

HyImpulse SR75 SaxaVord AEE V2

Assessment of Environmental Effects

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Abbreviations and Glossary
HyImpulse SR75 SaxaVord Spaceport AEE V2

Term	Expanded Term
'effect'	The term '*effect*' is defined as the consequences for the receptor of an impact.
'impact'	The term '*impact*' is defined as a change experienced by a receptor (this can be beneficial, neutral or adverse)
'receptor'	used throughout the Assessment of Environmental Effects (AEE) process and is defined as the element in the environment affected by a development (e.g. a bird in the case of ornithology)
ACH	Advanced Chain Home
AD	Alert Distance
AEE	Assessment of Environmental Effects
AIS	Automatic Identification System
ALARP	As Low as Reasonably Practical
AOB	Apparently Occupied Burrows
AOD	Above Ordnance Datum
AON	Apparently Occupied Nests
AQIA	Air Quality Impact Assessment
AQOs	Air Quality Objectives
AQS	Air Quality Strategy
BAP	UK Biodiversity Action Plan
CAA	UK Civil Aviation Authority
CAFF	Conservation of Arctic Flora and Fauna
CAFS	Cleaner Air for Scotland Strategy
CCP	Climate Change Plan
CH	Chain Home
CIEEM	Chartered Institute for Ecology and Environmental Management
CifA	Chartered Institute for Archaeologists
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COMAH	The Control of Major Accident Hazards Regulations (2015)
CoNaW Regs	The Control of Noise at Work Regulations
CRTN	Calculation of Road Traffic Noise
DfT	Department for Transport
DMRB	Design Manual for Roads and Bridges

Term	Expanded Term
EC	European Commission
EcIA	Ecological Impact Assessment
EEZ	UK Exclusive Economic Zone
ELV	Exposure Limit Value
EMODnet	European Marine Observation and Data Network
END	Assessment and Management of Environmental Noise
EPS	European Protected Species
EZI	Environmental Zone of Influence
FCS	Favourable Conservation Status
FID	Flight Initiation Distance
FTS	Flight Termination System
GCN	Guidelines for Community Noise
GDG	Guideline Development Group
GDP	Gross Domestic Product
GHG	Greenhouse Gas Emissions
GI	Ground Investigation
GP1	Shetland Islands Local Development Plan Policies 2014 – Sustainable Development
GP2	Shetland Islands Local Development Plan Policies 2014 – General Requirements for All Development
GVA	Gross Value Added
GWDTE	Groundwater Dependent Terrestrial Ecosystems
H_2O	Water Vapour
HES	Historic Environment Policy for Scotland
HDPE	High Density Polyethylene
HTPB	Hydroxyl-Terminated Polybutadiene
HMRC	His Majesty's Revenues and Customs
HyImpulse	the Applicant
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
JNCC	Joint Nature Consrvation Committee
Km	Kilometres
kN	Kilonewtons
LAQM	Local Air Quality Management

Term	Expanded Term
LCA	Coastal Edge Landscape Character Areas
LDP	Local Development Plan
LCTs	Landscape Character Types
LEAV	Lower Exposure Action Value
LEZ	Launch Exclusion Zone
LLAs	Local Landscape Areas
LOx	Liquid Oxygen
LRCC	Launch and Range Control Centre
LSPF	Launch Site Processing Facility
LULUCF	Land use / land use change factor
LVIA	Landscape and Visual Impact Assessment
LVs	Launch Vehicles
MOD	Ministry of Defence
MPAs	Marine Protected Areas
MSDS	Material Data Safety Sheets
NASA	National Aeronautics and Space Administration
NAQS	National Air Quality Strategy
NBN	National Biodiversity Network
NCAP	National Collection of Aerial Photography
NCN	National Cycle Network Routes
NIHL	Noise Induced Hearing Loss
NO_2	Nitrogen Oxide
NOAA	National Oceanic and Atmospheric Administration
NO_3	Nitrate
NPF4	National Planning Framework 4
NRHE	National Record of Historic Environment
NSA	National Scenic Area
NSA	New Statistical Account
NHZ	Natural Heritage Zone
NSRs	Noise Sensitive Receptors
NTS	Non-Technical Summary
NVC	National Vegetation Classification Survey
ONS	Office for National Statistics
OT	Oxidiser Tank Module
PAN	Planning Advice Note
PCA	Peatland Condition Assessment

Term	Expanded Term
PT	Pressurisation Tank Module
RAF	Royal Airforce
RCAHMS	Royal Commission on the Ancient and Historical Monuments of Scotland
RCP	Representative Concentration Pathway
RepLV	Representative Launch Vehicle
SACs	Special Areas of Conservation
SAT	Shetland Amenity Trust
SAXA-GRP-OPS-SSUM-001	SaxaVord Spaceport Launch Site Safety User's Manual
SBL	The Scottish Biodiversity List
SCA	Seascape Character Area
SEL	Sound Exposure Level
SENEL	Single Noise Exposure Level
SEPA	Scottish Environment Protection Agency
SGHE	Supplementary Guidance on the Historic Environment (published by Shetland Islands Council)
Shetland Space Centre	The Proposed Project
SIA	Space Industries Act 2018
SIC	Shetland Islands Council
SIR	Space Industry Regulations 2021
SMCP	Scheduled Monument Consent Policy
SMC	Scheduled Monument Consent
SMR	Sites and Monuments Record
SNH	Scottish Natural Heritage
SoNA	Survey of Noise Attitudes Study
SPA	Special Protection Area
SR75 Launch Vehicles	SR75 unguided sounding rockets
SSSI	Site of Special Scientific Interest
TEL	Transporter / Erector / Launcher Vehicle
The Shetland Plan	The Shetland Local Development Plan
UEAV	Upper Exposure Action Value
UNCLOS	United Nations Convention on the Law of the Sea
VHF	Very High Frequency radio
VMEs	Vulnerable Marine Ecosystems

Term	Expanded Term
WHO	World Health Organisation
ZTV	Zone of Theoretical Visibility

Glossary

Aborted Launch	**Aborted Launch** A launch event where the Launch Operator calls off the attempted launch prior to ignition.
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".
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
EZI	**Environmental Zone of Influence** The zone of influence is the area around the site that may be affected by the proposed changes within the site. Impacts could include the removal or alteration of habitat or increase human presence on or around the site.
Flight Corridor	**Flight Corridor** An area on the Earth's surface estimated to contain the hazardous debris from nominal flight of a launch vehicle and off-nominal flight of a launch vehicle, assuming a functioning flight termination system or other flight safety system.
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.
Hotfire Test	**Static Hotfire Test** Hotfire tests (also known as static hotfire tests) are when a Launch Operator carries out a hotfire test of their first stage engine(s).

Impact Dispersion Area	**Impact Dispersion Area** The area representing an estimated three standard deviation dispersion about a nominal impact point of an intermediate or final stage of a sub-orbital launch vehicle.
Launch Area	**Launch Area** The portion of a flight corridor from the launch point to a point 100 nautical miles (185 km) in the direction of the flight azimuth. Note this is what the Applicant has bounded the siting assessment to. Further downrange is under the remit of the Launch Operator licensees.
Launch Azimuth	**Launch Azimuth** The horizontal angular direction initially taken by a launch vehicle at lift-off, measured clockwise in degrees from true north.
Launch Vehicle (LV)	**Launch Vehicle** A launch vehicle or carrier rocket is a rocket propelled vehicle used to carry a payload from Earth's surface to space.
Nominal	**Nominal** In reference to launch vehicle performance, trajectory, or stage impact point, a launch vehicle flight where all launch vehicle aerodynamic parameters are as expected, all vehicle internal and external systems perform as planned, and there are no external perturbing influences (e.g., winds) other than atmospheric drag and gravity.
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 Event	**Off-nominal Launch Event** A launch event where the launch event proceeds beyond ignition but does not perform within expected/acceptable limits.
Scrubbed Launch	**Scrubbed Launch** A launch event where the Launch Operator calls off the attempted launch prior to ignition.
Sounding Rocket	**Sounding Rocket** Sounding rockets are one or two stage solid propellant rockets used for probing the upper atmospheric regions and for space research. They also serve as easily affordable platforms to test or prove prototypes of new components or subsystems intended for use in launch vehicles and satellites.
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.
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 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.
Sub-orbital	**Sub-orbital** Sub-orbital flights may go into space, then their path (or trajectory) carries them back to earth.
Test Launch	**Test Launch** A research/test launch event that proceeds beyond ignition and lift off.
Trajectory	**Trajectory** The position and velocity components as a function of time of a launch vehicle relative to an x, y, z coordinate system, expressed in x, y, z, ẋ, ẏ, ż.
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.
µg	**µg** In the metric system a microgram or microgramme is a unit of mess equal to one millionth of a gram. The unit system is µg according to the International System of Units.

Volume 1 – NON-TECHNICAL SUMMARY

Volume 1 – NON-TECHNICAL SUMMARY

Volume I – Non-Technical Summary

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1. Non-Technical Summary

1.1 Introduction

1.1.1 Aurora Environmental Consulting Limited has reviewed and updated this Assessment of Environmental Effects (AEE) on behalf of HyImpulse UK Ltd ('the Applicant') in regard to their application to the UK Civil Aviation Authority (CAA), the Regulator, for a sub-orbital launch operator licence under the Space Industry Act 2018.

1.1.2 The Applicant intends to launch SR75 guided sounding rockets ('SR75 Launch Vehicles') from SaxaVord Spaceport situated at Lamba Ness in Unst, Shetland. With an anticipated apogee of approximately 150 kilometres (km), launches of SR75 Launch Vehicles are covered by the Space Industries Act 2018 (SIA) and the associated Space Industry Regulations 2021 (SIR) and as such, the Applicant is applying for a launch operator licence.

1.1.3 As set out in the 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.

1.1.4 The Applicant's SR75 Launch Vehicle is a uniquely safe single-stage Launch Vehicle for microgravity experiments and atmospheric research. Its built-in-house hybrid rocket motor uses paraffin and liquid oxygen, which makes it the first European sounding rocket that exploits such combination of propellants. The SR75 has a thrust of 75 kilonewtons (kN) and is anticipated to reach an apogee of approximately 150 km and lift payloads of up to 300 kg.

Space Industry Act 2018

1.1.5 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.

1.1.6 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 from the UK;
- operate a spaceport in the UK; or
- provide range control services from the UK.

1.1.7 As the Applicant wishes to become a spaceflight operator and launch SR75 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

1.1.8 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, as Regulator, requires in support of an application

Relevant Guidance

Guidance for the Assessment of Environmental Effects

1.1.9 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.

1.1.10 The guidance describes the two licence types 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.*

1.1.11 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

1.1.12 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 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.*

1.1.13 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.

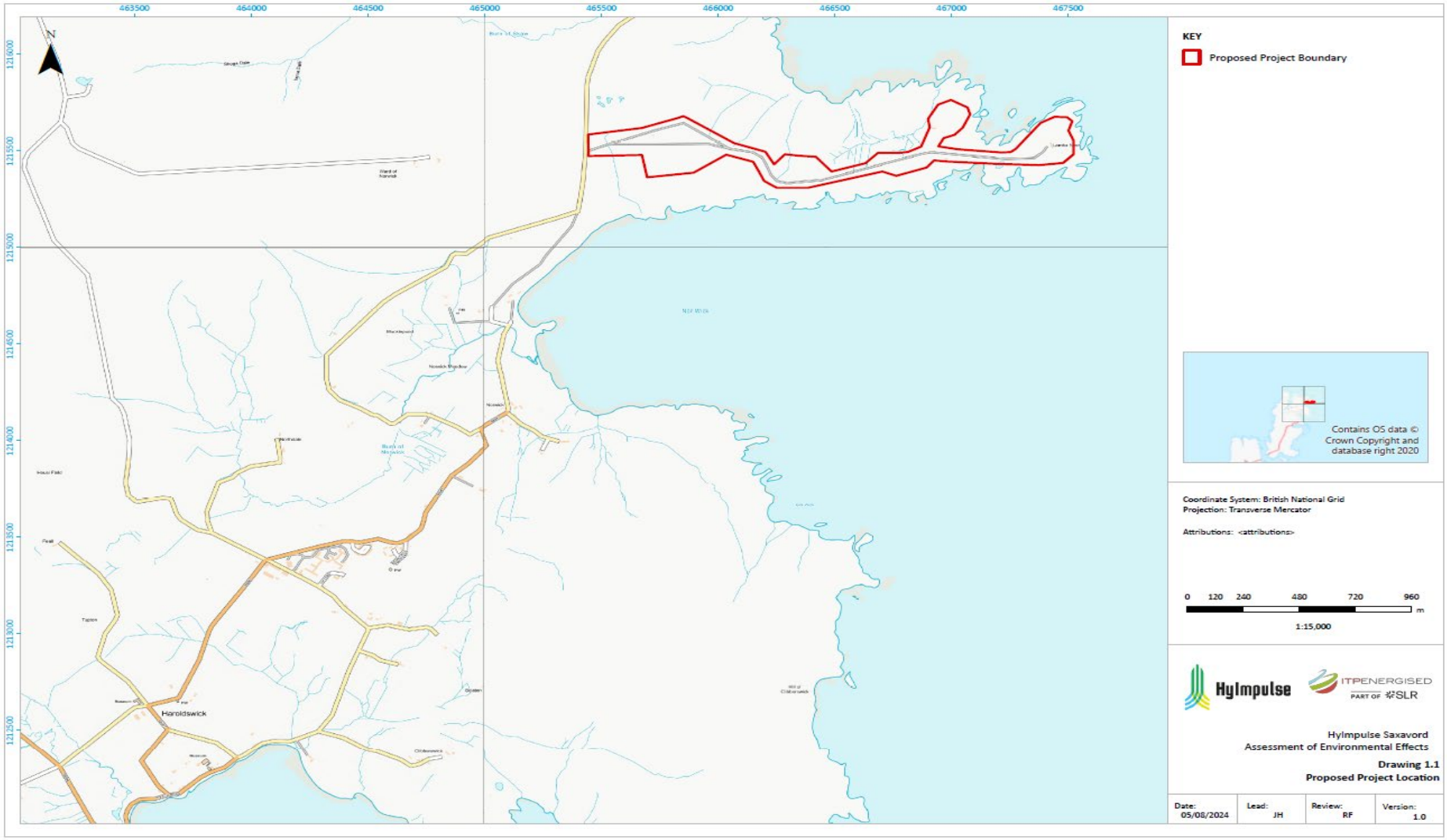
1.2 Proposed Project

Location

1.2.1 The Proposed Project will operate at SaxaVord Spaceport located at Lamba Ness in Unst, the most northerly of the Shetland Islands. The location of the Proposed Project is shown on Drawing 1.1 in Volume III of this AEE Report.

1.2.2 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 SR75 Launch Vehicle will take place. The Proposed Project is centred on national grid reference 466916 E, 1215580 N and occupies an area of approximately 31 hectares. It is approximately 2.5 km north-east of the settlement of Norwick.

Figure NTS-1 Location of Proposed Project



Proposed Project Description

1.2.3 The Proposed Project comprises the preparation and launch of SR75 Launch Vehicles from SaxaVord Spaceport situated at Lamba Ness in Unst, Shetland.

1.2.4 The SR75 Launch Vehicle is approximately 13 m long, 0.6 m in diameter and is a single-stage sub-orbital launch vehicle propelled by a hybrid engine and intended to host payloads for microgravity experiments or place payloads for re-entry in the atmosphere. Launches will take place in a northerly direction over the sea. It is anticipated that launches will take place from Launch Pad 2. The return to earth impact dispersion area is anticipated to be approximately 200 km downrange.

1.2.5 For safety reasons, the SR75 Launch Vehicle 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 will constrain trajectories in order to avoid nominal jettisoned separated components impacting inhabited land masses, including Jan Mayen, or waters within 12 miles of those coastlines, in compliance with international treaties.

1.2.6 The infrastructure required for the Proposed Project consists of:

- Launch Pad 2: located on the Lamba Ness peninsula and incorporating a launch pad, ground services storage and control, lightning protection mast, 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 SR75 Launch Vehicle will be assembled, and the payload(s) integrated in future years;
  - Administration Building and Hazardous Materials Store: located adjacent to the LSPF on the Lamba Ness peninsula;
  - Hangar A: located on the Lamba Ness peninsula, a forward position building close to the Launch Pad where final integration activities will take place; and
  - Support Infrastructure: located on the Lamba Ness peninsula including access, an internal track system and a series of small temporary buildings.

1.2.7 Subject to securing the appropriate permissions, consents and licences, the intention is to initiate first demonstration launch as soon as September 2025 and then assume a cadence of one launch per year from 2026.

Environmental Budget

1.2.8 The Applicant is applying for a maximum environmental budget of one launch per year.

1.2.9 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 30 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 6).

1.2.10 For other technical disciplines the appropriate timeframe for assessment varies:

- 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 environment to return fully to the baseline state 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.

- For climate change, a single launch event is the basis of calculations for greenhouse gas emissions. Considering climate resilience, UK Met Office projections of expected changes covering the period 2050-2079 are included based on the current 30 year lease for the spaceport.
- For accidents, the assessment is agnostic of timeframe and simply considers the potential environmental effects of accident scenarios as if occurred.

Environmentally Sensitive Periods of Time

1.2.11 Following consultation with NatureScot during the planning application stage for the Spaceport, SaxaVord Spaceport committed to a no-launch window whereby no launches or static hotfire 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. No SR75 static hotfire tests are proposed at SaxaVord.

1.3 Approach to AEE

1.3.1 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 potentially significant effects. An assessment of residual effects, those expected to remain following implementation of mitigation measures, is also presented.

1.3.2 The key stages in the AEE process are presented in Chapter 3 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 7).

1.3.3 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
- Marine environment
- Climate
- Land, Soils and Peat
- Landscape, Seascape and Visual Impact
- Material assets and cultural heritage
- Accidents and Disasters.

