause some distraction or disturbance	• Offices • Bars/Cafes/Restaurants where external noise may be intrusive • Sports grounds when spectator noise is not a normal partof the event and where quiet conditions are necessary (e.g. tennis, golf, bowls)
Low	Receptors where distraction or disturbance from noise is minimal	• Buildings not occupied during working hours • Factories and working environments with existing high noise levels • Sports grounds when spectator noise is a normal part for the event • Night clubs

BS4142:2014+A1:2019 - Methods for Rating and Assessing Industrial and Commercial Sound

BS 4142 (BSI, 2014) describes methods for rating and assessing sound[1] from industrial or commercial premises. The methods detailed in BS4142 use outdoor sound levels to assess the likely effects on people inside or outside a residential dwelling upon which sound is incident.

The Standard provides methods for determining the following:

- Rating levels for sources of industrial and commercial sound; and
- Ambient, background and residual sound levels.

These may be used for assessing sound from proposed, new, modified or additional sources of sound of a commercial or industrial nature.

The Standard makes use of the following terms:

- **Ambient sound level, $L_a = L_{Aeq,T}$** – the equivalent continuous sound pressure level of the totally encompassing sound in a given situation at a given time, usually from multiple sources, at the assessment location over a given time interval, T;
- **Background sound level, $L_{A90,T}$** – the A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90 percent of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels;
- **Specific sound level, $L_s = L_{Aeq,T}$** – the equivalent continuous sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, T;
- **Rating level, $L_{Ar,Tr}$** – the specific sound level plus any adjustment for the characteristic features of the sound; and
- **Residual sound level, $L_{r = LAeq,T}$** – the equivalent continuous sound pressure level at the assessment location when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound, over a given reference time interval, T.

The Standard determines the degree of noise impact by comparison of the background noise level at noise sensitive receptors (NSR) in the absence of the industrial facility (the specific source) with the ambient sound level when the specific source is operational.

Where particular characteristics, such as tonality, intermittency or impulsivity are present in the noise emissions of the specific source, the Standard requires that "penalties" be added to the specific sound level to derive the rating level, to account for the increased annoyance that these can cause. Where no such characteristics are present, or where they are inaudible at the receptor locations then no penalties apply and the rating level is the same as the specific level.

The following impact significance identifiers are provided in the Standard, in which the difference between the specific sound level and measured background level are considered:

- The greater the difference, the greater the magnitude of impact;
- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact;

[1] The Standard refers to sound levels, rather than noise levels, however, these terms can be used interchangeably, as noise is defined as "unwanted sound". This assessment uses the term "noise".

- A difference of around +5 dB is likely to be an indication of an adverse impact;
- The lower the rating level, relative to the measured background level, the less likely that the specific sound source will have an adverse (or significant adverse) impact; and
- Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact.

Appendix 8.3 Baseline Survey Records



NOISE DATA PROCESSING

Template Version Tracker

Version	Date	Changes	Updated by	Approved By
1	12/08/2019	Template Setup	Jonas B	Simon W

Project Information

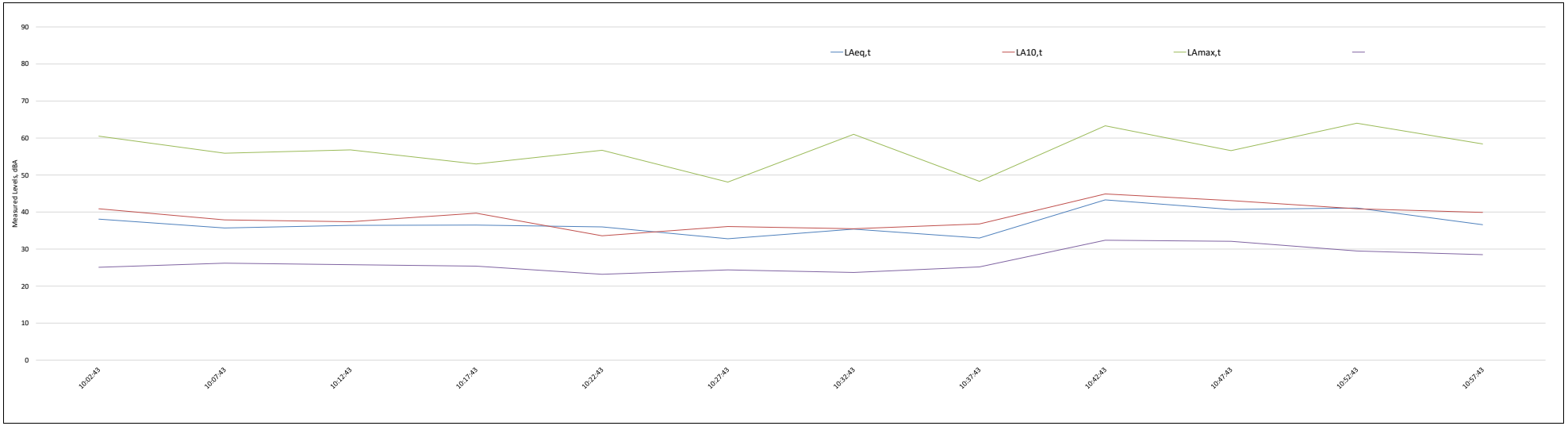
Client
ITPE Project Code
Project Name
Date
File Locations

Version	Date	Notes	Prepared by	Approved By

NMP1 - Unst Airport - Day



NMP Description	Open fields on access track to Unst airfield. Scattered dwellings along road to north, with Balta Sound inlet to the north
Weather Conditions	Dry, 15°C, overcast, low - moderate wind speed (<5 m/s)
Coordinates	HP624478,08115
File #	
Main Noise Sources	Bird calls, bleating sheep
Secondary Noise Sources	Very infrequent vehicle movements on loacl roads (8 movements during measurement), children playing at nearby house
Sound Level Meter Settings	5min averaging period, A-wt, Fast averaging.



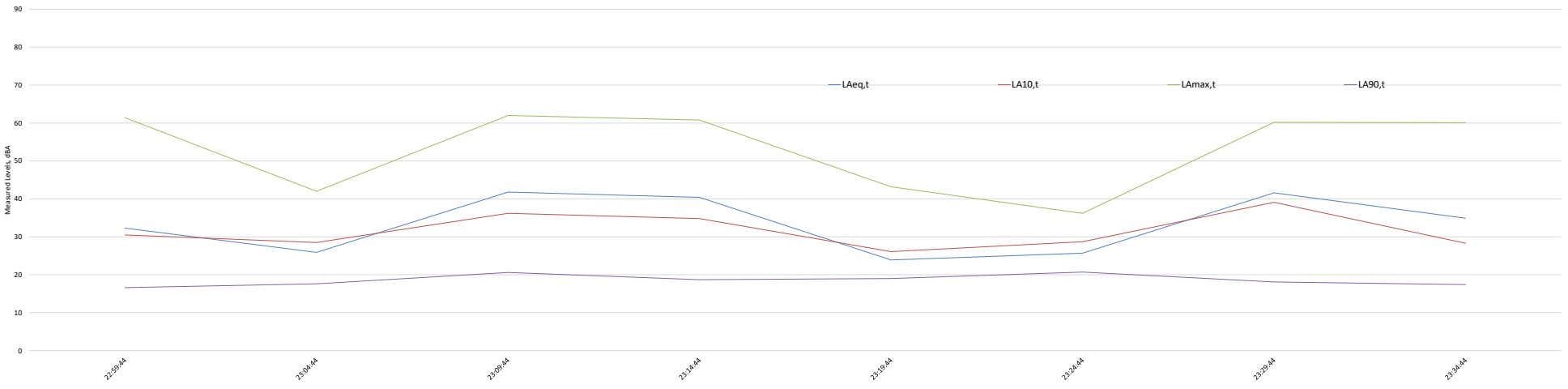
Date	Start Time	Measurement Time	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$	Notes
19/07/2018	10:02:43	00d 00:05:00.0	38.1	60.5	40.9	25.1	
19/07/2018	10:07:43	00d 00:05:00.0	35.7	55.9	37.9	26.2	
19/07/2018	10:12:43	00d 00:05:00.0	36.4	56.8	37.4	25.8	
19/07/2018	10:17:43	00d 00:05:00.0	36.5	53.0	39.7	25.4	
19/07/2018	10:22:43	00d 00:05:00.0	36.0	56.7	33.6	23.2	
19/07/2018	10:27:43	00d 00:05:00.0	32.8	48.1	36.1	24.4	
19/07/2018	10:32:43	00d 00:05:00.0	35.4	61.0	35.5	23.7	
19/07/2018	10:37:43	00d 00:05:00.0	33.0	48.3	36.8	25.2	
19/07/2018	10:42:43	00d 00:05:00.0	43.3	63.3	44.9	32.4	
19/07/2018	10:47:43	00d 00:05:00.0	40.7	56.6	43.1	32.1	
19/07/2018	10:52:43	00d 00:05:00.0	41.1	64.0	40.9	29.5	
19/07/2018	10:57:43	00d 00:05:00.0	36.6	58.4	39.9	28.5	

Period	Time (T)	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$
Mean	1 hr	38.2	56.9	38.9	26.8
Mode	1 hr	#N/A	#N/A	40.9	#N/A
Min	1 hr	32.8	48.1	33.6	23.2
Max	1 hr	43.3	64.0	44.9	32.4

NMP1 - Unst Airport - Night



NMP Description	Open fields on access track to Unst airfield. Scattered dwellings along road to north, with Balta Sound inlet to the north
Weather Conditions	Still - no wind. 15C, 60% cloud cover, dry.
Coordinates	HP 65083,15077
File #	
Main Noise Sources	Bird calls.
Secondary Noise Sources	Infrequent vehicles passing by on the nearby road.
Sound Level Meter Settings	5min averaging period, A-wt, Fast averaging.



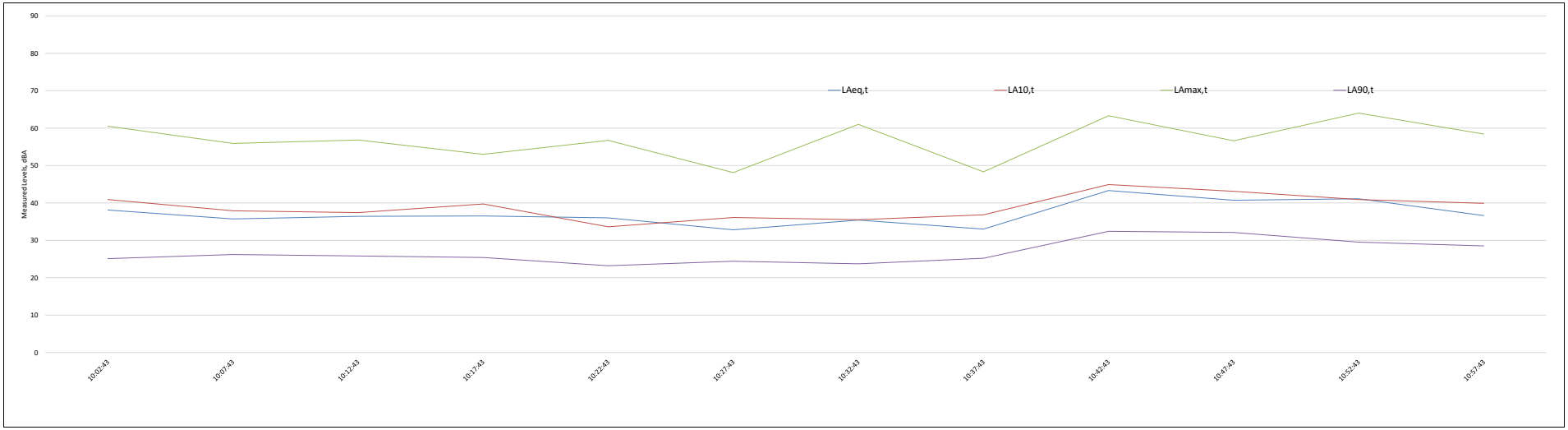
Date	Start Time	Measurement Time	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$	Notes
19/07/2018	22:59:44	00d 00:05:00.0	32.3	61.4	30.5	16.6	
19/07/2018	23:04:44	00d 00:05:00.0	25.9	42.0	28.5	17.6	
19/07/2018	23:09:44	00d 00:05:00.0	41.8	62.0	36.2	20.6	
19/07/2018	23:14:44	00d 00:05:00.0	40.4	60.8	34.8	18.7	
19/07/2018	23:19:44	00d 00:05:00.0	23.9	43.2	26.1	19.0	
19/07/2018	23:24:44	00d 00:05:00.0	25.7	36.2	28.7	20.7	
19/07/2018	23:29:44	00d 00:05:00.0	41.6	60.2	39.1	18.1	
19/07/2018	23:34:44	00d 00:01:51.5	34.9	60.1	28.3	17.4	

Period	Time (T)	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$
Mean	35 min	37.6	53.2	31.5	18.6
Mode	35 min	#N/A	#N/A	#N/A	#N/A
Min	35 min	23.9	36.2	26.1	16.6
Max	35 min	41.8	62.0	39.1	20.7

NMP2 - North Dale - Day



NMP Description	Open field near access track leading to Saxa Vord radar station.
Weather Conditions	Dry, 15°C, overcast, low - moderate wind speed (<5 m/s)
Coordinates	HP62478,08115
File #	
Main Noise Sources	Bird calls, sheep bleating, rustling of grasses in the wind.
Secondary Noise Sources	Very infrequent road traffic. Very distant/almost inaudible low hum.
Sound Level Meter Settings	5min averaging period, A-wt, Fast averaging.



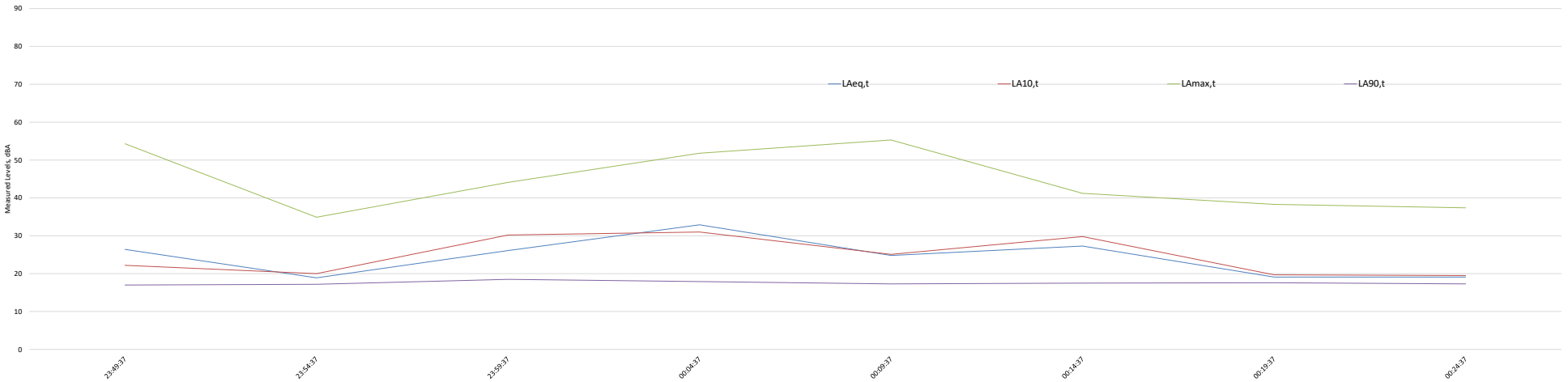
Date	Start Time	Measurement Time	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$	Notes
19/07/2018	11:29:47	00d 00:05:00.0	38.4	55.2	40.5	30.9	
19/07/2018	11:34:47	00d 00:05:00.0	37.1	55.5	39.5	30.9	
19/07/2018	11:39:47	00d 00:05:00.0	37.4	52.4	40.2	31.2	
19/07/2018	11:44:47	00d 00:05:00.0	39.5	54.7	42.3	31.9	
19/07/2018	11:49:47	00d 00:05:00.0	37.7	54.0	40.1	33.0	
19/07/2018	11:54:47	00d 00:05:00.0	37.7	51.1	40.5	31.4	
19/07/2018	11:59:47	00d 00:05:00.0	36.4	53.1	39.2	31.5	
19/07/2018	12:04:47	00d 00:05:00.0	36.6	51.4	39.5	31.5	
19/07/2018	12:09:47	00d 00:05:00.0	37.2	53.9	39.6	31.6	
19/07/2018	12:14:47	00d 00:05:00.0	38.2	53.4	40.6	33.3	
19/07/2018	12:19:47	00d 00:05:00.0	40.8	56.6	41.9	34.0	
19/07/2018	12:24:47	00d 00:05:00.0	41.7	59.7	43.4	33.2	
19/07/2018	12:29:47	00d 00:05:00.0	38.2	53.0	41.4	31.9	
19/07/2018	12:34:47	00d 00:05:00.0	39.0	50.1	41.7	34.1	
19/07/2018	12:39:47	00d 00:05:00.0	39.2	49.0	42.4	34.2	
19/07/2018	12:44:47	00d 00:05:00.0	44.6	62.8	46.1	35.1	
19/07/2018	12:49:47	00d 00:05:00.0	40.0	50.9	43.0	34.5	
19/07/2018	12:54:47	00d 00:05:00.0	41.2	53.7	44.4	35.3	
19/07/2018	12:59:47	00d 00:00:00.5	40.2	43.9	43.7	36.8	

Period	Time (T)	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$
Mean	1.5hr	39.5	53.4	41.6	33.0
Mode	1.5hr	37.7	#N/A	40.5	30.9
Min	1.5hr	36.4	43.9	39.2	30.9
Max	1.5hr	44.6	62.8	46.1	36.8

NMP2 - North Dale - Night



NMP Description	Open field near access track leading to Saxa Vord radar station.
Weather Conditions	Dry, no wind, 15C, 75% cloud cover
Coordinates	HP62478,08115
File #	
Main Noise Sources	Barely audible running water in nearby small watercourse.
Secondary Noise Sources	
Sound Level Meter Settings	



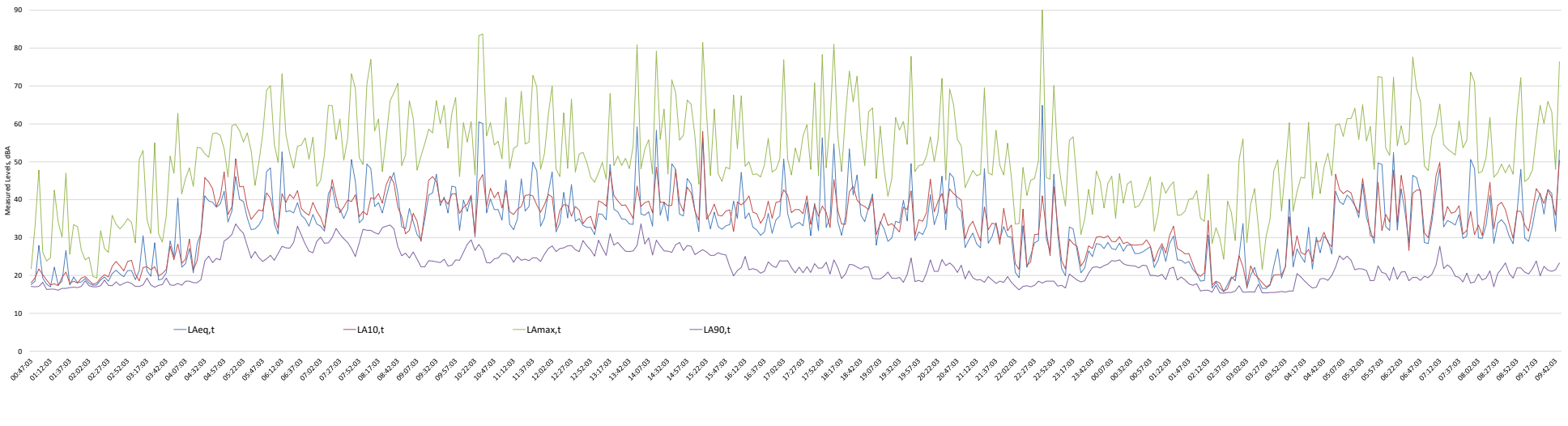
Date	Start Time	Measurement Time	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$	Notes
19/07/2018	23:49:37	00d 00:05:00.0	26.4	54.3	22.2	17.0	
19/07/2018	23:54:37	00d 00:05:00.0	18.9	34.9	20.0	17.2	
19/07/2018	23:59:37	00d 00:05:00.0	26.1	44.1	30.2	18.5	
20/07/2018	00:04:37	00d 00:05:00.0	32.9	51.8	31.0	17.9	
20/07/2018	00:09:37	00d 00:05:00.0	24.8	55.3	25.1	17.3	
20/07/2018	00:14:37	00d 00:05:00.0	27.3	41.2	29.8	17.5	
20/07/2018	00:19:37	00d 00:05:00.0	19.1	38.3	19.7	17.6	
20/07/2018	00:24:37	00d 00:05:00.0	19.1	37.4	19.5	17.3	

Period	Time (T)	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$
Mean	40 min	27.1	44.7	24.7	17.5
Mode	40 min	19.1	#N/A	#N/A	17.3
Min	40 min	18.9	34.9	19.5	17.0
Max	40 min	32.9	55.3	31.0	18.5

NMP3 - Saxa Vord - long term



NMP Description	Grounds of Saxa Vord hostel
Weather Conditions	Dry, no wind, 15C, 75% cloud cover
Coordinates	
File #	
Main Noise Sources	Wind and birdsong
Secondary Noise Sources	Infrequent traffic movements. People moving around the grounds.
Sound Level Meter Settings	



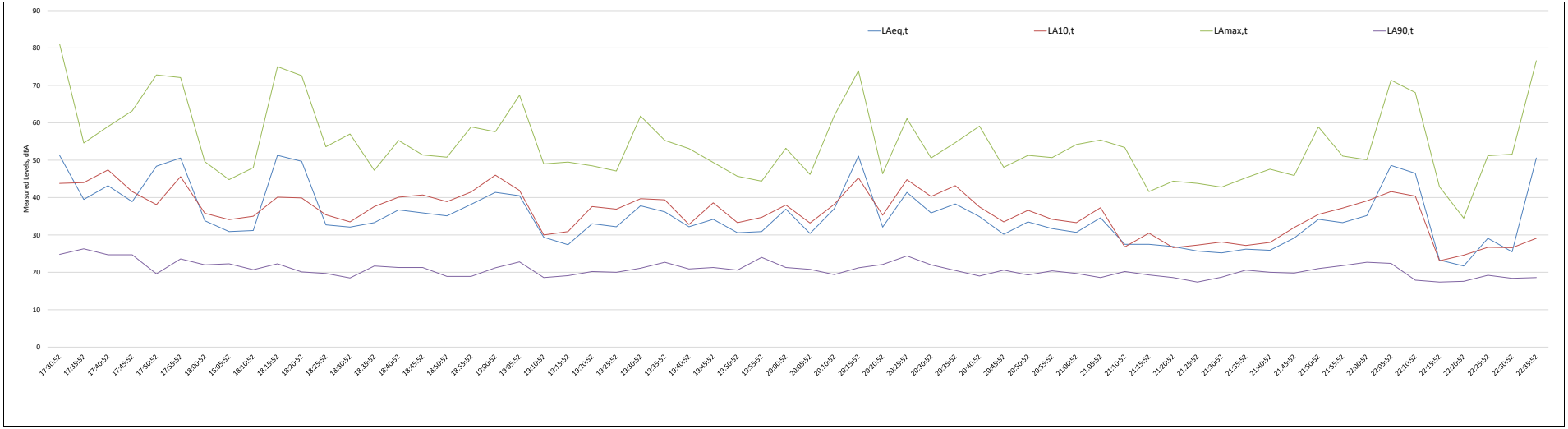
Period	Time (T)	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$
Mean	30 hr	44.8	51.4	33.8	22.2
Mode	30 hr	36.5	45.6	39.3	17.4
Min	30 hr	15.7	19.3	15.8	15.3
Max	30 hr	64.9	92.2	58.0	33.6

NMP3 - Saxa Vord - Day



MAP Location (Google Earth Screenshot)

NMP Description	Open field near access track leading to Saxa Vord radar station.
Weather Conditions	Dry, with light to moderate wind (5 m/s), 15°C, 70% RH
Coordinates	HP 64404,13441
File #	
Main Noise Sources	Bird calls. Infrequent vehicles passing by on the nearby road.
Secondary Noise Sources	Distant sheep bleating
Sound Level Meter Settings	5min averaging period, A-wt, Fast averaging.



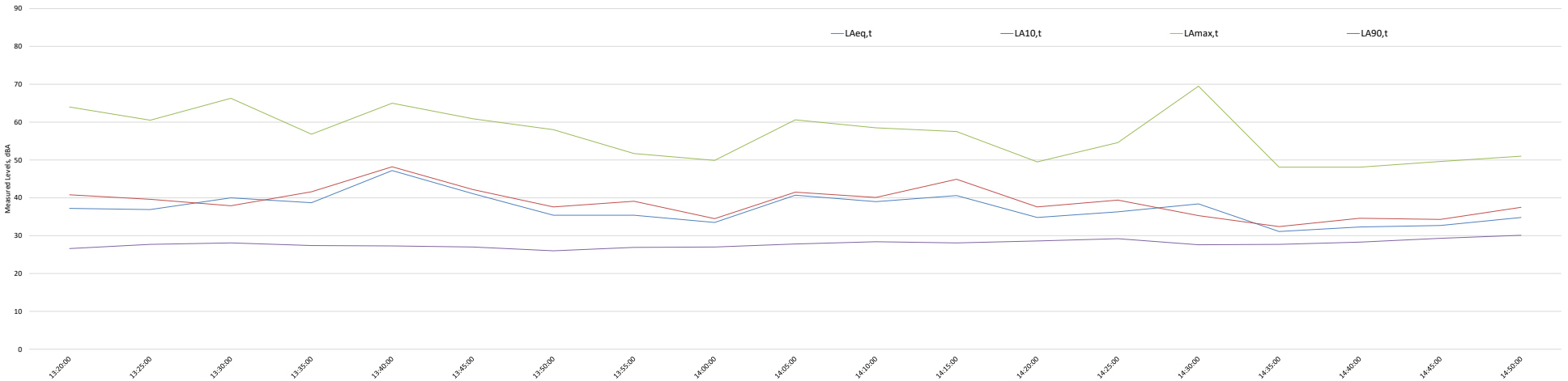
Period	Time (T)	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$
Mean	5 hr	42.4	54.6	36.1	20.7
Mode	5 hr	51.3	55.3	41.6	21.3
Min	5 hr	21.7	34.5	23.1	17.4
Max	5 hr	51.3	81.1	47.4	26.3

NMP5 Skaw - Day



MAP Location (Google Earth Screenshot)

NMP Description	
Weather Conditions	Moderate wind (5 m/s), 15°C, 70% RH, with wind increasingly gusty. Measurement abandoned due to onset of rain and increased wind speed.
Coordinates	HP 65083,15077
File #	
Main Noise Sources	Bird calls, running water in nearby small burn.
Secondary Noise Sources	Ocasional bangs from closing of gate in fence. Vehicle engines from nearby car park and farmer's quadbike. Pickup towing very rattly trailer
Sound Level Meter Settings	5min averaging period, A-wt, Fast averaging.



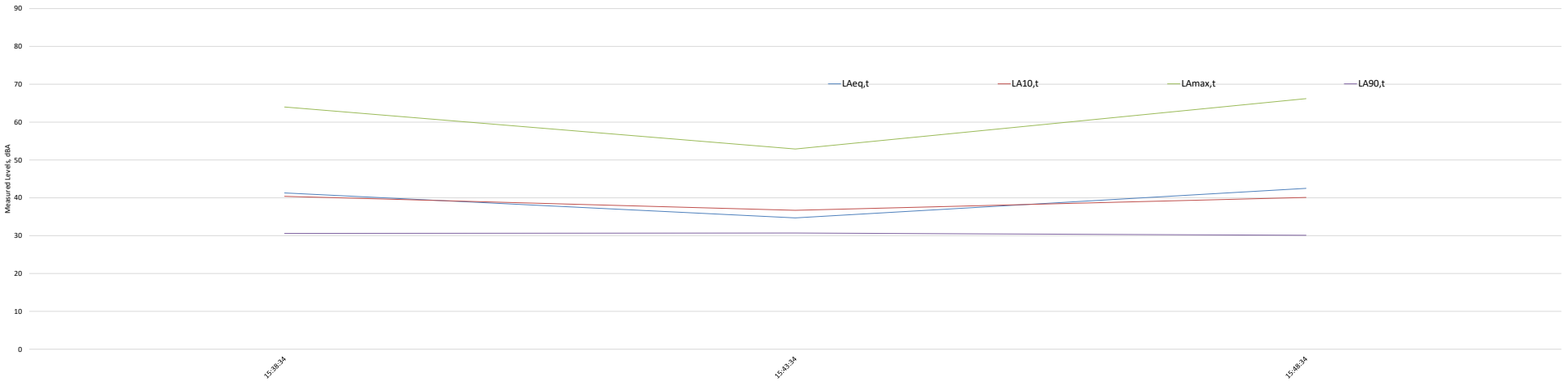
Date	Start Time	Measurement Time	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$	Notes
19/07/2018	13:20:00	00d 00:05:00.0	37.2	64.0	40.8	26.6	
19/07/2018	13:25:00	00d 00:05:00.0	36.9	60.5	39.6	27.7	
19/07/2018	13:30:00	00d 00:05:00.0	40.0	66.3	37.9	28.1	
19/07/2018	13:35:00	00d 00:05:00.0	38.7	56.8	41.6	27.4	
19/07/2018	13:40:00	00d 00:05:00.0	47.2	65.0	48.2	27.3	Pickup towing very rattly trailer leaves farm
19/07/2018	13:45:00	00d 00:05:00.0	41.1	60.9	42.2	27.0	
19/07/2018	13:50:00	00d 00:05:00.0	35.4	58.0	37.6	26.0	
19/07/2018	13:55:00	00d 00:05:00.0	35.4	51.7	39.1	26.9	
19/07/2018	14:00:00	00d 00:05:00.0	33.5	49.9	34.5	27.0	
19/07/2018	14:05:00	00d 00:05:00.0	40.7	60.6	41.5	27.8	
19/07/2018	14:10:00	00d 00:05:00.0	39.0	58.5	40.1	28.4	
19/07/2018	14:15:00	00d 00:05:00.0	40.6	57.5	44.9	28.1	
19/07/2018	14:20:00	00d 00:05:00.0	34.8	49.5	37.6	28.6	
19/07/2018	14:25:00	00d 00:05:00.0	36.3	54.6	39.4	29.2	
19/07/2018	14:30:00	00d 00:05:00.0	38.4	69.5	35.3	27.6	
19/07/2018	14:35:00	00d 00:05:00.0	31.1	48.1	32.4	27.7	
19/07/2018	14:40:00	00d 00:05:00.0	32.3	48.1	34.6	28.3	
19/07/2018	14:45:00	00d 00:05:00.0	32.7	49.6	34.3	29.3	
19/07/2018	14:50:00	00d 00:01:59.0	34.8	51.0	37.5	30.1	

Period	Time (T)	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$
Mean	1.5 hr	39.1	56.8	38.9	27.8
Mode	1.5 hr	35.4	48.1	37.6	27.7
Min	1.5 hr	31.1	48.1	32.4	26.0
Max	1.5 hr	47.2	69.5	48.2	30.1

NMP4 Battles Kirk - Day



NMP Description	
Weather Conditions	Moderate wind (5 m/s), 15°C, 70% RH, with wind increasingly gusty. Measurement abandoned due to onset of rain and increased wind speed.
Coordinates	HP 65083,15077
File #	
Main Noise Sources	Bird calls. Infrequent vehicles passing by on the nearby road.
Secondary Noise Sources	Distant sheep bleating
Sound Level Meter Settings	5min averaging period, A-wt, Fast averaging.