Environmental topics not considered within the AEE

1.3.4 The specification of the SR75 Launch Vehicle is within that of the limiting case representative launch vehicle (RepLV) considered for SaxaVord Spaceport, aligning closely with the Small Mass Emission Launch Vehicle - the least significant launch vehicle - considered within SaxaVord Spaceport AEE V3 (reference SR-APP-001019). It is therefore considered that no further assessment is required in addition to that previously submitted in the SaxaVord Spaceport AEE V3 for several of the topics listed:

- Population and human health
- Biodiversity (ecology and ornithology)
- Noise and vibration
- Water
- Land, Soils and Peat
- Landscape, Seascape and Visual Impact
- Material assets and cultural heritage

For each of these disciplines, a justification has been included in Chapter 3 for information.

Environmental Zone of Influence

1.3.5 For the purposes of this AEE, the environmental zone of influence (EZI) is based on and comprises the proposed launch flight corridor (extending in a northerly direction over the sea from Launch Pad 2 along an azimuth of 000 degrees) and all study areas required for the technical disciplines included in the AEE.

1.3.6 Within the EZI, the study areas 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 on Drawing 2.2, alongside the full extent of the EZI.

1.4 Air Quality

1.4.1 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.

1.4.2 SR75 Launch Vehicle 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 to easterly winds which combined occur typically for less than 17 % of the year. The maximum predicted 8-hour concentration of Carbon Monoxide (CO) at the identified receptor R1 is <1% of the Air Quality Strategy (AQS).

1.4.3 The effect of SR75 Launch Vehicle launch event emissions on all identified receptors is concluded to be negligible - no likely significant effect.

1.5 Climate Change

1.5.1 An assessment of the potential effects of Green House Gas emissions (GHG) associated with the Proposed Project on climate change has been undertaken.

1.5.2 The assessment considered emissions arising from the operation of the Proposed Project including transportation and combustion of SR75 Launch Vehicle hybrid engine.

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

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

1.5.5 The climate baseline has been characterised using Met Office climate data for the period 1981-2010.

1.5.6 GHG emissions in the context of overall annual emissions by the Shetland Islands are considered of minor significance.

1.5.7 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.

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

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

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

1.5.11 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 Personal Protective Equipment (PPE).

1.6 Marine and Transboundary Effects

1.6.1 Effects on the marine environment may arise from the return of SR75 Launch Vehicle components to earth. Such marine effects may occur in Scottish waters or in the waters of other countries (i.e., transboundary effects), specifically Denmark (Faroe Islands) and Norway.

1.6.2 For the purposes of this AEE, the EZI is based on the proposed sub-orbital launch flight corridors (based on azimuths of 000°) and corresponding launch areas of the SR75 Launch Vehicle. The impact dispersion area is a circle contained within the larger area demarcated as the SR75 Environmental Zone of Influence (EZI), as presented in Drawing 6.1.

1.6.3 The EZI comprises mostly deep water with a small amount of continental shelf and many bathymetric features. The water quality of these study areas is high, in that they do not have significant local input of anthropogenic contaminants such as metals, microplastics, and hydrocarbons. The study areas support numerous marine biota such as plankton, benthic habitats, fish and shellfish, seabirds, and marine mammals. The EZI has few marine protected areas (Drawing 6.2).

1.6.4 In the EZI, human activities are concentrated in the southern portion (close to the coast). This includes shipping and navigation, oil and gas cables and pipelines, and commercial fishing (Drawing 6.3). There is occasional use of the area for military activities. Marine archaeology is poorly known and so assumed to be present. Presence of oil and gas infrastructure, subsea cables and pipelines, marine renewable energy, dredge disposal sites, tourism, and marine archaeological features is shown on Drawings 6.3 – 6.5.

1.6.5 Several standard operating procedures are included as part of the project design which reduce the risk to human receptors from the proposed operations. It is anticipated that an exclusion zone will be implemented around the precited returning SR75 Launch Vehicle component impact zones. Communications to other maritime users of the location of SR75 Launch Vehicle component impact zones will comprise Notice to Mariners, NAVTEX warnings and Sécurité messages.

1.6.6 SR75 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 SR75 Launch Vehicle components and associated materials, such as metals, microplastics, and hydrocarbons; impacts from direct strike; impacts from disturbance/displacement associated with presence of the component and associated exclusion zones; and impact at the seabed from when the cone comes to rest.

1.6.7 The potential impacts on water quality, biodiversity (including Priority Marine Features), and human activities in the study areas have been assessed. All pathways have a negligible or minor risk of a likely significant effect on the receptors. No likely significant effect.

1.6.8 Because the risk is negligible or minor there is no requirement to apply mitigation in order to reduce the risk further. Accordingly, the residual effect to the receptors is also negligible or minor. No likely significant effect.

1.7 Accidents

1.7.1 A list of potential events was drawn up based on the Proposed Project activities.

1.7.2 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 5 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.

1.7.3 Accident events were subcategorised into failure of containment of liquid oxygen, 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.

1.7.4 Failures of containment were generally considered to be of minor 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 of the liquid oxygen. 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.

1.7.5 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 paraffin fuel occurred, the deflagration radius would be relatively small (likely within the spaceport boundary) and the fuel load may simply burn in situ until exhausted. Any such blaze would be limited in duration by the small (460 kg) quantities used by any SR75 LV. 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 HyImpulse SR75 Launch Vehicle design process and integrity checks.

1.7.6 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. Mitigation is inherent to the remote, northerly location of the Proposed Project, lack of receptors and exclusively northward launch trajectories to be used. Water strikes were considered of minor significance; wildlife and marine habitat receptors effects are discussed in the Marine Effects Chapter (Chapter 6) of this AEE Report and not considered significant.

1.8 Conclusion

1.8.1 The conclusion of the 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 II AEE Report

CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

1. Introduction

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1. Introduction

1.1 Introduction

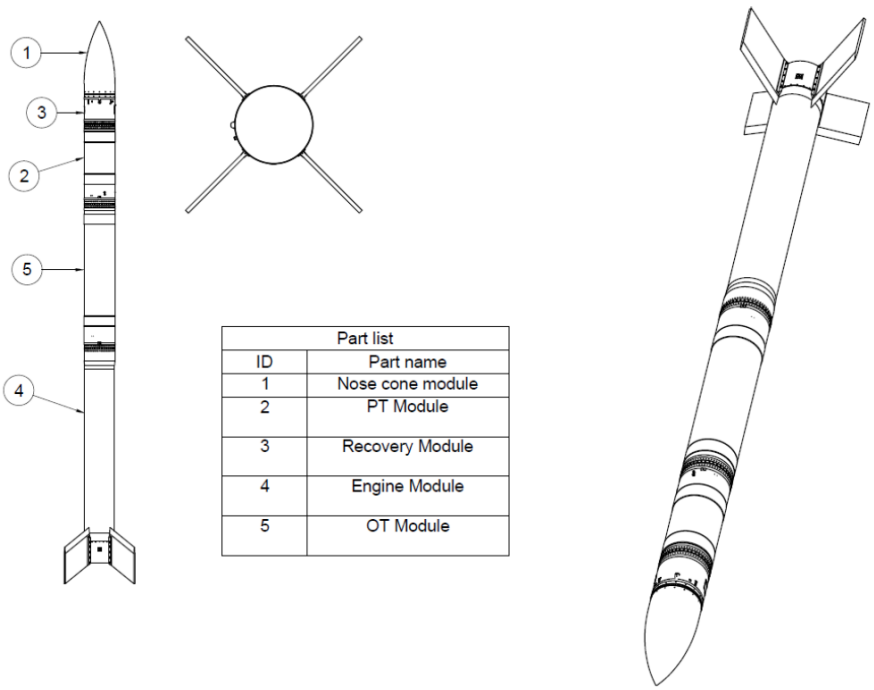
1.1.1 Aurora Environmental Consulting Limited (Aurora) has reviewed and updated this Assessment of Environmental Effects (AEE) on behalf of HyImpulse UK Ltd ('the Applicant') in regard to their application to the UK Civil Aviation Authority (CAA), the Regulator, for a sub-orbital launch operator licence under the Space Industry Act 2018.

1.1.2 The Applicant intends to launch SR75 guided sounding rockets ('SR75 Launch Vehicles') from SaxaVord Spaceport situated at Lamba Ness in Unst, Shetland. With an anticipated apogee of approximately 150 kilometres (km), launches of SR75 Launch Vehicles are covered by the Space Industries Act 2018 (SIA) and the associated Space Industry Regulations 2021 (SIR) and as such, the Applicant is applying for a launch operator licence.

1.1.3 Section 11 of the SIA stipulates that all applications for a launch operator licence are required to submit an 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, and cannot grant a launch operator licence until the AEE has been submitted.

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

1.1.5 The location of the Proposed Project is shown on Drawing 1.1 in Volume III and a schematic of the SR75 Launch Vehicle included as Figure 1.1. The Proposed Project is summarised in section 1.5 and described in full in Chapter 3.



Part list	
ID	Part name
1	Nose cone module
2	PT Module
3	Recovery Module
4	Engine Module
5	OT Module

Figure 1.1 SR75 Vehicle Overview

1.2 The Applicant

1.2.1 The Applicant for the Proposed Project is HyImpulse UK Ltd.

1.2.2 The Applicant's mission is to offer comprehensive, low-cost space solutions to everyone. HyImpulse is building launch services and space tugs that can reach any part of Low-Earth-Orbit without the usual hassles of high cost and long wait times, all thanks to their efficient paraffin-powered engines. The HyImpulse journey begins with a sounding rocket that carries 250 kg to 200 km altitude, demonstrating the technology that will in time power their Small Launcher Launch Vehicle, designed to deliver 600 kg payloads to orbit.

1.2.3 HyImpulse UK Ltd is a Scottish registered company, registration number SC684332 and registered address St. Olaf's Hall Church Road, Lerwick, Shetland, United Kingdom, ZE1 0FD. HyImpulse UK Ltd is a wholly owned subsidiary of the Germany company HyImpulse Technologies GmbH, incorporated in Germany (Handelsregister B Stuttgart, HRB 764976, VAT ID DE318131043) with its registered office at HyImpulse Technologies GmbH Headquarters, Wilhelm-Maybach-Straße 5, 74196 Neuenstadt am Kocher.

1.3 Background

1.3.1 As set out in the 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.

1.3.2 The Applicant's SR75 Launch Vehicle is a uniquely safe single-stage Launch Vehicle for microgravity experiments and atmospheric research. Its built-in-house hybrid rocket motor uses paraffin and liquid oxygen, which makes it the first European sounding rocket that exploits such combination of propellants. The SR75 has a thrust of 75 kilonewtons (kN) and is anticipated to reach an apogee of approximately 150 km and lift payloads of up to 300 kg.

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, sub-orbital activities and associated activities carried out in the UK.

1.4.2 The Act requires that a person or organisation wishing to undertake the following in 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 from 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 SR75 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, as 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 two licence types 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 SR75 Launch Vehicles from SaxaVord Spaceport situated at Lamba Ness in Unst, Shetland.

1.5.2 The SR75 Launch Vehicle is approximately 13 m long, 0.6 m in diameter and is a single-stage sub-orbital launch vehicle propelled by a hybrid engine and intended to host payloads for microgravity experiments or place payloads for re-entry in the atmosphere. Launches will take place in a northerly direction over the sea. It is anticipated that launches will take place from Launch Pad 2 within the SaxaVord Spaceport; however, due to current constraints at SaxaVord, it is also possible that the first launches may take place from Launch Pad 3. Both Launch Pads have been considered by the specialist teams undertaking the AEE and it has been concluded that Launch Pad 2 should the limiting case scenario for assessment given that it lies closer to both human and ecological receptors. As such, for the purposes of this AEE, it has been assumed that launches will take place from Launch Pad 2.

1.5.3 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 SR75 Launch Vehicle;
- Storage and Handling of SR75 Launch Vehicle propellant;
- Operation of Ground Support Equipment; and
- Launch of the SR75 Launch Vehicle (including component return impact zones).

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

- Launch Pad 2: located on the Lamba Ness peninsula and incorporating a launch pad, ground services storage and control, lightning protection mast, 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 SR75 Launch Vehicle will be assembled and the payload(s) integrated in future years;
  - Administration Building and Hazardous Materials Store: located adjacent to the LSPF on the Lamba Ness peninsula;
  - Hangar A: located on the Lamba Ness peninsula, a forward position building close to the Launch Pad where final integration activities will take place; and
- Support Infrastructure: located on the Lamba Ness peninsula including access, an internal track system and a series of small temporary buildings.

1.5.5 A full description of the Proposed Project is provided in Chapter 3.

1.5.6 Subject to securing the appropriate permissions, consents and licences, the intention is to initiate first demonstration launch as soon as September 2025 and then assume a cadence of one launch per year from 2026.

1.5.7 This AEE has been carried out assuming a single launch of the SR75 Launch Vehicle per year.

1.6 Environmental Budget

1.6.1 The Applicant is applying for a maximum environmental budget of one launch per year.

1.6.2 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 30 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 6).

1.6.3 For other technical disciplines the appropriate timeframe for assessment varies:

- 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 environment to return fully to the baseline state 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.
- For climate change, a single launch event is the basis of calculations for greenhouse gas emissions. Considering climate resilience, UK Met Office projections of expected changes covering the period 2050-2079 are included based on the current 30 year lease for the spaceport.
- For accidents, the assessment is agnostic of timeframe and simply considers the potential environmental effects of accident scenarios as if occurred.

1.6.4 Due to this variance between technical disciplines, appropriate timescales for assessment are detailed in each technical chapter.

Launch Frequency

1.6.5 The Applicant's environmental budget is for a single launch per year.

1.6.6 In line with the SaxaVord Spaceport commitment to a no-launch window between mid-May and the end of June in order to protect breeding birds, no launches of the SR75 Launch Vehicle will be carried out during this period. No SR75 static hotfire tests are proposed for SaxaVord.

1.7 Site Description

1.7.1 The Proposed Project will operate at the SaxaVord Spaceport located at Lamba Ness in 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 SR75 Launch Vehicle will take place. The Proposed Project site boundary is shown on Drawing 1.1 in Volume III, centred on national grid reference 466916 E, 1215580 N and occupies an area of approximately 31 hectares. 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 the 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. 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 1.2 in Volume III.

Geology, Hydrology, Hydrogeology Designations

1.8.2 There are no statutorily designated sites relevant to geology, hydrology or hydrogeology within the boundaries of the Proposed Project.

1.8.3 No internationally designated sites relevant to geology, hydrology or hydrogeology (i.e., Special Areas of Conservation) are located within the AEE environmental zone of influence (EZI). However, two relevant nationally designated sites are located within the EZI:

- The Norwick Site of Special Scientific Interest (SSSI) is approximately 150 m west of the Proposed Project along the coastal cliffs. It is designated for its geological interest (structural and metamorphic geology).
- The Norwick Meadows SSSI is approximately 800 m south-west of the Proposed Project. It is designated for sand dunes and valley fen.

Ecological Designations

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

1.8.5 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 Villa 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.

Landscape Designations

1.8.6 One Shetland National Scenic Area 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.

1.8.7 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.

Archaeological Designations

1.8.8 There are a number of national and international statutorily designated archaeological sites relevant to the Proposed Project.

1.8.9 The Proposed Project extends across the southern portion of the Scheduled Area of RAF Skaw. RAF Skaw is the northernmost 20th century Chain Home Radar Station and is composed of two areas. Numerous individual features within the southern portion of RAF Skaw have been recorded, including the remains of radar structures, domestic blocks and defensive structures.

1.8.10 Inner Skaw Scheduled monument is located immediately north of the Proposed Project. The designated asset comprises the remains of a multiperiod settlement with associated agricultural remains which dates from the Early Historic period onwards.

1.8.11 The Scheduled Monument of St John's Church at Norwick is a multi-period asset which encompasses an Iron Age broch and the remains of a post-medieval chapel located approximately 1.2 km south-west of the Proposed Project.

1.8.12 There are two Listed Buildings located within one kilometre of the Proposed Project. The Banks, Norwick, a group of Category C Listed 19th century crofts, are recorded approximately 670 m south-west of the Proposed Project. Another Category C Listed boat-roofed shed is located approximately 740 m north of the Proposed Project.

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 Spaceport committed to a no-launch window whereby no launches or static hotfire 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. No SR75 static hotfire tests are proposed at SaxaVord.

Night-time Operations

1.9.2 Shetland has long hours of daylight in the summer months, but long hours of darkness in winter. In Shetland in winter at this latitude it can be dark from 3pm through to 9am. However, for the purposes of this AEE the night-time period has been assumed to be 23:00 – 07:00, as used in previous AEEs for the Spaceport.

1.9.3 The Applicant is applying for a licence covering a maximum of one launch per year. Given the proposed frequency of launches and the short duration of the events adverse effects associated with sleep disturbance due to night-time launches are considered to be negligible.

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 This assessment has been undertaken by ITPEnergised and reviewed and updated by Aurora, 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)
AEE co-ordination, introductory and concluding chapters	Ruth Fain, Aurora	MGeol. (Hons) Environmental Geology	Chartered Scientist (CSci) Member of the Institution of Environmental Sciences (MIEnvSc) NEBOSH General Certificate	20+
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				
Air Quality	Annie Danskin, ITPEnergised	BEng (Hons) Environmental Engineering	Member of the Institution of Environmental Sciences (MIEnvSc)	20+
Marine Effects / Transboundary Considerations	Dr Liam Dickson, ERM	PhD Marine Biology	Member of the British Ecological Society	5+
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+

Discipline	Lead Specialist	Qualifications	Accreditations	Professional Experience (years)
	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)	13+
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+
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+

1.12 Availability of the AEE Report

1.12.1 The CAA will undertake a formal public consultation process on this AEE. 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 the CAA makes a decision on the application. Any representations on this AEE Report or other elements of the associated licence application should be made directly to the CAA.