Date	Start Time	Measurement Time	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$	Notes
19/07/2018	15:38:34	00d 00:05:00.0	41.3	64.0	40.4	30.6	
19/07/2018	15:43:34	00d 00:05:00.0	34.7	52.9	36.7	30.7	
19/07/2018	15:48:34	00d 00:05:00.0	42.5	66.2	40.1	30.1	

Period	Time (T)	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$
Mean	15 min	40.6	61.0	39.1	30.5
Mode	15 min	#N/A	#N/A	#N/A	#N/A
Min	15 min	34.7	52.9	36.7	30.1
Max	15 min	42.5	66.2	40.4	30.7

Appendix 8.4 Traffic Flow Data

Site number: 80332

Site details

Region	Scotland
Local authority	Shetland Islands
Road name	A968
Road classification	'A' road
Managed by	Local authority
Road type	Major
Start junction	Belmont ferry
End junction	B9086
Link length	16.50km (10.25 miles)
Easting, northing	460000, 1205400
Latitude, longitude	60.72720200, -0.90191201

Location





Annual Average daily flow

Year	Count method	Pedal cycles	Two wheeled motor vehicles	Cars and taxis	Buses and coaches	Light goods vehicles	Heavy goods vehicles	All motor vehicles
2019	Estimated using previous year's AADF on this link	2	150	333	0	0	11	494
2018	Estimated using previous year's AADF on this link	1	151	332	0	0	11	493
2017	Estimated using previous year's AADF on this link	1	144	334	0	0	11	488
2016	Estimated using previous year's AADF on this link	1	136	334	0	0	10	480
2015	Estimated using previous year's AADF on this link	1	126	330	0	0	10	466
2014	Estimated using previous year's AADF on this link	1	118	325	0	0	10	453
2013	Estimated using previous year's AADF on this link	2	109	321	0	0	9	439
2012	Estimated using previous year's AADF on this link	2	101	320	0	0	10	431
2011	Estimated using previous year's AADF on this link	2	105	326	0	0	10	441
2010	Estimated using previous year's AADF on this link	2	100	328	0	0	10	438

Appendix 9.1 GHG Calculations

Skyrora GHG calcs v1.0 **20/05/2022**



1. Launch

Kerosene	7000	kg
EF	3.193	kgCO2e/kg
CO2e	**22351**	kg

2. Transport

Trips	4		1 LV, 2 HTP, 1 fuel		
Road distance	Miles	km	Tanker full EF (kgCO2e/km)	Tanker empty EF (tCO2e/km)	kgCO2e
Loanhead to Aberdeen	135	217	1.07	0.65	1495
Lerwick to Toft	28	45	1.07	0.65	310
Ulsta to Gutcher	18	29	1.07	0.65	199
Belmont to Skaw	15	24	1.07	0.65	166
				Road subtotal	**2171**
Ferry distance			Ferry EF (kgCO2e/tonne km	Payload (t)	kgCO2e
Aberdeen to Lerwick	224	361	0.061	40	7040
Toft to Ulsta	2.9	5	0.061	40	91
Gutcher to Belmont	1.25	2	0.061	40	39
				Sea subtotal	**7170**
				Transport total	**9341**

Grand total per launch	**31.69**

Distances from Google Maps and ports.com
Factors from 2021 Defra GHG Conversion Factors

Appendix 10.1 Planning Policy Screening

Scotland's National Marine Plan Policies Screening Assessment

From: https://www.gov.scot/publications/scotlands-national-marine-plan/pages/1/

Marine Plan Policy Listing and Screening in Relation to the Proposed Development

Policy ID	Policy Title	Policy Text	Screening Rationale	Relevant Section of the AEE
GEN 1	General planning principle	There is a presumption in favour of sustainable development and use of the marine environment when consistent with the policies and objectives of this Plan.	Policy screened for consideration in AEE	Chapter 10
GEN 2	Economic benefit	Sustainable development and use which provides economic benefit to Scottish communities is encouraged when consistent with the objectives and policies of this Plan.	Policy screened for consideration in AEE	Chapter 10
GEN 3	Social benefit	Sustainable development and use which provides social benefits is encouraged when consistent with the objectives and policies of this Plan.	Policy screened for consideration in AEE	Chapter 10
GEN 4	Co-existence	Proposals which enable coexistence with other development sectors and activities within the Scottish marine area are encouraged in planning and decision making processes, when consistent with policies and objectives of this Plan.	Policy screened for consideration in AEE	Chapter 10
GEN 5	Climate change	Marine planners and decision makers must act in the way best calculated to mitigate, and adapt to, climate change.	Policy screened for consideration in AEE	Section 10.12
GEN 6	Historic environment	Development and use of the marine environment should protect and, where appropriate, enhance heritage assets in a manner proportionate to their significance.	Policy screened for consideration in AEE	Section 10.12, Sections 10.10.104 - 10.10.112
GEN 7	Landscape/seascape	Marine planners and decision makers should ensure that development and use of the marine environment take seascape, landscape and visual impacts into account.	Policy screened for consideration in AEE	Section 10.12
GEN 8	Coastal process and flooding	Developments and activities in the marine environment should be resilient to coastal change and flooding, and not have unacceptable adverse impact on coastal processes or contribute to coastal flooding.	Policy screened for consideration in AEE	Section 10.12
GEN 9	Natural heritage	Development and use of the marine environment must: (a) Comply with legal requirements for protected areas and protected species. (b) Not result in significant impact on the national status of Priority Marine Features. (c) Protect and, where appropriate, enhance the health of the marine area.	Policy screened for consideration in AEE	Section 10.12
GEN 10	Invasive non-native species	Opportunities to reduce the introduction of invasive non-native species to a minimum or proactively improve the practice of existing activity should be taken when decisions are being made.	Policy screened for consideration in AEE	Section 10.12
GEN 11	Marine litter	Developers, users and those accessing the marine environment must take measures to address marine litter where appropriate. Reduction of litter must be taken into account by decision makers.	Policy screened for consideration in AEE	Section 10.12
GEN 12	Water quality and resource	Developments and activities should not result in a deterioration of the quality of waters to which the Water Framework Directive, Marine Strategy Framework Directive or other related Directives apply.	Policy screened for consideration in AEE	Section 10.12
GEN 13	Noise	Development and use in the marine environment should avoid significant adverse effects of man-made noise and vibration, especially on species sensitive to such effects.	Policy screened for consideration in AEE	Section 10.12
GEN 14	Air quality	Development and use of the marine environment should not result in the deterioration of air quality and should not breach any statutory air quality limits.	Policy screened for consideration in AEE	Section 10.12
GEN 15	Planning alignment A	Marine and terrestrial plans should align to support marine and land-based components required by development and seek to facilitate appropriate access to the shore and sea.	Policy screened for consideration in AEE	Chapter 10
GEN 16	Planning alignment B	Marine plans should align and comply where possible with other statutory plans and should consider objectives and policies of relevant non-statutory plans where appropriate to do so. <applies to inshore waters only>	Policy screened for consideration in AEE	Section 10.12
GEN 17	Fairness	All marine interests will be treated with fairness and in a transparent manner when decisions are being made in the marine environment.	Policy screened for consideration in AEE	Chapter 10
GEN 18	Engagement	Early and effective engagement should be undertaken with the general public and all interested stakeholders to facilitate planning and consenting processes.	Policy screened for consideration in AEE	Section 10.3.1
GEN 19	Sound evidence	Decision making in the marine environment will be based on sound scientific and socio-economic evidence.	Policy screened for consideration in AEE	Chapter 10
GEN 20	Adaptive management	Adaptive management practices should take account of new data and information in decision making, informing future decisions and future iterations of policy.	Policy screened for consideration in AEE	Chapter 10
GEN 21	Cumulative impacts	Cumulative impacts affecting the ecosystem of the marine plan area should be addressed in decision making and plan implementation.	Policy screened for consideration in AEE	Section 10.13
FISHERIES 1		Taking account of the EU's Common Fisheries Policy, Habitats Directive, Birds Directive and Marine Strategy Framework Directive, marine planners and decision makers should aim to ensure: - Existing fishing opportunities and activities are safeguarded wherever possible. - An ecosystem-based approach to the management of fishing which ensures sustainable and resilient fish stocks and avoids damage to fragile habitats. - Protection for vulnerable stocks (in particular for juvenile and spawning stocks through continuation of sea area closures where appropriate). - Improved protection of the seabed and historical and archaeological remains requiring protection through effective identification of high-risk areas and management measures to mitigate the impacts of fishing, where appropriate. - That other sectors take into account the need to protect fish stocks and sustain healthy fisheries for both economic and conservation reasons. - Delivery of Scotland's international commitments in fisheries, including the ban on discards. - Mechanisms for managing conflicts between fishermen and/or between the fishing sector and other users of the marine environment.	Policy screened for consideration in AEE	Sections 10.10.141 - 10.10 .149
FISHERIES 2		The following key factors should be taken into account when deciding on uses of the marine environment and the potential impact on fishing: - The cultural and economic importance of fishing, in particular to vulnerable coastal communities. - The potential impact (positive and negative) of marine developments on the sustainability of fish and shellfish stocks and resultant fishing opportunities in any given area. - The environmental impact on fishing grounds (such as nursery, spawning areas), commercially fished species, habitats and species more generally. - The potential effect of displacement on: fish stocks; the wider environment; use of fuel; socio-economic costs to fishers and their communities and other marine users.	Policy screened for consideration in AEE	Sections 10.10.141 - 10.10 .149

FISHERIES 3		Where existing fishing opportunities or activity cannot be safeguarded, a Fisheries Management and Mitigation Strategy should be prepared by the proposer of development or use, involving full engagement with local fishing interests (and other interests as appropriate) in the development of the Strategy. All efforts should be made to agree the Strategy with those interests. Those interests should also undertake to engage with the proposer and provide transparent and accurate information and data to help complete the Strategy. The Strategy should be drawn up as part of the discharge of conditions of permissions granted. The content of the Strategy should be relevant to the particular circumstances and could include: - An assessment of the potential impact of the development or use on the affected fishery or fisheries, both in socio-economic terms and in terms of environmental sustainability. - A recognition that the disruption to existing fishing opportunities/activity should be minimised as far as possible. - Reasonable measures to mitigate any constraints which the proposed development or use may place on existing or proposed fishing activity. - Reasonable measures to mitigate any potential impacts on sustainability of fish stocks (e.g. impacts on spawning grounds or areas of fish or shellfish abundance) and any socio-economic impacts. Where it does not prove possible to agree the Strategy with all interests, the reasons for any divergence of views between the parties should be fully explained in the Strategy and dissenting views should be given a platform within the Strategy to make their case.	Policy screened for consideration in AEE	Sections 13.10.141 - 13.10 .149
FISHERIES 4		Ports and harbours should seek to engage with fishing and other relevant stakeholders at an early stage to discuss any changes in infrastructure that may affect them. Any port or harbour developments should take account of the needs of the dependent fishing fleets with a view to avoiding commercial harm where possible. Where a port or harbour has reached a minimum level of infrastructure required to support a viable fishing fleet, there should be a presumption in favour of maintaining this infrastructure, provided there is an ongoing requirement for it to remain in place and that it continues to be fit for purpose.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
FISHERIES 5		Inshore Fisheries Groups (IFGs) should work with all local stakeholders with an interest to agree joint fisheries management measures. These measures should inform and reflect the objectives of regional marine plans. <applies to inshore waters>	Policy not relevant to the Proposed Development (geographic policy)	N/A
AQUACULTURE 1		Marine planners and decision makers should seek to identify appropriate locations for future aquaculture development and use, including the potential use of development planning briefs as appropriate. System carrying capacity (at the scale of a water body or loch system) should be a key consideration.	Policy screened for consideration in AEE	N/A
AQUACULTURE 2		Marine and terrestrial development plans should jointly identify areas which are potentially suitable and sensitive areas which are unlikely to be appropriate for such development, reflecting Scottish Planning Policy and any Scottish Government guidance on the issue. There is a continuing presumption against further marine finfish farm developments on the north and east coasts to safeguard migratory fish species.	Policy screened for consideration in AEE	N/A
AQUACULTURE 3		In relation to nutrient enhancement and benthic impacts, as set out under Locational Guidelines for the Authorisation of Marine Fish Farms in Scottish Waters, fish farm development is likely to be acceptable in Category 3 areas, subject to other criteria being satisfied. A degree of precaution should be applied to consideration of further fish farming development in Category 2 areas and there will be a presumption against further fish farm development in Category 1 areas.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AQUACULTURE 4		There is a presumption that further sustainable expansion of shellfish farms should be located in designated shellfish waters if these have sufficient capacity to support such development.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AQUACULTURE 5		Aquaculture developments should avoid and/or mitigate adverse impacts upon the seascape, landscape and visual amenity of an area, following SNH guidance on the siting and design of aquaculture.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AQUACULTURE 6		New aquaculture sites should not bridge Disease Management Areas although boundaries may be revised by Marine Scotland to take account of any changes in fish farm location, subject to the continued management of risk.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AQUACULTURE 7		Operators and regulators should continue to utilise a risk based approach to the location of fish farms and potential impacts on wild fish.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AQUACULTURE 8		Guidance on harassment at designated seal haul out sites should be taken into account and seal conservation areas should also be taken into account in site selection and operation. Seal licences will only be granted where other management options are precluded or have proven unsuccessful in deterrence.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AQUACULTURE 9		Consenting and licensing authorities should be satisfied that appropriate emergency response plans are in place.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AQUACULTURE 10		Operators should carry out pre-application discussion and consultation, and engage with local communities and others who may be affected, to identify and, where possible, address any concerns in advance of submitting an application.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AQUACULTURE 11		Aquaculture equipment, including but not limited to installations, facilities, moorings, pens and nets must be fit for purpose for the site conditions, subject to future climate change. Any statutory technical standard must be adhered to. Equipment and activities should be optimised in order to reduce greenhouse gas emissions.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AQUACULTURE 12		Applications which promote the use of sustainable biological controls for sea lice (such as farmed wrasse) will be encouraged.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AQUACULTURE 13		Proposals that contribute to the diversification of farmed species will be supported, subject to other objectives and policies being satisfied.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AQUACULTURE 14		The Scottish Government, aquaculture companies and Local Authorities should work together to maximise benefit to communities from aquaculture development.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
WILD FISH 1		The impact of development and use of the marine environment on diadromous fish species should be considered in marine planning and decision making processes. Where evidence of impacts on salmon and other diadromous species is inconclusive, mitigation should be adopted where possible and information on impacts on diadromous species from monitoring of developments should be used to inform subsequent marine decision making.	Policy screened for consideration in AEE	Sections 10.10.141 - 10.10.149
OIL & GAS 1		The Scottish Government will work with DECC, the new Oil and Gas Authority and the industry to maximise and prolong oil and gas exploration and production whilst ensuring that the level of environmental risks associated with these activities are regulated. Activity should be carried out using the principles of Best Available Technology (BAT) and Best Environmental Practice. Consideration will be given to key environmental risks including the impacts of noise, oil and chemical contamination and habitat change.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
OIL & GAS 2		Where re-use of oil and gas infrastructure is not practicable, either as part of oil and gas activity or by other sectors such as carbon capture and storage, decommissioning must take place in line with standard practice, and as allowed by international obligations. Re-use or removal of decommissioned assets from the seabed will be fully supported where practicable and adhering to relevant regulatory process.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
OIL & GAS 3		Supporting marine and coastal infrastructure for oil and gas developments, including for storage, should utilise the minimum space needed for activity and should take into account environmental and socio-economic constraints.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
OIL & GAS 4		All oil and gas platforms will be subject to 9 nautical mile consultation zones in line with Civil Aviation Authority guidance.	Policy screened for consideration in AEE	Sections 10.10.76 - 10.10.83
OIL & GAS 5		Consenting and licensing authorities should have regard to the potential risks, both now and under future climates, to oil and gas operations in Scottish waters, and be satisfied that installations are appropriately sited and designed to take account of current and future conditions.	Policy screened for consideration in AEE	Sections 10.10.76 - 10.10.83
OIL & GAS 6		Consenting and licensing authorities should be satisfied that adequate risk reduction measures are in place, and that operators should have sufficient emergency response and contingency strategies in place that are compatible with the National Contingency Plan and the Offshore Safety Directive.	Policy screened for consideration in AEE	Sections 10.10.76 - 10.10.83

CCS 1		CCS commercialisation projects or developments should be supported through an alignment of marine and terrestrial planning processes, particularly where proposals allow timely deployment of CCS to re-use suitable existing redundant oil and gas infrastructure.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
CCS 2		Consideration should be given to the development of marine utility corridors which will allow CCS to capitalise, where possible, on current infrastructure in the North Sea, including shared use of spatial corridors and pipelines.	Policy screened for consideration in AEE	N/A
RENEWABLES 1		Proposals for commercial scale offshore wind and marine renewable energy development should be sited in the Plan Option areas identified through the Sectoral Marine Plan process. Plan Options are considered the preferred strategic locations for the sustainable development of offshore wind and marine renewables. This preference should be taken into account by marine planners and decision makers if alternative development or use of these areas is being considered. Proposals are subject to licensing and consenting processes.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
RENEWABLES 2		Sites with agreements for lease for wave and tidal energy development in the Pentland Firth Strategic Area must be taken into account by marine planners and decision makers if alternative use of these areas, or use which would affect access to these areas, is being considered. Proposals are subject to licensing and consenting processes. Regional Locational Guidance and the Pentland Firth and Orkney Waters Marine Spatial Plans should also be taken into account when reaching decisions.	Policy not relevant to the Proposed Development (geographic policy)	N/A
RENEWABLES 3		Marine planners and decision makers should consider proposals for sustainable development of test and demonstration for offshore wind and marine renewable energy development on a case-by-case basis where sites are identified. This preference should be taken into account by marine planners and decision makers if alternative development or use of these areas is being considered. Regional Locational Guidance should be taken into account and proposals are subject to licensing and consenting processes.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
RENEWABLES 4		Applications for marine licences and consents relating to offshore wind and marine renewable energy projects should be made in accordance with the Marine Licensing Manual and Marine Scotland's Licensing Policy Guidance.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
RENEWABLES 5		Marine planners and decision makers must ensure that renewable energy projects demonstrate compliance with Environmental Impact Assessment and Habitats Regulations Appraisal legislative requirements.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
RENEWABLES 6		New and future planned grid connections should align with relevant sectoral and other marine spatial planning processes, where appropriate, to ensure a co-ordinated and strategic approach to grid planning. Cable and network owners and marine users should also take a joined-up approach to development and activity to minimise impacts on the marine historic and natural environment and other users.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
RENEWABLES 7		Marine planners and decision makers should ensure infrastructure is fit for purpose now and in future. Consideration should be given to the potential for climate change impacts on coasts vulnerable to erosion.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
RENEWABLES 8		Developers bringing forward proposals for new developments must actively engage at an early stage with the general public and interested stakeholders of the area to which the proposal relates and of adjoining areas which may be affected.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
RENEWABLES 9		Marine planners and decision makers should support the development of joint research and monitoring programmes for offshore wind and marine renewables energy development.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
RENEWABLES 10		Good practice guidance for community benefit from offshore wind and renewable energy development should be followed by developers, where appropriate.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
REC & TOURISM 1		Opportunities to promote sustainable development of marine recreation and tourism should be supported.	Policy screened for consideration in AEE	Sections 10.10.160 - 10.10.168
REC & TOURISM 2		The following key factors should be taken into account when deciding on uses of the marine environment and the potential impact on recreation and tourism: - The extent to which the proposal is likely to adversely affect the qualities important to recreational users, including the extent to which proposals may interfere with the physical infrastructure that underpins a recreational activity. - The extent to which any proposal interferes with access to and along the shore, to the water, use of the resource for recreation or tourism purposes and existing navigational routes or navigational safety. - Where significant impacts are likely, whether reasonable alternatives can be identified for the proposed activity or development. - Where significant impacts are likely and there are no reasonable alternatives, whether mitigation, through recognised and effective measures, can be achieved at no significant cost to the marine recreation or tourism sector interests.	Policy screened for consideration in AEE	Sections 10.10.160 - 10.10.168
REC & TOURISM 3		Regional marine plans should identify areas that are of recreational and tourism value and identify where prospects for significant development exist, including opportunities to link to the National Long Distance Walking and Cycle Routes, and more localised and/or bespoke recreational opportunities and visitor attractions.	Policy screened for consideration in AEE	Sections 10.10.160 - 10.10.168
REC & TOURISM 4		Marine and terrestrial planners, marine decision makers and developers should give consideration to the facility requirements of marine recreation and tourism activities, including a focus on support for participation and development in sport. Co-operation and sharing infrastructure and/or facilities, where appropriate, with complementary sectors should be supported as should provision of low carbon transport options.	Policy screened for consideration in AEE	Sections 10.10.160 - 10.10.168
REC & TOURISM 5		Marine planners and decision makers should support enhancement to the aesthetic qualities, coastal character and wildlife experience of Scotland's marine and coastal areas, to the mutual benefit of the natural environment, human quality of life and the recreation and tourism sectors.	Policy screened for consideration in AEE	Sections 10.10.160 - 10.10.168
REC & TOURISM 6		Codes of practice for invasive non-native species and Marine Wildlife Watching should be complied with.	Policy screened for consideration in AEE	Sections 10.10.160 - 10.10.168
TRANSPORT 1		Navigational safety in relevant areas used by shipping now and in the future will be protected, adhering to the rights of innocent passage and freedom of navigation contained in UN Convention on the Law of the Sea (UNCLOS). The following factors will be taken into account when reaching decisions regarding development and use: - The extent to which the locational decision interferes with existing or planned routes used by shipping, access to ports and harbours and navigational safety. This includes commercial anchorages and defined approaches to ports. - Where interference is likely, whether reasonable alternatives can be identified. - Where there are no reasonable alternatives, whether mitigation through measures adopted in accordance with the principles and procedures established by the International Maritime Organization can be achieved at no significant cost to the shipping or ports sector.	Policy screened for consideration in AEE	Sections 10.10.160 - 10.10.168
TRANSPORT 2		Marine development and use should not be permitted where it will restrict access to, or future expansion of, major commercial ports or existing or proposed ports and harbours which are identified as National Developments in the current NPF or as priorities in the National Renewables Infrastructure Plan. Regional marine plans should identify regionally important ports and harbours, giving consideration to social and economic aspects of the port or harbour and the users of the facility subject to policies and objectives of this Plan. Regional plans should consider setting out criteria against which proposed activities and developments should be evaluated. <applies to inshore waters only>	Policy not relevant to the Proposed Development (sector specific policy)	N/A
TRANSPORT 3		Ferry routes and maritime transport to island and remote mainland areas provide essential connections and should be safeguarded from inappropriate marine development and use that would significantly interfere with their operation. Developments will not be consented where they will unacceptably interfere with lifeline ferry services.	Policy screened for consideration in AEE	Sections 10.10.94 - 10.10.103, Sections 10.10.150 - 10.10.159
TRANSPORT 4		Maintenance, repair and sustainable development of port and harbour facilities in support of other sectors should be supported in marine planning and decision making. <applies to inshore waters only>	Policy not relevant to the Proposed Development (sector specific policy)	N/A

TRANSPORT 5		Port and harbour operators should take into account future climate change and extreme water level projections, and where appropriate take the necessary steps to ensure their ports and harbours remain viable and resilient to a changing climate. Climate and sea level projections should also be taken into account in the design of any new ports and harbours, or of improvements to existing facilities. <applies to inshore waters only>	Policy not relevant to the Proposed Development (sector specific policy)	N/A
TRANSPORT 6		Marine planners and decision makers and developers should ensure displacement of shipping is avoided where possible to mitigate against potential increased journey lengths (and associated fuel costs, emissions and impact on journey frequency) and potential impacts on other users and ecologically sensitive areas.	Policy screened for consideration in AEE	Sections 10.10.94 - 10.10.103, Sections 10.10.150 - 10.10.159
TRANSPORT 7		Marine and terrestrial planning processes should co-ordinate to: - Provide co-ordinated support to ports, harbours and ferry terminals to ensure they can respond to market influences and provide support to other sectors with necessary facilities and transport links. - Consider spatial co-ordination of ferries and other modes of transport to promote integrated and sustainable travel options.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
CABLES 1		Cable and network owners should engage with decision makers at the early planning stage to notify of any intention to lay, repair or replace cables before routes are selected and agreed. When making proposals, cable and network owners and marine users should evidence that they have taken a joined-up approach to development and activity to minimise impacts, where possible, on the marine historic and natural environment, the assets, infrastructures and other users. Appropriate and proportionate environmental considertion and risk assessments should be provided which may include cable protection measures and mitigation plans. Any deposit, removal or dredging carried out for the purpose of executing emergency inspection or repair works to any cable is exempt from the marine licensing regime with approval by Scottish Ministers. However, cable replacement requires a marine licence. Marine Licensing Guidance should be followed when considering any cable development and activity.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
CABLES 2		The following factors will be taken into account on a case by case basis when reaching decisions regarding submarine cable development and activities: - Cables should be suitably routed to provide sufficient requirements for installation and cable protection. - New cables should implement methods to minimise impacts on the environment, seabed and other users, where operationally possible and in accordance with relevant industry practice. - Cables should be buried to maximise protection where there are safety or seabed stability risks and to reduce conflict with other marine users and to protect the assets and infrastructure. - Where burial is demonstrated not to be feasible, cables may be suitably protected through recognised and approved measures (such as rock or mattress placement or cable armouring) where practicable and cost-effective and as risk assessments direct. - Consideration of the need to reinstate the seabed, undertake post-lay surveys and monitoring and carry out remedial action where required.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
CABLES 3		A risk-based approach should be applied by network owners and decision makers to the removal of redundant submarine cables, with consideration given to cables being left in situ where this would minimise impacts on the marine historic and natural environment and other users.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
CABLES 4		When selecting locations for land-fall of power and telecommunications equipment and cabling, developers and decision makers should consider the policies pertaining to flooding and coastal protection in Chapter 4, and align with those in Scottish Planning Policy and Local Development Plans.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
DEFENCE 1		To maintain operational effectiveness in Scottish waters used by the armed services, development and use will be managed in these areas: - Naval areas including bases and ports: Safety of navigation and access to naval bases and ports will be maintained. The extent to which a development or use interferes with access or safety of navigation, and whether reasonable alternatives can be identified, will be taken into account by consenting bodies. Proposals for development and use should be discussed with the MOD at an early stage in the process. - Firing Danger Areas (Map 13): Development of new permanent infrastructure is unlikely to be compatible with the use of Firing Danger Areas by the MOD. Permitted activities may have temporal restrictions imposed. Proposals for development and use should be discussed with the MOD at an early stage in the process. - Exercise Areas (Map 13): Within Exercise Areas, activities may be subject to temporal restrictions. Development and use that either individually or cumulatively obstructs or otherwise prevents the defence activities supported by an exercise area may not be permitted. Proposals for development and use should be discussed with the MOD at an early stage in the process. - Communications: Navigations and surveillance including radar: Development and use which causes unacceptable interference with radar and other systems necessary for national defence may be prohibited if mitigation cannot be determined. Proposals for development and use should be discussed with the MOD at an early stage in the process.	Policy not relevant to the Proposed Development (geographic policy)	N/A
DEFENCE 2		For the purposes of national defence, the MOD may establish by-laws for exclusions and closures of sea areas. In most areas this will mean temporary exclusive use of areas by the MOD. Where potential for conflict with other users is identified, appropriate mitigation will be identified and agreed with the MOD, prior to planning permission, a marine licence, or other consent being granted.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
DEFENCE 3		The established code of conduct for managing fishing and military activity detailed in the documents 'Fishing Vessels Operating in Submarine Exercise Areas' [155] and 'Fishing Vessel Avoidance: The UK Code of Practice Fishing Vessel Avoidance' [156] will be adhered to.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AGGREGATES 1		Marine planners and decision makers should consider the impacts of other development or activity on areas of marine aggregate or mineral resource. Where an interaction is identified, consideration should be given to whether there are permissions for aggregate or mineral extraction and whether they require any degree of safeguarding.	Policy not relevant to the Proposed Development (geographic policy)	N/A
AGGREGATES 2		Decision makers should ensure all the necessary environmental issues are considered and safeguards are in place when determining whether any proposed marine aggregate dredging is considered to be environmentally acceptable and is in accordance with the other policies and objectives of this Plan.	Policy not relevant to the Proposed Development (sector specific policy)	N/A

Shetland Local Development Plan Policies Screening Assessment

From: https://www.shetland.gov.uk/downloads/file/1930/local-development-plan-2014

Local Development Plan Listing and Screening in Relation to the Proposed Development

Policy ID	Policy Title	Policy Text	Screening Rationale	Relevant Section of the AEE

GP 1	Sustainable Development	Development will be planned to meet the economic and social needs of Shetland in a manner that does not compromise the ability of future generations to meet their own needs and to enjoy the area's high quality environment. Tackling climate change and associated risks is a major consideration for all development proposals. New residential, employment, cultural, educational and community developments should be in or adjacent to existing settlements that have basic services and infrastructure in order to enhance their viability and vitality and facilitate ease of access for all. This will be achieved through Allocations, Sites with Development Potential and Areas of Best Fit.	Policy screened for consideration in AEE	Chapter 10
GP 2	General Requirements for All Development	Applications for new buildings or for the conversion of existing buildings should meet all of the following General Requirements: a. Developments should not adversely affect the integrity or viability of sites designated for their landscape and natural heritage value. b. Development should not occur any lower than 5 metres Above Ordnance Datum (Newlyn) unless the development meets the requirements of Policy WD1; c. Development should be located, constructed and designed so as to minimise the use of energy and to adapt to impacts arising from climate change, such as the increased probability of flooding; water stress, such as water supply; health or community impacts as a result of extreme climatic events; and a change in richness of biodiversity. d. Suitable water, waste water and surface water drainage must be provided; e. All new buildings shall avoid a specified and rising proportion of the projected greenhouse gas emissions from their use, through the installation and operation of low and zero-carbon generating technologies (LZCGT). The proportion of such emissions shall be specified in the council's Supplementary Guidance – Design. That guidance will also set out the approach to existing buildings which are being altered or extended, including historic buildings, and the approach to applications where developers are able to demonstrate that there are significant technical constraints to using on-site low and zero carbon generating technologies. f. Suitable access, car parking and turning should be provided; g. Development should not adversely affect areas, buildings or structures of archaeological, architectural or historic interest; h. Development should not sterilise mineral reserves; i. Development should not sterilise allocated sites as identified within the Shetland Local Development Plan; j. Development should not have a significant adverse effect on existing uses; k. Development should not compromise acceptable health and safety standards or levels; l. Development should be consistent with National Planning Policy, other Local Development Plan policies and Supplementary Guidance.	Policy screened for consideration in AEE	Chapter 10
GP 3	All Development: Layout and Design	All new development should be sited and designed to respect the character and local distinctiveness of the site and its surroundings. The proposed development should make a positive contribution to: • maintaining identity and character • ensuring a safe and pleasant space • ensuring ease of movement and access for all • a sense of welcome • long term adaptability, and • good use of resources The Planning Authority may request a Masterplan and/ or Design and Access Statement in support of development proposals. A Masterplan should be submitted with applications where Major Development is proposed; Major Development is defined in the Town and Country Planning (Hierarchy of Developments) (Scotland) Regulations 2009, Reg 2 (1). Further details for these requirements are set out in Supplementary Guidance.	Policy screened for consideration in AEE	Chapter 10
NH 1	International and National Designations	Any development proposal that is likely to have a significant effect on an internationally important site, (Special Area of Conservation (SAC), Special Protection Areas (SPA) or Ramsar Sites) and is not directly connected with or necessary to the conservation management of that site will be subject to an assessment of the implications for the site's conservation objectives. Development that could have a significant effect on a site will only be permitted where: • An appropriate assessment has demonstrated that it will not adversely affect the integrity of the site, or • There are no alternative solutions, and • There are imperative reasons of over-riding public interest that may, for sites not hosting a priority habitat type and/or priority species, be of a social or economic nature. Development that affects a National Scenic Area (NSA), National Nature Reserve (NNR) or a Site of Special Scientific Interest (SSSI) will only be permitted where: • It will not adversely affect the integrity of the area or the qualities or protected features for which it has been designated, or • Any such adverse effects are clearly outweighed by social, environmental or economic benefits of national importance.	Policy screened for consideration in AEE	Section 10.12