1.13 References

Literature

CAA et. al. (2021) *CAP2215 Guidance for the Assessment of Environmental Effects* [online]. Available at https://www.caa.co.uk/publication/download/18937

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

UK Government. (2024).*Space Industrial Plan* [online]. Available at https://assets.publishing.service.gov.uk/media/65f87517ca3670001113a332/space_industrial_plan_from_ambition_to_action.pdf

Websites

UK Government. (2020).*Size and Health of the UK Space Industry 2022* [online]. Available at https://www.gov.uk/government/publications/the-size-and-health-of-the-uk-space-industry-2022/size-health-of-the-uk-space-industry-2022

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 DESCRIPTION OF PROPOSED PROJECT

2. Description of Proposed Project

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2. Introduction

2.1 Introduction

2.1.1 The Proposed Project comprises the preparation and launch of SR75 Launch Vehicles from Launch Pad 2 at SaxaVord Spaceport situated at Lamba Ness in Unst, Shetland. The Applicant is applying for a maximum environmental budget of one launch per year.

2.1.2 With an anticipated apogee of approximately 150 km, launches of SR75 Launch Vehicles will be covered by the Space Industries Act 2018 and the associated Space Industry Regulations 2021 and as such, the Applicant is applying for a launch operator licence.

2.2 Background

2.2.1 The Applicant's mission is to offer comprehensive, low-cost space access. HyImpulse is building launch services and space tugs that can reach Low-Earth-Orbit without the usual hassles of high cost and long wait times, all thanks to their efficient paraffin-powered engines. Depending on its configuration, the sounding rocket SR75 can carry up to 250 kg to 200 km altitude. SR75 serves as technology demonstrator for HyImpulse Small Launcher orbital launch vehicle.

2.2.2 The Proposed Project covers flights of SR75 aiming to reach 150 km in altitude. SR75 payload will mainly target prototypes for testing microgravity or re-entry. Although no payload has been selected yet, the target is a CubeSat type 1.5U (dimensions 10 cm x 10 cm x 17.02 cm) for a maximum weight of 5 kg.

2.2.3 The SR75 Launch Vehicle is approximately 13 m long, 0.6 m in diameter and is a single-stage guided sub-orbital launch vehicle propelled by a hybrid engine and intended to host payloads for microgravity experiments or place payloads for re-entry in the atmosphere. Launches will take place in a northerly direction over the sea.

2.2.4 It is anticipated that launches will take place from Launch Pad 2 within the SaxaVord Spaceport; however, it is also possible that the first launches may take place from Launch Pad 3. Both Launch Pads have been considered by the specialist teams undertaking the AEE and it has been concluded that Launch Pad 2 represents the limiting case scenario for assessment given that it lies closer to both human and ecological receptors. As such, for the purposes of this AEE, it has been assumed that launches will take place from Launch Pad 2.

2.3 Proposed Project Location

2.3.1 The Proposed Project will operate at SaxaVord Spaceport located at Lamba Ness in Unst, the most northerly of the Shetland Islands. The location of the Proposed Project is shown on Drawing 1.1 in Volume III.

2.3.2 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 SR75 Launch Vehicle will take place. The Proposed Project is centred on national grid reference 466916 E, 1215580 N and occupies an area of approximately 31 hectares. It is approximately 2.5 km north-east of the settlement of Norwick.

2.4 Proposed Project Infrastructure

2.4.1 The infrastructure required for the Proposed Project will be provided by SaxaVord Spaceport, which is subject to regulation under the Act itself and received the UK's first Vertical Launch Spaceport Operator Licence from the CAA in December 2023. The Proposed Project site layout plan shows the infrastructure of SaxaVord Spaceport and is included as Drawing 2.1 in Volume III.

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

- Launch Pad 2: located on the Lamba Ness peninsula and incorporating a launch pad, ground services storage and control, lightning protection mast, 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 SR75 Launch Vehicle will be assembled and the payload(s) integrated in future years;
  - Administration Building and Hazardous Materials Store: located adjacent to the LSPF on the Lamba Ness peninsula;
  - Hangar A: located on the Lamba Ness peninsula, a forward position building close to the Launch Pad where final integration activities will take place; and
- Support Infrastructure: located on the Lamba Ness peninsula including access, an internal track system and a series of small temporary buildings.

2.4.3 It is anticipated that launches will take place from Launch Pad 2 within the SaxaVord Spaceport; however, it is also possible that the first launches may take place from Launch Pad 3. As such the Proposed Project boundary has been set to cover both launch pads.

2.4.4 Subject to securing the appropriate permissions, consents and licences, the intention is to initiate first demonstration launch as soon as September 2025 and then assume a cadence of one launch per year from 2026.

2.5 Proposed Impact Dispersion Area

2.5.1 Sub-orbital launches of the SR75 Launch Vehicle will take place along a due north (000°) azimuth from Launch Pad 2 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.

The impact dispersion area for sub-orbital launches is an area representing an estimated three standard deviation dispersion about a nominal impact point of an intermediate or final stage of a sub-orbital launch vehicle. Due to the proposed launch azimuth of 000° for the Proposed Project, this reflects a circular area of radius 100 km and with midpoint 200 km due north of Launch Pad 2; shown as the blue circle in Figure 2.1 below.

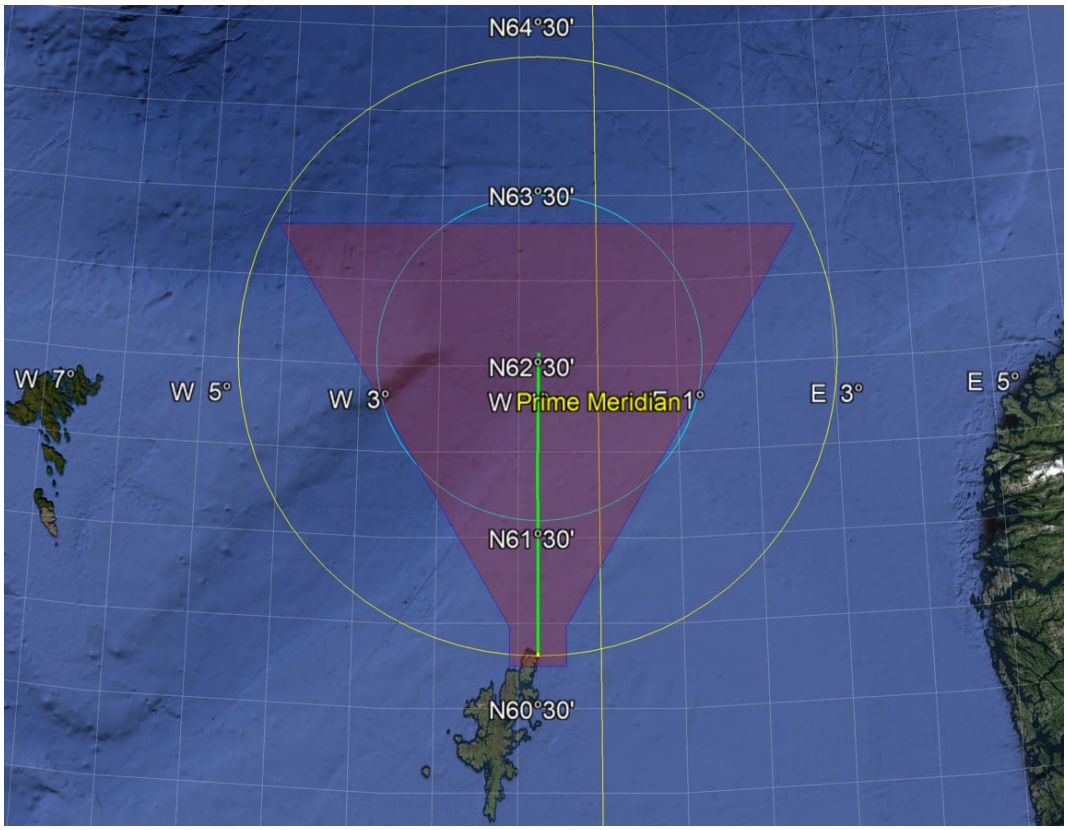


Figure 2.1 SR75 and SaxaVord Spaceport Impact Dispersion Areas

2.5.2 For reference, the impact dispersion area for sub-orbital launches as assessed in SaxaVord Spaceport AEE V3 is also shown in Figure 2.1 as the yellow circle. The SR75 Launch Vehicle impact dispersion area lies within the impact dispersion area for sub-orbital launches assessed for SaxaVord Spaceport.

2.6 Environmental Zone of Influence

2.6.1 For the purposes of this AEE, the environmental zone of influence (EZI) is based on and comprises the proposed launch flight corridor (extending in a northerly direction over the sea from Launch Pad 2 along an azimuth of 000°) and all study areas required for the technical disciplines included in the AEE.

2.6.2 Within the EZI, the study areas required for each technical discipline assessed vary and as such the rationale for each study area has been included in the relevant technical chapter. Individual study areas are shown, alongside the full extent of the EZI on Drawing 2.2 in Volume III.

2.7 Environmental Budget

2.7.1 The Applicant is applying for a maximum environmental budget of one launch per year.

2.7.2 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 30 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 6).

2.7.3 For other technical disciplines the appropriate timeframe for assessment varies:

- 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 environment to return fully to the baseline state 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.
- For climate change, a single launch event is the basis of calculations for greenhouse gas emissions. Considering climate resilience, UK Met Office projections of expected changes covering the period 2050-2079 are included based on the current 30 year lease for SaxaVord Spaceport.
- For accidents, the assessment is agnostic of timeframe and simply considers the potential environmental effects of accident scenarios as if occurred.

2.8 Proposed Project Operations

Launch Frequency and Duration

2.8.1 The Applicant's environmental budget is for a single launch per year.

2.8.2 In line with SaxaVord Spaceport's commitment to a no-launch window between mid-May and the end of June in order to protect breeding birds, no launches of the SR75 Launch Vehicle will be carried out during this period. No static hotfire tests of the SR75 Launch Vehicle are proposed at SaxaVord.

2.8.3 The duration of each SR75 launch campaign is anticipated to be approximately four weeks, starting with delivery of the SR75 Launch Vehicle and ending with successful launch and demobilisation of equipment. Timings included in this section are based on the 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 and based on the previous experience of HyImpulse from the launch campaign in Australia (April/May 2024).

Launch Campaign Operations Overview

2.8.4 Operations planned for each launch campaign of the SR75 Launch Vehicle are summarised in Figure 2.2.

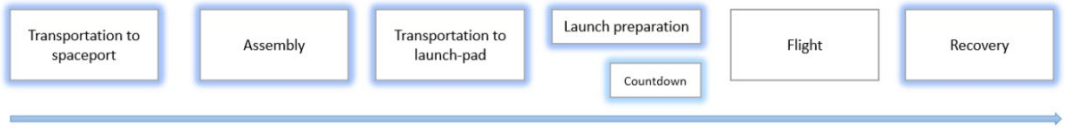


Figure 2.2 Proposed Launch Operations

2.8.5 Full details of launch operations carried out during a SR75 mission are contained within the SR75 Safety Operations Manual included separately as part of the launch operator licence application. All operations on the SR75 Launch Vehicle and in the Ground Support Equipment will be carried out by the Applicant. The key steps in a representative typical mission are set out below.

1. Transportation to SaxaVord Spaceport
    - SR75 subsystems assembly and testing, vehicle integration testing and disassembly into shipping containers at HyImpulse production site in Germany;
    - SR75 modules arrive on site at SaxaVord Spaceport; and
    - Ground Support Equipment arrives on site at SaxaVord Spaceport.

2. Assembly
    - Inspection, assembly and testing of SR75 subsystems conducted in the integration hangar (Hangar A);
    - SR75 integrated horizontally; and
    - Ground Support Equipment installed on Launch Pad 2.
3. Transportation to Launch Pad 2
    - SR75 Launch Vehicle transported horizontally from assembly hall to Launch Pad 2 using a truck;
    - Horizontal integration of SR75 with the launch rail; and
    - Verticalisation of the rail and the SR75 Launch Vehicle.
4. Launch preparation and countdown
    - Ground Support Equipment commissioned;
    - SR75 Launch Vehicle installed onto the launch rail and integrated with the Ground Support Equipment;
    - End-to-end and Hardware in the Loop testing performed on Ground Support Equipment / SR75 / launch control room;
    - Final testing (wet dress rehearsal);
    - Range exclusion zones activated on Launch Pad 2;
    - Fluid loaded onto the SR75 Launch Vehicle; and
    - Initiation of countdown sequence.
5. Launch and tracking.
6. Recovery operations.
7. Disassembly and removal of all equipment from SaxaVord Spaceport.

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

2.8.7 The SR75 Launch Vehicle and all associated commodities and payloads will be delivered to SaxaVord Spaceport in standard road containers. Propellants will be delivered by ISO tanker/container lorries by road. The paraffin fuel grain is transported with the SR75 Launch Vehicle as it is integrated already in its booster.

Launch Exclusion Zone

2.8.8 The dimensions of the launch exclusion zone (LEZ) for the Proposed Project are detailed fully in the HyImpulse SR75 Flight Safety Analysis document submitted separately to the CAA as part of the launch operator licence application and summarised below for information.

2.8.9 Figure 2.3 shows the LEZ for the Proposed Project.

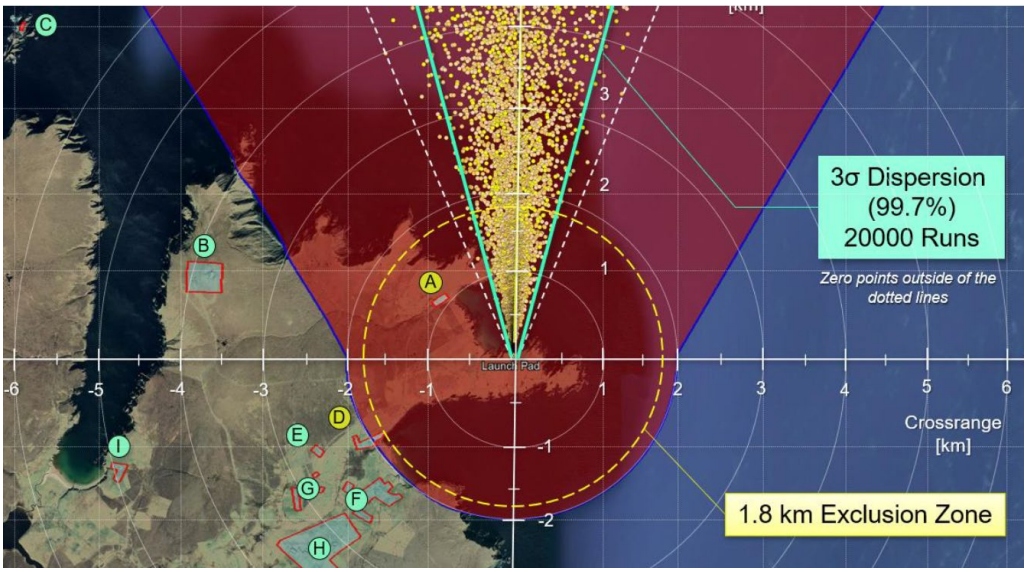


Figure 2.3 SR75 Launch Exclusion Zone

2.8.10 In line with the required operating procedures for SaxaVord Spaceport, the identified area of hazard on land will be protected by roadblocks during loading, operations and launch. The Spaceport procedure for sub-orbital launches includes the evacuation of the local population and domestic animals up to a 1.8 km radius from any launch and this will be undertaken and monitored by SaxaVord operatives.

2.8.11 The LEZ is the red area on Figure 2.3. The alphabetical letters identify settlements in the area. Only settlement A, the Haa, is included in the LEZ. This property, located approximately 0.6 km away, is uninhabited as it is unfit for habitation due to lack of a potable water supply. Accordingly, it has not been considered as a residential receptor for the SaxaVord Spaceport and is not considered further in this AEE. The closest residential receptors are therefore the properties in Norwick, (settlement D) located approximately 2.5 km south-west of Launch Pad 2.

2.8.12 Figure 2.4 shows the intended closure area from SaxaVord Spaceport AEE V3, highlighting that the LEZ provided by SaxaVord Spaceport satisfies the Applicant's requirements.

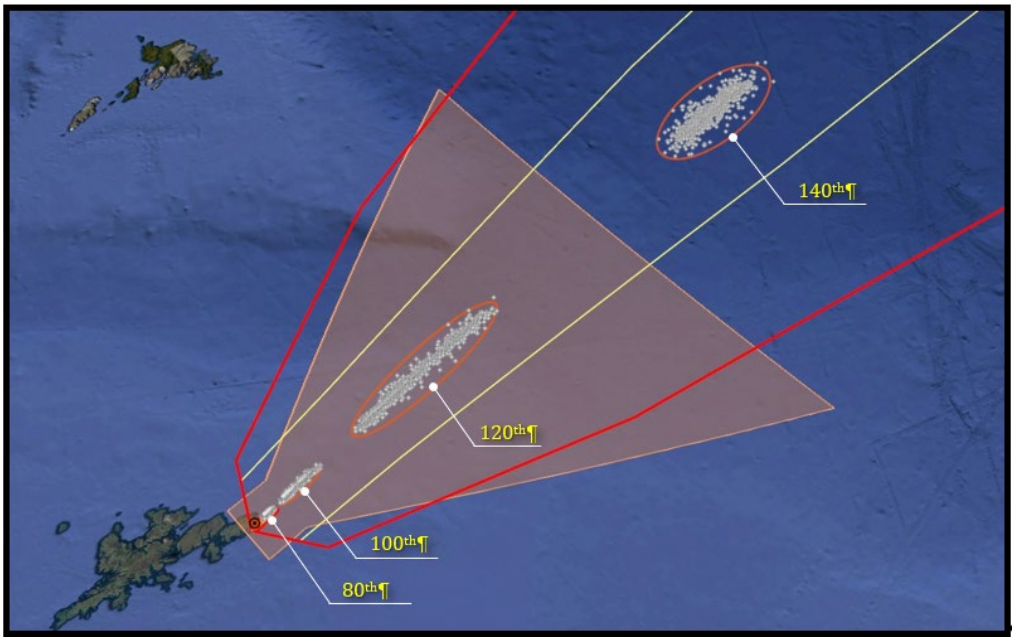


Figure 2.4 SaxaVord Spaceport LEZ

Launch Pad Set Up

2.8.13 Launch Pad 2 comprises a concrete slab with a launch pit sunk into it upon which the SR75 Launch Vehicle, on its launch rail, will sit for launch.

2.8.14 Adjacent to Launch Pad 2 there is a water tank / pump house to deliver water inundation during launches. The water deluge system is designed to deliver a large quantity of water to dampen acoustic loading on the launch vehicle and launch pad during lift-off. The water will also act to reduce the temperature of exhaust gases, protecting the launch pad infrastructure. However, based on the experience of the maiden launch from Australia of April/May 2024, the Applicant does not anticipate that the water deluge system will be required for SR75 launches.

2.8.15 The Launch Pad 2 concrete slab is surrounded on three sides by a wall to contain any deluge water (if used). The gradient of 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.

2.8.16 Launch Pad 2 includes an area for storage of fuels and gases using ISO road containers to allow the site to be cleared between launches. The Launch Pad 2 fuel storage area has 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.

2.8.17 Permanent lightning masts are positioned either side of Launch Pad 2, 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.

Ground Support Equipment

2.8.18 The Applicant will provide dedicated ground support equipment as required for each launch campaign. The ground support equipment has been developed to be mobile and easily transportable in a 6 m ISO container, which will be positioned temporarily at Launch Pad 2. The ground support equipment comprises:

- Propellant management control unit and software;
- Electrical ground support equipment for power and data interface provision to the SR75 before flight;
- Portable electronics unit to switch off powered systems for recovery operations; and
- Control room equipment and software to allow remote operation of the ground support equipment.

Table 2.1 – SR75 Ground Support Equipment Specification

Parameter	Specification
Fluids	Liquid oxygen, gaseous helium, gaseous nitrogen [provided by SaxaVord and connected to HyImpulse GSE]
Liquid oxygen supply	Storage tank [provided by SaxaVord]
Liquid oxygen operation pressure	Maximum 20 bar
Gaseous oxygen operation pressure	180 bar
Gaseous helium fluid supply	Bundle at 200 bar [provided by SaxaVord]
Gaseous helium operation pressure	200 bar / 400 bar

Parameter	Specification
Gaseous nitrogen fluid supply	Bundle or bottle at 200 bar [provided by SaxaVord]
Gaseous nitrogen operation pressure	200 bar / 60 bar / 10 bar / 6 bar
Interfaces to launch vehicle	Retractable mechanisms; electrical power and data interfaces
Operating modes	Manual: opening of fluid supplies, nitrogen cartridge loading Remote operation: all other activities

SR75 Launch Vehicle

2.8.19 The SR75 Launch Vehicle is a single stage launch vehicle which exploits hybrid propulsion technology. Its hybrid rocket motor uses liquid oxygen and a solid paraffin-based proprietary fuel to produce 75 kilonewtons (kN) of thrust.

2.8.20 A schematic and detailed specification of the SR75 Launch Vehicle are presented as Table 2.2 and Figure 2.5 respectively.

Table 2.2 – SR75 Specification

Parameter	Specification
Launch Vehicle	
Diameter	0.64 m
Length	13 m
Empty vehicle mass	800 kg
Lift-off mass	2,600kg
Anticipated apogee	150 km
Total Impulse (vacuum)	4.3 MN s
Launcher type	Rail
Recovery system	Yes (for booster module)
Propulsion	
Number of stages	1
Number of engines	1
Propellant combination	Liquid oxygen / paraffin-based fuel
Propulsion system architecture	Helium pressurised
Pressurisation gas mass	30 kg
Fuel mass	460 kg
Oxidiser mass	1,000 kg
Nominal thrust (sea-level)	75 kN

Parameter	Specification
Payload	
Purpose	STEM promotional
Payload type	CubeSat format 1.5 U 10cm x 10cm x 17.02 cm), passive
Payload mass	< 5 kg

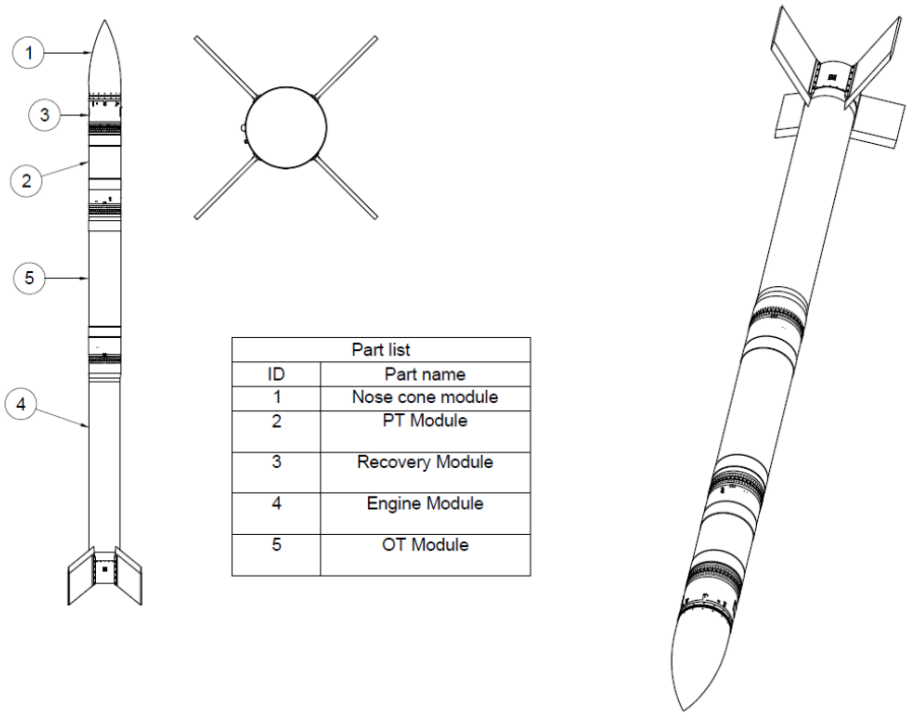


Figure 2.5 SR75 Launch Vehicle Overview

Nose Cone

2.8.21 The nose cone (ID1 in Figure 2.5) comprises composite material outer and payload of scientific equipment. The nose cone is constructed from glass fibre, epoxy resin, cork, steel, Pertinax (a hard paper material impregnated with phenolic resin), and paint.

2.8.22 The nose cone module (cone and connector) is the only element of the SR75 that will not be recovered.

Parachutes

2.8.23 The main and drogue parachutes are 11 m and 2.8 m diameter, respectively. Both are fabricated from nylon and Kevlar and will be retrieved from the marine environment following splashdown.

2.8.24 A hatch cover and retention plate are associated with the drogue parachute of the SR75 Launch Vehicle. The hatch cover materials include carbon fibre, epoxy resin, cork, aluminium, steel, and paint. The retention plate materials include carbon fibre, epoxy resin, steel, aluminium, and nylon. These will be recovered.

Booster Modules

2.8.25 The booster modules comprise the pressurisation tank (PT) module, the recovery module, the engine module and the oxidiser tank (OT) module (IDs 2-3-4-5 in Figure 2.5).

2.8.26 The engine module is made up of aluminium, brass, stainless steel, carbon and glass fibres, silica phenolic composite, Pertinax (phenolic resin treated laminated paper), graphite, cork, high density polyethylene (HDPE), hydroxyl-terminated polybutadiene (HTPB) and epoxy resin. The solid fuel of SR75 is paraffin, which will be completely burned under nominal flight conditions. The fins of the engine module consist of pertinax, carbon fibre, aluminium, and balsa wood.

2.8.27 The remaining booster modules are made of composite materials. The exterior of the launch vehicle is made of composite materials made of carbon fibre and epoxy resin, including the motor casing, intertank structures, tanks and recovery module. Steel and aluminium alloys are used for components of the propellant management system such as pipes, for the pneumatic system of the recovery system, and for other structural elements such as boxing for electrical components, brackets, fasteners. Lithium-polymer, lithium-Ion and lithium-metal batteries are also included in the booster as part of the avionics subsystem. Copper is present in the gaskets and cables, in single-figure kilogram quantities. Finally, there are also a small amount of plastic 3D-printed components.

Flight Termination System

2.8.28 The SR75 includes a Flight Termination System (FTS) to improve flight safety by allowing for mission termination in case of a non-recoverable flight deviation which poses potential risk to people and/or infrastructure.

2.8.29 The FTS operates by piercing a hole in the oxidizer tank through the actuation of a neutralisation charge, consequently stopping the oxidiser feed to the motor and thus terminating the thrust generation. The actuation of the FTS will not cause an explosive event. As a precautionary measure, it has been assumed that there will be no deceleration of any components.

2.8.30 It is possible that this action may result in break-up of the launch vehicle. In this event, the launch vehicle may fragment into three major debris components: nose cone; recovery module and pressurisation tank module; and oxidiser tank and motor. No further fragmentation is expected, beyond breakage of the fins at splashdown. Two major debris components of the launch vehicle will be retrieved on splashdown following actuation of the FTS (the recovery module and pressurisation tank module; and the oxidiser tank and motor).

Propellants

2.8.31 The motor casing and the fuel grain are part of the booster engine module (ID 4 in Figure 2.5). The solid fuel of SR75 contains paraffin, which is completely burned under nominal flight conditions.

2.8.32 The total mass of the SR75 launch vehicle at lift off will be approximately 2,600 kg of which approximately 1,460 kg will be propellant (fuel plus oxidiser).

Comparison with SaxaVord Spaceport AEE V3 sub-orbital launch vehicle

2.8.33 The specification of the SR75 Launch Vehicle is within that of the limiting case representative launch vehicle (RepLV) considered for SaxaVord Spaceport and, in fact, aligns closely with the Small Mass Emission Launch Vehicle - the least significant of the launch vehicles considered within the SaxaVord Spaceport AEE V3 (reference SR-APP-001019).

2.8.34 A full comparison of the specifications of the SR75 Launch Vehicle against the sub-orbital launch vehicle specification assessed as part of the SaxaVord Spaceport AEE V3 is presented in Table 2.3.

Table 2.3 – Comparison of SR75 against SaxaVord Spaceport AEE V3 sub-orbital launch vehicle

	HyImpulse SR75 Launch Vehicle	SaxaVord Spaceport AEE V3 Representative sub-orbital launch vehicle
Trajectory		
Estimated Impact Range	205 km	200 km

	HyImpulse SR75 Launch Vehicle	SaxaVord Spaceport AEE V3 Representative sub-orbital launch vehicle
Launch Safety Radius	1.8 km exclusion radius	5 km
Trajectory	Northerly	Northerly
Apogee	150 km	Unspecified
Launch Vehicle Parameters		
Stages	Single	Single
Fuel	Liquid oxygen and paraffin-based fuel	Solid with liquid oxidiser
LV diameter	0.64 m	Unspecified
LV length	13 m	Unspecified
Engine materials	Aluminium, brass, stainless steel, carbon fibres, glass fibres, silica phenolic composite, pertinax, graphite, cork, HDPE, HTPB, epoxy resin	Unspecified
Additional materials	Lithium-polymer, lithium ion and lithium metal batteries (avionics), copper (gaskets and cables), plastic (3D-printed components), pertinax, aluminium, balsa wood.	Unspecified
Vehicle Mass	800 kg	230 kg
Fuel mass	460 kg	>115 kg
Recovery considerations		
Components retrieved	Booster, main parachute, and drogue parachute (with hatch cover and retention plate) via parachutes and recovery vessel	Nose cone retrieval via parachute and recovery vessel
Components into marine environment	Nosecone (100-200 kg) and metal connection ring (1-3kg),	Booster
Parachute deployment altitude	6 km (drogue parachute), 1.5km (main parachute)	1 km
Recovery method	Booster and main parachute: onboard transmitter and two locator beacons identifiable with hand tracker, nosecone: visual, drogue parachute, hatch cover and retention	Onboard transmitter

	HyImpulse SR75 Launch Vehicle	SaxaVord Spaceport AEE V3 Representative sub-orbital launch vehicle
	plate: locator beacon and hand tracker	

2.8.35 The specification of the SR75 Launch Vehicle is well within that of the limiting case RepLV considered for SaxaVord Spaceport (30 m orbital launch vehicle with sea level thrust of approximately 634 kN) and aligns closely with the sub-orbital launch vehicle assessed for SaxaVord Spaceport. As such it is considered unlikely that the Proposed Project will give rise to any significantly different effects to those already assessed for the SaxaVord Spaceport RepLV. However, because the specification, composite materials and propellants of the SR75 Launch Vehicle are different to those assessed in the Spaceport AEE V3, AEE will be undertaken for all aspects and carried out topics where the specification differs between the two launch vehicles.

Launch Operations

2.8.36 Each launch period will run for approximately four weeks, beginning with the delivery of the SR75 Launch Vehicle and payload(s) to SaxaVord Spaceport and ending with launch, deployment and recovery of the payload and clean-down of the facility.

2.8.37 Launches require specific conditions to allow them to succeed, therefore it is possible there will be night-time launches (night-time defined for this AEE as the period between 23:00 and 07:00 hours).

2.8.38 The key steps in a representative nominal SR75 launch campaign are set out below.

Launch Vehicle and Payload Processing

2.8.39 The SR75 Launch Vehicle and payload will be delivered to SaxaVord Spaceport by the Applicant for assembly, integration and verification. It is anticipated that the SR75 Launch Vehicle and payload elements will be delivered to the Proposed Project by road in road containers or vans. The launch vehicle integration process involves the assembly of the launch vehicle. Emplacement of payload into the fairing will be undertaken under controlled conditions within Integration Hangar A, if required by the type of payload.

Fuel and Hazardous Materials Transportation and Storage

2.8.40 Launch Vehicle oxidant will be transported to the Proposed Project in ISO road containers using a just in time supply strategy, as and when required. A delivery holding area will be located at the entrance of SaxaVord Spaceport, and containers held there before being taken to Launch Pad 2 as required. At Launch Pad 2 the containers are stored in the designated protected areas.

2.8.41 Launch Vehicle fuel is solid, and the grain is already integrated into the booster before delivering the rocket to SaxaVord. The fuel grain does not pose a hazard and can be stored in the assembly hall during integration. The paraffin grain requires a controlled room temperature between 5° and 25°C.

2.8.42 Large volume fluid and gas containers will remain on their trailers for fuelling and de-fuelling. Oxidant and gases will be piped to the SR75 Launch Vehicle above ground and in a below ground trench over the launch pad. SR75 fuelling and defuelling is controlled by the Ground Support Equipment of HyImpulse located at Launch Pad 2.

2.8.43 Small volumes of auxiliary materials and oils in containers will be off-loaded to the ground within the control areas of Launch Pad 2 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.

Launch Vehicle Propellant Loading

2.8.44 Once the SR75 Launch Vehicle is assembled, it will be transported in a horizontal position to Launch Pad 2, attached to the launch rail, normally between 72 and 24 hours before launch, and connected to the launch pad electrical, fuel and communications systems through umbilical cables. Once horizontally integrated, the SR75 Launch Vehicle will be raised to a vertical orientation during the countdown sequence.

2.8.45 Once the SR75 Launch Vehicle is in a vertical position on the launch pad and prior to oxidant and gases being loaded, LO_X is used to pre-condition the line. Pressurant loading will then commence followed by loading of the oxidant and gases.

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

2.8.47 Wet dress rehearsals inherently have no significant environmental effects as no materials are combusted and so have not been considered further in this AEE.

2.8.48 Safety Clear Zones and a LEZ will be implemented at appropriate times to ensure the safety of the operation.

Launch, Ascent, Payload Deployment and Jettisoning of Objects

2.8.49 The SR75 Launch Vehicle will be loaded 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.

2.8.50 Approximately two minutes before launch, the SR75 Launch Vehicle will transition to its internal power source and continue to perform an autonomous series of preparatory configurations and status checks.

2.8.51 Approximately 20 seconds before launch the hold-down mechanism will be armed and launch command control relinquished to the SR75 Launch Vehicle. The automated ignition sequence will start approximately ten seconds before launch.

2.8.52 The SR75 Launch Vehicle will lift off from the launch rail following ignition. Engine cut-off will occur approximately 45 seconds after lift-off and the SR75 Launch Vehicle will reach an apogee of approximately 150 km before returning to earth.

2.8.53 The return to earth impact dispersion area is anticipated to be approximately 200 km downrange, as shown in Figure 2.6.