NH 2	Protected Species	Where there is good reason to suggest that a species protected under the Wildlife and Countryside Act 1981 (as amended), Annex IV of the Habitats Directive or Annex 1 of the Birds Directive is present on site, or may be affected by a proposed development, the Council will require any such presence to be established. If such a species is present, a plan should be provided to avoid or mitigate any adverse impacts on the species, prior to determining the application. Planning permission will not be granted for development that would be likely to have an adverse effect on a European Protected Species unless the Council is satisfied that: • The development is required for preserving public health or public safety or for other imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment; and • There is no satisfactory alternative; and • The development will not be detrimental to the maintenance of the population of the European Protected Species concerned at a favourable conservation status in their natural range. Planning permission will not be granted for development that would be likely to have an adverse effect on a species protected under Schedule 5 (animals) or 8 (plants) of the Wildlife and Countryside Act 1981 (as amended) unless the Council is satisfied that: • Undertaking the development will give rise to, or contribute towards the achievement of, a significant social, economic or environmental benefit; and • There is no satisfactory solution. Planning permission will not be granted for development that would be likely to have an adverse effect on a species protected under Schedules 1, 1A or A1 (birds) of the Wildlife and Countryside Act 1981 (as amended), unless the Council is satisfied that: o The development is required for preserving public health or public safety; and o There is no other satisfactory solution. Applicants should submit supporting evidence for any development meeting these criteria, demonstrating both the need for the development and that a full range of possible alternative courses of action have been properly examined and none found to acceptably meet the need identified. The Council will apply the precautionary principle where the impacts of a proposed development on natural heritage are uncertain but potentially significant. Where development is constrained on the grounds of uncertainty, the potential for research, surveys or assessments to remove or reduce uncertainty should be considered.	Policy screened for consideration in AEE	Section 10.12
NH 3	Furthering the Conservation of Biodiversity	Development will be considered against the Council's obligation to further the conservation of biodiversity and the ecosystem services it delivers. The extent of these measures should be relevant and proportionate to the scale of the development. Proposals for development that would have a significant adverse effect on habitats or species identified in the Shetland Local Biodiversity Action Plan, Scottish Biodiversity List, UK Biodiversity Action Plan, Annexes I and II of the Habitats Directive, Annex I of the Birds Directive (if not included in Schedule 1 of the Wildlife and Countryside Act) or on the ecosystem services of biodiversity, including any cumulative impact, will only be permitted where it has been demonstrated by the developer that; • The development will have benefits of overriding public interest including those of a social or economic nature that outweigh the local, national or international contribution of the affected area in terms of habitat or populations of species; and • Any harm or disturbance to the ecosystem services, continuity and integrity of the habitats or species is avoided, or reduced to acceptable levels by mitigation.	Policy screened for consideration in AEE	Section 10.12
NH 4	Local Designations	Development that affects a Local Nature Conservation Site or Local Landscape Area will only be permitted where: • It will not adversely affect the integrity of the area or the qualities for which it has been identified; or • Any such effects are clearly outweighed by social, environmental or economic benefits.	Policy screened for consideration in AEE	Section 10.12
NH 6	Geodiversity	Development will only be permitted where appropriate measures are taken to protect and/or enhance important geological and geomorphological resources and sites, including those of educational or research value. Proposals that will have an unavoidable effect on geodiversity will only be permitted where it has been demonstrated that: • The development will have benefits of overriding public interest including those of a social or economic nature that outweigh the local, national or international contribution of the affected area in terms of its geodiversity; • Any loss of geodiversity is reduced to acceptable levels by mitigation, and a record is made prior to any loss. For certain scales of development where a soil management plan is required, reference should also be made to geodiversity on site.	Policy screened for consideration in AEE	Section 10.12
NH 7	Water Environment	Development will only be permitted where appropriate measures are taken to protect the marine and freshwater environments to an extent that is relevant and proportionate to the scale of development. Development adjacent to a watercourse or water body must be accompanied by sufficient information to enable a full assessment of the likely effects. Where there is potential for the development to have an adverse impact the applicant/developer must demonstrate that: • There will be no deterioration in the ecological status of the watercourse or water body; • It does not encroach on any existing buffer strips and that access to these buffer strips has been maintained; and • Both during the construction phase and after completion it would not significantly affect: o Water quality flows in adjacent watercourses or areas downstream o Natural flow patterns and sediment transport processes in all water bodies or watercourses.	Policy screened for consideration in AEE	Section 10.12
HE 1	Historic Environment	The Council should presume in favour of the protection, conservation and enhancement of all elements of Shetland's historic environment, which includes buildings, monuments, landscapes and areas.	Policy screened for consideration in AEE	Section 10.12, Sections 10.10.104 - 10.10.114
HE 4	Archaeology	Scheduled monuments, designated wrecks and other identified nationally important archaeological resources should be preserved in situ, and within an appropriate setting. Developments that have an adverse effect on scheduled monuments and designated wrecks or the integrity of their settings should not be permitted unless there are exceptional circumstances. All other significant archaeological resources should be preserved in situ wherever feasible. Where preservation in situ is not possible the planning authority should ensure that developers undertake appropriate archaeological excavation, recording, analysis, publication and archiving in advance of and/ or during development.	Policy screened for consideration in AEE	Section 10.12, Sections 10.10.104 - 10.10.114

CST 1	Coastal Development	Proposals for developments and infrastructure in the coastal zone (above Mean Low Water Mark of Ordinary Spring Tides) will only be permitted where the proposal can demonstrate that: • It will not have a significant impact, either individually or cumulatively, on the natural, built environment and cultural heritage resources either in the sea or on land; • The location, scale and design are such that it will not have a significant adverse impact. • It does not result in any deterioration in ecological status or potential for any water body or prevent it from achieving good ecological status in the future; • There is no significant adverse impact on other users of marine resources, and/or neighbouring land. Proposals for marine aquaculture developments or amendments to existing fish farm developments will require to have regard to the foregoing criteria and will be assessed against the Supplementary Guidance Policy for Aquaculture. All proposals will be assessed against the Shetland Islands Marine Spatial Plan that sets out a spatial strategy and policy framework to guide marine developments in the coastal waters around Shetland. The Marine Spatial Plan identifies the constraints developers are required to consider when contemplating development in the coastal area and will form supplementary guidance to this plan.	Policy screened for consideration in AEE	Section 10.12

Appendix 10.2 Baseline

Environmental Zone of Influence

The sections below characterise the water quality, biodiversity and human receptors with likely presence in the EZI, based on a review of available published and unpublished literature, alongside resources from advisors and regulators.

Water Quality

Contaminants

Contaminants are chemical substances that are atypically found in the marine environment and have the potential to cause harm to marine life. Contaminants can be either anthropogenic or natural in origin. As stated by ICES (2003), there are four main groups of contaminants:

- Trace metals: heavy metals such as cadmium and mercury, from metallurgic industries, and copper, from anti-foulant;
- Organic compounds: from agricultural run-off;
- Oil: from marine activities and hydrocarbon extraction;
- Radioactive elements: from nuclear operations.

Oil pollution in the EZI is likely to be lower than other marine regions due to the low overall level of development and anthropogenic presence. The small amounts of exploration and drilling of oil in the Arctic has so far been limited to Russia, North America and west Greenland (i.e. none in the vicinity of the EZI) (NPC, 2015). The Arctic has received significant interest from the petroleum industry, and it is possible that exploration will become more widespread in the future. Marine traffic in the EZI typically decreases with distance from the coast, though there is an offshore convergence zone of traffic routes between Norway and Iceland (see Section 10.5). Though there have no doubt been occurrences of hydrocarbons entering the water from vessels, there had not been a major oil spill in the Arctic until June 2020 when one occurred from an energy plant in eastern Russia (though this is significantly outwith the EZI). The baseline level of hydrocarbons in the EZI is considered to be very low.

OSPAR have assessed the level of contaminants across different parts of the OSPAR maritime area as part of their 2017 Intermediate Assessment (OSPAR, 2017). The level of polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) in shellfish and sediments in the Northern North Sea (overlapping the southern extent of the EZI) is below levels likely to harm marine species. The level of polybrominated diphenyl ethers (PBDEs) in shellfish and sediment in the Northern North Sea is decreasing annually. Heavy metal (mercury Hg; cadmium Cd; and lead, Pb) concentrations in the fish and shellfish and sediments of the Northern North Sea are above background levels, but most are below the level at which effects would occur (with the exception of lead in sediments which are above levels where adverse ecological effects cannot be ruled out). Note that the Northern North Sea has potentially the highest level of anthropogenic pressure in the EZI as it is more proximate to land where anthropogenic sources of contaminants are higher.

In comparison to the North Sea, the Arctic is relatively unpolluted. Based on the OSPAR Commission Quality Status Report 2010, the Arctic (Region 1) has the lowest percentages of monitoring sites that have unacceptable levels of cadmium, mercury, lead, PAHs, and PCBs, out of all OSPAR regions (OSPAR, 2010). Of these, PAHs and PCBs are present in unacceptable levels in the highest percentages of sites (~30%), whereas for the heavy metals this is typically <10%. The monitoring sites included are restricted to coastal waters and so represent the worst-case scenario for pollutants as they are closer to the anthropogenic sources. It is likely that levels of pollutants offshore are lower than that reported at the coast. The release of most contaminants is controlled by legislative measures that aim to cease their production, and as a result there has been a general decrease in the number of pollutants in the Arctic which is predicted to continue.

There has been a historic decrease in the concentration of most anthropogenic radionuclides in the Eurasian Arctic (Josefsson, 1998). Concentration of radionuclides decreases with depth in the water column. The concentrations in the sediments of the deep Arctic Ocean are much lower than the concentrations on the shelf, primarily due to the low particle flux in the open ocean (Josefsson, 1998). There are no nuclear facilities

in the EZI (OSPAR, 2016), therefore input of radionuclides is limited to transport from distant sources and global fallout. In summary there are likely to be negligible concentrations of radionuclides in the EZI.

Microplastics

Microplastics, described as plastic particles or fragments less than 5 mm in length (NOAA, 2020a), are present in most marine systems around the world (Barceló and Picó, 2019). Although the Arctic is remote and difficult to study, there has been an increase in the focus on plastic pollution in this region. Microplastics have been found both in the water and the marine organisms such as fish in the Arctic, with the most common types being polyethylene and polyester (Morgana *et al.,* 2018). The concentration of microplastics is greater than most seas at lower latitude, indicating that the Arctic regions is a hotspot for plastic pollution (e.g., Obbard *et al.,* 2014). Plastic pollution can originate from local sources such as vessel discharge or more distant sources, which enter the region via sea surface and sub-surface currents. Given the comparatively few direct sources in the region, it is likely that most microplastics originate outside the Arctic. The amount of microplastics in the Arctic is predicted to increase in the coming years, due to the increase in anthropogenic presence and pressure as climate change increases accessibility to the region.

Biodiversity

Physical features

The physical features of the marine environment directly influence the biodiversity found in the surrounding waters. The EZI comprises predominantly deep waters up to ~4,000 m below relative sea level with some shallower areas adjacent to nearby land masses including Iceland, Faroe Islands and Jan Mayen (Figure A10.1). The area is characterised by bathymetric features including plateaus, basins, rises, and ridges, including segments of the Mid-Atlantic Ridge (Figure A10.2).

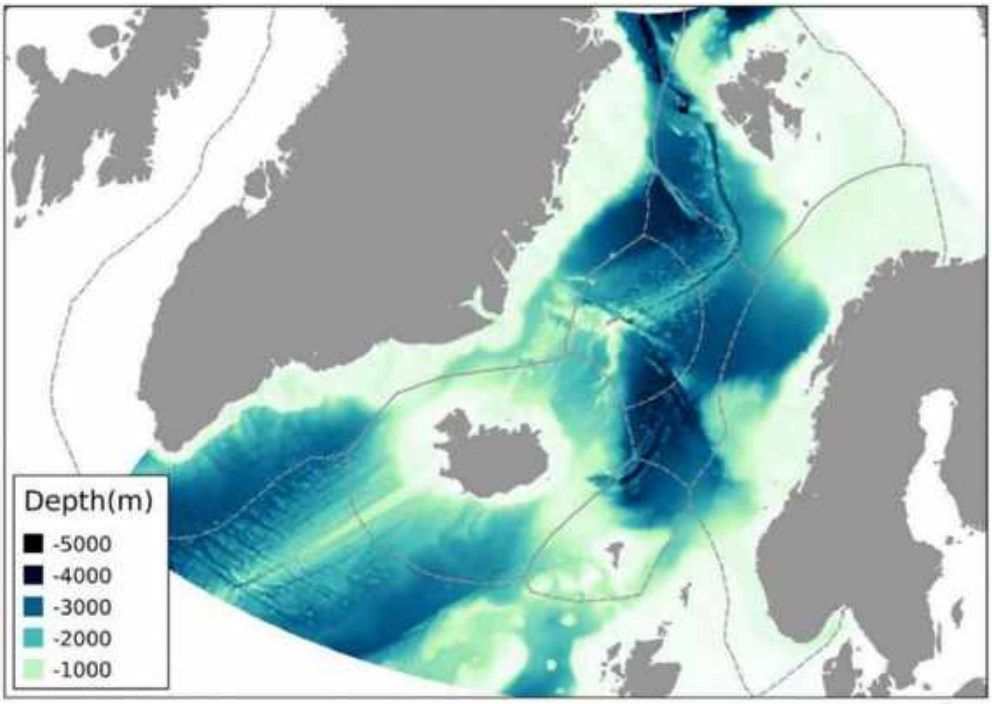


Figure A10.1 Water depth in the northeast Atlantic and Arctic regions (From: Buhl-Mortensen et al.*, 2019)*

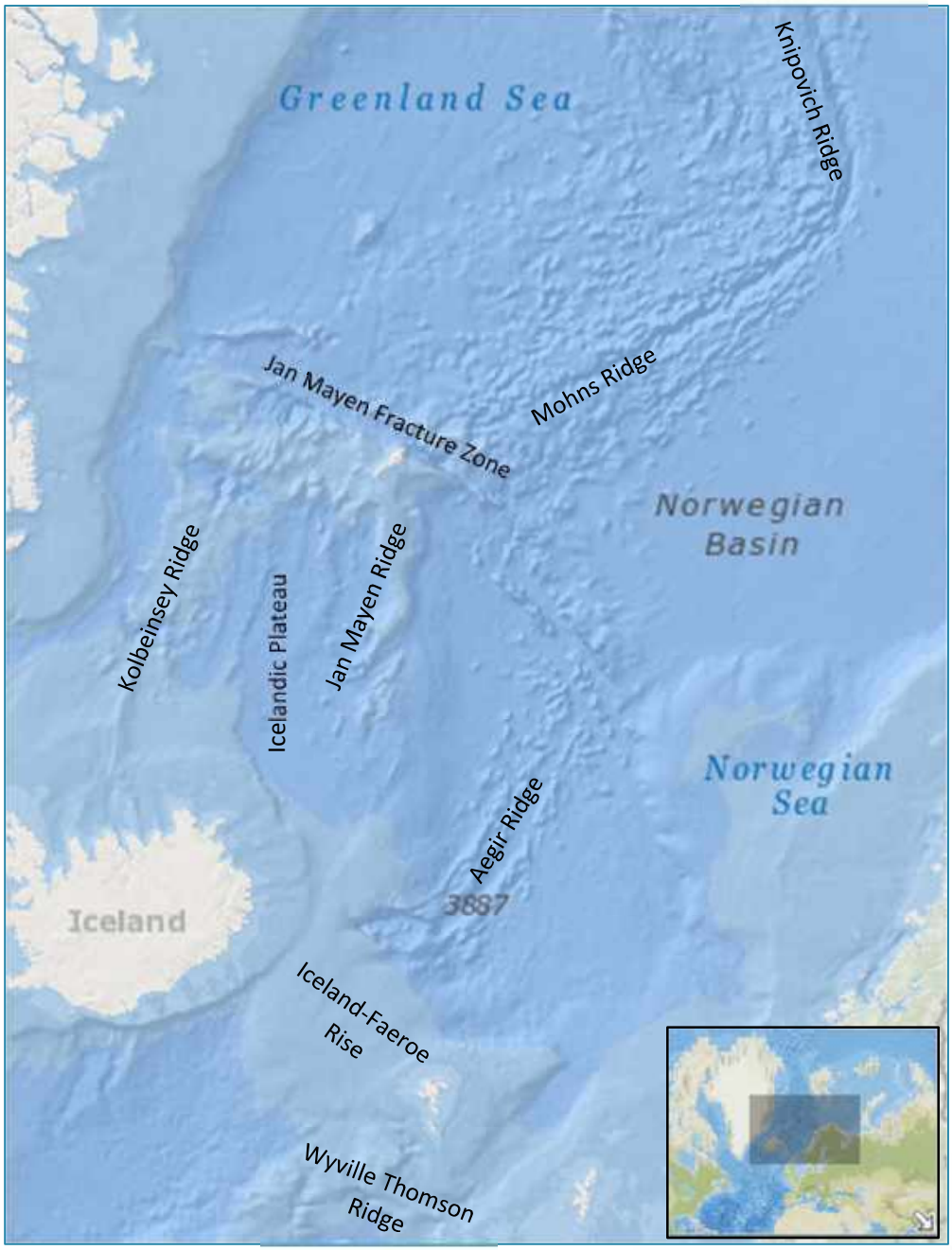


Figure A10.2 Bathymetry and bathymetric features in the vicinity of the EZI (Source: NOAA, 2020b)

Surface sea currents in the EZI comprise a mix of warm currents and cold currents (ICES, 2003). Travelling in a north-east direction, the North Atlantic Drift traverses between the UK and the Faroe Islands, through the Norwegian Sea and continues to the Arctic. Offshoots of this current travel between the Faroe Islands and Norway, south into the North Sea, and also circulate anti-clockwise from the Norwegian Sea towards Jan Mayen. Cold currents travel in a south/southwesterly direction from the Arctic; the East Greenland Current travels down the east coast of Greenland, with offshoots circulating clockwise towards Jan Mayen and north of Iceland (East Icelandic Current). The centre of the EZI comprises a convergence of cold and warm surface currents, resulting in gyres such as the Icelandic Gyre and Greenland Sea Gyre.

The highest annual mean sea surface temperature (SST) in the region is approximately 9-10°C, in the south and southeast of the EZI (NOAA, 2020c), as these waters are most influenced by the warm surface waters. Influence of the Arctic-derived sea surface currents in the north and west of the EZI lead to minimum annual mean SST of 0-3°C. The temperature is typically 2-3° below and above average in the winter and summer, respectively (NOAA, 2020c). Temperature at the sea-bottom is -1°C throughout much of the offshore waters of the EZI (Buhl-Mortensen *et al.,* 2019). Warmer sea-bottom temperatures of 6.8-9.4°C are present across the areas of continental shelf that extend around the Faroe Islands and north of Shetland (Buhl-Mortensen *et al.,* 2019). Annual salinity in the EZI is 35-36 with minimal seasonal variation (NOAA, 2020d).

The maximum Arctic sea ice extent does not extend into the EZI except for a very small portion in the northwest corner near to Greenland (NOAA, 2012). As this represents such a small portion of the EZI it is considered to have negligible effects on the biodiversity of the EZI.

The seabed sediments in waters beyond the continental shelf, which comprises the majority of the EZI, are characterised as A6.5 Deep-sea mud (EMODnet, 2019). The seabed sediments in the areas beyond national jurisdiction are described on EMODnet as A.6 Deep-sea bed with no further information on the sediments themselves. Other seabed sediments that are present on the continental shelf adjacent to the Faroe Islands include A5.27 Deep circalittoral sand, A6.3 Deep-sea sand or A6.4 Deep-sea muddy sand, and A5.45 Deep circalittoral mixed sediment. A similar range of deep-sea sediments are also present on the continental shelf that extends north of Shetland, with the addition of A5.15 Deep circalittoral coarse sediment.

Plankton

Plankton, comprising bacteria, Archaea, phytoplankton, protists and zooplankton, form the base of the food web in cold waters such as the EZI and so are extremely important to the ecosystem as a whole (CAFF, 2017). Despite this, the plankton community in this region is poorly known. A summary of the knowledge of plankton in Arctic waters, which encompasses the majority of waters in the EZI, is provided in CAFF's (2017) State of the Arctic Marine Biodiversity Report. Monitoring of plankton in the Arctic has been most frequent in the waters of Jan Mayen, Iceland, and Greenland.

Phytoplankton are the only primary producers in cold waters such as the EZI and so form the base of the food web (CAFF, 2017). The Atlantic Arctic comprises the highest diversity of phytoplankton of all Arctic regions, as it contains a mixture of Arctic and North Atlantic species (CAFF, 2017). Dinoflagellates and diatoms are the most common functional groups (as found by microscopy) in the Atlantic Arctic (CAFF, 2017). Phytoplankton and other single-celled plankton are the main food for larger zooplankton such as copepods.

The zooplankton community comprises single and multi-celled organisms and is highly diverse in the Arctic, with over 350 species recorded (CAFF, 2017). Multicellular zooplankton include a wide range of invertebrates and larvae of other marine organisms such as fish (CAFF, 2017). Their longer life spans have led to the development of strategies, such as vertical migrations on daily and seasonal cycles, and preferred depth niches (CAFF, 2017). Copepods are the most abundant and well-studied species group of zooplankton, accounting for 80-90% of zooplankton biomass in the Arctic (CAFF, 2017). Copepods are highly diverse as over 150 species have been recorded in Arctic waters (CAFF, 2017). The copepod *Calanus finmarchicus* is the most common copepod species in sub-Arctic waters (CAFF, 2017). Copepods and other zooplankton such as hyperiid amphipods and euphausiids, are important prey items for other marine species including fish, seabirds, and baleen whales.

Plankton are strongly affected by environmental conditions such as water depth, current patterns, salinity, and temperature. The cyclic variation of these environmental factors leads to a predictable series of seasonal blooms by different components of the plankton community. Phytoplankton bloom in the spring, followed by an increase in zooplankton in that extends through to summer and is closely linked to availability of food as well as warmer temperatures.

Benthic Species and Habitats

Benthic invertebrates are an important part of the food web and form part of the diet of fish, marine mammals, and seabirds (CAFF, 2017). Despite their importance, they remain relatively poorly understood. In the Arctic, monitoring has been focussed on macro- and mega-benthic species (species >1 mm and species identifiable through imagery techniques, respectively), with comparatively less monitoring effort on

meiofauna (0.1-1.0 mm) and microfauna (<0.1 mm) (CAFF, 2017). There has been an increase in benthic monitoring around Iceland, Greenland and the Norwegian Sea, though many Arctic areas remain poorly understood.

The benthos is influenced by a variety of environmental factors including water depth, currents, temperature, food availability, and seabed sediments. The degree to which these environmental factors influence the benthos depends on their life strategies. For example, benthic fauna can be mobile or sessile, with sessile organisms more heavily influenced by local environmental conditions than mobile species which can move to areas of suitable habitat. Similarly, relative influence of conditions will vary by the species' position in relation to the sediment i.e. in the sediment (infauna), on the sediment (epifauna), or just above the sediment (hyperbenthos).

Over 4,000 benthic species have been recorded in Arctic waters, accounting for the majority of marine diversity in the Arctic (CAFF, 2017). The most numerous species group in the Arctic, including the EZI, is arthropods (Figure A10.3). Other species of high richness in the several Arctic regions that overlap the EZI (Iceland, Faroe Islands, Norway West, and Greenland) are polychaetes and molluscs. Beyond these top three groups there are localised differences between the regions: in the Faroe Islands and Greenland foraminifera are the fourth most rich species; this position is held by echinoderms in Norway West; and in Iceland there are several different groups, including 'other', which contribute notable percentages of the total species richness. The total number of species in these regions range from 1,807-2,345.

There is a paucity of trawl stations in the offshore waters of the EZI in comparison to other regions of the Arctic. Nevertheless, the few trawl stations show that typically fewer than 20 benthic megafaunal species/taxa have been recorded at each trawl station in the EZI, which is low compared to other regions of the Arctic (CAFF, 2017).

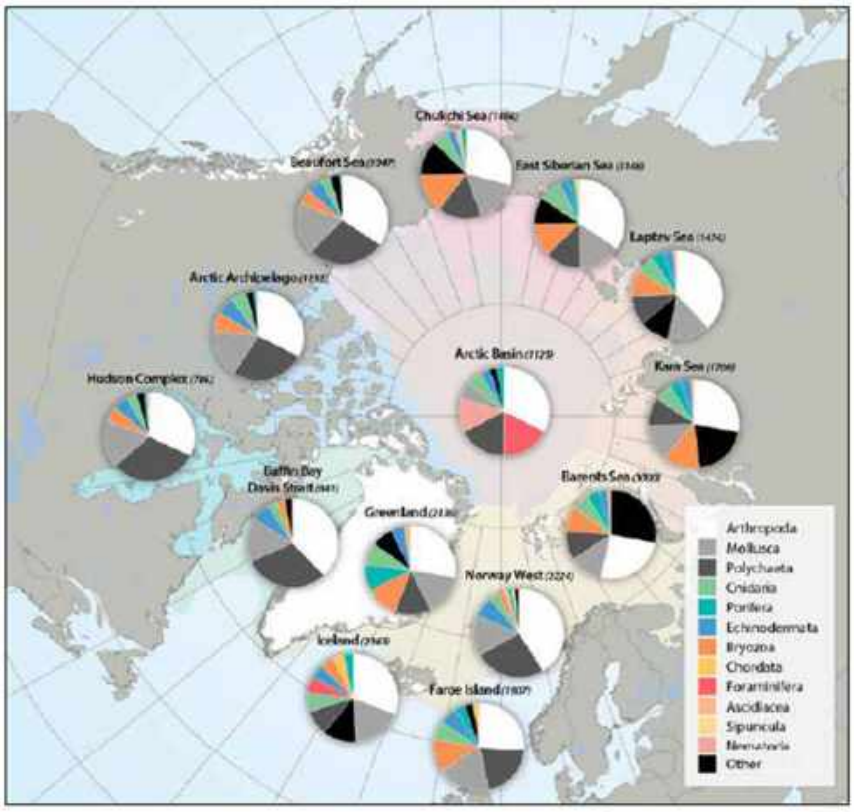


Figure A10.3 Regional pie charts showing the species/taxon number (in brackets) per region and the relative proportion of certain taxa in species richness (From: CAFF, 2017)

Certain benthic habitats, created by habitat-forming species, are especially sensitive to anthropogenic effects; these are known as Vulnerable Marine Ecosystems (VMEs). The FAO define VMEs as those areas that may be vulnerable to impacts from fishing activities (Buhl-Mortensen et al., 2019), though for the purpose of this study this definition is extended to include any anthropogenic activity that may interact with the seabed, which includes the proposed operations at SSC.

There are seven VME habitat types listed by the North East Atlantic Fisheries Commission (NEAFC): cold-water coral reef; coral garden; deep-sea sponge aggregations; seapen fields; tube-dwelling anemone patches; mud- and sand-emergent fauna; and bryozoan patches (FAO, 2020a). As shown in Figure A10.4, there are records of VMEs in the EZI, though comparatively fewer than the numbers recorded around the coast of Iceland, Norway, and the Faroe Islands (Buhl-Mortensen et al., 2019). The distribution of records is likely to be compounded by the amount of survey effort in each area. To overcome this, Buhl-Mortensen et al. (2019) modelled the predicted suitability of habitats throughout the Arctic and sub-Arctic for VMEs. The results of the modelling showed that the number of VMEs is negatively correlated with water depth and positively correlated with water temperature at the sea-bottom. The majority of the EZI is not predicted to provide conditions for VMEs, except for localised areas around the Faroes and the Faroe-Shetland belt.

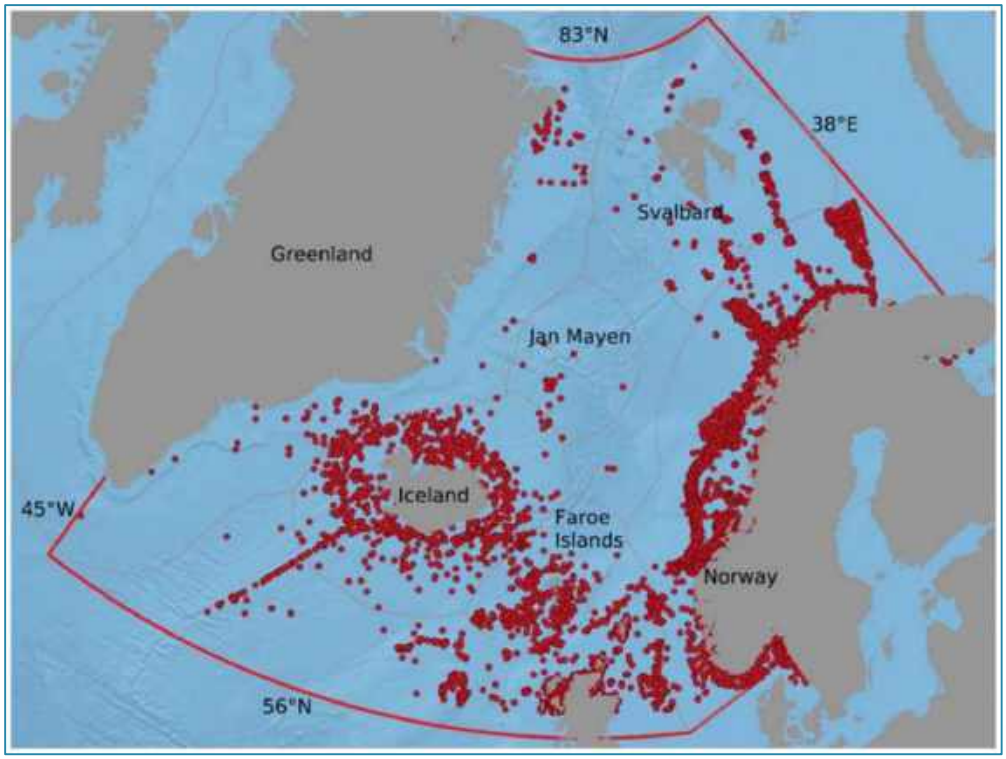


Figure A10.4 The location of Vulnerable Marine Ecosystem (VME) records in the northeast Atlantic (From: Buhl-Mortensen et al., 2019)

Fish

The Arctic waters of the EZI are highly productive and support a diverse fish community. A total of 633 species of marine fish have been recorded in the Arctic Ocean and adjacent seas (CAFF, 2017). Approximately 10% of these species are targeted commercially and so are subjected to stock assessments and are well-understood. Due to the lack of knowledge on the remaining 90%, this discussion focuses on the commercially important stocks.

According to OSPAR (2020), the Arctic waters support six fish species of major commercial importance: Atlantic cod *Gadus morhua*, saithe/pollock *Pollachius virens*, haddock *Melanogrammus aeglefinus*, blue whiting *Micromesistius poutassou*, Atlantic herring *Clupea harengus*, and capelin *Mallotus villosus*. The

analysis of commercial fisheries data from ICES presented in this section indicates that Atlantic mackerel *Scomber scombrus* are also of commercial importance.

Atlantic cod, saithe, haddock, and blue whiting are benthopelagic, feeding at or near the seabed, whereas Atlantic herring and capelin are pelagic mid-water column fish.

An overview of the distribution of these species and their spawning activity is presented in Table A10.1. Spawning grounds are not prevalent in the EZI due to its offshore location away from most coastal areas where spawning occurs. The exception are saithe and blue whiting which spawn offshore over deep waters. There may be minor overlap with spawning grounds at the southern extent of the EZI due to overlap with the northern North Sea. The key spawning period for most fish species is spring, though some Atlantic herring stocks in the EZI also spawn in autumn and summer.

Table A10.1 Overview of the key commercial fish species in the EZI (From: Johnson, 1977; Holste and Slotte, 1995; Jakobsson and Stefansson, 1999; Dickey-Collas et al., 2010; ICES, 2005; FishSource, 2019; FAO, 2020b)

Species	Spatial Distribution In The EZI	Spawning Activity
Atlantic cod *Gadus morhua*	Atlantic cod is present in discrete stocks around Norway, the Faroe Islands, Iceland, and the North Sea	Spawning typically occurs in discrete areas near the coasts of the country within the stock's home range, except for the North Sea where spawning activity is widespread. Spawning occurs from January to April
Saithe/pollock *Pollachius virens*	Saithe are widespread in the northeast Atlantic. They occur in three separate stock areas: Icelandic, Faroese, and Continental	Saithe spawn offshore, have nursery grounds in coastal waters, then migrate offshore as adults. They have spawning areas in the Norwegian Sea. Spawning occurs between January-March
Haddock *Melanogrammus aeglefinus*	Haddock stocks are present around Iceland, Faroe Islands and North Sea	Key spawning grounds are along Iceland, Norway and Shetland coasts, mostly outside of the EZI. Peak spawning occurs in March-April
Blue whiting *Micromesistius poutassou*	Blue whiting occurs in a single stock widespread in the northeast Atlantic	Spawning in northeast Atlantic occurs in deep water along the Faroe-Shetland channel. Spawning occurs in in spring
Atlantic herring *Clupea harengus*	The EZI overlaps considerably with the large northeast Atlantic/Norwegian stock of herring, as well as small distinct stocks around Iceland and the North Sea	These stocks spawn along the coast (of Norway, Iceland, and southern Shetland), outside of the EZI. Spawning occurs during autumn for the North Sea stock, in summer for the Icelandic stock, and in spring for the NE Atlantic stock
Capelin *Mallotus villosus*	The capelin stock that occurs in the EZI occurs in the waters between Jan Mayen and Iceland	Spawning grounds occur off southern Iceland, outside the EZI. Spawning occurs in spring
Atlantic mackerel *Scomber scombrus*	Atlantic mackerel occurs as a single stock throughout northeast Atlantic waters and are widespread	Spawning occurs in summer in warmer waters to the south of the EZI (though there is minor overlap with low density spawning at the southern limit of the EZI i.e. the northern North Sea)

Marine Ornithology

The cold northern regions of the North Atlantic are highly productive and support large numbers of breeding and visiting seabirds.