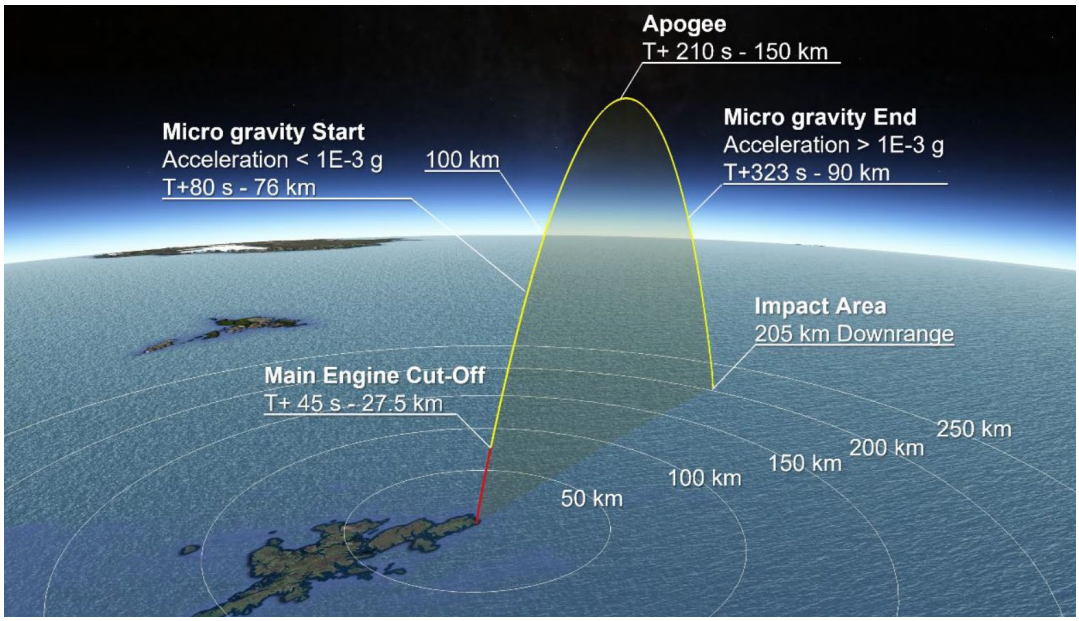


Figure 2.6 SR75 anticipated flight trajectory

2.8.54 For safety reasons, the SR75 will not fly over inhabited areas. The impact dispersion area will be subject to NAVTEX and Sécurité Notices to Airmen and Mariners to warn third parties to remain clear.

Post Launch Operations

2.8.55 Post launch operations involve the inspection, demobilisation and movement of all HyImpulse equipment away from Launch Pad 2 and into storage.

Launch Trajectory and Recovery Operations

2.8.56 The proposed trajectory of the SR75 Launch Vehicle will be in a northerly direction from Launch Pad 2 at SaxaVord Spaceport. The return to earth impact dispersion area is anticipated to be approximately 200 km downrange, as shown in Figure 2.6.

2.8.57 For safety reasons, the SR75 Launch Vehicle 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.

2.8.58 The Applicant will constrain trajectories in order to avoid nominal jettisoned separated components impacting inhabited land masses, including Jan Mayen, or waters within 12 miles of those coastlines, in compliance with international treaties. In the case of an off-nominal launch situation resulting in SR75 debris landing within 12 nautical miles of the coast of Shetland, SaxaVord Spaceport (as Range Operator) will maintain boundary vessels and a launch exclusion zone over the sea area and will instigate emergency response and recovery operations in partnership with the Applicant.

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

- Prior to any launch activity, SaxaVord Spaceport 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.

- On the day of launch, the publicly available Automatic Identification Systems (AIS) will be monitored by SaxaVord Spaceport to ensure that no fishing activity within the territories of the Faroes Islands is placed at risk by the Applicant's activities.

2.8.60 With reference to the United Nations Convention on the Law of the Sea (UNCLOS) and associated directives to prevent, reduce and control anthropogenic input to the marine environment the Applicant will seek to minimise deposition of debris where possible, and in particular avoid Marine Protected Areas (MPAs) / Vulnerable Marine Ecosystems (VMEs) and other sensitive marine features.

2.8.61 Following separation of the nose cone and payload, the booster module and nose cone will return to earth separately. For the booster module, during descent the drogue parachute will be ejected at an altitude of 6 km to slow down the vehicle. Later, at an altitude of approximately 1.5 km the main parachute will be deployed, and the drogue parachute will separate. The booster module will land in the sea and three other components will fall into the sea separately:

- Nose cone and its metal connection ring;
- Drogue parachute; and
- Hatch cover and retention plate of the drogue parachute.

2.8.62 The nose cone is the only part of the SR75 Launch Vehicle that will not be recovered; instead returning to earth and recording scientific data throughout its descent.

2.8.63 Planned debris is shown in Table 2.4. Three beacons will be installed on the SR75 Launch Vehicle; two on the booster module and one on the drogue parachute.

Table 2.4 – Planned Debris

Debris	Mass	Dimensions (LxWxH)	Recovery	Location System	Nominal Landing Position
Booster and main parachute	800 kg	11.5 m x 0.64 m diameter. Parachute 11 m diameter	Yes	Onboard transmitter with 2 locator beacons	205 km
Nose cone	200 kg	1.5 m long x 0.64 m diameter.	No	Visual	204 km
Nose cone connector	3 kg	2 m band (25mm x 25mm)	No	-	200-205 km
Drogue parachute	< 10 kg	Parachute 2.8 m diameter	Yes	Location beacon and hand tracker	205 km

2.8.64 The Applicant will provide the marine contractor with coordinates for the expected landing site prior to departure and an exclusion radius based on the probability of deviation from the expected landing site. SaxaVord Spaceport will confirm the marine exclusion zone position and radius following launch and will remain in contact with the vessel as the SR75 Launch Vehicle's location is tracked.

2.8.65 The vessel will standby outside the exclusion zone until either the SR75 Launch Vehicle has been confirmed to have landed or the vessel has good visual contact with the SR75 Launch Vehicle components descending under parachute; after which recovery will be attempted.

Test Launches

2.8.66 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

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

2.8.68 Off-nominal launch events (when the launch event proceeds beyond ignition but does not perform within expected/acceptable limits) are considered in Chapter 6 (Marine and Transboundary) and Chapter 7 (Accidents) of this AEE Report.

2.8.69 Unlike the RepLV assessed in the SaxaVord Spaceport AEE V3, deflagration following ignition of propellant during any SR75 launch failure would not create a fireball extending several metres from the launch pad complex, due to the safety of the hybrid engine technology.

2.8.70 The blast radius from, for example, pressurized fluid tanks, does not extend beyond 100 m from the SR75 Launch Vehicle. The duration of any subsequent propellant burn-off would be minimal in the open air.

2.8.71 Peat depth and condition surveys have been 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 since the risk of explosion of SR75 is negligible.

2.8.72 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 3 APPROACH TO AEE

3. Introduction

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3. Approach to AEE

3.1 Introduction

3.1.1 This AEE Report comprises a Non-Technical Summary (NTS) as Volume I, the main AEE Report text as Volume II, accompanying drawings as Volume III and technical appendices as Volume IV.

3.1.2 As detailed in Chapter 2, the Proposed Project comprises the preparation and launch of SR75 Launch Vehicles from SaxaVord Spaceport, situated at Lamba Ness in Unst, Shetland. The SR75 Launch Vehicle is approximately 13 m long, 0.6 m in diameter and is a single-stage sub-orbital launch vehicle propelled by a hybrid engine and intended to host payloads for microgravity experiments or place payloads for re-entry in the atmosphere. Launches will take place in a northerly direction over the sea.

3.1.3 The project will be regulated under the Space Industry Act 2018 ('the Act').

3.1.4 The Proposed Project consists of the following elements:

- Preparation of the SR75 Launch Vehicle;
- Storage and Handling of SR75 Launch Vehicle propellant;
- Operation of Ground Support Equipment; and
- Launch of the SR75 Launch Vehicle (including component return impact zones).

3.1.5 It is anticipated that launches will take place from Launch Pad 2 within the SaxaVord Spaceport; however, due to current constraints at SaxaVord, it is also possible that the first launches may take place from Launch Pad 3. Both Launch Pads have been considered by the specialist teams undertaking the AEE and it has been concluded that Launch Pad 2 should the limiting case scenario for assessment given that it lies closer to both human and ecological receptors. As such, for the purposes of this AEE, it has been assumed that launches will take place from Launch Pad 2.

3.1.6 The specification of the SR75 Launch Vehicle is within that of the limiting case representative launch vehicle (RepLV) considered for SaxaVord Spaceport, aligning closely with the Small Mass Emission Launch Vehicle - the least significant launch vehicle of those considered within SaxaVord Spaceport AEE V3.

3.1.7 The Applicant is applying for a maximum environmental budget of one launch of the SR75 Launch Vehicle from SaxaVord Spaceport per year.

3.2 Legislation, Policy and Guidance

3.2.1 The Space Industry Act 2018 ('the Act') 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.

3.2.2 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 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.

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

3.2.4 There are no regulations specific to 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). As applicable, reference is also made to 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* (CAA, 2021).

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

- Guidelines for Environmental Impact Assessment, Institute of Environmental Management and Assessment (IEMA, 2006);
- Environmental Impact Assessment Guide to Delivering Quality Development (IEMA, 2016);
- A Handbook on Environmental Impact Assessment Version 5 (Scottish Natural Heritage, 2018);
- Shetland Local Development Plan (Shetlands Islands Council, 2014); and
- Shetland Outdoor Access Strategy (Shetland Islands Council, 2019).

3.3 The AEE Process

3.3.1 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).

3.3.2 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 7).

3.3.3 As stated in the CAA guidance document, the process of AEE can be broken down into four main phases as shown in Figure 3.1.

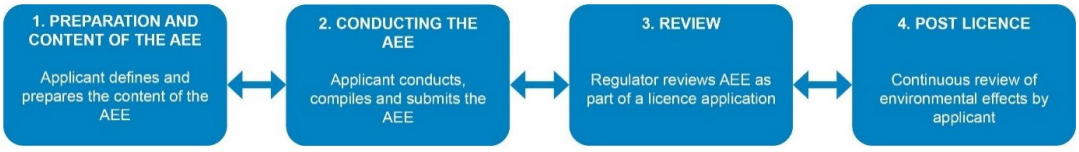


Figure 3.1 Overview of the AEE Process

3.4 AEE Scope

Environmental Zone of Influence

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

- the extent of the Proposed Project and the trajectory of the SR75 Launch Vehicle;
- the nature of the baseline environment, sensitive receptors and the 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.

3.4.2 For the purposes of this AEE, the EZI is based on and comprises the proposed launch flight corridor (extending in a northerly direction over the sea from Launch Pad 2 along an azimuth of 000 degrees) and all study areas required for the technical disciplines included in the AEE.

3.4.3 Within the EZI, the study areas 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. in Volume III

Temporal Scope

3.4.4 The baseline year used for the assessment of effects has been taken as 2025, with the assumption that SaxaVord Spaceport is fully constructed and operational. However, as appropriate technical disciplines have carried out pre-assessment studies and/or literature reviews from wider timeframes, for example the Climate Chapter refers to the 1981 – 2010 baseline and the Marine and Transboundary Effect chapters refer to datasets spanning the period 1970 – 2020 as relevant.

Environmental Budget

3.4.5 The Applicant is applying for a maximum environmental budget of one launch per year.

3.4.6 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 30 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 6).

3.4.7 For other technical disciplines the appropriate timeframe for assessment varies.

- For air quality, due to the fact that only one launch will occur at any given time and launches of the SR75 Launch Vehicle and other launch operators' launch vehicles will be phased with time enough for the environment to return fully to the baseline state 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.
- For climate change, a single launch event is the basis of calculations for greenhouse gas emissions. Considering climate resilience, UK Met Office projections of expected changes covering the period 2050-2079 are included based on the current 30 year lease for the spaceport.
- For accidents, the assessment is agnostic of timeframe and simply considers the potential environmental effects of accident scenarios as if occurred.

3.4.8 Due to this variance between technical disciplines, appropriate timescales for assessment are detailed in each technical chapter.

3.5 AEE Content

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

3.5.2 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.'

3.5.3 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. The following environmental topics have been considered in the preparation of this AEE:

- 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.

Environmental topics not considered within the AEE

3.5.4 As described in Chapter 2, the specification of the SR75 Launch Vehicle is within that of the limiting case representative launch vehicle (RepLV) considered for SaxaVord Spaceport, aligning closely with the Small Mass Emission Launch Vehicle - the least significant launch vehicle - considered within SaxaVord Spaceport AEE V3 (reference SR-APP-001019). For several of the topics listed above, it is therefore considered that no further assessment is required in addition to that previously submitted in the SaxaVord Spaceport AEE V3. For each discipline where this is the case, a justification has been included below for information.

Population and Human Health

3.5.5 Within the context of SaxaVord Spaceport, and particularly as one of the first launches, the Proposed Project represents a transformational and much needed economic development opportunity for Unst and for the Shetland Islands and, as detailed within the SaxaVord Spaceport AEE V3 Population and Human Health Chapter, will generate significant beneficial local effects through:

- employment associated with operation of the Spaceport;
- demand for goods and services to support the operation of the Spaceport;
- temporary hosting of HyImpulse staff who will utilise local shops, hospitality and other amenities; and,
- attraction of tourists who will visit SaxaVord Spaceport to watch the launch (including outside the current summer tourism season).

3.5.6 The proposed first launch of the SR75 Launch Vehicle in 2025 will contribute significantly to the development of SaxaVord Spaceport and so to the economic benefits that the Spaceport has been previously assessed as potentially being able to generate.

3.5.7 The Applicant confirms that there are no material changes required to SaxaVord Spaceport operational systems or infrastructure as a result of the Proposed Project and therefore the SaxaVord Spaceport AEE V3 assessment of population effects can be considered an equivalent assessment for the purposes of this AEE. Whilst relevant (air quality) effects on human health from the Proposed Project are discussed in detail in Chapter 4 of the AEE Report; population effects have otherwise not been considered further in this AEE.

3.5.8 The SaxaVord Spaceport AEE V3 Population and Human Health Chapter has been included for reference as Appendix 3.1 in Volume IV.

Biodiversity (Ecology and Ornithology)

Ecology

3.5.9 The ecological assessment undertaken as part of SaxaVord Spaceport AEE V3 concluded that there was one likely significant residual effect at local level, on coastal grassland habitat in relation to land-take from operation of the Spaceport.

3.5.10 The assessment noted that the likely significant ecological effect from overall operation of the SaxaVord Spaceport (and within that, therefore, operation of the Proposed Project) was inherently associated with the land-take and infrastructure required for the construction of the Spaceport and carried over into the SaxaVord Spaceport AEE V3 for assessment only by nature of the continued operation of the Spaceport infrastructure. Ecological effects of the Spaceport overall have been assessed by Shetland Islands Council and the relevant statutory consultees (including NatureScot and SEPA) during the planning stage of the SaxaVord Spaceport and the Spaceport (and, by extension, associated future activities of Launch Operators) found to be suitable for development. Habitats management 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 by the planning authority and its consultees.

3.5.11 The Applicant confirms that there are no material changes required to SaxaVord Spaceport infrastructure or operations as a result of the Proposed Project and therefore the assessment of ecological effects submitted as part of SaxaVord Spaceport AEE V3 can be considered an equivalent assessment for the purposes of this AEE.

3.5.12 The SaxaVord Spaceport AEE V3 Ecology Chapter has been included for reference as Appendix 3.2.

Ornithology

3.5.13 As part of SaxaVord Spaceport planning and AEE works, targeted and licensed breeding bird surveys were undertaken following agreed standardised survey methods between 2018 and 2020 within the ornithological EZI for the Spaceport. Subsequent surveys undertaken by SaxaVord Spaceport in 2022 and 2023 have shown that ornithological populations around the spaceport remain steady, with no significant changes to bird numbers associated with works at the Spaceport.

3.5.14 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 were 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.

3.5.15 Potential impacts from SaxaVord Spaceport, based on 30 launches per year of the limiting case 30 m orbital launch vehicle were assessed and the magnitude of predicted operational effects found to be either ‘no effect’ or ‘negligible’ for all bird species considered except one. Minor operational impacts are predicted for a confidential Schedule 1 breeding species in the absence of mitigation.

3.5.16 Proposed mitigation measures relating to launches were outlined in the SaxaVord Spaceport Habitats Management Plan and have subsequently been included as planning conditions for the Spaceport. After mitigation, all residual effects were predicted to be not significant.

3.5.17 The SaxaVord Spaceport has a proposed capacity for 30 launches per annum of up to 30 m orbital vehicles. Given the scale of the Proposed Project (just one sub-orbital launch of a 13 m launch vehicle with 75 kN thrust per year) it is considered therefore that there is no requirement for further assessment of ornithological effects.

3.5.18 The Applicant confirms that there are no material changes required to SaxaVord Spaceport infrastructure as a result of the Proposed Project and therefore the ornithological assessment submitted as part of the SaxaVord Spaceport AEE V3 can be considered an equivalent assessment for the purposes of this AEE.

3.5.19 The SaxaVord Spaceport AEE Ornithology Chapter has been included for reference as Appendix 3.3.

Noise and Vibration

3.5.20 The limiting-case RepLV considered as part of SaxaVord Spaceport AEE V3 was a 30 m launch vehicle with sea level thrust of approximately 634 kN. Potential noise and vibration effects of the SaxaVord RepLV were assessed with regard to static engine tests, launches and non-launch activities, with reliance on modelling and calculations undertaken by Blue Ridge Research and Consulting LLC, 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.

3.5.21 Noise during engine tests and launches from the SaxaVord Spaceport was found to be audible at identified noise sensitive receptors and exceeded the criterion for community annoyance associated with aircraft noise. However, it was noted that instantaneous noise levels would be below the threshold at which damage to hearing may occur and the short duration of audible noise 'events' associated with engine tests and launches, and their infrequent occurrence, would reduce the associated levels of annoyance to below that which may be associated with aircraft noise from conventional airports. Accordingly, adverse health effects were not anticipated. Noise effects associated with engine tests and launches were therefore assessed as not significant, resulting in no likely significant effect. Vibration (air overpressure) associated with static engine tests and launch events was also evaluated and found to result in a low likelihood of damage complaints and was therefore determined to be not significant, resulting in no likely significant effect.

3.5.22 The SR75 launch vehicle, with a thrust 75 kN, is much smaller than the SaxaVord Spaceport RepLV and therefore no further noise assessment is required in terms of the Proposed Project. As such, the noise assessment submitted as part of the SaxaVord Spaceport AEE V3 can be considered an equivalent (though noted: worse case) assessment for the purposes of this AEE.

3.5.23 The SaxaVord Spaceport AEE V3 Noise and Vibration Chapter has been included for reference as Appendix 3.4.

Water, Land, Soils and Peat

3.5.24 Due to the temporary nature of each proposed launch and the fact that the delivery, assembly and launch of the SR75 Launch Vehicle will not have any 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 the water environment or on land, soils and peat. As such, these elements have not been considered further in this AEE.