The EZI overlaps ICES region E1 (Barents and Norwegian Seas), which has a seabird community comprising 69% auks, 18% gulls, 10% petrels, and ≤2% eiders, terns and Pelecaniformes (Barrett *et al.,* 2006). There is not a single estimate for the number of species that may occur in the EZI. In Jan Mayen, over 98 bird species have been recorded (Gabrielsen and Strøm, 2004); 64 seabird species are recognised as part of the Arctic ecosystem (CAFF, 2017); and approximately 60 seabird species have been recorded in the Faroe Islands. It is clear that the EZI supports a highly diverse seabird community.

There are approximately 7.4 million breeding pairs, and 25.5 million seabirds total, in region E1 (Barrett *et al.,* 2006). Of the breeding birds, approximately 70% are auk species. The Faroe Islands, which lie adjacent to the study area, have recorded at least 21 species of seabird are reported to breed (Visit Faroe Islands, 2020). The most abundant breeding seabirds are northern fulmar *Fulmarus glacialis*, European storm-petrel *Hydrobates pelagicus*, Atlantic puffin *Fratercula arctica*, black-legged kittiwake *Rissa tridactyla*, and common guillemot *Uria aalge*. On Jan Mayen, 27 birds have been reported to breed, most of which are related to the marine environment (Gabrielsen and Strøm, 2004). The most common breeding species here are northern fulmar, black-legged kittiwake, Brünnich's guillemot *Uria lomvia*, and little auk *Alle alle*. Skov *et al*. (1995) reported that the most common seabirds during summer in the southern portion of the EZI was northern fulmar and Atlantic puffin.

Table A10.2 provides an overview of the seabird species groups that are likely to be present within the EZI, detailing example species, their distribution and feeding ecology. From the available data it is apparent that there is the potential for multiple species to be present in the EZI at all times of the year, either on a resident, breeding, wintering or migratory basis. The numbers of seabirds present will vary seasonally and also across different locations in the EZI.

Seabird species establish nests and rear chicks on land, therefore there are only a few locations in the EZI where breeding may occur. Some species breed throughout all land-based locations in the EZI and may be seen in the region most of the year-round. Other species' breeding is limited to the Arctic, in the northern part of the EZI, however these species may be seen at-sea in the southern part of the EZI during winter. Most seabird species breed on the sea cliffs, though some also use areas further inland such as heathlands (Visit Faroe Islands, 2020). The breeding season for seabird runs from May through September (Visit Faroe Islands, 2020), and so during this summer period seabirds are present in the highest numbers. During the breeding season seabirds will undertake at-sea foraging trips whilst at the colony. The distances to which they forage varies greatly between species, from 25 km for great cormorant to up to several hundreds of kilometres for northern gannet and northern fulmar (Woodward *et al.,* 2019).

The distribution of seabirds outside the breeding season is comparatively less well-known. It is hypothesised that seabird abundance in winter is linked to areas of high productivity, such as the waters southwest of Greenland, which is used by seabirds from both European and North American colonies (Boertmann *et al.,* 2004; Fredericksen *et al.,* 2012).

The SEATRACK project presents tracking data of seabirds from northwest Europe colonies during the non-breeding season (autumn through spring, August to April) from 2009-2019 (SEAPOP, 2020). Seabird distribution during the winter varies greatly depending on the species' strategy. Species including Atlantic puffin, black-legged kittiwake, common guillemot, and northern fulmar are widely distributed in the EZI during the non-breeding season. Brünnich's guillemot and little auk distribution is restricted to the northerly portion, bounded to the south by Iceland. Some species like common eider, European shag, glaucous gull herring gull remain close to their breeding colonies year-round. Lesser black-backed gull are concentrated around their breeding colonies but also have significant hotspots along southerly migration corridors to the equator.

The seabird community is diverse in form, comprising species that occupy a range of feeding niches, including surface-feeders like the gulls, sub-surface divers like auks, gannets and divers, and bottom feeders such as sea ducks (Barrett *et al.,* 2006; CAFF, 2017). Many seabirds feed exclusively in the marine environment, however, some also opportunistically scavenge or feed off the land, such as gulls and geese.

Table A10.2 Seabird groups, representative species with likely presence in the EZI and their autecology (From: Virtual Hebrides, 2014; CAFF, 2017; Oceanwide Expeditions, 2020; RSPB, 2020; Visit Faroe Islands, 2020)

Species Group	Representative Species	Spatiotemporal Distribution In The EZI	Feeding Ecology
Gaviformes	Great northern diver *Gavia immer*, red-throated diver *G. stellata*	Summers in Scotland and Iceland, which coincides with their breeding season (April-May). Great northern diver breeds in more northerly latitudes than red-throated diver. Once summer has passed, they move to warm waters further south. During the breeding season divers occupy sheltered water bodies, whereas outside the breeding season they spend time at sea.	Undertakes dives, up to 60 m in depth (for the great northern diver), to catch fish and crustaceans.
Sea ducks	Long-tailed duck *Clangula hyemalis*, common eider *Somateria mollissima*, velvet scoter *Melanitta fusca*, red-breasted merganser *Mergus serrator*	Some species of sea duck, like common eider and red-breasted merganser, breed in the EZI. Others, like the long-tailed duck and velvet scoter, do not as they breed along Arctic coasts. Those species that breed in the EZI do not typically reside there in winter, whereas the long-tailed duck and velvet scoter can be found in Iceland and Britain in winter.	Sea ducks dive to locate prey, taking aquatic invertebrates, fish, and plant matter. The extent of their diving nature varies; the best diver is the long-tailed duck, which can dive to 60 m.
Geese	Pink-footed goose *Anser brachyrhnychus*, barnacle goose *Branta leucopsis*, brent goose *B. bernicla*	These geese species typically breed in the northern part of the EZI such as Iceland, though barnacle geese have a small breeding population in the UK (south of the EZI). They are more common in the southern part of the EZI whilst migrating and during winter.	Geese feed off the land, eating grain, winter cereals, potatoes and grass
Pelecaniformes	Great cormorant *Phalacrocorax carbo*, European shag *P. aristotelis*, northern gannet *Morus bassanus*	European shag, great cormorant and gannets have been known to breed at coastal sites in the EZI, as well as having presence in other seasons in lower numbers	Pelecaniformes are piscivores and are well-adapted to visual hunting of fish. Shags and cormorants hunt in shallower waters as they target prey at the seabed, whereas gannets hunt shoaling fish near the surface

Species Group	Representative Species	Spatiotemporal Distribution In The EZI	Feeding Ecology
Petrels	Northern fulmar *Fulmarus glacialis*, Arctic skua *Stercorarius parasiticus*, great skua *Stercorarius skua*, Manx shearwater *Puffinus puffinus*, European storm-petrel *Hydrobates pelagicus*	The skuas, Manx shearwater and European storm-petrel visit the EZI during the warmer months; they breed here in summer and can also been seen in spring and autumn. Fulmar also breed here though they can be seen year-round in the EZI	Skuas are parasitic feeders in that they steal food from other seabirds, as well as scavenging off dead animals. Fulmars are opportunistic feeders, taking fish and invertebrates but also rubbish and carrion. Manx shearwater and European storm-petrel feed on small fish and invertebrates, and offal at the surface
Gulls	Black-legged kittiwake *Rissa tridactyla*, common gull *Larus canus*, herring gull *Larus argentatus*, glaucous gull *Larus hyperboreus*, great black-backed gull *Larus marinus*, lesser black-backed gull *Larus fuscus*, ivory gull *Pagophila eburnea*, black-headed gull *Chroicocephalus ridibundus*	Most gull species can be seen year-round in the EZI, with the exception of lesser black-backed gull which is absent in winter. Many species breed in the EZI, such as black-legged kittiwake, great black-backed gull, and glaucous gull, and so are more numerous in the warmer months. Iceland gull and glaucous gull are predominantly winter visitors.	Kittiwakes are exclusive marine feeders in that they eat small fish or the remains of fish, caught at the sea surface. Other gull species will also take land-based prey, carrion and rubbish, with less importance on marine prey
Terns	Arctic tern *Sterna paradisea*, common tern *Sterna hirundo*	Arctic tern is a common breeder in the EZI, and common tern breeds in low numbers on Shetland. Both species can be found in the warmer summer months, following which they migrate south in winter	Terns predominantly get their food from marine sources, eating small fish and pelagic invertebrates. They visually scan the sea for food at or just beneath the surface
Auks	Atlantic puffin *Fratercula arctica*, little auk *Alle alle*, common guillemot *Uria aalge*, Brünnich's guillemot *Uria lomvia*, black guillemot *Cepphus grylle*, razorbill *Alca torda*	Auks are the most abundant and the most abundantly breeding seabird species group in the EZI. Outside the breeding season auks are scarcer. Some species like Brünnich's guillemot and little auk only breed in the northern region of the EZI, and winter at sea in the southern portion.	Auk species feed on fish and crustaceans. Auks are characterised by their short wings which they use to propel themselves on whilst diving for food

Marine Megafauna

A number of marine mammal species (cetaceans, including whales, dolphins and porpoises, and pinnipeds, including seals and walrus) have been recorded within the EZI. Information from several sources that report on areas overlapping the EZI have been reviewed, including OSPAR (2020) and the North Atlantic Marine Mammal Commission (NAMMCO, 2020), a body that comprises representatives from Faroe Islands, Greenland, Iceland and Norway.

Seven species of pinniped, including six species of true seal and the walrus, are found in the waters of the Arctic and the North-east Atlantic (NAMMCO, 2020; OSPAR, 2020). Of these, four species of seal and the walrus are considered to be associated with the sea ice and do not have any management areas that are within the EZI (NAMMCO, 2019), therefore these species are not considered further. The two remaining seal species, harbour seal *Phoca vitulina* and grey seal *Halichoerus grypus*, are described as coastal and are likely to be present in the EZI.

Sixteen species of cetacean, including six species of baleen whale and 10 species of toothed whale, are common permanent residents in the North Atlantic region (NAMMCO, 2020). Of these, three species are associated with the sea ice, namely bowhead whale *Balaena mysticetus*, beluga *Delphinapterus leucas*, and narwhal *Monodon monoceros*, and shall not be considered further. The remaining species have movement patterns which overlap the EZI.

Table A10.3 provides an overview of the marine mammal species that are likely to be present within the EZI, detailing their distribution and feeding ecology. From the available data it is apparent that there is the potential for multiple species to be present in the EZI at all times of the year. The numbers of marine mammal's present will vary seasonally and also across different locations in the EZI.

A survey conducted in summer 1987 and 1989 reported that the most abundant species were long-finned pilot whale *Globicephala melas*, Atlantic white-sided dolphin *Lagenorhynchus acutus*, and common dolphin *Delphinus delphis*, which accounted for 93% of the cetacean abundance observed (Skov *et al.,* 1995).

Other species of megafauna that may be present in the EZI include common sunfish *Mola mola* and basking shark *Cetorhinus maximus* (CMS, 2020; Ocean Sunfish, 2020). These species have been included as part of the megafauna because their behavioural trait, of often remaining just below the sea surface, is more similar to marine mammals than other fish species.

Table A10.3 Overview of the marine mammal species with likely presence in the EZI (Source: NatureScot, 2019; SCOS, 2019; NAMMCO, 2020; NBN Atlas, 2020)

Marine Mammal Species	Abundance	Distribution	Habitat	Key Seasons	Prey
Harbour seal *Phoca vitulina*	The combined populations in Norway, Shetland and Iceland are approximately 23,500	There are several distinct populations in the EZI; Ireland-Scotland, Faroe Islands (historical), Iceland, and West Coast Norway	Harbour seals typically remain within 50 km of their coastal haul out sites	Harbour seal breeding season across their range occurs from February to July, though breeding colonies will differ in their timing	They are generalist predator, taking predominantly small to medium sized fish including cod, herring, sandeel and flatfish
Grey seal *Halichoerus grypus*	The combined populations in Norway, Faroe Islands, Shetland and Iceland is approximately 16,500	There are 2 distinct populations in the EZI; the northeast Atlantic which occurs in the waters of Scotland, Faroe Islands and Norway; and the Icelandic population	Grey seal haul out on islands, isolated beaches or on the pack ice. From these haul out sites they undertake foraging trips which can be 1-30 days, and up to several hundred kilometres from their haul out sites	Grey seal breeding season runs from late September until February/March, with peak activity in October/November	They are generalist feeders, taking a wide variety of prey usually near the sea bottom (demersal and benthic fish)
Polar bear *Ursus maritimus*	The total population is approximately 20,000 to 25,000. Around the Arctic basin the population trend is data deficient. Iceland has 700. 5 populations are stable, 2 are increasing	They have a circumpolar distribution, living in Canada, Alaska, Greenland, the Russian Arctic, the Norwegian Arctic and on the ice,	Primary habitat is the North Polar Basin. Encompassing Arctic Ocean. Using annual sea ice fields/coverage attached to	Migratory patterns: recede northward in spring and southward in the fall due to ice coverage. Breeding can take place from late January to February, but usually from March to	Carnivorous. Primary food source is Ringed Seals *Phoca hispida*, bearded seals *Erignathus barbatus,* hooded seals

Marine Mammal Species	Abundance	Distribution	Habitat	Key Seasons	Prey
	4 are in decline and 8 are data deficient.	shelves surrounding the North Pole.	shorelines. Summer habitat is surrounding land masses. They have a very large range and have been found 100km from the coastline.	June on sea ice. April to May is peak breeding time. Implantation of fertilised eggs doesn't occur until October/November due to the females' nutrition. Female hibernation takes place from October/November until January, through March or April. Pups are born from late November/January. Peak pupping is in mid-December.	*Cystophora cristata,* Harp Seals *Pagophilus groenlandicus* (especially newborn pups) and beluga whales *Delphinapterus leucas.* Occasionally eats small mammals, birds, eggs, kelp, berries, and grass. Eating skin and blubber leaving meat for scavengers.
Blue whale *Balaenoptera musculus*	Abundance of blue whale in the North Atlantic is low, estimated to be 2,490 in the Central North Atlantic	The species is rare in the northeast Atlantic except for in the waters around Iceland. There have also been sightings around Jan Mayen. The species undertakes extensive migrations each year, and are present in North Atlantic waters during summer months only, for feeding	Generally, occur in offshore waters	Very little is known of blue whale mating and calving. Calving generally occurs in the winter, whilst the species is in warm waters	Blue whale feed almost exclusively on euphausiids (krill)

Marine Mammal Species	Abundance	Distribution	Habitat	Key Seasons	Prey
Common minke whale *Balaenoptera acutorostrata*	Minke whales in the EZI comprise the northeast Atlantic stock, which has most recently been estimated as having an abundance of approximately 90,000 individuals	The species is common in the northeast Atlantic, particularly in Icelandic waters. Like other baleen whales, common minke whale undertakes extensive migrations each year, summering in the cool North Atlantic waters that comprise their feeding areas	Generally, occur in offshore waters though occasionally recorded in productive inshore waters e.g. upwelling zones	Calving of common minke whale generally occurs in the winter, whilst the species is in warm waters	Common minke whales feed on a variety of fish and invertebrates. In Arctic waters their diet comprises mostly krill, with increasing importance of fish with distance south
Fin whale *Balaenoptera physalus*	There are two fin whale management areas within the EZI; East Iceland and Faroe Islands, and North-West Norway. These two populations comprise approximately 30,500 individuals	Fin whale is distribution through the North Atlantic with peak numbers west of Iceland. Like other baleen whales, fin whale undertakes extensive migrations each year, summering in the cool North Atlantic waters that comprise their feeding areas	Fin whales are largely pelagic, but may occasionally be seen in coastal waters	Mating and calving occur in the warm breeding grounds during winter	Fin whale feed on euphausiids (krill) and small pelagic fish
Humpback whale *Megaptera novaeangliae*	There are two discrete humpback whale areas in the EZI; the Iceland/Faroes, and Norway. Abundance in these two areas is	Humpback whales in the northeast Atlantic are most common in Icelandic waters, with fewer sightings in offshore areas. Most	Humpback whales are largely pelagic, though during the feeding season they occur in highly	Mating and calving occur in the warm breeding grounds during winter	Feed mainly on euphausiids (krill) and small schooling fish

Marine Mammal Species	Abundance	Distribution	Habitat	Key Seasons	Prey
	estimated at 20,500 individuals	humpback whales undertake extensive migrations each year, though some remain in the cool waters of the North Atlantic year-round	productive upwelling zones		
Sei whale *Balaenoptera borealis*	The most recent surveys indicate an abundance of ~4,000 animals in the Central North Atlantic and European Atlantic	Sei whale distribution is poorly understood due to their offshore nature. Most sightings in summer are between Greenland and Iceland, with some in the Faroe-Shetland Channel. Scarce in UK and Norwegian waters	Sei whale prefers offshore and warmer waters than other baleen whales. They are often associated with bathymetric features like rises, due to prey abundance	Mating and calving occur in the warm breeding grounds during winter	The diet will vary depending on what is locally available. Preferred prey includes copepods, euphausiids (krill), other crustaceans and fish
Atlantic white-sided dolphin *Lagenorhynchus acutus*	Likely to be a single stock across the North Atlantic. Most recent surveys indicate 130,000 animals in this region	In the northeast Atlantic they are found in waters between East Greenland, Iceland, UK and Norway	They are found throughout the EZI, over steep areas of the continental shelf and open oceanic waters. They have a large home range that they move throughout, following seasonal movements of their prey	Birthing occurs in the summer months, from May to August with a peak in June and July	They have a varied diet, feeding opportunistically on schooling fish and occasionally cephalopods

Marine Mammal Species	Abundance	Distribution	Habitat	Key Seasons	Prey
Common bottlenose dolphin *Tursiops truncatus*	There have been several estimates of common bottlenose dolphin abundance in the wider European Atlantic waters, ranging from 19,000-28,000	Common bottlenose are found in waters across the Atlantic Ocean, as far north as Scotland, Faroe Islands and Norway	Common bottlenose dolphin inhabits a wide range habitats, from inshore sheltered areas to open oceans	Calving occurs during the warmer months, from May to October, peaking when sea temperatures are warmest	Common bottlenose dolphin varies their diet depending on location and season. They take pelagic and demersal fish, cephalopods and crustaceans
Harbour porpoise *Phocoena phocoena*	An estimated 22,800 animals occur in the European waters north of the UK	Harbour porpoise are mostly associated with the coasts of Iceland, Norway, Faroe Islands, and the UK. They have been known to make seasonal movements depending on habitat and prey requirements	Harbour porpoise is found in coastal areas, though they may sometimes be observed over deeper waters offshore	Mating and birthing occurs in summer, from May to July	Harbour porpoise diet varies by season and location. They can take a wide variety of benthic and pelagic prey, though only take two or three species at a time
Killer whale *Orcinus orca*	Up to 14,000 killer whales are estimated to use the waters of Iceland and Norway; these likely move within the wider northeast Atlantic	In the northeast Atlantic, killer whale may be found off the coast of Shetland, Iceland, and Norway	Killer whales can be found both inshore and offshore, in association with their prey. They undertake long-distance movements throughout their range	Calving of killer whales is poorly understood, but it is thought that there is no distinct season	Killer whales are generalist feeders, taking a range of marine species, though can become specialised in local areas

Marine Mammal Species	Abundance	Distribution	Habitat	Key Seasons	Prey
Long-finned pilot whale *Globicephala melas*	The most recent survey centred around the Faroe Islands indicated a population abundance of 344,000	The species is widely distributed in the northeast Atlantic. They are frequently found in the waters around the Faroe Islands, though do not typically go further north than Iceland	The species utilises both coastal and offshore habitats. Movements coincide with movements of prey	Breeding and mating usually takes place between April and September	Diet primarily consists of schooling squid, small pelagic fish also taken
Northern bottlenose whale *Hyperoodon ampullatus*	Approximately 28,000 individuals have been estimated for the North Sea, Norwegian Sea, and the waters around Iceland and the Faroe Islands	The species only occurs in the cool, northern parts of the North Atlantic. They are regularly seen in the Norwegian Sea and off the Faroe Islands	These whales prefer deep waters seaward of the continental shelf. Migration strategies vary between individuals	The breeding of northern bottlenose whale is not well understood. Calving is thought to occur in spring to early summer	The species feeds on deep-water squid only
Risso's dolphin *Grampus griseus*	There is an estimated abundance of 11,000 individuals in the northeast Atlantic	The species prefers warmer waters of the North Atlantic, hence it is only an occasional visitor to the EZI	Risso's dolphin are primarily found over continental slope, outer shelf, and oceanic areas. They do not undertake migrations, but will move to follow prey distribution	Risso's dolphin calve year-round, with a peak in summer between March and July	Their diet comprises cephalopods, with variable importance of species dependent on location
Sperm whale *Physeter macrocephalus*	The most recent survey around Iceland/Faroes created an abundance estimate of 23,200 individuals	Sperm whales are found throughout the world's oceans, right up to the ice edge at the poles.	Sperm whales are found in the open ocean though increase in numbers around the	Sperm whales breed and calve in the summer months in tropical waters	Their diet comprises mostly deep-sea cephalopods, with

Marine Mammal Species	Abundance	Distribution	Habitat	Key Seasons	Prey
			continental shelf and seamounts. Migrations are sec-specific, with predominantly males found at higher latitudes		some fish species also taken
Striped dolphin *Stenella coeruleoalba*	In the European Atlantic waters it is estimated that there are 372,000 striped dolphin	Striped dolphin are found in warm waters; the observations in Norway, Faroe Islands and Iceland are considered extra-limital	The species' distribution is linked to prey availability	Calving of striped dolphins occurs in summer or autumn	Their diet comprises mostly oceanic pelagic fish, particularly lanternfish and cod
White-beaked dolphin *Lagenorhynchus albirostris*	In excess of 100,000 individuals are estimated to occur in the North Atlantic Ocean	White-beaked dolphin are found in the cold waters of the North Atlantic. The species is common around Iceland, Norway, and the UK	The species shows a preference for water depths <200m, though it can be found both on and off the continental shelf	Both mating and calving is thought to occur in the summer months, between June and September	The species feeds mostly on fish species, but occasionally cephalopods and crustaceans too
Beaked whales Ziphiidae	The most recent surveys indicate that at least 14,500 individuals occur in European waters (closest extent to The EZI)	Beaked whales are found in all oceans of the world, though some species have restricted distribution	Generally found in deep waters area off continental shelves, often associated with areas of steep bathymetric relief	The reproduction of beaked whales is unknown	Beaked whales take deep water species of squid a fish, which they detect using echolocation

Marine Protected Areas

The EZI supports several Marine Protected Areas (MPAs) of different designations and under different jurisdictions. There are also a range of MPAs in coastal waters of the countries in the vicinity of the EZI, such as Iceland, Greenland, and Norway. Further details on the MPAs that have direct spatial overlap with the EZI are provided in Table A10.4.

Table A10.4 Details of marine protected areas that overlap the EZI (Source: JNCC, 2020a; Scottish Natural Heritage, 2020)

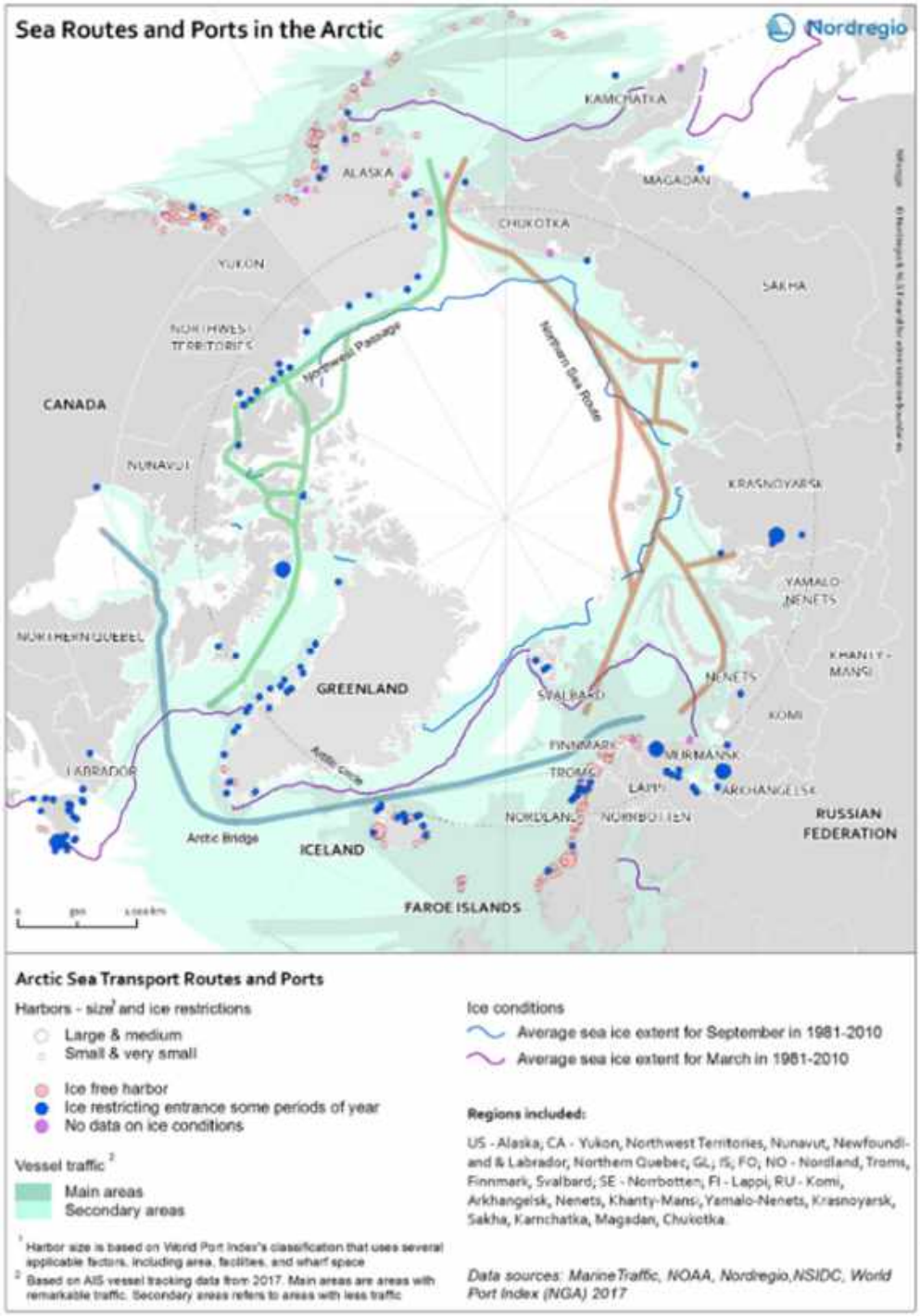
Marine Protected Area	Designated Features
Faroe-Shetland Sponge Belt Nature Conservation Marine Protected Area	Deep sea sponge aggregations Offshore subtidal sands and gravels Ocean quahog aggregations Continental slope Quaternary of Scotland - continental slope channels; iceberg ploughmark fields, prograding wedges Submarine Mass Movement - slide deposits Marine Geomorphology of the Scottish Deep Ocean Seabed - sand wave field, sediment wave field
North-east Faroe-Shetland Channel Nature Conservation Marine Protected Area	Deep sea sponge aggregations Offshore dee- sea muds Offshore subtidal sands and gravels Continental slope Quaternary of Scotland - prograding wedge; Submarine Mass Movement - slide deposits Marine Geomorphology of the Scottish Deep Ocean Seabed - contourite sand/silt Cenozoic Structures of the Atlantic Margin - mud diapirs
West Shetland Shelf Nature Conservation Marine Protected Area	Offshore subtidal sands and gravels
Hermaness, Saxa Vord and Valla Field Special Protection Area	Fulmar *Fulmarus glacialis*, breeding Gannet *Morus bassanus*, breeding Great skua *Stercorarius skua*, breeding Guillemot *Uria aalge*, breeding Kittiwake *Rissa tridactyla*, breeding Puffin *Fratercula arctica*, breeding Red-throated diver *Gavia stellata*, breeding Seabird assemblage, breeding Shag *Phalacrocorax aristotelis*, breeding
Fetlar Special Protection Area	Arctic skua *Stercorarius parasiticus*, breeding Arctic tern *Sterna paradisaea*, breeding Dunlin *Calidris alpina schinzii*, breeding Fulmar, breeding Great skua, breeding Red-necked phalarope *Phalaropus lobatus*, breeding Seabird assemblage, breeding Whimbrel *Numenius phaeopus*, breeding

Marine Protected Area	Designated Features
Fetlar to Haroldswick Nature Conservation Marine Protected Area	Black guillemot *Cepphus grylle* Circalittoral sand and coarse sediment communities Horse mussel beds Kelp and seaweed communities on sublittoral sediments Maerl beds Shallow tide-swept coarse sands with burrowing bivalves Marine Geomorphology of the Scottish Shelf Seabed
Pobie Bank Reef Special Area of Conservation	Reefs
Jan Mayen Strict Nature Reserve	The whole island and up to 12 nautical miles from the coastline

Humans/Human Activities

Shipping and Navigation

As the EZI encompasses mostly open ocean, there are very few ports in the EZI itself. Ports are present along of the coasts of adjacent countries such as Shetland, Iceland, Faroe Islands, and Norway, though these are mostly small (Figure A10.5). The majority of the EZI lies within the main area of vessel traffic in the Arctic, with the waters around Jan Mayen and Greenland form part of the secondary areas of traffic (Figure A10.5). The EZI does not overlap any of the three main Arctic Sea transport routes (Figure A10.5). As displayed for the wider region in Figure A10.6, vessel density is highest adjacent to the coasts where there are ports (Iceland, Norway, the Faroe Islands) which is mostly outside the EZI. Vessel density in the EZI can be characterised as low.



FigureA10.5 Sea routes and ports in the Arctic (From: Nordregio, 2020)



Figure A10.6 Ship traffic density in the vicinity of The EZI (From: EMODnet, 2020)

Oil and gas

Oil and gas infrastructure are present in high density in the UK Exclusive Economic Zone (EEZ) portion of the Study Area, and to a lesser extent in Norwegian waters. Many boreholes have been drilled in these areas; the majority of boreholes are located within active licence areas for hydrocarbon exploration. Installations are restricted to the west of Shetland and northeast of Shetland (in UK/Norwegian waters) and these are mostly operational with some being decommissioned (EMODnet, 2020). In the waters of Jan Mayen several deep-sea boreholes were drilled in 1974 but these have not been further exploited (Orkustofnun, 2008). Drilling campaigns have also occurred in the Faroe Islands with mixed success (Offshore Mag, 2004), and at present there are no installations.

There is significant interest by the petroleum industry in extraction of the potential hydrocarbon reserves located in The EZI, particularly in the offshore areas of the Faroe Islands, Iceland, and Norway. It is likely that hydrocarbon extraction in the area will increase in the coming years, therefore the potential risk to new developments will need to be taken into account for future launches from the SSC.

Cables and pipelines

Several subsea cables traverse the southern section of The EZI in UK and Faroese waters. These are (TeleGeography, 2020):

- FARICE-1: this cable connects Iceland, the Faroe Islands and Scotland and is owned by Icelandic company Farice. Landfall points are Dunnet Bay, Scotland, Funningsfjordur, Faroe Islands, and Seydisfjordur, Iceland;
- SHEFA-2: this cable connects the Faroe Islands with Shetland and north Scotland and is operated by the Faroese company Shefa. The cable makes landfall at Torshavn, Faroe Islands, Sandwick and Maywick in Shetland, Ayre of Cara in Orkney, and Banff in Scotland. There is also a cross-cable which connects Glen Lyon and BP Clair Ridge offshore;
- CANTAT-3: this cable connects Vestmannaeyjar, Iceland, Tjornuvik, Faroe Islands, and several locations in the North Sea and Denmark. It is also operated by Shefa;
- DANICE: this cable connects Landeyjasandur, Iceland, to Denmark, and is operated by Farice.

In addition to subsea cables, oil and gas pipelines are present in the southern portion of The EZI in UK and Norwegian waters. There are four pipelines that connect the various platforms in the oil and gas fields to the west of Shetland and those to the northeast of Shetland to onshore stations on Shetland such as the Sullom Voe Terminal. There is also a network of interconnecting pipelines between the numerous platforms in the oil and gas field to the northeast of Shetland.

Military

The EZI is used for military exercises by the North Atlantic Treaty Organization (NATO) and Russia. The EZI lies within Russia's bastion defence area, an area in the Norwegian Sea in which Russia has undertaken complex military exercises, including as recent as June 2020 (The Barents Observer, 2020). The EZI is also overlapped by the NATO sea exercise areas, which has been used for large exercises such as the Trident Juncture in 2018 (DW, 2018). Military exercises occur intermittently in these areas and can comprise both marine and aviation operations. There is potential for military activity to increase in The EZI in the future with increasing accessibility to the Arctic.

Other sea users

Other sea users include marine renewables (wave, wind, and tidal), aquaculture areas, marine aggregate dredging and disposal sites, carbon capture and storage, natural gas storage and minerals evaporites areas . There appear to be three other users of the marine environment in the EZI; aquaculture, waste disposal sites and marine renewable energy. There are many aquaculture sites located on the coast of Shetland. Aquaculture is of extreme economic importance to Shetland; in conjunction with fisheries it accounts for £300 million a year of revenue (Fish Farming Expert, 2020). The two waste disposal sites, located offshore in Faroese and Norwegian waters, have been utilised for dumping munitions (EMODnet, 2020). There are two marine renewable energy installations in The EZI, at the coast of Shetland, which are Shetland Tidal Array and the NOVA 30 Demonstrator (EMODnet, 2020). Though there are no offshore wind farms within the EZI, one offshore wind farm, Hywind Tampen, is located adjacent to the southeast corner (4C Offshore, 2020). There are no marine aggregate dredging sites, carbon capture and storage, or natural gas storage and mineral evaporites areas in The EZI (EMODnet, 2020).

Socioeconomics/Tourism

Due to the offshore location of the EZI, there are minimal sources of marine tourism. Perhaps the only source is cruise liners, which may be present in The EZI whilst transiting between ports in the wider region (Marine Vessel Traffic, 2020). As passengers do not disembark in the EZI, cruise ships can be considered as part of shipping and navigation.

For further consideration of the socioeconomics and tourism of Shetland, please see Chapter 14 of this EIA Report.

Marine Archaeology

There is a paucity of readily available information on the marine archaeological features in offshore waters across several countries' jurisdiction. Information on marine archaeological data is likely held by the countries that overlap The EZI, namely Scotland, Denmark, Iceland, and Norway. The difficulty of acquiring this data has been determined to be disproportionate to the level of information required to provide a preliminary characterisation.

Information on the location of shipwrecks in Scottish waters is available to view on Marine Scotland's National Marine Plan interactive (NMPi) website. There are numerous wrecks in the Scottish extent of The EZI; to illustrate, see Figure A10.17 for the location of wrecks within 90 km of the launch site. It can be inferred from the NMPi that the number of wrecks decreases with distance from the coast and increasing water depth. The potential for maritime wrecks is greater closer to land, notably ports and historic transit passages, but there is still potential outside of this. It is understood that there were several notable battles that occurred in The EZI which may provide discrete areas where a greater number of finds would be located. Aviation and prehistory are likely to have a different spatial distribution. It is therefore logical to assume that the number of wrecks present in The EZI will be low.

There is limited palaoelandscape potential where glacial, though there may be a few discrete areas closer to land and in sheltered locations.

Commercial Fisheries

The EZI overlaps the territorial fishing waters of several countries: Scotland, Norway, Denmark (Greenland and Faroe Islands). Beyond these territorial waters fishing rights are controlled by the NEAFC.

The estimated fishing effort in The EZI is variable. Based on Figure A10.7, fishing effort in the southern portion of The EZI (between Scotland and the Faroe Islands) is high (~1.0h/km^2), and decreases with increasing distance north through The EZI. With exception of south of Faroe Islands, fishing in most countries' waters is concentrated around the coast and so has minimal effort overlap with The EZI (Kroodsma et al., 2018; ICES, 2019a; 2019b). An assessment of estimated fishing effort in the NEAFC area indicated that fishing effort in 2005 was at or below 750 signals in each 0.5° × 0.5° grid cell for the portion of the NEAFC area that overlaps The EZI (FIRMS, 2009). The gear type that corresponded to the highest amount of effort in The EZI is pelagic trawls and seines, with bottom otter trawls used in highly localised areas also (Kroodsma et al., 2018; ICES, 2019a; 2019b).

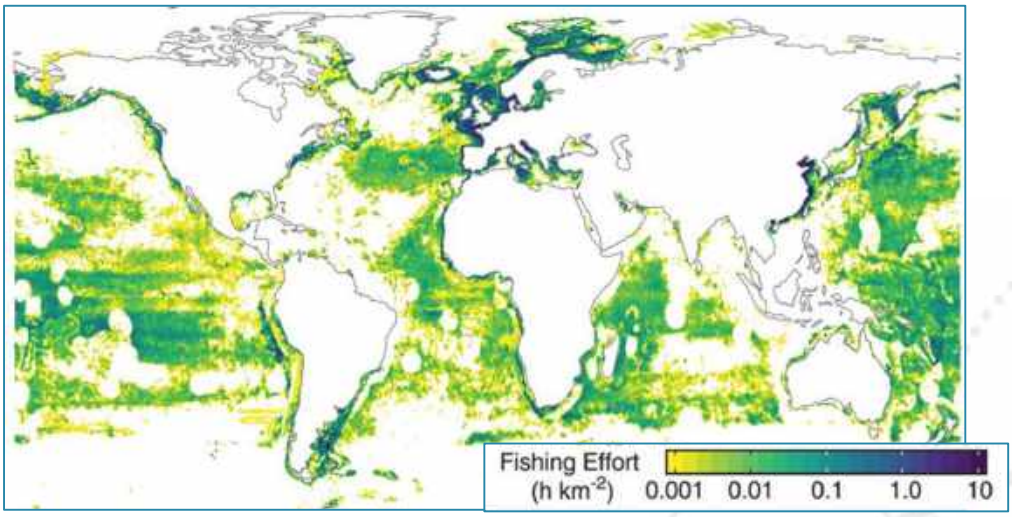


Figure A10.7: Total global fishing effort [hours fished per square kilometre (h/km^2)] in 2016 by all vessels with automatic identification system enabled (From: Kroodsma et al., 2018)

The EZI overlaps the following ICES Statistical Areas: IIa (Norwegian Sea), IVa (Northern North Sea), Va (Iceland Grounds), Vb (Faroes Grounds), and XIVa (North-East Greenland) (EC, 2020). ICES report on the annual nominal catches for all ICES regions submitted by the 20 ICES member countries (ICES, 2020). Data from the period 2013-2017 has been analysed for the purposes of characterising fishing in these areas.

Across all years in the period 2013-2017, the ICES area with the highest landings was Area IIa, which averaged approximately 3 mega tonnes (Mt) live weight per year. Landings in Area IIa have increased on a near-yearly basis. Area Va has traditionally been the second most productive, though in 2017 the amount landed here was slightly lower than in Area Vb, as this area has seen a near doubling in the total live weight landed across the timeframe analysed. Area IVa has consistently reported approximately 1 Mt each year. Landings in North-East Greenland are notably lower than the other regions.

Table A10.5 Total annual catch landed in each ICES Statistical Area overlapped by The EZI

Region	2013	2014	2015	2016	2017
IIa Norwegian Sea	2,949,560	3,111,124	3,132,679	2,878,558	3,596,486
IVa Northern North Sea	872,379	1,012,761	962,860	1,013,493	997,513
Va Iceland Grounds	2,561,050	1,747,167	2,352,502	1,765,015	1,914,735
Vb Faroes Grounds	1,158,214	1,234,380	1,618,992	1,559,118	1,960,229
XIVa North-East Greenland	2,493	56,624	11,079	19,354	10,500

Through analysis of the catch data it is also possible to comment on the relative contribution of different species to the overall landings in each area (as displayed in Figure A10.8-Figure A10.12). In Area IIa, Atlantic herring, Atlantic cod and Atlantic mackerel were the three most landed species for the period 2013-2017. A total of 4.2 Mt, 4.0 Mt, and 3.8 Mt were landed of Atlantic herring, Atlantic cod, and Atlantic mackerel, respectively. Atlantic herring and Atlantic mackerel were the two most commercially important species in Area IVa, with 1.8 Mt and 1.5 Mt landed, respectively. In Area Va, the following species comprised the most live weight landed (in decreasing order): capelin, Atlantic cod, Atlantic mackerel, Atlantic herring. Blue whiting dominated the landings in with over 5.7 Mt landed, an order of magnitude greater than the next most landed species. The two major species landed in Area XIVa are Atlantic herring and capelin, though the amount landed is much smaller than in other areas. In summary, the most commercially important species across the region are Atlantic cod, Atlantic mackerel, Atlantic herring, capelin, and blue whiting.

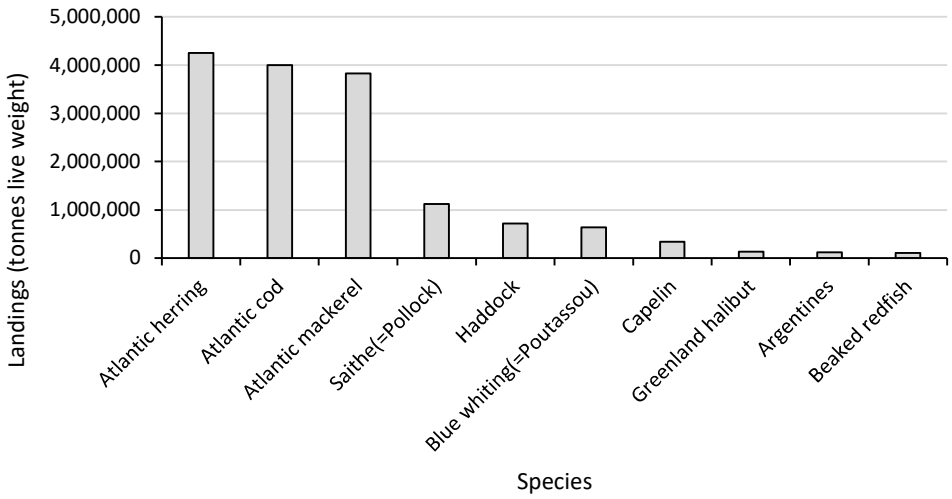


Figure A10.8 Landings weight of the top 10 species landed in Area IIa

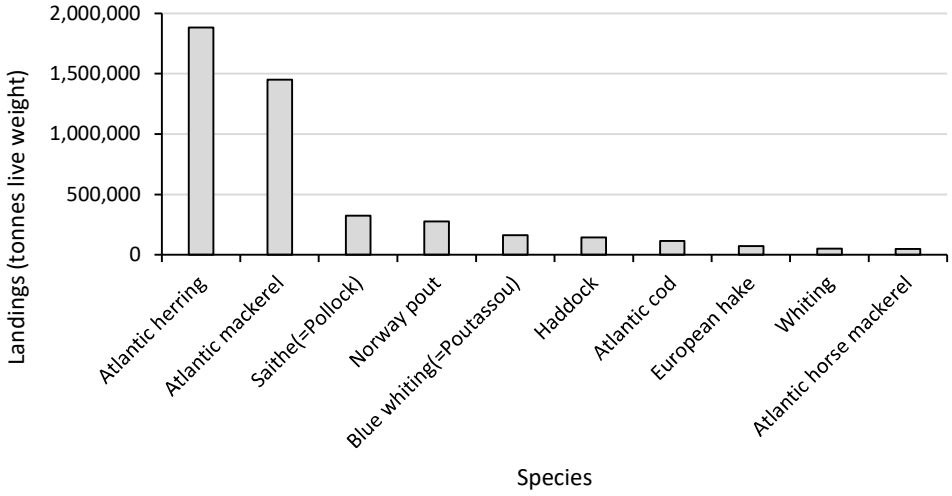


Figure A10.9 Landings weight of the top 10 species landed in Area IVa

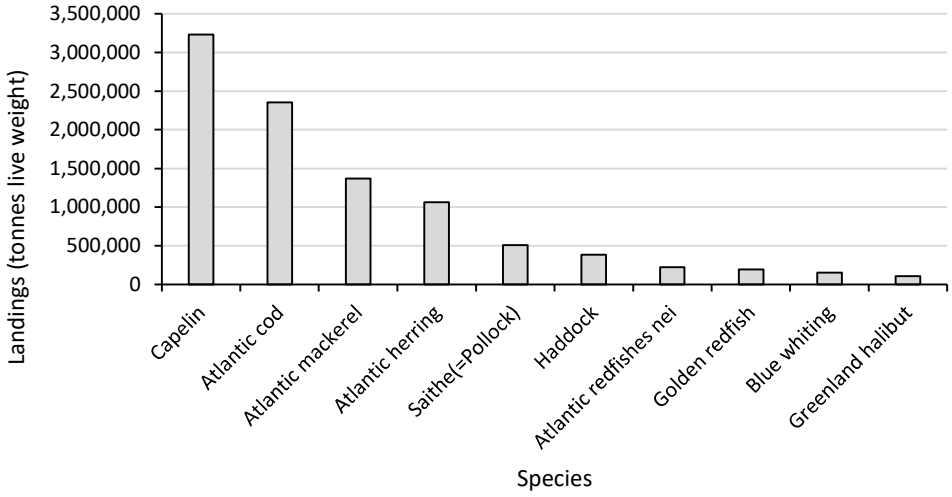


Figure A10.10 Landings weight of the top 10 species landed in Area Va

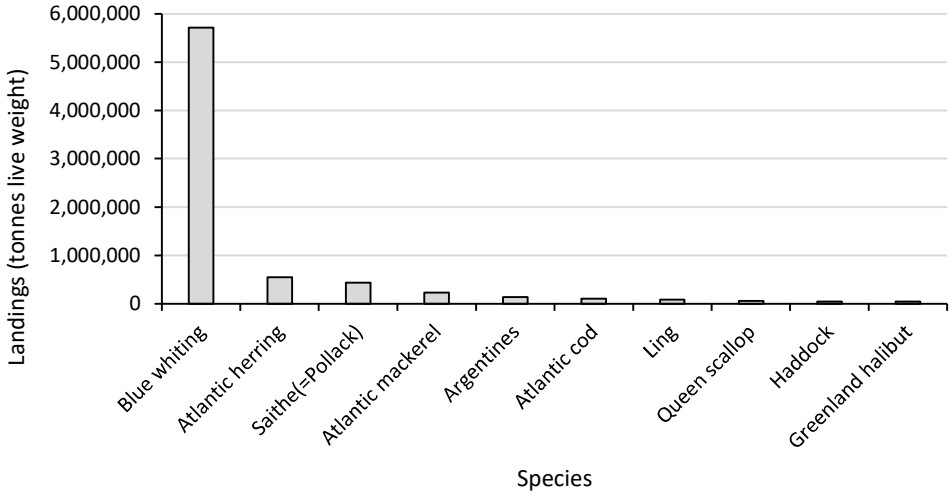
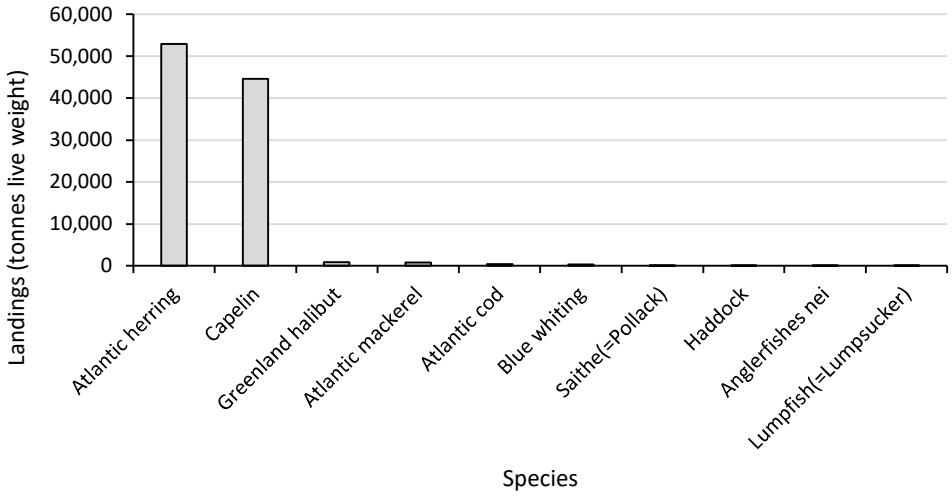


Figure A10.11 Landings weight of the top 10 species landed in Area Vb



FigureA10.12 Landings weight of the top 10 species landed in Area XIVa

Appendix 10.3 Water Quality Risk Matrix

SSC AEE Report Technical Appendix 10.3 - water quality risk matrix

Receptor	Water quality
Pressure Pathway/Impact	Effects from Fuel Spillage

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	The water quality of an area is of high environmental value and underpins the surrounding marine environment.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed	Sea water exposed to hydrocarbons will lead to local increases in hydrocarbon concentration which could lead to notable changes to the water's properties.	2
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure		
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure	Sea water exposed to hydrocarbons will lead to local increases in hydrocarbon concentration which could affect the water's properties.	2
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	The source of hydrocarbons (LVs) will pass through the water column and then rest on the seabed. It is anticipated that any residual fuel will be released into the marine environment immediately upon entering it, following which it'll disperse. Given the small amount of residual fuel expected, it is anticipated that hydrocarbon levels local to the LV will reach background levesl over a short time scale.	0
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	**7**	**2**

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	The water quality receptor is likely to be exposed to impacts over considerable periods of time, i.e. the duration of the 30 year licence.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There is expected to be up to 10 launches per year in the initial years, rising to a maximum of 30 launches per year. However, the occurrence of residual fuel is anticipated to be rare as under normal circumstances all fuel it utilised during the launch.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the highly limited impact zone at the waters surface as a result of hydrocarbon spill (<0.5 km^2), impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	**4**	**1**

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability		
1	Impact is measurable above natural variability (0-5% change in contaminant concentration)	Direct impacts to the hydrocarbon concentration of the sea water is likely to be measureable above natural variability, as there are limited other sources of hydrocarbons in the marine environment.	1
2	Impact is measurable above natural variability (6-10% change in contaminant concentration)		
3	Impact is measurable above natural variability (>10% change in contaminant concentration)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions		
1	Impact is measurable above present baseline conditions (0-5% change in contaminant concentration)	Direct impacts to the hydrocarbon concentration of the sea water is likely to slightly detectable above the baseline (at a very localised scale), as there are limited other sources of hydrocarbons in the marine environment.	1
2	Impact is measurable above present baseline conditions (6-10% change in contaminant concentration)		
3	Impact is measurable above present baseline conditions (>10% change in contaminant concentration)		

Overall Magnitude of Impact	**2**	**1**

Overall Risk (sensitivity x exposure x magnitude)	**Low**	**2**

Receptor	**Water quality**
Pressure Pathway/Impact	**Effects from Metal Corrosion**

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	The water quality of an area is of high environmental value and underpins the surrounding marine environment.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed	Sea water exposed to metal corrosion will lead to local increases in metal concentration which could lead to notable changes to the water's properties.	2
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure		
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure	Sea water exposed to metal corrosion will lead to local increases in metal concentration which could affect the water's properties.	2
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)		
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)	The source of metals (LVs) will pass through the water column and then rest on the seabed. Metal corrision could happen throughout this passage, though it is anticipated to be highest at the seabed due to longevity in this environment. The LV has only small amounts of metals, predominantly aluminium, which is one of the least corrosive in the marine environment. Given the longevity of aluminium in the marine environment, water quality will recover over a long time scale.	2
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	**9**	**2**

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	The water quality receptor is likely to be exposed to impacts over considerable periods of time, i.e. the duration of the 30 year licence.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)		
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)	There is expected to be up to 10 launches per year in the initial years, rising to a maximum of 30 launches per year.	1
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the highly limited impact zone around LVs as they pass through the water column and rest at the seabed, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	5	2

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability		
1	Impact is measurable above natural variability (0-5% change in contaminant concentration)	Direct impacts to the metal concentration of the sea water is likely to be measureable above natural variability. Aluminium is the main metal which is occurs naturally in the marine environment but in low concentration.	1
2	Impact is measurable above natural variability (6-10% change in contaminant concentration)		
3	Impact is measurable above natural variability (>10% change in contaminant concentration)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions		0
1	Impact is measurable above present baseline conditions (0-5% change in contaminant concentration)	Direct impacts to the metal concentration of the sea water is likely to be measureable above the baseline. Aluminium is the main metal which is occurs naturally in the marine environment but in low concentration.	
2	Impact is measurable above present baseline conditions (6-10% change in contaminant concentration)		
3	Impact is measurable above present baseline conditions (>10% change in contaminant concentration)		

Overall Magnitude of Impact	1	1

Overall Risk (sensitivity x exposure x magnitude)	Low	4

Receptor	Water quality
Pressure Pathway/Impact	Effects from Microplastics and Debris

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	The water quality of an area is of high environmental value and underpins the surrounding marine environment.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed	Microplastic exposure will lead to local increases in microplastic concentration which could lead to notable changes to the water's properties.	2
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure		
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure	Microplastic exposure will lead to local increases in microplastic concentration which could affect the water's properties.	2
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	The source of microplastics (LVs) will pass through the water column and then rest on the seabed. Microplastics have the potential to be released throughout this passage. Given the small amount of plastics expected, it is anticipated that microplastic levels local to the LV will reach background levesl over a short time scale.	0
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	7	1

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	The water quality receptor is likely to be exposed to impacts over considerable periods of time, i.e. the duration of the 30 year licence.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)		
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)	There is expected to be up to 10 launches per year in the initial years, rising to a maximum of 30 launches per year. It is noted that, based on our current understanding, not all of the rockets launched from the SSC site will contain plastics (so far, 1 of 3 clients' rockets has been identified as utilising plastic).	1
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the limited impact zone around LVs as they sink through the water column, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	**5**	**2**

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability		0
1	Impact is measurable above natural variability (0-5% change in contaminant concentration)	Direct impacts to the microplastic concentration of the sea water is likely to be slightly measureable above natural variability.	1
2	Impact is measurable above natural variability (6-10% change in contaminant concentration)		
3	Impact is measurable above natural variability (>10% change in contaminant concentration)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions		0
1	Impact is measurable above present baseline conditions (0-5% change in contaminant concentration)	Direct impacts to the microplastic concentration of the sea water is likely to be slightly measureable above the baseline (at a highly local scale).	1
2	Impact is measurable above present baseline conditions (6-10% change in contaminant concentration)		
3	Impact is measurable above present baseline conditions (>10% change in contaminant concentration)		

Overall Magnitude of Impact	**2**	**1**

Overall Risk (sensitivity x exposure x magnitude)	**Low**	**2**

Appendix 10.4 Biodiversity Risk Matrix

Skyrora AEE Report Technical Appendix 10.4 - biodiversity risk matrix - marine ornithology

Receptor	Marine Ornithology
Pressure Pathway/Impact	Effects from Fuel Spillage/Metal Corrosion/Debris and Microplastics - indirect effects to prey

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	Marine ornithological receptors have a high cultural value and many species are protected by international law. The Arctic Region region has notable presence of marine ornithological features, though it is not considered a special habitat. There is the presence of breeding colonies for seabirds, but only on land.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed	Marine ornithological features are very tolerant of impacts as they range over a wide area and alternative feeding areas are available to them.	1
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure	Marine ornithological features are considered very adaptable by virtue of their ability to forage over wide ranges and take a variety of prey.	1
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	Species that target that area would be able to return as soon as the Skyrora XL Launch Vehicle had passed through the water column (predicted to be <1 year)	0
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	5	1

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	Species are likely to be exposed to impacts over considerable periods of time, i.e. the full duration of the licence.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)		
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)	There are expected to be up to 16 launches per year.	1
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the limited impact zone from the returning Skyrora XL Launch Vehicles and wide foraging ranges of seabirds exposure to impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	5	2

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability	The magnitude of the impact (i.e. any changes at a population scale) will not be detectable above natural variability.	0
1	Impact is measurable above natural variability (0-5% change)		
2	Impact is measurable above natural variability (6-10% change)		
3	Impact is measurable above natural variability (>10% change)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	The magnitude of the impact (i.e. the amount of feeding habitat that becomes unvailable on the short timescale) will not be detectable above the baseline.	0
1	Impact is measurable above present baseline conditions (0-5% change in baseline population)		
2	Impact is measurable above present baseline conditions (6-10% change in baseline population)		
3	Impact is measurable above present baseline conditions (>10% change in baseline population)		

Overall Magnitude of Impact	0	0

Overall Risk (sensitivity x exposure x magnitude)	Negligible	0

Receptor	Marine Ornithology
Pressure Pathway/Impact	Direct stike causing mortality/serious injury - whilst loafing/flying

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	Marine ornithological receptors have a high cultural value and many species are protected by international law. The Arctic Region region has notable presence of marine ornithological features, though it is not considered a special habitat. There is the presence of breeding colonies for seabirds, but only on land.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed	If a seabird is struck by returning parts of the Skyrora XL Launch Vehicle it will likely have lethal or serious injury consequences	3

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure		
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure	If a seabird is struck by returning parts of the Skyrora XL Launch Vehicle it will likely have lethal or serious injury consequences to which it cannot adapt	3

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)		
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale	If a seabird is struck by returning parts of the Skyrora XL Launch Vehicle it will likely have lethal or serious injury consequences which are not recoverable	3

Overall Sensitivity of the Receptor	12	3

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	Species are likely to be exposed to impacts over considerable periods of time, i.e. the full duration of the licence.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There are expected to be up to 16 launches per year; however, a single individual will only be exposed to this impact pathway a maximum of one time during it's lifetime.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the highly spatially limited impact zone from the returning Skyrora XL Launch Vehicles and wide habitat usage by seabirds exposure to impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	4	1

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability	The very low level of effects on seabirds will not be measurable above natural variability.	0
1	Impact is measurable above natural variability (0-5% change)		
2	Impact is measurable above natural variability (6-10% change)		
3	Impact is measurable above natural variability (>10% change)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	The very low level of effects on seabirds will not be measurable above the baseline.	0
1	Impact is measurable above present baseline conditions (0-5% change in baseline population)		
2	Impact is measurable above present baseline conditions (6-10% change in baseline population)		
3	Impact is measurable above present baseline conditions (>10% change in baseline population)		

Overall Magnitude of Impact	0	0

Overall Risk (sensitivity x exposure x magnitude)	Negligible	0

Receptor	Marine Ornithology
Pressure Pathway/Impact	Disturbance Effects from the Return of Launch Parts

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	Marine ornithological receptors have a high cultural value and many species are protected by international law. The Arctic Region region has notable presence of marine ornithological features, though it is not considered a special habitat. There is the presence of breeding colonies for seabirds, but only on land.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed	Seabirds are predicted to be entirely tolerant of the disturbance effect from the presence of an Skyrora XL Launch Vehicle and recovery vessel at the sea surface.	2
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure	Seabirds are predicted to have a high adaptability to the disturbance effect from the presence of an Skyrora XL Launch Vehicle and recovery vessel at the sea surface.	1
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	As seabirds are predicted to not be changed or affected by the disturbance effect, they will reocver instantly.	0
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	6	2

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time	Marine ornithology features are likely to be exposed to impacts over considerable periods of time, i.e. the full duration of the licence, however disturbance events will only occur for a minimal period of time (up to 45 minutes per launch)	1
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time		

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)		
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)	There are expected to be up to 16 launches per year.	1
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the limited impact zone of noise and visual disturbance around the Skyrora XL Launch Vehicle stages/vessel, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	3	1

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability	Direct impacts to marine ornithology will not be measureable above natural variability.	0
1	Impact is measurable above natural variability (0-5% change)		
2	Impact is measurable above natural variability (6-10% change)		
3	Impact is measurable above natural variability (>10% change)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	Direct impacts to marine ornithology will not cause a measurable change in the baseline.	0
1	Impact is measurable above present baseline conditions (0-5% change in baseline population)		
2	Impact is measurable above present baseline conditions (6-10% change in baseline population)		
3	Impact is measurable above present baseline conditions (>10% change principle in baseline population)		

Overall Magnitude of Impact	0	0

Overall Risk (sensitivity x exposure x magnitude)	Negligible	0

Skyrora AEE Report Technical Appendix 10.4 - biodiversity risk matrix - marine protected areas

Receptor	Marine Protected Areas	
Pressure Pathway/Impact	Effects from Fuel Spillage/Metal Corrosion/Debris and Microplastics	See the risk matrix for water quality, benthic habitats, and marine ornithology for effects to designated marine ecological and water quality features of the MPAs.

Receptor	Marine Protected Areas	
Pressure Pathway/Impact	Direct loss of seabed habitat via deposition of material on the seabed	See the risk matrix for benthics for effects to designated marine ecological and water quality features of the MPAs.

Receptor	Marine Protected Areas	
Pressure Pathway/Impact	Direct strike causing mortality/serious injury	See the risk matrix for marine ornithology for effects to designated marine ecological features of the MPAs.

Receptor	Marine Protected Areas	
Pressure Pathway/Impact	Disturbance Effects from the Return of Launch Parts	See the risk matrix for plankton, fish, marine megafauna and marine ornithology for effects to designated marine ecological features of the MPAs.