Landscape, Seascape and Visual Impact

3.5.25 As the specification of the SR75 Launch Vehicle is within that of the limiting case RepLV assessed as part of the SaxaVord Spaceport AEE V3, it is considered that no further assessment of visual impact is required in addition to that previously submitted in SaxaVord Spaceport AEE V3.

3.5.26 The Applicant confirms that there have been no material changes to the SaxaVord Spaceport infrastructure required for the Proposed Project and that the SR75 Launch Vehicle, at 13 m, is much smaller than the SaxaVord limiting case RepLV. Therefore, the assessment of landscape, seascape and visual impact completed as part of SaxaVord Spaceport AEE V3 can be considered an equivalent assessment for the purposes of this AEE.

3.5.27 The SaxaVord Spaceport AEE Landscape, Seascape and Visual Impact Chapter has been included for reference as Appendix 3.5.

Material Assets and Cultural Heritage

3.5.28 Due to the small number of launches proposed by the Applicant (maximum one per year), the temporary nature of each proposed launch and the fact that the delivery, assembly and launch of the SR75 Launch Vehicle 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.

3.5.29 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 by the planning authority and its consultees. No further assessment for the purposes of this AEE is required.

3.5.30 It is acknowledged that SaxaVord Spaceport AEE V3 includes a commitment by the Spaceport to monitoring vibration effects on cultural heritage assets during the operational phase; however, this is the responsibility of the Spaceport Operator, not of the Applicant. The Applicant is committed to complying with any related monitoring required by SaxaVord Spaceport.

3.5.31 The Applicant confirms that there are no material changes required to SaxaVord Spaceport infrastructure or operations as a result of the Proposed Project and therefore the assessment of cultural heritage effects submitted as part of SaxaVord Spaceport AEE V3 can be considered an equivalent assessment for the purposes of this AEE.

3.5.32 The SaxaVord Spaceport AEE Material Assets and Cultural Heritage Chapter has been included for reference as Appendix 3.6.

3.6 AEE Methodology

3.6.1 The Applicant has engaged competent experts, as detailed in Chapter 1, to conduct the AEE.

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

- Baseline survey (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.

Assessing Significance

3.6.3 Throughout the AEE, 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.

3.6.4 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.

3.6.5 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.

3.6.6 Table 3.1 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 3.1 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

3.6.7 The following terms are used in this AEE Report 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.

3.6.8 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 result in significant effects, 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.

3.6.9 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 8.

Assessment of Cumulative Effects

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

3.6.11 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.

3.6.12 Due to the location of SaxaVord Spaceport, from where the Proposed Project will operate, on the north coast of Unst; for all but one of the technical disciplines assessed there are no potential inter-project cumulative effects other than those from other SaxaVord Spaceport based launch operators as there are no other existing or proposed developments in the EZI. The exception to this is the marine and transboundary assessment (Chapter 6) 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.

3.6.13 The potential for inter-project cumulative effects from separate launch operators within the envelope of the SaxaVord Spaceport Operations and environmental budget is considered at length in SaxaVord Spaceport AEE V3 (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 sub-orbital, 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."*

3.6.14 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.

3.6.15 Given that between environmental topics there is little overlap (for example, simultaneously occurring air quality and climate effects on a receptor have no combined cumulative effect together) and because only one launch will occur at any given time and launches of the SR75 Launch Vehicle will be phased with time enough for the EZI to return fully to the baseline state, for all but one of the technical disciplines assessed there are no potential intra-project cumulative effects. The exception to this is the marine and transboundary assessment (Chapter 6) wherein the potential additive effects of multiple launches have been assessed through time.

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

Assessing Mitigation Measures

3.6.17 As required, 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.

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

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

3.6.20 The Applicant is committed to implementing all mitigation measures and monitoring requirements identified in this AEE Report.

Review of the AEE

3.6.21 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.

3.6.22 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

3.6.23 The Applicant will be responsible for required monitoring of environmental effects across the EZI throughout operation of the Proposed Project.

3.7 Assumptions, Limitations and Uncertainty

3.7.1 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.

3.7.2 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 for the duration of the Proposed Project.
- Information provided by third parties, including publicly available information and databases, is correct at the time of submission.

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

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

3.8 AEE Report

3.8.1 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.

3.8.2 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);
- a description of the Proposed Project (AEE Report Volume II, Chapter 2);
- detail on the scope of the Assessment (this Chapter)
- 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 7); 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 7 and summarised in Chapter 8).

3.8.3 References are included within each Chapter in Volume II.

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

3.8.5 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.

3.9 References

Literature

CAA et. al. (2021) *CAP2215 Guidance for the Assessment of Environmental Effects* [online]. Available at https://www.caa.co.uk/publication/download/18937

Civil Aviation Authority (2023) *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* [online]. Available at https://www.caa.co.uk/publication/download/20735

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.*

IEMA. (2016) *Environmental Impact Assessment Guide to Delivering Quality Development, Institute of Environmental Management and Assessment.*

SaxaVord Spaceport. (2024) *SaxaVord Spaceport AEE V3* [online]. Available at https://www.caa.co.uk/publication/download/21052

Websites

Natural Heritage. (2018). *A Handbook on Environmental Impact Assessment Version 5* [online]. Available at https://www.nature.scot/sites/default/files/2018-05/Publication%202018%20-%20Environmental%20Impact%20Assessment%20Handbook%20V5.pdf

Shetland Islands Council. (2019). *Shetland Outdoor Access Strategy* [online]. Available at https://www.shetland.gov.uk/downloads/file/2027/outdoor-access-strategy-sg-2019

Shetlands Islands Council. (2014). *Shetland Local Development Plan* [online]. Available at https://www.shetland.gov.uk/development-plans-policy/development-plans

Legislation

HMSO. (2018). *The Space Industry Act 2018* [online]. Available at https://www.legislation.gov.uk/ukpga/2018/5/contents

CHAPTER 4 AIR QUALITY

4. Air Quality

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4. Air Quality

4.1 Introduction

4.1.1 This chapter considers the potential effects of the Proposed Project on local air quality. The element of the Proposed Project with the potential to affect local air quality and cause effects at receptors relevant for human health is the combustion emissions from launches of SR75 Launch Vehicles.

4.1.2 It is anticipated that launches will take place from Launch Pad 2 within the SaxaVord Spaceport; however, it is also possible that the first launches may take place from Launch Pad 3. Both Launch Pads have been considered and it has been concluded that Launch Pad 2 should the limiting case scenario for assessment given that it lies closer to both human and ecological receptors. As such, for the purposes of this assessment, it has been assumed that launches will take place from Launch Pad 2.

4.1.3 The specification of the SR75 Launch Vehicle is within that of the limiting case representative launch vehicle (RepLV) considered for SaxaVord Spaceport and, in fact, aligns closely with the Small Mass Emission Launch Vehicle - the least significant of the launch vehicles considered within the SaxaVord Spaceport AEE V3 (reference SR-APP-001019). As such, it is considered highly unlikely that the Proposed Project will produce significant air quality effects. However, it is noted that the fuel type for the Proposed Project (paraffin and liquid oxygen – LOx - hybrid) is distinct from that assessed in the Spaceport AEE and as such, even though emissions are likely to be insignificant, an air quality impact assessment (AQIA) specific to the Proposed Project has been undertaken.

4.1.4 The pollutants considered in this assessment are carbon monoxide (CO) emissions from SR75 launches from Launch Pad 2 at a rate of one per year for 30 years.

4.1.5 This chapter does not assess the potential for emissions from traffic or point sources associated with operation of the Proposed Project to cause effects at ecological sites and receptors relevant for human health as these emissions per launch event were adequately assessed in the SaxaVord AEE and concluded to have negligible impact. As there is no material change between the Proposed Project and the scenario assessed for SaxaVord, these elements are not considered further in this AEE.

4.1.6 There are no airborne pollutants associated with launch activities considered likely to have any significant adverse effects on important local ecology.

4.2 Legislation, Policy and Guidelines

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 sub-orbital activities from the UK;
- operate a spaceport in the UK; or
- provide range control services from the UK.

4.2.2 As the Applicant wishes to launch a Launch Vehicle from the UK, they are required to apply for a launch operator licence and submit an AEE.

Space Industry Regulations 2021

4.2.3 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

European Legislation

4.2.4 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 directive on air quality.

National Legislation

4.2.5 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. An updated UK Strategy was published in July 2007; (Defra, 2007) and in Scotland is now superseded by the second Cleaner Air For Scotland 2 (CAFS) Strategy (Scottish Government, 2021).

4.2.6 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).

4.2.7 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 4.1.

Table 4.1 Air Quality Standard Relevant for the Assessment

Pollutant	Air Quality Standard	
	Concentration (µg/m^3)	Averaging Period
For the Protection of Human Health (Scotland)		
CO	10 mg/m^3	Running 8-hour mean

Guidance

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

4.2.8 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 (Department for Transport, 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.*

Guidance for the Assessment of Environmental Effects

4.2.9 The CAA (July 2021) Guidance for the Assessment of Environmental Effects document explains the process for completing an assessment of environmental effects as part of a licence application under the Space Industry Act.

4.2.10 The AEE Guidance requires that potential direct and indirect significant effects of proposed spaceflight activities on environmental features, including air quality, 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.
- The AEE must address a range of environmental topics, including air quality.

Air Quality Guidance

4.2.11 The assessment also uses the guidance documents listed below:

- The Technical Guidance LAQM.TG(22) for Local Air Quality Management, (Defra, 2022);
- 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);
- Civil Aviation Authority (CAA) Airspace Change guidance CAP 1616 (CAA,, 2020).

4.3 Consultation

4.3.1 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. No additional consultation was undertaken for this AQIA.

4.4 Assessment Methodology and Significance Criteria

Scope of the Assessment

4.4.1 The scope of the assessment included the following:

- identification of the environmental zone of influence (EZI) – equivalent to the study area - and air quality sensitive receptors;
- collection of baseline CO concentrations at the Proposed Project;
- collection of emissions data from the launch of an SR75 Launch Vehicle from the Applicant;
- development of a representative scenarios from Launch Pad 2 only;
- development of a time-dependant puff model of a jet release with specified duration using the advanced dispersion model ADMS 6 (CERC, 2024) in a range of meteorological conditions and wind directions;
- development of a time-integrated dose model to predict total concentration at the closest residential receptor during the lifetime of the puff release in each scenario using ADMS 6 in a range of meteorological conditions and wind directions;
- conversion of dose concentrations to 8-hour running mean concentrations and comparison with the AQS for CO;
- preparation of contour maps and results tables demonstrating the puff concentration at one-minute intervals after launch for the worst-case meteorological condition;
- specification of mitigation measures required where necessary; and
- residual summary of effects.

Effects Scoped Out of the Assessment

4.4.2 There are no airborne pollutants associated with launch events considered likely to have any significant adverse effects on ecological receptors therefore, the effect of emissions from launch events on ecological sites has not been considered further in the assessment.

Environmental Zone of Influence

4.4.3 Maps and aerial images of the Proposed Project and the surrounding area have informed the selection of an appropriate air quality study area which is included within the SR75 environmental zone of influence (EZI) for the assessment.

4.4.4 The closest air quality sensitive receptors in each direction from Launch Pad 2 were identified, and a study area up to 4 km from the launch position was defined to track the puff release until CO concentrations returned to ambient background levels under a range of meteorological conditions. The closest occupied sensitive receptor is Banks Cottage at Norwick which is 2077 m from Launch Pad 2. This is shown as R1 alongside the wider EZI on Drawing 4.1 in Volume III.

4.5 Method of Assessment

Launch Event Emissions

4.5.1 The emission rate of exhaust gases from the SR75 Launch Vehicle will vary and decrease with height during the launch event. However, exhaust gases have been modelled as a short-term puff release from ground level at Launch Pad 2 for the duration it takes the launch vehicle to reach an altitude of 1000 ft, the height within which an assessment of effects of an airspace change is required by the CAA (CAA,, 2020). The time for an SR75 Launch Vehicle to reach an altitude of 1000 ft is 1.7 seconds.

This is considered to simulate the maximum potential impact of launch event exhaust gas emissions at identified receptors.

4.5.2 The puff model in ADMS 6 (CERC, 2024) enables releases of up to one-hour duration to be modelled and concentrations at chosen downwind distances to be predicted at different timesteps (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 event, the total dose concentration is the most appropriate for further comparison with health based AQSs.

4.5.3 Launch trajectories will be in a northerly direction over the sea. They will not occur simultaneously with any other launch events or from any other Launch Pad.

4.5.4 The Launch Vehicles propellant will be a mixture of solid paraffin and LOx. The majority of emissions from combustion of this propellant are water vapour (H_2O) and carbon dioxide (CO_2) alongside much smaller quantities of carbon monoxide (CO).

4.5.5 The only pollutant that requires assessment with respect to air quality for potential effects on human health is CO.

4.5.6 Launch event greenhouse gas emissions (including CO_2) are quantified and climate impact assessed in Chapter 5.

4.5.7 The assessment is included in detail in Volume IV, Appendix 4.1.

Assessment Criteria

4.5.8 The change in pollutant concentrations with respect to baseline concentrations has been described at identified sensitive receptors. The absolute magnitude of pollutant concentrations in the "with Proposed Project" scenario is calculated and is used to consider the risk of the relevant AQS for CO being exceeded.

4.5.9 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 4.2 below**.** A change of less than 0.5 % of the AQS is described as Negligible.

Table 4.2 – Impact Magnitude Descriptors for Individual Receptors

Long Term Average Concentration at Receptor	% Change in concentration relative to AQS			
	1 %	2-5 %	6-10 %	>10 %
75 % or less of AQAL	negligible	negligible	slight	moderate
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

4.5.10 The reported magnitude impacts for each receptor are 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 have been considered. The descriptors used to characterise the overall significance of effects at sensitive receptors are summarised in Table 4.3.

Table 4.3 - 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.

Assessment of Residual Effect

4.5.11 An assessment of predicted significant residual effects, taking account of committed mitigation measures, is presented in Section 4.11

4.6 Baseline Conditions

4.6.1 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 during the AEE application for SaxaVord Spaceport, that no ambient baseline air quality monitoring was necessary. Background concentrations of CO were taken from Defra LAQM background maps (Defra, 2024). The maximum 2024 annual background concentration of CO in the study area is predicted to be 0.051 milligrams per cubic metre (mg/m^3).

4.7 Receptors Brought Forward for Assessment

4.7.1 The receptor brought forward for assessment is:

- Banks Cottage-The closest residential receptor to Launch Pad 2, located 2,077 m to the west south-west (R1 on Drawing 4.1);

4.8 Potential Effects

4.8.1 The assessment of the potential effects of emission from launch events in Volume IV Appendix 4.1 predicted ambient CO concentrations at R1 at one-minute intervals after release. The maximum period when the ambient CO concentration was predicted to be detectible above background levels (a minimum increase of 0.001 mg/m^3, i.e. 2% of the background level of 0.051 mg/m3) at receptor R1 was 25 minutes in Stability Class A conditions using UK average wind speeds.

4.8.2 Using the Unst average wind speeds, the maximum period when the CO concentration was predicted to be detectible above background at receptor R1 was three minutes in Stability Classes F and G.

4.8.3 The maximum predicted dose with UK average wind speeds was at R1 was 8.17 mg.s/m^3 CO over three minutes (Stability C).

4.8.4 The maximum predicted dose with Unst average wind speeds was at R1 was 8.82 mg.s/m^3 CO over two minutes (Stability C).

4.8.5 Considering both sets of meteorological conditions, the maximum predicted dose at R1 over the lifetime of the jet release of equivalent to 7.1-7.6 parts per million (ppm) over 2-3 minutes. There are no health effects due to this level of exposure to CO over periods of 2-3 minutes (Goldstein, 2008).

4.8.6 The maximum predicted 8-hour concentration at R1 was 0.051 mg/m^3, 0.51 % of the AQS, when modelled using UK and Unst average wind speeds and wind directions of 45°, 70° and 90°. These wind directions only occur on Unst for a maximum of 17 % of the time.

4.8.7 The assessment demonstrated that there is no predicted 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 launch events.

4.8.8 The effect of SR75 Launch Vehicle launch event emissions on all identified receptors is concluded to be negligible - **no likely significant effect**.

4.9 Cumulative Assessment

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

4.9.2 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.

4.9.3 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 air quality.

4.9.4 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 only one launch will occur within any 24-hour period and the ambient air quality within the study area will be able to return fully to its baseline state between launches, it is considered that there is no potential for air quality additive or intra-project cumulative effects.

4.10 Residual Effects

4.10.1 The residual effects on air quality from the Proposed Project are concluded to be negligible - **no likely significant effect**.

4.11 Summary

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

4.11.2 SR75 Launch Vehicle 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 to easterly winds which combined occur typically for less than 17 % of the year. The maximum predicted 8-hour concentration of CO at the identified receptor R1 is <1 % of the AQS.

4.11.3 The effect of SR75 Launch Vehicle launch event emissions on all identified receptors is concluded to be negligible - **no likely significant effect**.

4.12 References

CAA, 2020, *Airspace Change – Guidance on the regulatory process for changin the notified airspace design and planned and permanent redistribuition of air traffic, and on providing airspace information, CAP 1616,* CAA.

CAA et. al. (2021) *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

CERC, 2024, Cambridge Environmental Research Consultants. Link to series of validation documents available at https://www.cerc.co.uk/environmental-software/model-validation.html

Defra (2022). *Local Air Quality Management - Technical Guidance (TG22).* Available at: https://laqm.defra.gov.uk

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

Goldstein (2008), *Carbon monoxide poisoning*, Journal of Emergency Nursing 34 (6) 538-542, PMID 19022078

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 (2021), *Cleaner Air for Scotland 2– The Road to a Healthier Future,* Scottish Government. Available at: https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2021/07/cleaner-air-scotland-2-towards-better-place-everyone/documents/cleaner-air-scotland-2-towards-better-place-everyone/cleaner-air-scotland-2-towards-better-place-everyone/govscot%3Adocument/cleaner-air-scotland-2-towards-better-place-everyone.pdf

UK Health and Safety Executive, (2020), *EH40/2005 Workplace Exposure Limits (Fourth Edition 2020).* Available at: https://www.hse.gov.uk/pubns/priced/eh40.pdf

Websites

Defra, (2024), *UK Air-Air Information Resource.* Available at: https://uk-air.defra.gov.uk/data/laqm-background-home. Accessed 11 July 2024.

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 5 CLIMATE CHANGE

5. Climate Change

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5. Climate Change

5.1 Introduction

5.1.1 This chapter evaluates the potential impact of the launch of the HyImpulse SR75 Launch Vehicle (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.

5.1.2 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 GHG assessment.

5.1.3 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.

5.2 Legislation, Policy and Guidelines

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 SR75 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 the Regulators Licensing rules, which specify what information the UK Civil Aviation Authority (CAA), the regulator, requires in support of an application.

Additional Legislation

5.2.4 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

5.2.5 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 five-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

5.2.6 The following best practice guidance for assessing climate change effects 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); and
- Climate Change Allowance for Flood Risk Assessment in Land Use Planning (SEPA,2022).

Considerations noted in the DfT guidance for the regulator

5.2.7 The Department for Transport issued '*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.

5.2.8 The 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 taken in this AEE are summarised below.

Alternative Fuels

5.2.9 Calculated emissions per launch of the HyImpulse SR75 Launch Vehicle in this AEE assume that solid paraffin hydrocarbon is the fuel of choice with liquid oxygen (LOx) 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.

5.2.10 HyImpulse is using a solid paraffin grain as fuel instead as part of their proprietary propulsion technology.

5.2.11 HyImpulse is committed to the research and development of non-fossil paraffin fuel synthesis, but this process is currently in early development and no firm dates for commercial production are yet known.

5.2.12 The only potentially non-fossil derived fuel currently used in the space industry is liquid hydrogen. This fuel is not suited to smaller launch vehicles such as the SR75 due to the extra weight and complexity involved with cryogenic storage.

Efficiency savings

5.2.13 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 but the savings per launch will be negligibly small.

Ozone depletion

5.2.14 Stratospheric ozone depletion by the reaction with Launch Vehicle exhaust compounds is reported to be related to the action of black carbon caused by the incomplete combustion of hydrocarbons. 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.

5.2.15 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.

5.2.16 The most effective mitigation against black carbon will be the sectoral transition to carbon-free fuels which will be supported but not specifically pursued by HyImpulse Whilst it is possible that emissions from non-carbon fuels such as hydrogen 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

5.2.17 Local meteorological conditions are not considered a relevant consideration in the context of the climate effects of the Proposed Project but are considered by the air quality assessment (Chapter 4) in terms of their influence on dispersion of potential air pollutants formed by combustion.

Offsetting

5.2.18 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 currently considered to offer a guarantee of genuine savings through atmospheric removal of GHGs.

Other considerations

5.2.19 No other ancillary fuels or ignition compounds are present on the SR75 LV to further contribute to GHG emissions.

5.3 Assessment Methodology and Significance Criteria

5.3.1 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

5.3.2 The scope of the GHG assessment includes operational emissions of the Proposed Project which are predominated by emissions from launches.

5.3.3 The Environmental Zone of Influence (EZI) for the assessment of the potential adverse climate change effects on the Proposed Project is restricted to the Proposed Project boundary and the transport network utilised for the transport of materials and personnel.

Desk Study

5.3.4 An assessment has been undertaken of current and future climate trends in the EZI, 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

5.3.5 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 years covered by the climatic modelling considered.

5.3.6 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

5.3.7 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

5.3.8 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

5.3.9 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

5.3.10 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 5.7.

5.3.11 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.

5.3.12 To mitigate against potential significant effects, a baseline carbon footprint is calculated and then used as a basis to reduce emissions.

Limitations to Assessment

5.3.13 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.

5.4 Baseline Conditions

Current Baseline – Climatic Conditions

5.4.1 A local climate baseline is provided by Met Office Historic Climate Data which presents a set of 20-year averages, covering the period 1981-2010 for a range of parameters. Some baseline data cover a more recent period but are not comparable with the climate change scenario models used in this assessment.

5.4.2 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 **Error! Reference source not found.** 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 in Unst is 13.4 knots, with the highest average wind speed recorded in the month of January, an average of 16.7 knots.

Table 5.1 – 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

5.4.3 Local and regional CO_2 emissions data tables published by the UK Government contain historic emissions data for the period 2005 - 2022 for all UK local authorities and councils; these are the current data following the latest update in June 2024. The total emissions and emissions per capita in the Shetland Islands for the last ten years are reproduced in Table 5.2 and include all fossil fuel and land use / land use change factor (LULUCF) related GHG emissions. Between 2013 and 2022, CO_2 emissions per capita in the Shetland Islands have decreased reasonably consistently though 2020 was an outlier due to the COVID-19 pandemic and saw much lower than usual transport emissions for Shetland.

Table 5.2 – Shetland Islands Local Authority CO_2 emissions estimate 2013-2022 (kilotonnes CO_2)

Year	Kilotonnes CO_2	Population ('000s)	Per Capita Emissions (tonnes)
2013	623.4	23.2	26.9
2014	611.6	23.2	26.3
2015	604.7	23.2	26.0
2016	587.7	23.2	25.3
2017	578.9	23.1	25.0
2018	573.2	23.0	24.9
2019	568.3	23.0	24.7
2020	550.4	22.9	24.0
2021	558.8	22.9	24.4
2022	556.0	23.0	24.2

Future Baseline

5.4.4 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.

5.4.5 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 Gross Domestic Product (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.

5.4.6 The climate variables considered relevant to this assessment are mean air temperature, maximum air temperature, wind speed and precipitation.

5.4.7 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.

5.4.8 In general, the trends become more pronounced over time with more extreme trends arising by the late 2070s.

Mean air temperature

5.4.9 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.

5.4.10 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.

5.4.11 The baseline maximum temperature recorded at Baltasound, Unst is 15.2°C for the month of August (see Table 5.1), 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

5.4.12 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.

5.4.13 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

5.4.14 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.

5.4.15 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.

5.5 Receptors Brought Forward for Assessment

5.5.1 The sensitive receptors in the instance of this climate change assessment are the SR75 Launch Vehicles, 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.

5.6 Standard Mitigation

5.6.1 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.

5.6.2 To mitigate against potential significant effects caused by the Proposed Project, the following measures will be applied to reduce resulting GHG emissions:

- Iterative increases in energy efficiency as data is collected from launches and used to inform the Launch Vehicle design process; and
- Surface and marine vehicle transport will similarly decarbonise over the later 2020s and 2030s reducing GHG emissions from these sources.

5.7 Potential Effects

Influence of the Proposed Project on Climate Change

5.7.1 An assessment of the likely GHG emissions resulting from the Proposed Project has been undertaken in accordance with the methodology specified in Section 5.4.

5.7.2 A number of input parameters were required in order to quantify the carbon footprint, these are specified in Table 5.3.

5.7.3 A full overview of the emissions factors and calculation data is provided in Appendix 5.1 in Volume IV.

Table 5.3 – GHG Assessment Boundaries

Source of GHG Emissions	Input Data	Emissions Factor Source	Description
Transport	Distance travelled by Heavy Goods Vehicle (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

5.7.4 The transportation of payloads to the SaxaVord Spaceport has been 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.

5.7.5 The emissions associated with a single launch of the SR75 Launch Vehicle have been calculated and can be simply factored to represent the emissions from multiple launches.

Table 5.4 – GHG Emission Sources

Source of GHG Emissions	GHG Emissions (tCO_2e)
Launch	1.4
Transport of SR75 Launch Vehicle and dedicated launch equipment	3.8
Total	**5.2**

5.7.6 The major contributor to GHG emissions will be from the transportation of the SR75 Launch Vehicles to the launch site. The Launch Vehicle (LV) and all dedicated launch equipment and fuel will be packaged for delivery in Neuenstadt, Germany. Emissions from the transportation of the SR75 Launch Vehicle, fuel and equipment will require two shipping containers loaded onto articulated lorries, travelling the distance from the works at Neuenstadt by road to the nearest suitable port at Hamburg, with onward transport assumed by small container vessel to Aberdeen. A combination of ferry and road transport is assumed to deliver the loads from Aberdeen to Lerwick and thence across Shetland to SaxaVord Spaceport.

5.7.7 A single road tanker of liquid oxygen originating from Bridge of Don near Aberdeen has been assumed. In reality far less than a tankerload will be required by each SR75 launch so this element is an overestimate.

5.7.8 Emissions from the launch vehicle are a smaller proportion of the overall total GHG emissions than the transportation. The majority will in fact arise in Germany from road transportation.

5.7.9 Distance and emission factor assumptions are presented in Appendix 5.1.

5.7.10 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 likely significant effect**.

5.7.11 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 Proposed Project to Climate Change

High wind speeds

5.7.12 Damage to the SR75 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.

5.7.13 Met Office climate models anticipate that there will be a barely distinguishable change from baseline wind speed conditions between 2020 - 2078.

5.7.14 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.

5.7.15 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 SR75 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. Future versions of the SR75 will feature guidance systems and Thrust Vectoring Control to compensate for sudden changes in wind speed and direction during both launch and flight. Following the implementation of these mitigation measures, the effect of strong winds on the Proposed Project can be considered minor adverse with **no likely significant effect**.

Heavy precipitation

5.7.16 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.

5.7.17 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.

5.7.18 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.

5.7.19 SEPA's Climate Change Allowance for Flood Risk Assessment in Land Use Planning guidance advises that a 40 % increase in rainwater drainage provision be applied to activities taking place in Shetland.

5.7.20 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 likely significant effect**.

High temperatures

5.7.21 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.

5.7.22 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.

5.7.23 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.

5.7.24 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.

5.7.25 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 likely significant effect**.

5.8 Residual Effects

5.8.1 No significant residual effects have been identified following the implementation of mitigation measures.

5.9 Cumulative Assessment

5.9.1 The climate resilience risks identified are limited in their spatial extent to the Proposed Project and therefore no cumulative effect with other committed launch projects is considered in this climate change impact assessment.

5.10 Summary

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

5.10.2 The assessment considered emissions arising from the operation of the Proposed Project including transportation and combustion of SR75 Launch Vehicle hybrid engine.

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

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

5.10.5 The climate baseline has been characterised using Met Office climate data for the period 1981-2010.

5.10.6 GHG emissions in the context of overall annual emissions by the Shetland Islands are considered of minor significance.

5.10.7 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.

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

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

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

5.10.11 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 Personal Protective Equipment (PPE).

5.11 References

BEIS. (2019). *BEIS UK Local authority and regional carbon dioxide emissions national statistics: 2005-2017*. Retrieved from https://www.gov.uk/government/collections/uk-local-authority-and-regional-carbon-dioxide-emissions-national-statistics

BEIS. (2020). *BEIS Greenhouse Gas Reporting: Conversion Factors 2020*. Retrieved from https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2020

CIBSE. (2008). *Chartered Institute of Building Services Engineers TM46 Energy Benchmarks*. Retrieved from https://www.cibse.org/Knowledge/knowledge-items/detail?id=a0q20000008I7evAAC

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

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. (2020a). *Meteorological Office UK Climate Averages*. Retrieved from https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages

Met Office. (2020b). *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.lwgislation.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

Uni. Bath. (2011). *University of Bath Sustainable Energy Research Team Inventory of Carbon and Energy*. Retrieved from http://wiki.bath.ac.uk/display/ICE/Home+Page;jsessionid=2358DA949145979F0F8865783188344D

CHAPTER 6 MARINE AND TRANSBOUNDARY EFFECTS

6. Marine and Transboundary Effects

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6. Marine and Transboundary Effects

6.1 Introduction

6.1.1 This chapter considers the marine and transboundary effects from operation of the Proposed Project.

6.1.2 Transboundary effects of the Proposed Project are environmental effects that may arise in a different country as a consequence of the Proposed Project.

6.1.3 The majority of the potential environmental effects of the Proposed Project are expected at or near the Proposed Project's site. However, the SR75 Launch Vehicle may splashdown further away in Scottish or international waters and potentially interact with the marine environment.

6.1.4 All launches will take place in a northerly direction over the sea. For safety reasons, the SR75 Launch Vehicle 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 will constrain trajectories in order to avoid nominal jettisoned separated components impacting inhabited land masses, including Jan Mayen, or waters within 12 miles of those coastlines, in compliance with international treaties. In the case of an off-nominal launch situation resulting in SR75 debris landing within 12 nautical miles of the coast of Shetland, SaxaVord Spaceport (as Range Operator) will maintain boundary vessels and a launch exclusion zone over the sea area and will instigate emergency response and recovery operations in partnership with the Applicant.

6.1.5 The scope of the transboundary effects assessment is concerned with assessment of the marine environmental effects of the returning SR75 Launch Vehicle and any component(s) arising. The UK Government has consulted with the governments of countries where the launch vehicles are predicted to land within the waters of their Exclusive Economic Zone (EEZ), specifically Norway, Faroe, Greenland and Iceland, to come to an agreement to allow launch vehicle debris to fall in their waters. Although only a small portion of the EZI overlaps with EEZs of other countries (Faroe and Norway), there is the potential (although unlikely) for impact of the SR75 Launch Vehicle outside of UK waters.

6.2 Legislation, Policy, and Guidelines

Legislation and Guidance

6.2.1 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

6.2.2 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 6.1) 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 to ensure that the content of the AEE demonstrates due consideration of the issues highlighted by the Plan policies.

6.2.3 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 6.1.

6.2.4 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.

6.2.5 Appendix 6.1 lists these Plan policies and indicates the section of the AEE where information is presented to account for the requirements of the policy.

6.2.6 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.

6.2.7 Appendix 6.1 lists these Shetland Plan policies and indicates the section of the AEE where information is presented to account for the requirements of the policy.

6.3 Scope of Assessment

Environmental Zone of Influence

6.3.1 Sub-orbital launches of the SR75 Launch Vehicle are proposed to occur from the Proposed Project. For the purposes of this AEE, the EZI is based on the proposed launch and impact areas of the SR75 Launch Vehicle.

6.3.2 The trajectories and likely impact zone for returning material from launches of the SR75 Launch Vehicle is spatially limited compared to orbital launches, as the SR75 Launch Vehicle is smaller and has a reduced range. The impact dispersion area for the SR75 Launch Vehicle is contained within the area demarcated as the SR75 Environmental Zone of Influence (EZI), as presented in Drawing 6.1.

Desk Study

6.3.3 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 Oceanic and Atmospheric Administration (NOAA) resources;
- European Marine Observation and Data network (EMODnet);
- International Council for the Exploration of the Sea (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.

6.4 Assessment Methodology

6.4.1 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'.

6.4.2 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 study areas. 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

6.4.3 The sensitivity assessment used is an assessment of the relative sensitivity of the receptor features within the impact zone to effects associated with returning launch vehicles. 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.
- 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.

6.4.4 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.

6.4.5 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).

6.4.6 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.

6.4.7 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.

6.4.8 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. The following limits have subsequently been used to determine whether the sensitivity of the receptor is negligible, low, medium or high.

Table 6.1 – Receptor Sensitivity Scoring

Combined Score	Sensitivity
0-3	Negligible (0)
4-6	Low (1)
7-9	Medium (2)
10-12	High (3)

Exposure

6.4.9 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.

6.4.10 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. The following limits have subsequently been used to determine whether the exposure to the impact is negligible, low, medium or high.

Table 6.2 – Receptor Exposure Scoring

Combined Score	Exposure
0	Negligible (0)
1-4	Low (1)
5-7	Medium (2)
8-9	High (3)

Magnitude

6.4.11 Magnitude is defined in terms of the level of the impact above background conditions and natural variability by whatever parameters are measurable.

6.4.12 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.

6.4.13 The following limits have subsequently been used to determine whether the magnitude of the impact is negligible, low, medium or high.

Table 6.3 – Magnitude

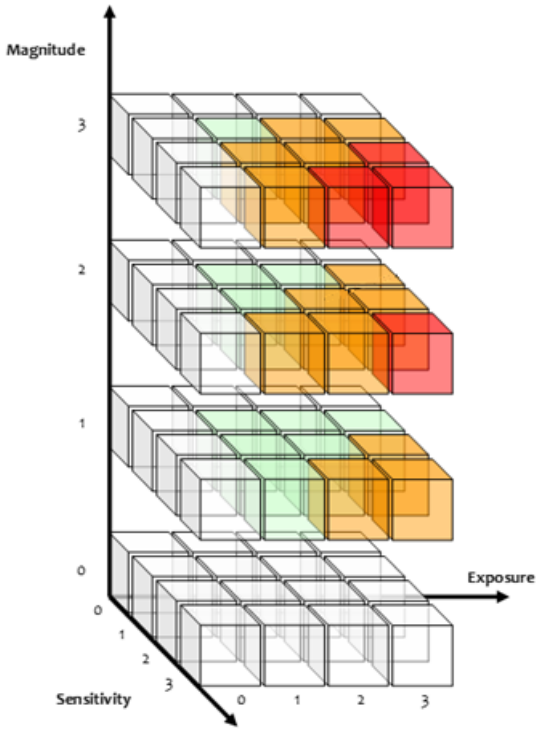
Combined Score	Magnitude
0	Negligible (0)
1-2	Low (1)
3-4	Medium (2)
5-6	High (3)

Summary of Methodology Used to Determine Level of Environmental Risk

6.4.14 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

6.4.15 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 6-1 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.