Appendix 10.5 Humans and Human Activities Risk Matrix

Skyrora AEE report Appendix 10.5 - humans and human activities risk matrix

Receptor	**Commercial and Recreational Fishing**
Pressure Pathway/Impact	**Displacement of fishing stock**

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	The EZI supports commercially important fisheries for several nations.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed	Fishing vessels in the EZIs are predominantly mobile, due to their mostly offshore location, and therefore are able to move to follow displaced fishing stocks.	1
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure	Adaptability is high as most fishing vessels will be able to move to follow displaced fishing stocks.	1
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	Fish are highly mobile and will be able to return to an area once a Skyrora XL Launch Vehicle has passed, predicted to occur on the short-term scale. Fishing vessels are adaptable and would also be able to return to the area where fish were.	0
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	**5**	**1**

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time	Fish are likely to be exposed to impacts over considerable periods of time, i.e. the full duration of the licence. However, given the short duration of the proposed impact, the longevity of the exposure is reduced.	2
3	Receptor is exposed to impact over extensive periods of time		

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)		
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)	There are expected to be up to 16 launches per year.	1
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the highly limited impact zone around LVs as they pass through the water column and rest at the seabed, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	**4**	**1**

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability	The displacement of fish as a result of LVs entering the marine environment will not be detectable above natural variation.	0
1	Impact is measurable above natural variability (0-5% change in fishing stock)		
2	Impact is measurable above natural variability (6-10% change in fishing stock)		
3	Impact is measurable above natural variability (>10% change in fishing stock)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	The fish stock baseline will not change as a result of the LVs entering the marine environment.	0
1	Impact is measurable above present baseline conditions (0-5% change in fishing stock)		
2	Impact is measurable above present baseline conditions (6-10% change in fishing stock)		
3	Impact is measurable above present baseline conditions (>10% change in fishing stock)		

Overall Magnitude of Impact	**0**	**0**

Overall Risk (sensitivity x exposure x magnitude)	**Negligible**	**0**

Receptor	Commercial and Recreational Fishing
Pressure Pathway/Impact	Vessel displacement

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	The EZI supports commercially important fisheries for several nations.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed	Vessels will receive communications wrt to the location of exclusion zones around the predicting landing area of Skyrora XL Launch Vehicles. Vessels are highly mobile and will be able to move away from these locations if required. Given the highly localised nature of the impact zones in comparison to the distribution of target species, fishing vessels are considered very tolerant of the impact.	1
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure	Adaptability is high as most fishing vessels will be able to move to areas outside the impact zone.	1
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	Fishing vessels are highly mobile and will be able to return to an area once an Skyrora XL Launch Vehicle has passed, predicted to occur on the short-term scale (i.e. hours).	0
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	5	1

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	Fishing vessels are likely to be exposed to impacts over considerable periods of time, i.e. the full duration of the licence.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)		
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)	There is expected to be up to 16 launches per year.	1
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the small spatial extent of the impact zone around returning Skyrora XL Launch Vehicles, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	5	2

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability		
1	Impact is measurable above natural variability (0-5% change in distribution of fishing vessels)	The displacement of fishing vessels as a result of LVs entering the marine environment will be slightly detectable above natural variation.	1
2	Impact is measurable above natural variability (6-10% change in distribution of fishing vessels)		
3	Impact is measurable above natural variability (>10% change in distribution of fishing vessels)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	The fishing vessel presence baseline will not change as a result of the exclusion zones around Skyrora XL Launch Vehicles entering the marine environment	0
1	Impact is measurable above present baseline conditions (0-5% change in distribution of fishing vessels)		
2	Impact is measurable above present baseline conditions (6-10% change in distribution of fishing vessels)		
3	Impact is measurable above present baseline conditions (>10% change in distribution of fishing vessels)		

Overall Magnitude of Impact	1	1

Overall Risk (sensitivity x exposure x magnitude)	Low	2

Skyrora AEE report Appendix 10.5 - humans and human activities risk matrix

Receptor	**Human infrastructure (subsea cables/pipelines)**
Pressure Pathway/Impact	**Direct impact as a result of LVs returning**

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	Subsea cables and pipelines are of high financial value.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed	Subsea cables and pipelines would potentially be intolerant of the impact of an Skyrora XL Launch Vehicle as it could cause significant structural damage.	3

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure		
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure	Subsea cables and pipelines would potentially be not adapble to the impact of an Skyrora XL Launch Vehicle as it could cause significant structural damage.	3

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)		
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale	Subsea cables and pipelines could potentially not recover from the impact of an Skyrora XL Launch Vehicle if it caused significant structural damage.	3

Overall Sensitivity of the Receptor	**12**	**3**

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	Human infrastructure are likely to be exposed to impacts over extensive periods of time, i.e. the full duration of the licence.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There is expected to be up to 16 launches per year. However, the likelihood of Skyrora XL Launch Vehicles repeatedly encountering any given human infrastructure is extemely low, taking into account the extent of the EZI.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the highly limited impact zone around Skyrora XL Launch Vehicles, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	**4**	**1**

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability		N/A
1	Impact is measurable above natural variability (0-5% change in total numbers of individuals)		N/A
2	Impact is measurable above natural variability (6-10% change in total numbers of individuals)		N/A
3	Impact is measurable above natural variability (>10% change in total numbers of individuals)		N/A

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions		
1	Impact is measurable above present baseline conditions (0-5% change in total undisturbed available habitat)	If the impact was to occur then the magnitude of the impact would be high. However, it is considered that the likelihood of such an impact is negligible, hence the overall magnitude has been reduced	1
2	Impact is measurable above present baseline conditions (6-10% change in total undisturbed available habitat)		
3	Impact is measurable above present baseline conditions (>10% change in total undisturbed available habitat)		

Overall Magnitude of Impact	**1**	**1**

Overall Risk (sensitivity x exposure x magnitude)	**Low**	**3**

Skyrora AEE report Appendix 10.5 - humans and human activities risk matrix

Receptor	**Marine and Coastal Tourism**
Pressure Pathway/Impact	**Interference/Displacement**

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value	The EZI supports a moderate amount of tourism and recreation activitly, which are mostly concentrated at the coast.	2
3	Receptor has a high financial, environmental or cultural value		

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed	Notices will be given out prior to launches from the SaxaVord Spaceport which will allow many tourism/recreational activities to temporarily alter location or pause for the duration of the launch.	1
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure	Most vessels are highly mobile and will be able to adapt if required to move away, with only small vessels that are slightly less adaptable.	1
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	All vessels are highly mobile and will be able to return to an area once a Skyrora XL Launch Vehicle has passed, predicted to occur on the short-term scale (i.e. hours).	0
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	**4**	**1**

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time	Tourism activities are likely to be exposed to impacts over considerable periods of time, i.e. the full duration of the licence, however only for a short period per launch (45 minutes), up to a maximum of 11.25 hours over the licence term (30 launches per year × 30 years × 0.75 hours).	1
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time		

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)		
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)	There is expected to be up to 16 launches per year.	1
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the small spatial extent of the impact zone around returning Skyrora XL Launch Vehicles and the concentration of most tourist activities around the coast, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	**3**	**0**

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability	N/A	N/A
1	Impact is measurable above natural variability (0-5% change in total numbers of individuals)	N/A	N/A
2	Impact is measurable above natural variability (6-10% change in total numbers of individuals)	N/A	N/A
3	Impact is measurable above natural variability (>10% change in total numbers of individuals)	N/A	N/A

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	The current tourism baseline will not impacted by the temporary implementation of small exclusion zones.	0
1	Impact is measurable above present baseline conditions (0-5% change in total undisturbed available habitat)		
2	Impact is measurable above present baseline conditions (6-10% change in total undisturbed available habitat)		
3	Impact is measurable above present baseline conditions (>10% change in total undisturbed available habitat)		

Overall Magnitude of Impact	**0**	**0**

Overall Risk (sensitivity x exposure x magnitude)	**Negligible**	**0**

Skyrora AEE report Appendix 10.5 - humans and human activities risk matrix

Receptor	**Military Activities**
Pressure Pathway/Impact	**Vessel displacement**

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	Military activities are important in terms of economics and defence. Military activities occur intermittently in the EZI.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed	There will be communications wrt to the location of exclusion zones around the predicting landing area of Skyrora XL Launch Vehicles. Military vessels are highly mobile and will be able to move away from these locations if required.	1
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure	Military vessels are highly mobile and will be able to adapt if required to move away, with only small vessels that are slightly less adaptable.	1
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	Military vessels are highly mobile and will be able to return to an area once an Skyrora XL Launch Vehicle has passed, predicted to occur on the short-term scale (i.e. hours).	0
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	**5**	**1**

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	Vessels are likely to be exposed to impacts over considerable periods of time, i.e. the full duration of the licence.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There is expected to be up to 16 launches per year. Howver, military exercises occur on an intermittent basis i.e. not every month.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the small spatial extent of the impact zone around returning Skyrora XL Launch Vehicles, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	**4**	**1**

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability	N/A	N/A
1	Impact is measurable above natural variability (0-5% change in total numbers of individuals)	N/A	N/A
2	Impact is measurable above natural variability (6-10% change in total numbers of individuals)	N/A	N/A
3	Impact is measurable above natural variability (>10% change in total numbers of individuals)	N/A	N/A

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	The baseline military exercise in the EZI is highly intermittent. Therefore the baseline will not change as a result of short-term implementation of exclusion zones.	0
1	Impact is measurable above present baseline conditions (0-5% change in total undisturbed available habitat)		
2	Impact is measurable above present baseline conditions (6-10% change in total undisturbed available habitat)		
3	Impact is measurable above present baseline conditions (>10% change in total undisturbed available habitat)		

Overall Magnitude of Impact	**0**	**0**

Overall Risk (sensitivity x exposure x magnitude)	**Negligible**	**0**

Skyrora AEE report Appendix 10.5 - humans and human activities risk matrix

Receptor	**Navigation and Shipping**
Pressure Pathway/Impact	**Vessel displacement**

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value	The EZI supports a moderate density of shipping traffic, which is mostly concentrated at the coast.	2
3	Receptor has a high financial, environmental or cultural value		

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed	Vessels will receive communications with respect to the location of exclusion zones around the predicting landing area of Skyrora XL Launch Vehicles. Most vessels are highly mobile and will be able to move away from these locations if required. There are no shipping lanes from which vessels could not move.	1
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure	Most vessels are highly mobile and will be able to adapt if required to move away, with only small vessels that are slightly less adaptable.	1
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	All vessels are highly mobile and will be able to return to an area once an Skyrora XL Launch Vehicle has passed, predicted to occur on the short-term scale (i.e. hours).	0
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	**4**	**1**

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	Vessels are likely to be exposed to impacts over considerable periods of time, i.e. the full duration of the licence.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)		
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)	There are expected to be up to 16 launches per year.	1
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the small spatial extent of the impact zone around returning Skyrora XL Launch Vehicles, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	**5**	**2**

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability	N/A	N/A
1	Impact is measurable above natural variability (0-5% change in total numbers of individuals)	N/A	N/A
2	Impact is measurable above natural variability (6-10% change in total numbers of individuals)	N/A	N/A
3	Impact is measurable above natural variability (>10% change in total numbers of individuals)	N/A	N/A

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	The current shipping baseline will not impacted by the temporary implementation of small exclusion zones.	0
1	Impact is measurable above present baseline conditions (0-5% change in total undisturbed available habitat)		
2	Impact is measurable above present baseline conditions (6-10% change in total undisturbed available habitat)		
3	Impact is measurable above present baseline conditions (>10% change in total undisturbed available habitat)		

Overall Magnitude of Impact	**0**	**0**

Overall Risk (sensitivity x exposure x magnitude)	**Negligible**	**0**

Skyrora AEE report Appendix 10.5 - humans and human activities risk matrix

Receptor	**Maritime archaeology**
Pressure Pathway/Impact	**Direct impacts - damage**

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	Any marine archaeological site in the EZI area is likely to have a high value associated, dependent on the items era.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed	The tolerance of any archaeological sites in the area are considered relatively vulnerable via impact.	3

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure		
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure	There is no adaptability of any archaeological items or sites.	3

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)		
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale	As any archaeological finds are anthropogenic items or sites, they are unable to recover.	3

Overall Sensitivity of the Receptor	**12**	**3**

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	Marine archaeological sites are likely to be exposed to impacts over considerable periods of time, i.e. the full duration of the licence.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There are expected to be up to 16 launches per year; however, the likelihood of Skyrora XL Launch Vehicles repeatedly impacting any given marine archaeological site is extemely low, taking into account the extent of the EZI.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the small spatial extent of the impact zone around Skyrora XL Launch Vehicles reaching the seabed, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	**4**	**1**

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability		N/A
1	Impact is measurable above natural variability (0-5% change in total numbers of individuals)		N/A
2	Impact is measurable above natural variability (6-10% change in total numbers of individuals)		N/A
3	Impact is measurable above natural variability (>10% change in total numbers of individuals)		N/A

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions		
1	Impact is measurable above present baseline conditions (0-5% change in total undisturbed available habitat)	There is a very low likelihood that Skyrora XL Launch Vehicles reaching the seabed will have known impact on marine archaeological sites, but if this did occ	1
2	Impact is measurable above present baseline conditions (6-10% change in total undisturbed available habitat)		
3	Impact is measurable above present baseline conditions (>10% change in total undisturbed available habitat)		

Overall Magnitude of Impact	**1**	**1**

Overall Risk (sensitivity x exposure x magnitude)	**Low**	**3**

Appendix 10.6 Water Quality Risk Assessment for Accidental Aeronautical Events

SSC AEE Report Technical Appendix 10.6 - Accidental Aeronautical Event risk matrix

Receptor	**Water quality, sediment quality, and ecological receptors**
Pressure Pathway/Impact	**Effects from Fuel Spillage**

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	The water quality of an area is of high environmental value and underpins the surrounding marine environment.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed	Sea water exposed to hydrocarbons will lead to regional (~50km2) increases in hydrocarbon concentration which could lead to notable changes to the water's properties.	2
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure		
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure	Sea water exposed to hydrocarbons will lead to local increases in hydrocarbon concentration which could affect the water's properties.	2
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)		
1	Receptor will recover entirely within medium timescales (1-5 years)	The source of hydrocarbons (LVs) will pass through the water column and then rest on the seabed. It is anticipated that any fuel will be released into the marine environment immediately upon entering it, following which it will disperse. Given the small amount of residual fuel expected, it is anticipated that hydrocarbon levels local to the LV will reach background levesl over a short time scale.	1
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	**8**	**2**

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time	The water quality receptor is likely to be exposed to impacts over a limited period of time, even if there were to be >1 event over the duration of the licence because any two events would impact different geographic areas.	1
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time		

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)		
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)	The potential for exposure to accidental aeronautical events will exist over a considerable period of time, i.e. the duration of the license (30 years), however the likelihood of an event occurring means that exposure to the impact is extremely infrequent.	1
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales		
2	Receptor is exposed to impact over considerable spatial scales	Hydrocarbon spill of fuel contents could affect a large area (~50 km^2), impacts will be low.	2
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	**4**	**1**

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability		
1	Impact is measurable above natural variability (0-5% change in contaminant concentration)		
2	Impact is measurable above natural variability (6-10% change in contaminant concentration)	Direct impacts to the hydrocarbon concentration of the sea water is likely to be measureable above natural variability, as there are limited other sources of hydrocarbons in the marine environment.	2
3	Impact is measurable above natural variability (>10% change in contaminant concentration)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions		
1	Impact is measurable above present baseline conditions (0-5% change in contaminant concentration)		
2	Impact is measurable above present baseline conditions (6-10% change in contaminant concentration)	Direct impacts to the hydrocarbon concentration of the sea water is likely to detectable above the baseline, as there are limited other sources of hydrocarbons in the marine environment.	2
3	Impact is measurable above present baseline conditions (>10% change in contaminant concentration)		

Overall Magnitude of Impact	**4**	**2**
Overall Risk (sensitivity x exposure x magnitude)	**Low**	**4**

Receptor	**Water quality**
Pressure Pathway/Impact	**Effects from Metal Corrosion**

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	The water quality of an area is of high environmental value and underpins the surrounding marine environment.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed	Sea water exposed to metal corrosion will lead to local increases in metal concentration which could lead to notable changes to the water's properties.	2
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure		
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure	Sea water exposed to metal corrosion will lead to local increases in metal concentration which could affect the water's properties.	2
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)		
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)	The source of metals (LVs) will pass through the water column and then rest on the seabed. Metal corrision could happen throughout this passage, though it is anticipated to be highest at the seabed due to longevity in this environment. The LV has only small amounts of metals, predominantly aluminium, which is one of the least corrosive in the marine environment. Given the longevity of aluminium in the marine environment, water quality will recover over a long time scale.	2
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	**9**	**2**

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	The water quality receptor is likely to be exposed to impacts over considerable periods of time, i.e. the duration of the 30 year licence.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)		
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)	There is expected to be up to 10 launches per year in the initial years, rising to a maximum of 30 launches per year.	1
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the highly limited impact zone around LVs as they pass through the water column and rest at the seabed, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	5	2

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability		
1	Impact is measurable above natural variability (0-5% change in contaminant concentration)	Direct impacts to the metal concentration of the sea water is likely to be measureable above natural variability. Aluminium is the main metal which is occurs naturally in the marine environment but in low concentration.	1
2	Impact is measurable above natural variability (6-10% change in contaminant concentration)		
3	Impact is measurable above natural variability (>10% change in contaminant concentration)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions		0
1	Impact is measurable above present baseline conditions (0-5% change in contaminant concentration)	Direct impacts to the metal concentration of the sea water is likely to be measureable above the baseline. Aluminium is the main metal which is occurs naturally in the marine environment but in low concentration.	
2	Impact is measurable above present baseline conditions (6-10% change in contaminant concentration)		
3	Impact is measurable above present baseline conditions (>10% change in contaminant concentration)		

Overall Magnitude of Impact	1	1

Overall Risk (sensitivity x exposure x magnitude)	Low	4

Receptor	**Water quality**
Pressure Pathway/Impact	**Effects from Microplastics and Debris**

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	The water quality of an area is of high environmental value and underpins the surrounding marine environment.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed	Microplastic exposure will lead to local increases in microplastic concentration which could lead to notable changes to the water's properties.	2
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure		
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure	Microplastic exposure will lead to local increases in microplastic concentration which could affect the water's properties.	2
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	The source of microplastics (LVs) will pass through the water column and then rest on the seabed. Microplastics have the potential to be released throughout this passage. Given the small amount of plastics expected, it is anticipated that microplastic levels local to the LV will reach background levesl over a short time scale.	0
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	**7**	**1**

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	The water quality receptor is likely to be exposed to impacts over considerable periods of time, i.e. the duration of the 30 year licence.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)		
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)	There is expected to be up to 10 launches per year in the initial years, rising to a maximum of 30 launches per year. It is noted that, based on our current understanding, not all of the rockets launched from the SSC site will contain plastics (so far, 1 of 3 clients' rockets has been identified as utilising plastic).	1
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the limited impact zone around LVs as they sink through the water column, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	**5**	**2**

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability		0
1	Impact is measurable above natural variability (0-5% change in contaminant concentration)	Direct impacts to the microplastic concentration of the sea water is likely to be slightly measureable above natural variability.	1
2	Impact is measurable above natural variability (6-10% change in contaminant concentration)		
3	Impact is measurable above natural variability (>10% change in contaminant concentration)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions		0
1	Impact is measurable above present baseline conditions (0-5% change in contaminant concentration)	Direct impacts to the microplastic concentration of the sea water is likely to be slightly measureable above the baseline (at a highly local scale).	1
2	Impact is measurable above present baseline conditions (6-10% change in contaminant concentration)		
3	Impact is measurable above present baseline conditions (>10% change in contaminant concentration)		

Overall Magnitude of Impact	**2**	**1**

Overall Risk (sensitivity x exposure x magnitude)	**Low**	**2**

Appendix 11.1 LVIA Methodology

Appendix 11.1 Landscape and Visual Impact Assessment Methodology

Introduction

1.1.1 The Landscape and Visual Impact Assessment method follows good practice guidance and advice on the assessment of the impacts of development on landscape and visual resources contained in the following documents:

- Guidelines for Landscape and Visual Assessment (Landscape Institute and Institute of Environmental Assessment, 3rd Edition 2013) (GLVIA 3);
- Landscape Character Assessment: Guidance for England and Scotland, The Countryside Agency and NatureScot, 2002;
- Landscape Character Assessment Guidance for England and Scotland. Topic Paper 6: Techniques and Criteria for Judging Capacity and Sensitivity, The Countryside Agency and Scottish Natural Heritage, 2004; and
- Scottish Planning Policy, 2014;
- Visual Representation of Windfarms: Guidance, Version 2.2, NatureScot, 2017;
- Working Draft 11 – Guidance for Assessing the Effects on Special Landscape Qualities of National Scenic Areas, NatureScot, (November 2018); and
- Visual Representation of Development Proposals, The Landscape Institute, Technical Guidance Note 09/19 (17th September 2019).

1.1.2 The general approach to the LVIA includes the following tasks:

- Scoping;
- Baseline Assessment (comprising desk study, field survey and reporting); and
- Assessment and Reporting.

1.1.3 These tasks are described in detail below.

Scoping

1.1.4 The scope of the LVIA was agreed through written communication with NatureScot and Shetland Islands Council during 2020 including confirmation of the viewpoints to be included in the assessment (further details are provided in Chapter 11).

The Landscape and Visual Baseline

1.1.5 The first stage of the assessment reviews the existing landscape and visual resource of the Environmental Zone of Influence (EZI) in terms of its character, quality (i.e. the baseline condition) and establishes sensitivity of the resources/receptors. The baseline assessment forms the basis against which to assess the magnitude and significance of the predicted landscape and visual effects arising from the Proposed Project.

1.1.6 The EZI for the LVIA is defined by a 15 km radius offset from the centre of the Proposed Project, as shown in Drawing 11.1.1. This extent of EZI was determined as appropriate, given the heights of the separate elements of the Proposed Project, accepted best practice, and was agreed in consultation with NatureScot and Shetland Islands Council.

1.1.7 The baseline assessment has three elements:

- Description – the process of collecting and presenting information about landscape and visual resources in a systematic manner;

- Classification – the more analytical activity whereby landscape and visual resources are refined into units of distinct and recognisable character; and
- Evaluation – the process of attributing a sensitivity rating to a given landscape or visual resource, by reference to specified criteria.

1.1.8 In determining these elements, the baseline assessment process comprises three stages: desk study, field survey and analysis. These are described below.

Future Baseline

1.1.9 In the absence of the Proposed Project, the land within the application boundary is expected to remain in its current state. No other changes are expected to occur.

Desk Study

1.1.10 The location of the Proposed Project and the extent of the application boundary is shown in Drawing 11.1.1. This is also detailed in Chapter 3 (Proposed Project). As part of the desk study, existing map and written data regarding the Proposed Project site and its environs were reviewed, including:

- Scottish Planning Policy (SPP), 2014;
- The Shetland Local Development Plan (LDP) 2014;
- Onshore Wind Energy, Supplementary Guidance, Shetland Local Development Plan, 2014 (Adopted February 2018);
- Local Landscape Areas, Supplementary Guidance, Shetland Local Development Plan, Consultation Draft 2014
- Shetland Coastal Character Assessment, NAFC Marine Centre, University of the Highlands and Islands, 2016;
- An assessment of the sensitivity and capacity of the Scottish seascape in relation to offshore windfarms, Scottish Natural Heritage Commissioned Report No.103, 2005
- Scottish Landscape Character Types Map and Descriptions (NatureScot, 2019)
- Inventory of Historic Gardens and Designed Landscapes in Scotland, Historic Scotland; and
- Ordnance Survey Maps.

1.1.11 The desk study enabled the definition of the baseline landscape and visual resource within the EZI and the main users of the area, key viewpoints and key features were identified (these were subsequently confirmed as part of the field studies).

1.1.12 The aim of the baseline visual assessment was to ensure that a representative range of viewpoints were included in the visual assessment in order to represent the identified receptors. The potential extent of visibility of the Proposed Project was identified by reference to Ordnance Survey map data, the draft zone of theoretical visibility mapping, and observations made in the field. Following this, potential visual receptors likely to be affected by the Proposed Project were identified.

1.1.13 The viewpoints were selected to ensure that the visual assessment included a representative range in relation to the following criteria:

- Type of receptor - including different landscape character areas if appropriate;
- Distance of receptor from Proposed Project - to a maximum distance of a 15 km radius offset, as shown in Drawing 11.1.1; and
- Direction of receptor from Proposed Project, with the aim of achieving an even distribution from different compass points around the site.

1.1.14 The desk study provides the basis for subsequent field survey work. It informs the description of the Landscape, Seascape and Coastal Character Areas (LCAs, SCAs and CCAs) for the EZI, the definition of the potential extent of visibility and the identification of the principal viewpoints and receptors, which were subsequently confirmed during the field survey.

Field Survey

1.1.15 The baseline landscape assessment included field survey work, carried out to verify the landscape, seascape and coastal character areas identified within the EZI and gain a full appreciation of the relationship between the Proposed Project and the landscape.

1.1.16 Field survey work also verified the appropriateness of the proposed viewpoints. This involved checking the initial viewpoint selection on the ground, to ensure that there will be views of the Proposed Project from these locations. In some instances, this can be remedied by slight adjustments of the location, although this has to remain relevant to the particular receptor(s) for which the viewpoint was selected. It is also important to ensure that the selected viewpoints are a representative view, and demonstrate potential visibility of the Proposed Project for the selected location. The fieldwork was supported by analysis of Ordnance Survey maps, and observations were recorded with photographs.

Analysis and Reporting

1.1.17 Analysis and reporting of the baseline assessment took place after completion of the desk and field surveys. The baseline landscape assessment provided a description, classification and evaluation of the landscape, seascape and coastal character of the EZI from which to assess the potential landscape effects of the Proposed Project. The baseline visual assessment provided an initial list of viewpoints for the viewpoint assessment, with brief commentary on viewpoint location, distance from the Proposed Project, receptors and rationale for selection, from which to assess the potential visual effects of the Proposed Project.

1.1.18 The baseline assessment is supported by Drawing 11.1.1 LVIA EZI, Drawing 11.1.2 Landscape Designations (including National Cycle Routes), Drawing 11.1.3 Landscape (Seascape and Coastal) Character Areas, Drawing 11.1.4 Viewpoint Locations, Drawings 11.2.1a - 11.2.1b Zone of Theoretical Visibility (ZTV) maps.

1.1.19 The baseline assessment provided a description of the landscape and visual resource from which an assessment of the landscape and visual effects of the Proposed Project can be undertaken to determine the development's acceptability in principle and the appropriate mitigation measures.

Assessment of Landscape and Visual Effects

1.1.20 The assessment describes the changes in the character and quality of the landscape and visual resources that are expected to result from the Proposed Project.

1.1.21 In assessing landscape impacts, the potential direct effects on the fabric of the landscape are considered, together with the potential effects on the perception of landscape character. The latter depends on a number of factors:

- the nature of the landscape area, including factors such as the nature of views and sense of enclosure;
- the extent of the potential visibility of the Proposed Project (e.g. the number of potential viewpoints and extent of the Proposed Project seen);
- the proportion of the character area with potential visibility; and
- the distance to the Proposed Project.

1.1.22 The baseline landscape character assessment together with an assessment of the potential effects on each character area is included in the assessment, along with consideration of the extent of potential significant effects.

1.1.23 A viewpoint analysis has been carried out to identify and evaluate the potential effects on visual amenity arising from the Proposed Project at specific representative locations in the EZI. The viewpoints selected are considered to be representative of the spectrum of receptors in the EZI, located at different distances, directions and elevations relative to the Proposed Project. The viewpoints were identified and agreed through consultation with Shetland Islands Council and NatureScot.

1.1.24 The assessment involved the preparation of existing photographs and photomontages from representative viewpoints to illustrate existing views, to predict the extent of views of the Proposed Project and to assist, together with field work, in the assessment of effects. These are shown in Drawings 11.3.1.1 - 11.3.3.2.

Assessment Criteria

1.1.25 The aim of the LVIA is to identify, predict and evaluate likely significant landscape and visual effects associated with a Proposed Project. Wherever reasonably possible, identified effects are quantified, however, the nature of LVIA requires an element of interpretation using professional judgement. In order to provide a level of consistency to the assessment, the prediction of magnitude and assessment of significance of the landscape and visual effects have been based on pre-defined criteria.

Sensitivity of the Landscape and Magnitude of Change

1.1.26 The capacity of the landscape to accommodate change of the type and scale involved in the formation of the Proposed Project is assessed. Part of this process involves an assessment of landscape sensitivity, and susceptibility to change, in the context of these proposals.

1.1.27 The sensitivity of the landscape is not absolute and varies according to the existing landscape, the nature of the Proposed Project and the type of change being considered. The determination of the sensitivity of the landscape resource to changes associated with the Proposed Project is defined as high, medium, low or negligible - or intermediate bands between these. It is developed from guidance within GLVIA 3, and based on professional interpretation of a combination of parameters as follows:

- Key landscape characteristics - a professional evaluation informed by an understanding of the key characteristics of the landscape and existing character assessments, describing the elements that make up the landscape including:
  - Landscape value, as reflected by local, regional or national landscape designation;
  - Landscape scale – which is the relative size of the main landscape elements and components;
  - Physical influences such as landform;
  - Land cover, including different types of vegetation; and
  - The nature of views - whether open, closed, long or short distance, simple or diverse.

1.1.28 GLVIA 3 advises that the two components of 'value' and 'susceptibility' to change are taken into account in assigning sensitivity to change from the Proposed Project to landscape and visual receptors. The two factors are described and explained in greater detail below.

Landscape Value

1.1.29 Establishing landscape value requires an understanding of how society values different Landscapes. This is used to inform judgements on the significance of effects. Value is most often expressed through designation; however, undesignated landscapes and components of individual landscapes also need to be examined. As part of the baseline the following factors are considered when developing an understanding of landscape value:

- Landscape quality/condition - the physical state of the landscape;
- Scenic quality - aspects of the landscape that appeal to the senses;
- Rarity - presence of unusual or rare features;
- Recreation values - particularly where landscape experience is important;
- Perceptual aspects - value for particular experience such as tranquillity; and
- Cultural associations - with people such as writers or artists, events, etc.

1.1.30 Information on landscape value is included in the baseline descriptions of landscape character, and in information included in the citations for designated landscapes. This information has been reviewed and refined through survey and analysis.

Susceptibility to Change

1.1.31 GLVIA 3 defines susceptibility to change as *'the ability of the landscape to accommodate the proposed development without undue consequences for the maintenance of the baseline situation and/or the achievement of landscape planning policies and strategies.'*

1.1.32 The degree to which a particular landscape type or area can accommodate change will vary with:

- existing land use;
- the pattern and scale of the landscape;
- visual enclosure/openness of views, and distribution of visual receptors; and
- the scope for mitigation, which will be in character with the existing landscape.

1.1.33 Key characteristics likely to be affected by the Proposed Project are evaluated, taking into account *'quality, value, contribution to landscape character, and the degree to which the particular element or characteristic can be replaced or substituted'.*

Landscape Sensitivity

1.1.34 In order to evaluate the sensitivity of the landscape receptor the criteria outlined in Table 11.1.1 below have been used, combining an understanding of the landscape value and susceptibility to change, based on GLVIA 3.

1.1.35 In some instances, a landscape with important components and high quality may be of a lower sensitivity as a result of its potential tolerance to change and opportunities for mitigation. Conversely a landscape with few features of interest may be of a higher sensitivity because it is vulnerable to change with little opportunity to mitigate change.

1.1.36 Having described the landscape resource and the key components that contribute to the character of the landscape character areas, and categorised the sensitivity of each landscape type to change, the probable magnitude of change sustained as a result of the Proposed Project is assessed. This change could be adverse, neutral or beneficial. The assessment of the magnitude of change is described below.

Table 11.1.1 - Landscape Sensitivity

Description	Sensitivity
Landscape with important components, usually of particularly distinctive character and high quality, susceptible to relatively small changes and for which mitigation will be difficult or not possible. Some less distinctive or lower quality landscapes may also fall into this category where characteristics are such that mitigation of negative changes will be difficult. Landscape is often recognised through designation.	High Sensitivity
Landscape with characteristics reasonably tolerant of changes or for which mitigation is likely to be possible. These landscapes may be of high quality or of distinctive character but will usually be relatively ordinary and moderately valued.	Medium Sensitivity
A less distinctive or relatively poor landscape with few features of quality or interest, potentially tolerant of substantial change and with scope for mitigation of any negative changes.	
Considerably modified or degraded landscape, with few/no features of quality or interest e.g. heavily industrialised landscapes.	Low Sensitivity

Magnitude of Change on Landscape Receptors

1.1.37 Each effect on landscape needs to be assessed in terms of its size or scale, the geographical extent of the area influenced, and its duration and reversibility.

Size or Scale (including nature of influence on landscape character)

1.1.38 Judgements are made about the size or scale of the change in the landscape that are likely to be experienced as a result of the Proposed Project. The judgements take account of:

- the extent to which landscape elements will be lost, the proportion of the total extent that this represents and the contribution of that element to the character of the landscape;
- the degree to which aesthetic or perceptual aspects of the landscape are altered either by removal of existing components of the landscape or by addition of new ones; and
- whether the effect changes the key characteristics of the landscape which are critical to its distinctive character.

Geographic Extent

1.1.39 The geographic extent over which landscape effects are considered to be distinct from size or scale, the extent of effects will vary according to the nature of the proposal. The effect of a development may have an influence at the following scales:

- at site level, within the development site itself;
- at the level of the immediate setting of the site;
- at the scale of the landscape character area within which the proposal lies; or
- at a larger scale influencing several landscape character areas.

Table 11.1.2 – Judgement on Magnitude

Level of Magnitude	Definition of Magnitude
Substantial	Total loss or major alteration to key elements/features/ characteristics of the baseline (pre-development) conditions such that post development character/composition of baseline will be fundamentally changed.
Moderate	Partial loss or alteration to one or more key elements/features/ characteristics of the baseline (pre-development) conditions such that post development character/ composition/ attributes of baseline will be partially changed.
Slight	Minor loss of or alteration to one or more key elements/features/ characteristics of the baseline (pre-development) conditions. Change arising from the loss/alteration will be discernible but underlying character/composition of the baseline condition will be similar to pre-development circumstances/patterns.
Negligible	Very minor loss or alteration to one or more key elements/features/ characteristics of the baseline (pre-development) conditions. Change barely distinguishable, approximating to the "no change" situation.
None	No change.

Visual Receptor Sensitivity and Magnitude of Change

1.1.40 The sensitivity of visual receptors depends upon:

- the location of the viewpoint;
- the context of the view;
- the activity of the receptor; and
- frequency and duration of the view.

Value attached to Views

1.1.41 Judgements are also made about the value attached to views experienced taking account of:

- Recognition of the value attached to particular views, for example in relation to heritage assets, or through planning designations.
- Indication of value attached to particular locations as a distinctive view through appearance in guide books, provision of formal facilities such as a car park and sign board, references in art and literature.

Susceptibility of Visual Receptors to Change

1.1.42 The susceptibility of different visual receptors to changes in views is a function of:

- the occupation or activity of people experiencing the view at particular locations; and
- the extent to which their attention or interest may therefore be focussed on the views and visual amenity they experience at particular locations.

1.1.43 Visual receptor susceptibility is defined as high, medium, or low, or a gradation of these, as set out in Table 11.1.3.

Table 11.1.3 – Judgement on Sensitivity

Level of Sensitivity	Definition of Visual Receptor Sensitivity
High	Users of outdoor recreational facilities including strategic recreational footpaths, cycle routes or rights of way, whose attention may be focused on the landscape; important landscape features with physical, cultural or historic attributes; views from principal settlements; visitors to beauty spots and picnic areas.
Medium	Other footpaths; people travelling through or past the landscape on roads, train lines, boats or other transport routes, views from minor settlements.
	People engaged in outdoor sports or recreation (other than appreciation of the landscape), those whose attention may be focused on their work or activity rather than the wider landscape.
Low	Views from heavily industrialised or densely built up areas.

Magnitude of Change on Visual Receptors

1.1.44 The magnitude of visual change arising from the Proposed Project is described as substantial, moderate, slight, or negligible/none based on the overall extent of visibility. For individual viewpoints it will depend upon:

- distance of the viewpoint from the development;
- duration of effect;
- angle of view in relation to main receptor activity;
- proportion of the field of view occupied by the development;
- background to the development; and
- the extent of other built development visible, particularly vertical, elements.

Size or Scale

1.1.45 Judging magnitude of visual effects identified needs to take account of:

- The scale of change in the view with respect to the loss or addition of features in the view and changes in its composition, including the proportion of the view occupied by the Proposed Project.
- The degree of contrast or integration of any new features or changes in the landscape with the existing or remaining landscape elements and characteristics in terms of form, scale and mass, line, height, colour and texture.
- The nature of the Proposed Project, in terms of the relative amount of time over which it will be experienced and whether views will be full, partial or glimpses.

Geographical Extent

1.1.46 The geographical extent of a visual effect will vary with different viewpoints and is likely to reflect:

- the angle of the view in relation to the main activity of the receptor;
- the distance of the viewpoint from the Proposed Project; and
- the extent of the area over which the changes would be visible.

Duration and Reversibility of Landscape Effects

1.1.47 The effects on the landscape will continue for the permitted life of the wind farm. Following this time period, in the absence of a renewed planning permission, the Proposed Project will be removed and the landscape reinstated with the majority of the proposed changes being fully reversible following de-commissioning.

Level and Significance of Effects

1.1.48 The significance of any identified landscape or visual effect has been assessed as major, moderate, minor or no effect. These categories have been determined by consideration of viewpoint sensitivity (combining susceptibility and value) and predicted magnitude of change (size, scale, geographical extent, duration) as described above, with the following matrix in Table 4 used as a guide to correlating sensitivity and magnitude to determine significance of effects.

Table11.1.4 – Significance of Effects on Landscape and Visual Receptors

Sensitivity	Magnitude of Change			
	Substantial	**Moderate**	**Slight**	**Negligible**
	←			→
High ↑	Major	Major to Moderate	Moderate	Moderate to Minor
Medium	Major to Moderate	Moderate	Moderate to Minor	Minor
Low	Moderate	Moderate to Minor	Minor	Minor to None
Negligible ↓	Moderate to Minor	Minor	Minor to None	Minor to None

1.1.49 This assessment has been calibrated such that the threshold of significance is major to moderate. In this assessment, moderate level effects, and those below this level are not considered to be significant. Where, for the purpose of this assessment, the landscape or visual effect has been classified as major or major/moderate, this is considered to be a significant effect in terms of the Guidance for the Assessment of Environmental Effects, 2021. It is recognised that in some landscape and visual assessment methodologies a moderate level may be considered to be significant, but this is due to assessors calibrating their scale of effects differently, rather than because the threshold has been set high here. Essentially in an assessment where moderate is considered significant, the level of effect will be broadly similar to that which is described as major/moderate here. The Guidelines for Landscape and Visual Impact Assessment require that each assessor develops and explains their methodology but do not set out a prescriptive approach. Variation between assessors is therefore common. It should be noted that effects are not always adverse and may also be beneficial, however this chapter assumes that the effect is adverse unless otherwise stated.

1.1.50 The table is not used as a prescriptive tool, and the methodology and analysis of potential effects at any particular location must make allowance for the exercise of professional judgement. Thus, in some instances, a particular parameter may be considered as having a determining effect on the analysis.

Supporting Graphics

Approach

1.1.51 The LVIA is supported by a range of drawings including viewpoint photography. These have been prepared in adherence to the principles presented in the Guidelines for Landscape and Visual Impact Assessment (Landscape Institute and Institute of Environmental Assessment, 3rd Edition 2013), the Landscape Institute's Advice Note Technical Guidance Note 06/19 Visualisation of Development Proposals, and the Visual Representation of Windfarms: Guidance, Version 2.2, NatureScot, 2017.

Photography

1.1.52 All photography was undertaken through the use of a full frame digital Single Lens Reflex (dSLR) (Canon EOS 5d) camera mounted with a 50 millimetre (mm) 'fixed' lens (Canon EF 50mm - f/1.4 USM). The camera was mounted on a tripod with a panoramic head in order to obtain a stable platform for the single frame and panoramic views. The position of the tripod was recorded with a handheld GPS device. In addition to recording the location of the viewpoint, observations with regard to time of day, weather, cloud cover, and visibility were recorded.

1.1.53 Following completion of the fieldwork, the photography was reviewed, and the clearest images selected for the production of panoramic images. In some cases, small adjustments are made to the images through the use of Adobe Photoshop/CS3 software in order to improve clarity.

1.1.54 The panoramas were then prepared through the joining of two or more images (typically three) in Photoshop.

Visualisations

1.1.55 The visualisations supporting the LVIA have been presented in order to provide a view of the Proposed Project within its landscape context and assist the assessor in determining the change and resultant effect on the viewpoint location.

1.1.56 The photomontages have been prepared through the use of Adobe Photoshop and Resoft Windfarm software. Use of Windfarm allows the Proposed Project to be accurately positioned in the photograph/panorama and rendered so as to account for cloud cover, sun position and colour of the Proposed Project. While every effort is undertaken to render the Proposed Project to account for the prevailing lighting conditions, where the Proposed Project may appear indistinct to the background, manipulation of the rendering of the Proposed Project has been applied in order to make the Proposed Project appear more distinct.

1.1.57 The presentation of graphics material requires careful consideration in order to prepare a visualisation that provides an accurately scaled depiction of the Proposed Project for use at the viewpoint location. In this instance, where a photomontage has been prepared for a viewpoint, the photomontage has been presented at A3 height and A1 width. These comprise:

- 1) Baseline panorama and matching photomontage. A panorama, using an angle of view of 90°, illustrating the existing view presented alongside an identically sized matching photomontage. The size of the image and matching wireframe is 820mm by 130mm, with a 90° horizontal field of view and a 14.2° vertical field of view. To accommodate the required field of view the image is presented as a cylindrical projection. This format shows the wider landscape context within which the Proposed Project will sit and allows direct comparison of the changes to be made in addition to providing a useful aid memoire. The recommended viewing distance for these visualisations is at a comfortable arm's length, as set out on the visualisation drawing.

1.1.58 In views where a photomontage has not been prepared, a wireframe view has been submitted. As with the photomontages, the Proposed Project has been accurately positioned and the wireframe outputted so as to match the field of view to the panorama/photograph.

1.1.59 It should be noted that the LVIA has not been solely conducted on the visualisations presented within the ES but has included analysis of a range of wireframe views and other visualisations in addition to review of computer modelling of the site in addition to other materials not presented in this assessment.

Visibility Mapping

1.1.60 The visibility mapping or Zones of Theoretical Visibility (ZTVs) maps have been prepared through the use of Resoft's Windfarm computer software. The ZTV uses the Ordnance Survey's OS Terrain 5 digital terrain data which provides a representation of the bare-earth ground surface, in combination with a model of the tidal device. The terrain model does not account for areas of tall vegetation and buildings which may in actuality screen the development, and in this regard, the model may overstate visibility of the Proposed Project.

1.1.61 When calculating the extent of visibility, the software accounts for earth curvature and atmospheric refraction and provides the results in bands of colour. These are set to be clearly recognisable and distinct.

1.1.62 View height is also factored into the calculation, for the purposes of this assessment; the view height has been set at 1.5 m above ground level.

1.1.63 While the ZTV provides a useful indication of where visibility of the Proposed Project might be experienced, it should be noted that a very small portion of the Proposed Project model used in the modelling may give rise to the indication of visibility, i.e. visibility to a small component of the Proposed Project might indicate greater visibility. In some instances, it may be useful to confirm the nature of visibility with wireframe views as part of the analysis of the visibility mapping.

Appendix 11.2 Landscape Character Types within the EZI

Appendix 11.2 Landscape Character Types within the EZI

Introduction

11.2.1 Using accepted, systematic methods of landscape character assessment, the surrounding landscape has been subdivided into different landscape character types, each with a distinctive character based upon local patterns of geology, land form, land use, cultural and ecological features. These provide baseline information which can be used to guide landscape change and provide a baseline against which to make judgements on the likely effects of the Proposed Project upon landscape character.

11.2.2 Within the Environmental Zone of Influence (EZI), the relevant landscape character assessment is the NatureScot web-based dataset, the 2019 Landscape Character Type map and associated Landscape Character Type Descriptions.

11.2.3 This dataset provides an assessment of the landscape character of the area, and considers the likely pressures and opportunities for change in the landscape. The Landscape Character Types (LCTs) which fall within the 15 km radius EZI are illustrated in Figure 11.1.3 and listed below:

- 349. Major Uplands
- 350. Peatland and Moorland
- 352. Inland Valleys
- 353. Farmed and Settled Lowlands and Coast
- 354. Farmed and Settled Voes and Sounds
- 355. Coastal Edge

Landscape Character Area Descriptions

11.2.4 This section describes Landscape Character Areas that coincide with the EZI. The descriptions and the assessment of sensitivity of the Landscape Character Areas form the baseline to the assessment of effects on Landscape Character.

11.2.5 There are six LCAs within the detailed EZI all of which would potentially be affected to some degree by the Development, as identified through analysis of the ZTV plans. The launch site is situated within the 'Coastal Edge' LCA, the section of new link road spans the Major Uplands and Farmed and Settled Voes and Sounds LCA, and the Launch/Range Control Building is located within the Farmed and Settled Voes and Sounds LCA.

Table 1 – Major Uplands

Key Characteristics
The Shetland Islands are generally low-lying, such that distinct areas of high land are more prominent. The landcover is dominated by peatland and heather moorland peaty mires.
➢ Rounded hills, occurring either in series connected by high level rounded ridges along a linear band, or as isolated single hills or hill groups. ➢ Often steep slopes at the coast, or cliff edges with dramatic natural coastal landforms. ➢ Mainly simple landcover of peat bog and heather moorland grading to rough grassland on some lower slopes, contrasting with the ordered fields of adjoining lowlands and the intricate coastline.

- Hill grazing and low-key peat cutting.
- Mainly uninhabited and often difficult to access on foot or by road, with roads mainly absent on higher land.
- In some areas tracks ascend to hillside or hilltop features such as masts, wind turbines, isolated farms and peat cuttings.
- Exposed high land with panoramic views, forming landmark features which themselves are often visible for miles.
- Relatively expansive, although scale is difficult to discern and reduced by the presence of manmade structures.
- A sense of remoteness and wild character in places.

Landscape Character Description	
Landform	Major Uplands consist of the highest land in Shetland which forms the main physical structure of the islands. They occur in long bands aligned with the main north-south fault lines. Here the metamorphic bedrock has been sliced into north-south strips by fault movements. Along these tracts a series of rounded hills, connected by high land or rounded ridges, rises up to 208 metres above sea level, above surrounding lower land. On Unst, the high points of Hermaness Hill and Saxa Vord provide important landmark features signalling the northernmost point of the Shetland Isles.
Landcover	The main superficial deposits of the hills are boulder clay and other glacial deposits, and peat. The poor, peaty and often waterlogged soils give rise to landcover dominated by heather moorland and bog with occasional lochans. Rough grassland tends to occur on lower slopes in some areas and the coastal areas of Unst support maritime grasslands. Hermaness and Saxa Vord are both significant in respect of their colonies of sea birds and natural vegetation. Unimproved, unenclosed rough hill grazing is the main land-use, along with peat cutting. The lower margins of this type include inbye crofting land. Military uses occupy the strategic location at Saxa Vord in the north.
Settlement	This Landscape Character Type is mainly uninhabited. The often-uneven ground of tussocky grass, bogs and peat hags is a barrier to foot access. Small crofting settlements sometimes occur on the edges of this type at low levels. Roads tend to skirt the hill land, following more amendable routes in adjoining valleys and farmed areas, crossing the type only where there is no alternative to passing over highland. Several masts and aerials are sited on these hills as the high land provides ideal locations with line of sight to many settlements and the islands' road network. Several of these structures have been abandoned and left standing. The RAF radar dome and aerials at Saxa Vord form a distinctive landmark. "Vord" is an Old Norse word for a heap of stones, or cairn, which is often associated with watch towers or convenient lookout points on hills. Evidence of previous occupation includes cairns and abandoned military sites of prehistoric and historic dates. There is evidence of prehistoric settlement and land use in these areas. On Unst, the uplands have significant folkloric associations including stories relating to trows, creatures of Norse folklore,) and to two giants (Herman and Saxi).

Perception	The uniform texture and colour across most of these landscapes is apparent when viewed from a distance. The scattering of road and track scars, peat cuttings and quarries introduce detailed features and breaks up the expanse of moorland, reducing the sense of naturalness. Where many of these features occur together in one area, this results in a haphazard and jumbled appearance which undermines the simplicity of the landcover and landform. Hill tracks and roads usually present a functional appearance - they can be seen directly to connect with the point of destination and their reason for being built. These upland landscapes are exposed to the full force of Atlantic weather. They are relatively expansive, with sweeping slopes and hills, the sense of scale being enhanced by the contrast with adjoining farmed landscapes. The peatland, lochans and erosion scars provide a subtle interplay of texture, with muted colours. This contrasts with the more rich and varied colours and textures of ordered, green pastures of the lowlands and the intricate, coastline of voes and sounds and islands. The apparent scale of the landscape is sometimes difficult to discern due to the moorland vegetation with little diversity in colour or texture. Occasional manmade structures introduce an element of scale, and often make the hills appear smaller and less extensive. Wild character is reduced in the vicinity of manmade structures, particularly where these occur in clusters as they are often very prominent in the open moorland landscape.
Overall sensitivity to the Proposed Project	The landscape is large scale, with a generally simple skyline. The existing infrastructure visible at Saxa vord is a landmark feature in local views. Given the presence of existing development it has an overall **High to Moderate sensitivity** to the Proposed Project.

Table 2 – Peatland and Moorland

Key Characteristics
The Peatland and Moorland Landscape Character Type on Shetland consist of lower-lying undulating ground dominated by low moorland vegetation, usually forming a backdrop to farmed and settled coasts.
➢ Broadly undulating moorlands with occasional small hills, some areas with smaller scale undulations. ➢ Expanses of smooth or hummocky heather moorland and boggy heather grassland. ➢ Stony, rough textured heathland communities Unst and Fetlar. ➢ Rough, mainly unenclosed hill grazing. ➢ Mainly uninhabited, with few roads and man-made structures. ➢ Many visible archaeological relics indicating stages in historic land use. ➢ Prominent, linear stone dykes in places. ➢ Simple composition forms a contrasting backdrop to farmed lowlands, often marked by an abrupt boundary at the hill dyke. ➢ High land provides vantage points for views. ➢ Wild character in larger, remote areas.

Landscape Character Description	
Landform	The areas of Peatland and Moorland on Shetland rise gently from the farmed coastal lowlands to between 20 and 150 metres above sea level. The location, geology and landform of this type vary, resulting in subtle differences in character. Peatland and Moorland occurs on a variety of sedimentary, metamorphic and igneous bedrock. The landform is mainly of low relief with gentle slopes, with local variation in the scale of undulations and surface texture. In the east of the northern islands the serpentine bedrock has an upper layer of shattered rock and glacial drift creating a broadly undulating landform. Small areas of standing water, rock, boulders and hummocky heather form a rough textured surface. Here, the drainage pattern radiates outwards from higher land in a relatively simple pattern. The landform tends to be of low, gently rounded hills, or hummocky with small scale undulations.
Landcover	Landcover is mainly heather moorland and grassland on peaty soils, varying in species composition according to the underlying substrate and local conditions. On Unst glacial deposits are more widespread and the underlying serpentine rocks are usually free of peat and give rise to a stony surface and base-rich soils which support an unusual hummocky heathland vegetation cover with grasslands. The features of this landscape are clearly exhibited at Keen of Hamar on Unst, where the surface is sorted into stone stripes, and thinner soils on lower slopes support rare heathland flower communities. Land use consists mainly of rough grazing on hill land. Although this type usually lacks fences and recent stone walls, long drystane (dry stone) dykes are significant features on Unst, providing strong linear patterns across the natural landform. Mostly non-commercial peat cutting occurs on the edges of this type close to the surrounding crofts and settlements.
Settlement	These areas are mainly uninhabited. Roads and tracks are largely absent, and where present they are routed purposely through the landscape to connect coastal settlements which are separated by the moorland. Other manmade structures are limited to electricity poles and occasional communications masts and beacons. Several wind turbines are present, with more proposed, adding further built structures in this landscape. The archaeology of these areas is mostly evident on the lower margins and consists of many abandoned and ruined structures such as crofts and planticrubs (traditional small stone enclosures for growing young plants, usually kale), earlier farms and enclosures, and several horizontal water mills, as well as prehistoric burnt mounds.
Perception	The low-relief landform and unvarying landcover in many areas of this type results in a relatively simple composition. In this subtle landscape of mainly muted colours, interest is provided by the small-scale diversity in texture provided by exposed rock. In some parts of Unst and Fetlar the texture is dominated by fractured stones and the special plant communities here create a distinct colour and texture. These moorlands usually form a simple, expansive back drop and contrast to the adjoining enclosed lowland pastures and cultivated fields. The boundary between these two landscape types is often abrupt, along the hill dyke, and emphasises the differences in scale, texture and colour. The more remote parts of this type have

	wild character due to the general lack of habitation and man-made structures, and their relative isolation from main settlements.
Overall sensitivity to the Proposed Project	This landscape includes areas of varied scale with a generally undulating landform and occasional man-made features. The smooth, convex land cover with a lack of structures, undifferentiated landcover and wide horizons lends a **moderate to high** sensitivity to the Proposed Project.

Table 3 – Inland Valleys

Key Characteristics	
The Inland Valleys Landscape Character Type on Shetland consists of low lying, narrow channels cutting through Major Uplands, and often aligned with fault lines.	
➢ Long, narrow channels cut through major uplands, mainly located inland and often associated with the erosion of fault lines. ➢ Relatively level valley floors and steep mid-slopes rising to concave upper slopes ➢ Fertile soils in lower, accessible areas with enclosed fields, contrasting with upper moorland slopes, the boundary usually abruptly delineated at the inbye/outbye boundary. ➢ Settled in accessible, lower areas with farms and crofts and connected by roads following the line of the valley. ➢ Abundant archaeological remains visible in the low ground cover. ➢ Enclosed views along the valley and up to skylines, occasionally opening to the sea and adjoining coastal farmland. ➢ Inland and enclosed larger valleys with few sea views.	
Landscape Character Description	
Landform	Inland Valleys on Shetland consist of low-lying, narrow channels running between major uplands. The landform is mainly the result of erosion by ancient water courses. The valley and enclosing landforms are usually large scale and well defined. The slopes tend to be concave falling to convex and are relatively steep at the midpoint, particularly if within a major fault line. Valley floors are relatively flat or broadly undulating and rise gently to merge with side slopes. In places there is an abrupt change of slope where the level valley floor surface meets the thrust of the side slope, for example on Unst. Drainage patterns consist of small tributary burns descending perpendicular to the side slopes into a central burn running the length of the valley, occasionally collecting in linear lochs and small lochans. Burns are often straightened in agricultural land.

Landcover	The valleys contain boulder clay drifts and alluvium, and peat deposits occur on slopes. The low-lying, sheltered areas with fertile soils support a landcover of mainly improved grass land, with rough grassland and heather moorland on higher ground. The valleys are dominated by extensive peat deposits and moorland vegetation. These areas are often associated with patches of standing water, eroded and exposed peat, peat slides, small inland lochs and wetlands. Here, the areas which have been improved to grassland contrast sharply with the surrounding moorland vegetation. The land use is mainly farming and clusters of crofts located in lower, sheltered and accessible areas. Domestic peat cutting occurs at lower levels near settlements. Hill land of rough grazing tends to dominate the larger areas of this Landscape Character Type.
Settlement	The drier, lower land is settled with occasional farms and crofting settlements. Fields are mainly geometric pastures of different sizes which extend up the slopes of the valley. Individual fields are often difficult to discern due to the wide spread use of stock proof fencing and the equal grazing levels across adjoining pastures. The inbye boundary is clearly defined by changes in grazing pressure and is sometimes bounded by a stone dyke. These long-settled, fertile areas contain many archaeological sites, including cairns and mounds, the ruins of townships and farmsteads, enclosures, planticrubs (traditional small stone enclosures for growing young plants, usually kale) and horizontal mills. At Petester there is an extensive and complex field system, of roughly rectangular enclosures and terraces.
Perception	There is often great diversity in colour and texture provided by the combination of improved land, heathland, rough grassland and water bodies. The muted colours and simple landcover of moorland contrast with the ordered landscape of crofting, emphasising the differences in intensity of land use between inbye and outbye land. These valleys are unusual in Shetland, being a mainly inland landscape with few views of the sea. Views are contained by the adjoining uplands and channelled along the valley, or drawn up to nearby skylines. In a few areas, views extend to adjoining coastal farmland and to the sea. The more remote areas of this Landscape Character Type have a sense of isolation, enhanced by the simple moorland landscapes and the sense of historical time depth from the ruins of earlier occupation.
Overall sensitivity to the Proposed Project	This landscape is of a medium scale with a concave landform and simple predictable skylines. The relative absence of settlement lends this area a **moderate** sensitivity to the Proposed Project.

Table 4 – Farmed and Settled Lowlands and Coast

Key Characteristics	
Much of Shetland's farmland lies in a narrow strip between the uplands and the coast. The Character Type is located in exposed parts of this strip. These landscapes are dominated by rough grassland and pasture resulting from long established crofting.	
➢ Mainly narrow tracts of low lying, gently sloping or undulating landform adjoining the sea, with some areas of flat coastal plain and occasional small rounded hillocks. ➢ Natural and varied coastal edge with indented, low coastal cliffs and occasional beaches and bays. ➢ A variable patchwork of landcover mainly consisting of rough grassland, mixed with pastures, arable fields, heather and machair, occasional wetlands, beaches and dunes. ➢ Predominantly farmed and settled with a high proportion of traditional croft land. ➢ A varying pattern of fields, crofts and farms according to location, landform, productivity, agricultural practices and the character of settlement and farm buildings. ➢ Many archaeological sites and historic buildings providing visible evidence of the history of settlement since prehistoric times. ➢ The field and settlement patterns from human intervention in some traditional crofting areas, enhanced by the contrasting coastal and upland setting. ➢ Open, windswept landscapes with little shelter and constant views of the coastline, and across voes and sounds to other land.	
Landscape Character Description	
Landform	The Farmed and Settled Lowland and Coast - Shetland Landscape Character Type occurs as many mainly narrow tracts of productive land, usually adjacent to the coast, generally consisting of low-lying land, usually under 50 metres above sea level, with a gently sloping or undulating landform, and some areas of flat coastal plain. Occasional very small, rounded hillocks rise to around 90 metres above sea level. The coastal edge consists mainly of low, deeply indented, rocky cliffs and headlands, with occasional sandy or pebbly bays. Variations in this Landscape Character Type reflect subtle differences in landform, landcover and land use. The productivity, management and agricultural practices undertaken, the character and pattern of settlement, the artefacts of past and present agricultural practices all strongly influence character. Subtle landform variations interact with a number of other factors to influence character. Larger areas of flat land are often associated with the good calcareous soils, greener pastures and larger more intensively farmed fields with an open character, close to broader bays. The presence of occasional low hills tends to be linked to heather moorland, and this higher ground provides a measure of enclosure and allows for elevated views. The

	shape of the coastal edge may be abrupt, rocky and exposed, as along the indented low cliffs, or gently sloping flat and relatively sheltered next to inlets and beaches.
Landcover	These landscapes occur on a variety of soils, derived from blown sand, peat, and glacial drift materials. The sloping land assists with surface water drainage, and areas of peat bog are relatively uncommon except in lowland basins. The nature of the vegetative cover varies according to the relative productivity of the land, its underlying geology and soils, and the management practices undertaken. Trees and woodlands are absent from these exposed landscapes. Rough pasture is the dominant landcover overall, which is mixed with varying amounts of arable land, improved grassland, maritime grassland, and occasionally machair in more productive areas, and heather moorland on less productive land, usually associated with higher elevations. At the coast natural features include sand dunes, slacks and marshland. This mix of vegetation cover occurs as an integrated patchwork within each tract. Differences in the proportion and balance of vegetation types between tracts lead to variation of character.
Settlement	These areas have generally been farmed and settled for a long period and their character is a result of successive settlement and land use in the same area. Agriculture is the main land use consisting predominantly of grazing and small areas of arable land, mainly under a crofting system. Crofted lands vary from broad areas of well-managed traditional fields of good quality grazing on fertile ground, to more exposed, narrow and marginal areas of abandoned fields and degraded heather moorland. These areas are some of the most settled rural landscapes in Shetland. The balance between settlement and farmland, and the style and pattern of development, vary. Overall, settlement patterns are mainly sparsely scattered individual crofts and dwellings, crofting townships and occasional small nucleated settlements. In more intensively farmed areas small, distinct, nucleated settlements occur on elevated ground, avoiding the best growing land, and include larger farms with associated large agricultural buildings. This landscape character type has been densely occupied for thousands of years, and typically has visible sites and buildings of all periods of prehistory and history.
Perception	The overall perception of these landscapes varies according to several factors such as the level of land management and productivity, settlement pattern and new development, and the location and setting. The pattern of human intervention in some traditional crofting areas reflects the strong relationship between landform, settlement and landuse, and is enhanced by the contrasting coastal and upland setting. This contrasts with areas characterised by derelict crofts, abandoned fields, and degraded moorland, and other areas of intensive use with larger scale field sizes and large scale

	farm buildings. Elsewhere the style and pattern of new development does not reflect the character of the landscape, and sometimes leaves fields as left over space between scattered developments. The variety and richness of colour and texture varies according to the level of productivity and land management. Areas of arable land and improved or maritime grassland can be particularly rich in colour contrasting strongly with areas of rough pasture or moorland and natural coastlines. Similarly, texture can vary greatly from the coarse nature of rough pasture to close cropped improved grassland or the fine texture and seasonal flowers of machair. Most of this Landscape Character Type consists of narrow coastal tracts which are strongly influenced by the coastline and sea. The coastal location of this Landscape Character Type results in a mainly open landscape and constant but ever-changing views of the coastline, and across voes and sounds to other land. Areas, such as coastal crofts on Unst, are characterised by the striking contrast between the ordered fields of well managed traditional grazings and the natural coastal scenery.
Overall sensitivity to the Proposed Project	This landscape is of a small scale with occasional settlements maintaining the traditional pattern of crofting settlement. There is a strong association with the coastal fringe and significant historic interest. Overall, the LCA has a **medium** sensitivity to development.

Table 5 – Farmed and Settled Voes and Sounds

Key Characteristics
The Farmed and Settled Voes and Sounds Landscape Character Type, dominated by pasture and rough grassland resulting from long established farming, occurs around the enclosed coastal waters.
➢ Narrow, low lying coastal strips of gently sloping or undulating land around enclosed waters. ➢ Complex, indented coastline which provides shelter. ➢ Mainly agricultural land use on improved and unimproved pastures with heathland, wetland and wet pastures which add variety. ➢ Unusual grassland and heathland on base-rich soils on Unst. ➢ Scarce broadleaf tree cover found in very small remnant woodland patches and recent plantations. ➢ Mostly traditional crofting in linear or scattered patterns, with some estates. ➢ Larger settlements around harbours with historic built heritage.

➢ Mainly inland, minor road network with branches to beaches and harbours. ➢ Abundant archaeology across all periods of human settlement. ➢ Rural areas provide a contrasting backdrop and setting for settlements. ➢ Rural areas and settlements contrast with the surrounding, large scale hill land. ➢ Views are ever-changing due to the complex coastline and interlocking landforms. ➢ Remote settlements have a strong sense of isolation and tranquillity.	
Landscape Character Description	
Landform	Farmed and Settled Voes and Sounds are found around Shetland's enclosed and sheltered coastal waters, occurring as many, mainly narrow, coastal bands of productive land and some larger nucleated settlements. These areas are usually less than 150 metres above sea level. The low, complex coastal edge consists of many inlets with rocky headlands, low cliffs and small sandy or shingle bays. The landform is often gently sloping towards the sea or gently undulating, with few areas of open water. Small burns usually fall directly to the coast. Flatter, wetter land is often found at the head of voes. Boulder clay is usually found in valleys with peat deposits on higher ground. In Unst and Fetlar, magnesian gley soils are formed over serpentine rocks.
Landcover	Landcover varies according to the relative productivity of the land, the underlying geology, management practices undertaken, and the degree of shelter afforded by location. The species mixes of heath and grassland cover vary according to soil types, exposure to salt spray and the degree of management, and subtly alters their colour and texture. The dominant forms of landcover are improved pastures, which highlight the location of better soils, and rough grassland. This grazed land is interspersed with patches of wetland and flush vegetation. There are some areas of arable land, and small numbers of wind-blown trees and shrubs beside some of the more sheltered voes and sounds, usually planted close to buildings.
Settlement	As a result of the favourable conditions, there is a long history of successive periods of settlement and agricultural land use. Consequently, the character, pattern and extent of settlement and farming in these areas are the major factors influencing landscape character. Settlement patterns are related to agricultural land use, which has been practised over many centuries. There is extensive evidence of medieval and post-medieval agriculture in most settled voes. Subtle differences in geology, soils and agricultural practices affect the character of rural areas. Settlement usually consists of scattered crofts and dwellings in sheltered locations, associated with an ordered landscape of improved and unimproved grazing land. Fields are usually geometric and divided by

	fencing, although this varies. On Unst and Fetlar the underlying geology of serpentine rocks, magnesium rich soils, exposure to salt spray and heavy grazing produce a mosaic of herb rich heaths and sedge patches with a characteristic patchwork appearance. This remote area is relatively undeveloped and maintains a strong traditional pattern of crofting. The character of the Farmed and Settled Voes and Sounds is greatly influenced by the relationship between the development and the land or sea. Harbour areas relate to the depth of sea, shape of the coastline and shelter provided by the landform. Crofted landscapes tend to be located away from the coast, except near beaches, and fields run down slope terminating abruptly at the coastal edge where there are often signs of the crofters' use of marine resources in the form of boat nousts and kelp kilns. The road network links settlements and often travels inland to avoid the indentations of the coastline, branching off to harbours and beaches. Most roads are minor and follow the slope or undulations of the land. For many of the crofting landscapes within this Landscape Character Type there is a rational relationship between the main elements of dwellings, grazing land and landform which reflect traditional crofting practices and requirements for shelter and better soils, with a clear distinction between inbye and outbye.
Perception	In rural areas the mosaic of improved and unimproved grasslands and wetlands creates a subtle variation of colour and texture. The small scale landscapes of traditional crofting patterns and clusters of buildings around harbours are in sharp contrast to the adjoining uninhabited expanses of rough grazing, heather moorland and natural coastal scenery. Human activity in farmed landscapes and the busy nature of settlements, particularly harbours and ferry terminals, emphasises these differences. The indented coastline creates a strong sense of enclosure in many areas, either around a narrow voe or within a series of indented bays and headlands. The rough, natural features and organic shapes of the coastline provide a contrasting fringe to the smooth green pastures. Moving through this landscape there is a constant change in orientation and composition of views, as headlands overlap and interlock with voes, sounds and the open sea.
Overall sensitivity to the Proposed Project	This landscape is of a small scale with occasional settlements maintaining the traditional pattern of crofting settlement. There is a strong association with the coastal fringe and significant historic interest, lending a **higher** degree of sensitivity to the Proposed Project.

Table 6 – Coastal Edge

Key Characteristics	
The dramatic Coastal Edge Landscape Character Type occurs in several narrow strips around the exposed, mainly rocky coastline of Shetland. It forms the edge of upland and lowland Landscape Character Types, and includes dramatic coastal features, including towering sea cliffs, stacks and natural arches.	
➢ Narrow indented coastal edge of rocky headlands, inlets and promontories on exposed parts of the coast. ➢ Mainly high to moderately high cliffs with frequent features of coastal erosion including stacks, arches, blowholes, caves and storm beaches. ➢ Diversity of colour and rock forms derived from the wide variety of bedrock. ➢ Short, colourful swards of maritime heath and grasslands on cliff tops and some sheltered cliffs, with bare, scoured rock in exposed locations. ➢ Undeveloped and uninhabited, and mostly inaccessible by road. ➢ Modern man-made structures limited to a few lighthouses and a radar station. ➢ Many prehistoric and wartime archaeological relics revealed in short grassy landcover. ➢ Diverse and dramatic coastal scenery with a variety of coastal views. ➢ Remote, exposed, open and highly natural landscape with wild character.	
Landscape Character Description	
Landform	The Coastal Edge Landscape Character Type forms the narrow coastal edge of adjoining upland and lowland Landscape Character Types on Shetland. The height of coastline varies from high cliffs to low beaches and inlets. The majority of the coastline is of high to moderately high indented rocky headlands, with inlets and promontories, and occasional small beaches and rocky bays. The underlying bedrock consists of granites, schists and gneiss. This varied geology sits on some of the most exposed coasts of Britain, and has been eroded to form a highly fractured coastline consisting of towering sea cliffs, stacks, geos (clefts), gloups (blow holes), caves, natural arches, skerries (small rocky islands), wave scoured platforms and waterfalls. The underlying bedrock influences the height, texture and colour of exposed rock and the type of feature formed. The coastline of Burrafirth, Unst is impressive, with cliffs of ochre-coloured metamorphic rock. At Unst, the western edge of the ridge has cliffs and stacks terminating to the north with Hermaness Hill and out to the sloping, pointed rocks of Muckle Flugga.
Landcover	Landcover in these narrow coastal strips relates to the surrounding inland character type and varies from heather moorland to closely grazed pastures. At the coast, the soils and vegetation are influenced by sea spray, and support short swards of maritime grasslands and heath. The colourful, diverse flora includes fine grasses, Spring Squill and Sea Pink, which are protected from grazing on cliffs. Exposed cliff edges are stripped of soil and vegetation by wave action and sea spray.
Settlement	These exposed landscapes are mainly uninhabited and most of the coastline is undeveloped. Much of the coastline is inaccessible by road, except at small bays

	and inlets. The coastal features are popular with visitors and for scientific study, and some parts of the coastline have interpretation signs and parking facilities. Man-made structures are rare and include wartime defences and occasional lighthouses. 20th Century defence sites include radio and radar stations at Saxa Vord, Skaw and Unst.
Perception	The diversity of coastal scenery allows for a wide variety of coastal views of distant horizons, nearby islands and shore lines. Coastal features are often best seen from opposite coastlines or promontories. The undulating land and lack of coastal roads often results in the coastal edge being hidden from view or difficult to access. Having approached through heathland or farmland, when coastal features come into view their dramatic form is surprising and invites further exploration. A few cliff top paths provide intimate views of coastal features, revealing their detailed structure and true scale. These extensive, complex coastal areas with the variety of outstanding and dramatic natural features, birds and marine life, together with the colour of maritime flora and movement of the sea combine to create a highly natural landscape. There is a strong sense of openness and exposure, and the sea is rarely calm. The sight, sound and smell of the sea, lack of man-made structures and difficulty of access create a strong wild character. Adding to this experience, the cliffs provide vantage points for observing migrating whales, passing dolphins and harbour porpoises.
Overall sensitivity to the Proposed Project	This landscape has a rugged and irregular landform made up of complex coastal features. There is an absence of settlement and modern development that lends a higher degree of sensitivity. However locally at Skaw and Lambaness the presence of disused radar and defence infrastructure it has a locally **low to moderate sensitivity** to the Proposed Project.

Appendix 11.3 Coastal Character Areas within the EZI

Appendix 11.3 Coastal Character Areas within the EZI

Introduction

11.3.1 The Shetland Coastal Character Assessment (CCA) was prepared by the NAFC Marine Centre (NAFC) in 2016 with guidance from NatureScot, as part of the development of the Shetland Island's Marine Spatial Plan.

11.3.2 It provides information about the various coastal character types (CCTs) found around Shetland, the experiences the coast currently offers to local people and visitors, and identifies sensitivity to development.

11.3.3 The report identifies and maps different coastal character types, describes the key features and character of each area and identifies any areas around the coast which are considered to be sensitive to onshore and/or offshore development. The report was developed so that it relates to the Shetland Landscape Character Assessment.

11.3.4 The four Coastal Character Areas (CCAs) which fall within the 15 km Environmental Zone of Influence (EZI) are illustrated in Figure 11.1.3 Volume III and listed below:

- 13. Burrafirth
- 16. East Unst
- 19. Hermaness
- 20. Skaw

Coastal Character Area Descriptions

11.3.5 This section describes Coastal Character Areas that coincide with the Proposed Project EZI. The descriptions and the assessment of sensitivity of the Landscape Character Areas form the baseline to the assessment of effects on Landscape Character.

11.3.6 There are two CCAs within the detailed EZI all which would be affected by the Proposed Project, as identified through analysis of the ZTV plans. The launch site is surrounded to the north by the within the 'Skaw' CCA, and the to the south by the 'East Unst' CCA.

11.3.7 A short description of each of the CCAs, taken from the Shetland Coastal Character Assessment, is provided in the baseline assessment tables below. These describe the main features, key characteristics and sensitivity of the coastal character area to the Proposed Project.

Table 11.3.1 – East Unst CCA

Key Characteristics
The East Unst Coastal Character Area runs from Lamba Ness in the north to Mu Ness in the south. There is some aquaculture in the area confined to Basta Voe. It is also a busy fishing area and shipping area. The landscape is characterised by moorland ending in cliffs and steep terrain along the coast. There are a few areas of special interest such as the Keen of Hamar.
➢ *Large sandy bays* ➢ *Historic landscapes such as Sand Wick* ➢ *Busy shipping area* ➢ *Low levels of aquaculture*

Coastal Character Description	
Coastal Experience	The East Unst CCC is an interesting area with a rich history. To the north the attractive Norwick beach is a popular area in summer. Various tourist attractions can be found around Haroldswick and Baltasound. The Keen of Hamar has an almost other worldly feel, being compared to a lunar landscape. Sand Wick is another appealing area with a large sandy beach and Muness Castle has a commanding view over the Ham of Muness.
Overall sensitivity to the Proposed Project	Much of the East Unst CCA is devoid of modern development and many areas are important internationally. The coast is of **high sensitivity** to the Proposed Project.

Table 11.3.2 – Skaw CCA

Key Characteristics	
The Skaw Coastal Character Area runs from the Noup to Lamba Ness characterised by a rocky exposed coastline with small bays. The landscape is mainly heather moorland ending in cliffs.	
➢ *Cliff scenery* ➢ *Small beaches* ➢ *Most northerly house in Britain*	
Coastal Character Description	
Coastal Experience	The Skaw CCA is a dramatic coastline with panoramic views. It has a remote feel with the remains of the Radar Station which reflect the strategic importance of the coastline during the second world war. The beach at the Wick of Skaw is secluded, one of the only places in Shetland where the oyster plant can be found. There are dramatic views from the point of Lamba Ness looking back across Saxa Vord and the tall sea cliffs.
Overall sensitivity to the Proposed Project	The Skaw CCA is valued for its scenic qualities. The coast is of **high sensitivity** to the Proposed Project.

Appendix 11.4 Seascape Character Areas within the EZI

Appendix 11.4 Seascape Character Areas within the EZI

Introduction

11.4.1 The NatureScot commissioned report 103, Commissioned Report No. 103, An assessment of the sensitivity and capacity of the Scottish seascape in relation to windfarms, 2005, provides baseline information relevant to the EZI. It was prepared to assess the seascape issues with regard to offshore wind energy developments, and a request for the inclusion of seascape units from this document was made in the scoping response received from Shetland Islands Council.

11.4.2 The report defines seascape character around the Scottish Coastline. Seascape character is made up of physical characteristics of hinterland, coast and sea plus a range of perceptual responses to the seascape, as well as visual aspects. Seascape sensitivity is defined as *'the measure of how vulnerable or robust seascape character is to change'.*

11.4.3 One Seascape Character Area (SCA) falls within the EZI, Seascape Area 33, Shetland. The seascape area, which is described below, includes two Seascape Types as illustrated on Drawing 11.1.3 in Volume III and listed below:

- Seascape Character Type 1: Remote High Cliffs
- Seascape Character Type 13 D: Islands, Sounds and Voes

Seascape Character Area Descriptions

11.4.4 This section describes the Seascape Character Area and the Seascape Types that coincide with the Proposed Project EZI. The descriptions and the assessment of sensitivity of the Seascape Character Areas form the baseline to the assessment of effects on Seascape Character.

11.4.5 The following table sets out the main features, key characteristics and sensitivity of the Shetland Seascape Character Area to development of the type proposed. Short descriptions of the Seascape Character types are also set out below.

Table 11.4.1 – Area 33: Shetland

Key Characteristics	
➢ indented coastline of fragmented islands, skerries, sounds and voes; ➢ generally low, often rocky, edge with landscape often appearing 'submerged' but with some high cliffs, over 200m, tall in places; ➢ voes and Sounds form sheltered narrow channels of coastal waters with open sloping hinterland of pasture, rough grazing and scattered crofting; ➢ views over small islands to open sea are a feature; ➢ a dramatic, exposed seascape.	
Coastal Character Description	
Scale and Openness	Undulating landform can often contain views and the indented nature of the coastline reduces scale. Overall scale is large however, outwith voes and sounds, due to openness of landscape and close presence of sea.
Form	A very fragmented landform with numerous islands and deeply indented coastline of voes and headlands. Some dramatic high cliffs on exposed coasts. Landform is

	generally simple, with smooth broadly rounded low hills and often insignificant rocky coastline and has some vertical emphasis.
Settlement	Generally, sparsely settled, with the main settlement of Lerwick on the coast. Buildings tend to be small and low. Sullom Voe Oil Terminal only large-scale industrial feature present. Aquaculture has a significant visual impact in many sheltered areas with most voes now containing some form of fish farm development.
Lighting	Very low levels of lighting due to sparse settlement although the Sullom Voe oil terminal and commercial part of Lerwick harbour are illuminated.
Modification/ Remoteness/ Sense of Naturalness	Modified to some extent by small scale farming/crofting often in narrow strip along sheltered coasts. Keen sense of remoteness on many outlying islands and unsettled coasts. Perception is of a generally undeveloped area with a strong sense of history and distinctive culture although the oil industry is also associated with Shetland.
Overall sensitivity to the Proposed Project	Development may affect the intricate land/sea relationship and views of outlying islands and the appreciation of the vertical scale of high cliffs where these are present. The perception of remoteness and wildland qualities of some coastal areas and the highly natural character of the outlying islands may also be affected by development. The coast is of **high sensitivity** to the Proposed Project.

Table 11.4.2 – Seascape Character Type 1: Remote High Cliffs

Physical Characteristics
High cliffs, often over 200 m tall, with occasional small sandy or stony bays at their base, contained by rocky headlands. Stacks, caves and collapsed cliffs are often features of this coastline. There is a strong contrast of line and form arising between the sheer verticality of cliffs and wide horizontal expanse of the sea. This type usually has a high moorland, or occasionally, mountainous, hinterland where semi-natural heathland is the dominant landcover. Settlement is generally absent although occasional small villages can be found tucked in bays and inlets or extensive crofting on tops within Highland areas. Light houses can be prominent features on headlands. This type has a remote, wild character due to the absence of roads and settlement. Access and views to the coast from the hinterland are restricted due to the cliffs. Wide elevated views are directed along the coast and out to open sea. Views of rigs or boats can be a focus within the maritime component of this type. The Northern quality of light often gives intense clarity in views.
Experiential Qualities
The Atlantic coast of Shetland coast has a particularly exposed character and are physically remote from settlement. The coast is difficult to access, and the water's edge is often blocked by impassable steep cliffs. These are exhilarating and awe-inspiring coastlines due to the great height of cliffs giving elevated and distant views and being particularly dramatic when the sea is turbulent. The noise of sea birds nesting on cliffs and waves add to the attraction and excitement of this seascape type.

Table 11.4.3 – Seascape Character Type 13D: Low, rocky island coasts – Islands, sounds and voes

Physical Characteristics
Generally low rocky coastline, rising to cliffs in places. Moorland, either rocky, 'Stepped' or boggy, tends to back a narrow sparsely settled open coastal fringe, usually some crofting and few settlements. Views of open Atlantic Ocean in the main. This sub type comprises the farmed and settled coastal lowlands of Shetland where a deeply indented coastline creates sounds and voes with fragmented islands. This sub type generally has an insignificant low, hard coastal edge, often appearing smooth and 'submerged'. Voes and sounds form sheltered narrow channels of coastal waters with open, gently sloping hinterland of pasture, rough grazing and scattered crofting. Views over small islands to open sea are often a feature.
Experiential Qualities
These island seascapes can feel very remote due to the sparse settlement, moorland or low-key crofting hinterland and exposure to open sea. Strong sense of being on an island due to close proximity of sea often with 'all round' views and little distance from the sea.

Appendix 11.5 Special Landscape Qualities Assessment

Appendix 11.5 Special Landscape Qualities Assessment – Shetland National Scenic Areas

Introduction

11.5.1 This appendix provides a detailed assessment of effects on the Special Landscape Qualities of the Shetland National Scenic Area. The assessment is based on emerging guidance prepared by NatureScot on assessing how special landscape qualities may be affected by development proposals.

Policy Context

11.5.2 National Scenic Area (NSA) is a conservation designation used in Scotland and administered by NatureScot. The designation's purpose is to identify areas of exceptional scenery and to protect them from inappropriate development. NSAs were first established in 1980, under planning legislation, by order of the Secretary of State. Part 10 of the Planning etc. (Scotland) Act 2006 gave NSAs a statutory basis. The Town and Country Planning (National Scenic Areas) (Scotland) Designation Directions 2010 then brought this into force. In December 2010, NSAs were designated under this new legislation.

11.5.3 Scottish Planning Policy (SPP) is a statement of Scottish Government policy on how nationally important land use planning matters should be addressed. With regard to National Designations, SPP states that:

"Development that affects a National Park, National Scenic Area, Site of Special Scientific Interest or a National Nature Reserve should only be permitted where:

the objectives of designation and the overall integrity of the area will not be compromised; or

any significant adverse effects on the qualities for which the area has been designated are clearly outweighed by social, environmental or economic benefits of national importance."

(paragraph 212, emphasis added).

Methodology

11.5.4 The assessment is based on the following draft NatureScot methodology: Working Draft 11 – Guidance for Assessing the Effects on Special Landscape Qualities (November 2018), including the parameters for levels of effect.

11.5.5 The guidance advocates a narrative approach, to provide transparency when drawing conclusions and making judgements of effect on experiential and perceptual qualities, taking four steps as summarised in the following bullets.

- Step 1 The Proposal – Gain as full an understanding of the proposal as possible.
- Step 2 Define the Study Area and Scope of the Assessment identifying the area likely to be affected.
- Step 3 The Analysis of Impacts and Effects on SLQs.
- Step 4 Summary of Impacts on the SLQs, implications for the NSA and possible future effects on SLQs and recommendations for mitigation.

11.5.6 The aim of the assessment is to understand the effects of Proposed Project on the NSA's defined special landscape qualities and to determine whether these effects will compromise the overall integrity of the NSA, or undermine the objectives of designation.

Shetland NSA – identification of relevant special landscape qualities

11.5.7 The following text sets out the overall special landscape qualities of the Shetland NSA and those special landscape qualities identified for the relevant constituent sub units, which will be indirectly influenced by the Proposed Project.

11.5.8 The Shetland NSA includes seven separate small areas of coastal landscape, which have been identified as being of outstanding scenic interest. Of these, the Hermaness sub-area falls into the zone of theoretical visibility within 15km of the Proposed Project. This area, situated in the north Unst, is the focus of the assessment.

11.5.9 The overall special qualities of the Shetland NSA are described within The Special Qualities of the NSAs, NatureScot commissioned report, 2010, as:

- "The stunning variety of the extensive coastline;
- Coastal views both close and distant;
- Coastal settlement and fertility within a large hinterland of unsettled moorland and coast;
- The hidden coasts;
- The effects and co-existence of wind and shelter;
- A sense of remoteness, solitude and tranquillity;
- The notable and memorable coastal stacks, promontories and cliffs;
- The distinctive cultural landmarks; and
- Northern light."

11.5.10 Some special qualities are generic to all the identified NSA areas, whereas others are specific to sub areas within the NSA. For the Hermaness sub area of the NSA *"a sense of remoteness, solitude and tranquillity"* special quality is highlighted, as discussed below.

Hermaness sub area of the Shetland NSA

11.5.11 The Hermaness sub area of the Shetland NSA includes the following specific special qualities, which are described within the NatureScot report:

- *"At Hermaness on Unst, the coastal topography varies from the 175m high cliffs at the Neap, to the sandy beach and machair at the head of the narrow Burrafirth.*
- *Cultural landmarks include the western edge of the Hermaness area which contains the northerly military installations in the British Isles at Saxa Vord."*

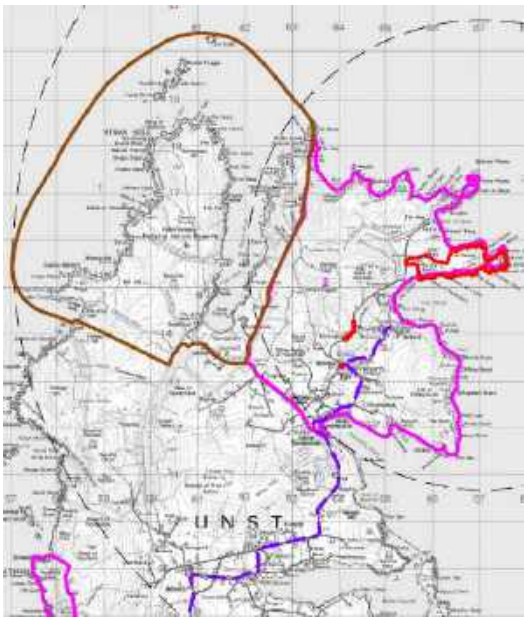
11.5.12 Drawings 11.2.1a to 11.2.2b illustrate the extent of theoretical visibility of the Proposed Project, indicating a small area of visibility at the summit of Saxa Vord Hill over a distance of 2.5 km and partial visibility to the extended lightning masts only on Launch Pad Three from the headland to the north of Saxa Vord Hill at a distance of 4.7 km. Viewpoint 1.8, Headland to the north of Saxa Vord radar station, Drawing 11.3.1.8 illustrates the very limited visibility from the headland to the north of Saxa Vord Hill, within the NSA; and Viewpoint 1.9, Hermaness Hill, Drawing 11.3.19 illustrates the absence of visibility from the headland at Hermaness.

Assessment of Effects on the Shetland National Scenic Area

11.5.13 The following staged assessment follows the draft NatureScot guidance set out in the following document: *Working Draft 11 – Guidance for Assessing the Effects on Special Landscape Qualities (November 2018).*

Step 1: The Proposal

Table 11.5.1 Assessment of Effects on the Shetland National Scenic Area – Step 1: The Proposal

The Proposed Project	
The Proposed Project comprises three separate components: The Launch Site between Inner Skaw and Lamba Ness peninsula to the north east of Unst; a new section of link Road at Northdale, Unst; and the conversion of the former Valhalla Brewery at Saxa Vord Resort to the Launch Control Centre. A detailed description of the Proposed Project is set out in Chapter 3: Project Description. The site is located within the north eastern part of the island of Unst. The Shetland NSA includes seven designated areas. Of these the Hermaness sub-area falls into the very edge of the zone of theoretical visibility within 2.5 km of the Proposed Project. The adjacent plan extract from Drawing 11.1.2 illustrates the position of the Proposed Project and the Hermaness sub area of the NSA to the north east and the Fethaland sub unit of the NSA to the south west, denoted with the brown boundary line.	

Step 2: Define the Study Area and Scope of the Assessment identifying the area likely to be affected

11.5.14 The following extracts from Drawing 11.2.1 illustrates visibility of the Launch Site ZTV overlaid with the Hermaness NSA sub unit. Only c.200m² of the Hill summit at Saxa Vord Hill indicates visibility to the Launch Site and a similar extent of the headland to the north of Saxa Vord Hill indicates visibility to the extended lightning masts on Launch Pad Three.

11.5.15 The boundaries of the component landscape character units/coastal character units are indicated on these plan extracts.

Table 11.5.2 Hermaness Sub Area of the Shetland NSA: Theoretical Visibility of the Launch Site

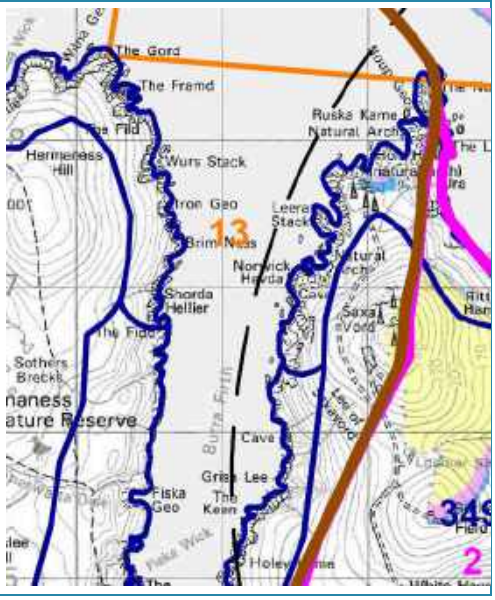
The Proposed Project	
National Scenic Areas (Herma Ness) Local Landscape Areas Visibility of Site Visibility of baseline built form only Visibility of lightning masts only Combined visibility of baseline built form and lightning masts Combined visibility of lightning masts and rocket launch sites Combined visibility of baseline built form, lightning masts and rocket launch sites The component Landscape Character Areas and Coastal Character Areas indirectly influenced are as follows: ▪ LCT 349 Major Uplands ▪ CCA 13, Burra Firth	

Table 11.5.3 Assessment of Effects on the Shetland National Scenic Area: how the area is used by people

How the area is used and experienced by people
Hermaness Sub Area Crofting settlement with associated pastures lie at the head of Burra Firth. To the north east, the hill at Saxa Vord is the location of the Saxa Vord radar station, housed within distinctive spherical radar domes. Hermaness is home to the Hermaness National Nature Reserve, a haven for thousands of populations of seabirds during the breeding season. As such the area is frequently visited by tourists and ornithologists. Hermaness Hill is also the most northerly headland of the Shetland Islands. The car parking at Burrafirth provides access to the core path network which leads to Hermaness Hill, facilitating access to the dramatic coastal scenery. The seaward area of the NSA attracts people engaged in recreational sailing and a trip along the eastern coast of Unst can be included as part of a multi-day trip for the experienced sea kayaker in good conditions. However, fast tidal movement, tidal races, overfalls and ocean swell limit activity. There are no ferry routes passing through this area though fishing vessels, cruise ships and other shipping will pass close to the NSA. Permanent settlement is limited to the Lighthouse Station, Upper and Lower Sotland, Sanfield and Buddabrake at the southern extent of Burrafirth. Residents of this scattered settlement will not experience views to the Proposed Project. Hermaness is a popular focus for walking and ornithology with access formalised along a route leading from Burra Firth via Winnswarta Dale to the north west coastline at Humlataes and on to Herma Ness and Hermaness Hill.

Table 11.5.4 Hermaness Sub Unit – Typical Views

Hermaness Sub Unit

View to Saxa Vord Radar Radome and access road, grid reference 462970, 1217656

View to the headland at Virdik and the Holm of Skaw, grid reference 462970, 1217656

View towards Baltasound from Hermaness Hill, grid reference 460648, 1217592



View towards the cliffs at Tonga and to Valla Field to the south from Hermaness Hill, grid reference 460648, 1217592

Step 3: Effects on the Special Landscape Qualities

11.5.16 The following table sets out the special landscape qualities (SLQs) relevant to the NSA sub unit at Hermaness and considers the effect of the Proposed Project on the key characteristics and SLQs.

11.5.17 It should be noted that the Proposed Project is not located within the NSA and effects will be indirect, with only a visual influence, and no direct physical effects.

11.5.18 The Proposed Project will be experienced against a baseline which is already influenced by human activity and development, for example the existing settlement pattern and road network, the prominently sited radar facilities at Saxa Vord and the lighthouse at Muckle Flagga and the associated (former) shore station in Burrafirth.

Table11.5.5 Assessment of Effects on the Shetland National Scenic Area – Step 3: The Assessment

Assessment of effect and risk	
SLQs identified at scoping and refined during subsequent study, including detailed SLQ descriptions / underpinning landscape characteristics	**Effects of the Proposed Project on key characteristics and SLQs**
Generic Special Landscape Quality: *"The stunning variety of the extensive coastline"* *"Shetland's long, extensive coastline is highly varied: from fissured and fragmented hard rock coasts, to gentler formations of accumulated gravels, sands, spits and bars; from remarkably steep cliffs to sloping bays; from long, sheltered voes to cliffs exposed to the full fury of the Atlantic Ocean."* *"The landscape is an intimate mix of sea and land. The sea reaches far inland by way of voes, firths and sounds, an inland coast in marked contrast to the dynamic outer coast of wild Atlantic 'oceanscapes'. Here the land reaches into the open sea on many points and promontories."*	The Proposed Project would not have had a direct effect on the "*stunning variety of the extensive coastline"* of the NSA because the Proposed Project is not located in the NSA, being located at a distance beyond 2.5 km from the closest NSA boundary. The limited areas with visibility within the Hermaness sub unit of the NSA include: the summit area of Saxa Vord Hill within the dominating influence of the Saxa Vord Radar Station Radome and associated infrastructure; with a further small area of partial visibility to the extend lightning masts only on Launch Pad Three, from a small area of the headland to the north of

Assessment of effect and risk	
"This huge variety has arisen from the interaction between geology, glaciation and sea level changes, and results in the dramatic coastal scenery as encapsulated within the seven areas of the NSA."	Saxa Vord Hill, seen in the context of dismantled radar equipment and broken fencing. The influence of the Proposed Project will be well separated from the foreground intensity of the coastal experience and the special qualities of the sub areas of the NSA would not be affected. **Risk of damage / loss to SLQ:** No Change to SLQ
Generic Special Landscape Quality: *"Coastal settlement and fertility within a large hinterland of unsettled moorland and coast"* *"Thousands of years of human occupation has given the landscape a rich archaeological heritage, including ancient brochs and modern crofts."* *"Settlement has always been constrained by the nature of the land, largely confined to strips of ground rarely out of sight of the sea. Houses are concentrated at the heads of voes or in sheltered bays, well placed to make use of the sea and coastal resources."* *"The green, inbye land of the crofts and farms contrasts with the common grazings of wild, unimproved and uninhabited moorland and bog. There are also long lengths of remote and uninhabited coast."*	Settlement within Hermaness sub area is set within the sheltered setting of Burra Firth. The surrounding landform prevents any inter-visibility with the Proposed Project. **Risk of damage / loss to SLQ:** No Change to SLQ
Generic Special Landscape Quality: *"The hidden coasts"* *"Because the land is undulating, markedly so in the western mainland, the actual brink of the coastal edge may be hidden or difficult of access. This brings an element of surprise when caves, geos and gloups are suddenly encountered, inviting further exploration."*	The immediate coastline of Hermaness is predominantly inaccessible, with walking access restricted to the coastal path above the cliffs. Routes follow closely around the indented terrain, and the foreground changes constantly. The SLQ relates to the immediate coastline of the NSA and the Proposed Project would only have indirect effects on wider views and visibility is extremely limited. **Risk of damage / loss to SLQ:** No Change to SLQ
Generic Special Quality: *"The effects and co-existence of wind and shelter"* *"The wind appears ever-present and the absence of trees, or even shrubs, gives an open and exposed feel to much of the landscape. The frequent gales can be awe-inspiring, and in high seas fröde (sea-foam) can fleck the coastal grasslands, well-inland from the coastal edge."* *"Weather, skies and light are rarely static, with continual movement of clouds, waves, sea-spray*	The Proposed Project would not have a significant influence on *"the effects and co-existence of wind and shelter".* **Risk of damage / loss to SLQ:** No Change to SLQ

Assessment of effect and risk	
and grasses. The interplay of light and shade moving across the sea, the coastal grasslands or the interior moorland adds a special dynamism." *"With wind a determining force, so the presence of shelter is acutely perceived. Hence, an awareness of both wind and shelter is a particular quality of these areas. There may be the distant sound of stormy seas pounding the mouth of a bay or voe, while inland waters or a sheltered hollow remain still and calm."*	
Generic Special Landscape Quality: *"A sense of remoteness, solitude and tranquillity"* *"The feeling of being at the northern limits of the British Isles is marked. The Shetland Isles are remote in themselves, and within the archipelago there are also degrees of remoteness."* *"Most of the coastline is undeveloped and natural, and long-stretches can be traversed without seeing anyone or any human influence."* *"Hence solitude and tranquillity underpin much of the NSA coast, and it is easy to wander with only the seabirds for company. However, tranquillity can give way to alarm as the wind picks up, the rain begins and an Atlantic storm sets in."* *"Muckle Flugga, within the Hermaness section of the NSA, is further from the Scottish/English border than Lands End."*	The Proposed Project would not have a direct effect on *"A sense of remoteness, solitude and tranquillity".* However, the presence of the Proposed Project in distant views would have an indirect effect owing to the very slight (occasional) increase presence of man-made artefacts in views. The landscape remains very exposed, wild and dynamic and the *"sense of remoteness, solitude and tranquillity"* will remain intact. **Risk of damage / loss to SLQ:** Negligible, limited to indirect effects.
Generic Special Landscape Quality: *"The notable and memorable coastal stacks, promontories and cliffs."* *"Where open to the full fury of the Atlantic Ocean, the sea has carved impressive cliffs, forming spectacular, towering, vertical scenery, varying greatly in colour according to the complex geology."* *"The coast also contains many distinctive stacks, promontories and other features that form memorable images. Within the NSA these include:"* • *"Muckle Flugga with its distinctive sloping, pointed rocks"* • *"The imposing cliffs of Hermaness itself, with its nesting seabirds."*	The Proposed Project will not have a direct effect on *"the notable and memorable coastal stacks, promontories and cliffs."* as it is located in a geographically separate area. The Proposed Project is set back from the distinctive *"coastal stacks, promontories and cliffs"* of the NSA and would not interrupt direct views to these features. **Risk of damage / loss to SLQ:** Negligible, limited to indirect effects.

Step 4: Summary of Effects on the SLQs

Table 11.5.6 Assessment of Effects on the Shetland National Scenic Area – Step 3: The Assessment

Assessment of effect and risk
The Proposed Project is located beyond the Shetland NSA, however, the Proposed Project has a minor indirect influence on the Hermaness sub area on north Unst. The Proposed Project will be visible from the summit area of Saxa Vord Hill in the context of the dominating influence of the Saxa Vord Radar Radome. A further small area of visibility is recorded on the remote headland to the north of Saxa Vord Hill, across a very small area, with visibility of the extended lightning masts on Launch Pad 3 appearing a distant minor element visible in the context of coastal views, set back from foreground coastal features. Many of the SLQs relate to the physical attributes of the NSA and the experience of these from within the NSA and the Proposed Project will only affect the wider setting of the NSA. As such the Special Landscape Qualities of the Hermaness sub-unit of the Shetland NSA will not be at risk or compromised by the Proposed Project and the overall integrity and objectives of the Shetland NSA will be maintained.

Appendix 12 -

Appendix 13 -

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