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

Figure 6-1 – The risk assessment matrix

6.4.16 Table 6.4 below presents the transposition of the risk values into the terminology used in the wider AEE Report.

Table 6.4 – 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

6.4.17 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

6.4.18 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.

6.4.19 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.

6.4.20 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 effect significance. If specific mitigation measures are not applied significant effects will remain.

Assessment of Residual Effect Significance

6.4.21 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

6.4.22 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.

6.5 Baseline Conditions

6.5.1 The baseline conditions are described in terms of their water quality, biodiversity (including Priority Marine Features) 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 6.2.

6.6 Receptors Brought Forward for Assessment

6.6.1 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.

6.6.2 Physical features (e.g. coastal processes), landscape/seascape visual disturbance, and introduction of invasive non-native species, and air quality have been screened out due to a lack of pathway of effect.

6.6.3 The flight path and impact dispersion area of the SR75 Launch Vehicle avoids oil fields to the west of Shetland and areas of surface infrastructure (eight populated platforms) to the east of Shetland (further details in document LP-008-SAXA). Accordingly, oil and gas surface infrastructure are scoped out of this assessment.

6.6.4 As described in the baseline environment, there is negligible presence of other sea users and socio-economics/tourism in the EZI. Accordingly, these human activities have been scoped out for assessment.

6.6.5 Details of which features/receptors are being taken forward for assessment are presented in Table 6.5 below.

Table 6.5 – Receptors taken forward in the assessment

Receptor	Taken Forward for Assessment
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

6.7 Assessment Envelope

6.7.1 As per the AEE Regulations, the impact assessment should be based on the worst-case parameters, known as the Rochdale envelope.

6.7.2 Certain worst-case scenarios, such as the maximum number of launches, are already known and have been set as limits as part of the project design.

6.7.3 A full description of the proposal is provided in Chapter 3 Description of Proposed Project. For completeness, this assessment envelope presents a subset of the project description that is relevant to this chapter.

SR75 Launch Vehicle

6.7.4 The SR75 launch vehicle is a single-stage, small (13 m) launch vehicle with a hybrid fuel source that uses liquid oxygen and solid paraffin-based proprietary fuel. This hybrid system produces 75 kilonewtons (kN) of thrust.

6.7.5 The payload of scientific equipment is designed for research and development and will be retrieved following splashdown. This will be the responsibility of the Applicant and is assessed in detail below.

6.7.6 Launches of the SR75 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.

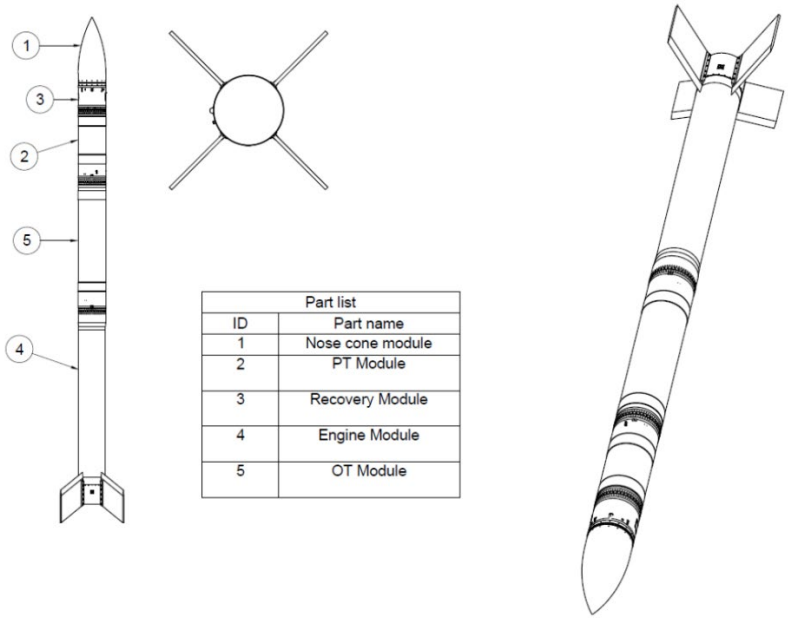
6.7.7 The impact dispersion area the SR75 Launch Vehicle is an area representing an estimated three standard deviation dispersion about a nominal impact point of an intermediate or final stage of a sub-orbital launch vehicle. Due to the proposed launch azimuth of 000° for the Proposed Project, this reflects a circular area of radius 100 km and with midpoint 200 km due north of Launch Pad 2, as shown in Drawing 6.1. The impact dispersion area is encompassed within the wider SaxaVord Spaceport sub-orbital EZI.

Physical Properties

6.7.8 A detailed specification table and schematic of the SR75 Launch Vehicle are presented as Table 6.6 and Figure 6-2 respectively.

Table 6.6 – SR75 Specification

Parameter	Specification
Launch Vehicle	
Diameter	0.64 m
Length	13 m
Empty vehicle mass	800 kg
Lift-off mass	2,600 kg
Anticipated apogee	150 km
Total Impulse (vacuum)	4.3 MN s
Launcher type	Rail
Recovery system	Yes (for booster module)
Propulsion	
Number of stages	1
Number of engines	1
Propellant combination	Liquid oxygen / paraffin-based fuel
Propulsion system architecture	Helium pressurised
Pressurisation gas mass	30 kg
Fuel mass	460 kg
Oxidiser mass	1,000 kg
Nominal thrust (sea-level)	75 kN
Payload	
Purpose	STEM promotional
Payload type	CubeSat format 1.5 U 10cm x 10cm x 17.02 cm), passive
Payload mass	< 5 kg



Part list	
ID	Part name
1	Nose cone module
2	PT Module
3	Recovery Module
4	Engine Module
5	OT Module

Figure 6-2 SR75 Launch Vehicle Overview

Nose cone

6.7.9 The nose cone (ID1 in Figure 6-2) houses the payload of scientific equipment. The nose cone is constructed from glass fibre, epoxy resin, cork, steel, Pertinax (a hard paper material impregnated with phenolic resin), and paint.

6.7.10 The nose cone module (cone and connector) is the only element of the SR75 that will not be retrieved.

Parachutes

6.7.11 The main and drogue parachutes are 11 m and 2.8 m diameter, respectively. Both are fabricated from nylon and Kevlar and will be retrieved from the marine environment following splashdown.

6.7.12 A hatch cover and retention plate are associated with the drogue parachute of the SR75 Launch Vehicle. The hatch cover materials include carbon fibre, epoxy resin, cork, aluminium, steel, and paint. The retention plate materials include carbon fibre, epoxy resin, steel, aluminium, and nylon. These will be recovered from the marine environment.

Booster Modules

6.7.13 The booster modules comprise the pressurisation tank (PT) module, the recovery module, the engine module and the oxidiser tank (OT) module (IDs 2-3-4-5 in Figure 6-2).

6.7.14 The engine module is made up of aluminium, brass, stainless steel, carbon and glass fibres, silica phenolic composite, Pertinax (phenolic resin treated laminated paper), graphite, cork, high density polyethylene (HDPE), HTPB and epoxy. The solid fuel of SR75 is paraffin, which will be completely burned under nominal flight conditions. The fins of the engine module consist of pertinax, carbon fibre, aluminium, and balsa wood.

6.7.15 The remaining booster modules are made of composite materials. The exterior of the launch vehicle is made of composite materials, including the motor casing, intertank structures, tanks and recovery module. Steel and aluminium alloys are used for components of the propellant management system such as pipes, for the pneumatic system of the recovery system, and for other structural elements such as boxing for electrical components, brackets, fasteners. Lithium-polymer, lithium-ion and lithium-metal batteries are also included in the booster as part of the avionics subsystem. Copper

is present in the gaskets and cables, in single-figure kilogram quantities. Finally, there are also a small amount of plastic 3D-printed components.

Flight Termination System

6.7.16 The SR75 includes a Flight Termination System (FTS) to improve flight safety by allowing for mission termination in case of a non-recoverable flight deviation which poses potential risk to people and/or infrastructure.

6.7.17 The FTS operates by piercing a hole in the oxidizer tank through the actuation of a neutralisation charge, consequently stopping the oxidiser feed to the motor and thus terminating the thrust generation. The actuation of the FTS will not cause an explosive event. As a precautionary measure, it is assumed there will be no deceleration of any components.

6.7.18 It is possible that this action may result in break-up of the launch vehicle. In this event, the launch vehicle may fragment into three major debris components: nose cone; recovery module and pressurisation tank module; and oxidiser tank and motor. No further fragmentation is expected, beyond breakage of the fins at splashdown. Two major debris components of the launch vehicle will be retrieved on splashdown following actuation of the FTS (the recovery module and pressurisation tank module; and the oxidiser tank and motor).

Propellants

6.7.19 The motor casing and the fuel grain are part of the booster engine module (ID 4 in Figure 6-2). The solid fuel of SR75 contains paraffin, which is completely burned under nominal flight conditions.

6.7.20 The total mass of the SR75 launch vehicle at lift off will be approximately 2,600 kg of which approximately 1,460 kg will be propellant (fuel plus oxidiser).

Launch Trajectory and Recovery Operations

6.7.21 The proposed trajectory of the SR75 Launch Vehicle will be along a due north (000°) azimuth from Launch Pad 2 at SaxaVord Spaceport. Launches 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.

6.7.22 The return to earth impact dispersion area is anticipated to be approximately 200 km downrange within the UK EEZ, as shown in Drawing 6.1, however there is some overlap of the EZI/impact dispersion area with Danish (Faroe) and Norwegian waters.

6.7.23 Following separation of the nose cone and payload, the booster module and nose cone will return to earth separately. For the booster module, during descent the drogue parachute will be ejected at an altitude of 6 km to slow down the vehicle. Later, at an altitude of approximately 1.5 km the main parachute will be deployed, and the drogue parachute will separate. The booster module will land in the sea and two other components will fall into the sea separately:

- Nose cone and its metal connection ring;
- Drogue parachute.

6.7.24 The nose cone is the only part of the SR75 Launch Vehicle that will not be recovered.

6.7.25 Planned debris is shown in Table 6.7. Three beacons will be installed on the SR75 Launch Vehicle; two on the booster module and one on the drogue parachute.

Table 6.7 – Planned Debris

Debris	Mass	Dimensions (LxWxH)	Recovery	Location System	Nominal Landing Position
Booster and main parachute	800 kg	11.5 m x 0.64 m diameter. Parachute 11 m diameter.	Yes	Onboard transmitter with two locator beacons	205 km
Nose cone	200 kg	1.5 m long x 0.64 m diameter.	No	Visual	204 km
Nose cone connector	3 kg	2 m band (25 mm x 25 mm)	No	-	200-205 km
Drogue parachute, hatch cover, and retention plate	< 10 kg	Parachute 2.8 m diameter	Yes	Location beacon and hand tracker	205 km

6.7.26 The Applicant will provide the marine Contractor with coordinates for the expected landing site prior to departure and an exclusion radius based on the probability of deviation from the expected landing site. SaxaVord Spaceport will confirm the marine exclusion zone position and radius following launch and will remain in contact with the vessel as the SR75 Launch Vehicle's location is tracked.

6.7.27 The vessel will standby outside the exclusion zone until either the SR75 Launch Vehicle has been confirmed to have landed, or the vessel has good visual contact with the SR75 Launch Vehicle components descending under parachute; after which recovery will be attempted.

Impact Dispersion Area

6.7.28 The impact dispersion area is an area representing an estimated three standard deviation dispersion about a nominal impact point of the SR75 Launch Vehicle. Due to the proposed launch azimuth of 000°, this reflects a circular area with midpoint 200 km due north of the launch site as shown in Drawing 6.1.

Comparison with SaxaVord Spaceport AEE V3 sub-orbital launch vehicle

6.7.29 The specification of the SR75 Launch Vehicle is within that of the limiting case representative launch vehicle (RepLV) considered for SaxaVord Spaceport and, in fact, aligns closely with the Small Mass Emission Launch Vehicle - the least significant of the launch vehicles considered within the SaxaVord Spaceport AEE V3 (reference SR-APP-001019).

6.7.30 A full comparison of the specifications of the SR75 Launch Vehicle against the sub-orbital launch vehicle specification assessed as part of the SaxaVord Spaceport AEE V3 is presented in Table 6.8.

Table 6.8 – Comparison of SR75 against SaxaVord Spaceport AEE V3 sub-orbital launch vehicle

	HyImpulse SR75 Launch Vehicle	SaxaVord Spaceport AEE V3 Representative sub-orbital launch vehicle
Trajectory		
Estimated Impact Range	205 km	200 km
Launch Safety Radius	1.8 km exclusion radius	5 km
Trajectory	Northerly	Northerly
Apogee	150 km	Unspecified
Launch Vehicle Parameters		
Stages	Single	Single
Fuel	Liquid oxygen and paraffin-based solid fuel	Solid with liquid oxidiser
LV diameter	0.64 m	Unspecified
LV length	12.965 m	Unspecified
Engine materials	Aluminium, brass, stainless steel, carbon fibres, glass fibres, silica phenolic composite, Pertinax, graphite, cork, HDPE, HTPB, epoxy	Unspecified
Additional materials	Lithium-polymer, lithium ion and lithium metal batteries (avionics), copper (gaskets and cables), plastic (3D-printed components, minimal)	Unspecified
Total Mass	~1050 kg	230 kg
Fuel mass	460 kg	>115 kg
Recovery considerations		
Components retrieved	Booster, main parachute, and drogue parachute (with hatch cover and retention plate) via parachutes and recovery vessel	Nose cone retrieval via parachute and recovery vessel
Components into marine environment	Nose cone (100-200 kg) and metal connection ring (1-3 kg)	Booster
Parachute deployment altitude	6 km (drogue parachute), 1.5 km (main parachute)	1 km
Recovery method	Booster and main parachute: onboard transmitter and two locator beacons identifiable with hand tracker, nosecone: visual, drogue parachute,	Onboard transmitter

	HyImpulse SR75 Launch Vehicle	SaxaVord Spaceport AEE V3 Representative sub-orbital launch vehicle
	hatch cover and retention plate: locator beacon and hand tracker.	

6.7.31 As the specification of the SR75 Launch Vehicle is well within that of the limiting case RepLV considered for SaxaVord Spaceport (30 m orbital launch vehicle with sea level thrust of approximately 634 kN) and aligns closely with the sub-orbital launch vehicle assessed for SaxaVord Spaceport it is considered unlikely that the Proposed Project will give rise to any significantly different effects to those already assessed for the SaxaVord Spaceport RepLV. However, because the specification, composite materials and propellants of the SR75 Launch Vehicle are different to those assessed in the Spaceport AEE V3, AEE will be considered for all aspects and carried out topics where the specification differs between the two launch vehicles.

6.8 Standard Mitigation

6.8.1 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, as these are larger than UK exclusion zones. Launches will follow a due north (000°) azimuth from Launch Pad 2 at SaxaVord Spaceport. The exclusion zone will cover a radius of 1.8 km around Launch Pad 2. Prior to launch, the area will be registered on Marine Charts and will be activated via a Notice to Mariners.

6.8.2 An exclusion zone is not anticipated to be required for the booster and nose cone. For these, a Notice to Mariners will be published, and NAVTEX warnings and Sécurité messages will be broadcast over Very High Frequency (VHF) radio, with the exact areas dependent upon individual launches. This will ensure that other maritime users are aware of the launch operations and will assist in the implementation of temporary exclusion zones. In addition, continuous monitoring of Automatic Identification System (AIS) and radar will be carried out from land to ensure navigational safety at all times in the indicative impact zone.

6.9 Potential Effects

6.9.1 A series of effect pathways on the marine environment have been identified as a result of the return of launch vehicles to Earth. Table 6.9 below summarises the effect pathways to be considered for SR75 launches from the Proposed Project.

6.9.2 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 temporary exclusion zone around the returning SR75.

Table 6.9 – Impacts considered for the impact assessment of SR75 launches

Key: ✓ = Impact present; ✗ = Impact not present

Impact	SR75 Launches
Effects on Water and Sediment Quality, and Ecological Receptors from Fuel/Propellent Spillage	✓
Effects on Water and Sediment Quality, and Ecological Receptors from Metal Corrosion and Toxic Contamination	✓

Impact	SR75 Launches
Effects on Water and Sediment Quality, and Ecological Receptors from returning components and microplastics (Including Ingestion)	✓
Smothering of Marine Organisms, Habitat Alteration (Including Reef Effects) and Habitat Loss via Deposition of Material on the Seabed	✓
Direct Strike	✓
Acoustic Disturbance (including Underwater Noise) from the Impact of the Jettisoned Objects Hitting the Sea Surface	✓
Toxic Contaminants from Jettisoned Objects	✓
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 Returned Components, Changes to Topography and Re-routing of Vessel Traffic	✓
Interference with Marine and Coastal Tourism Activities/Industry	×
Landscape/seascape visual disturbance	×
Introduction of invasive non-native species	×

6.9.3 The risk assessment matrices that correspond to the written description of the environmental effects in the sections below are provided in:

- Appendix 6.3 – water quality risk matrix (Technical Appendix 6.3);
- Appendix 6.4 – biodiversity risk matrix (Technical Appendix 6.4); and,
- Appendix 6.5 –human activity risk matrix (Technical Appendix 6.5).

SR75 Sub-orbital Launches

Effects on Water and Sediment Quality and Ecological Receptors from Fuel/Propellent Spillage

6.9.4 It has been assumed that all solid propellant will be consumed under nominal flight conditions. There is therefore not expected to be any residual solid propellant in the SR75 Launch Vehicle upon impact.

6.9.5 The liquid propellant is liquid oxygen, which has a boiling point of -183°C (Air Products, 2015) and so would be expected to evaporate upon release. It is anticipated that any residual liquid propellant in the returning SR75 Launch Vehicle will be expelled upon impact on the sea surface. The input of a residual amount of oxygen into the marine environment is not predicted to have any lasting impacts and will quickly dissipate into the environment. The marine biodiversity receptors that have the 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.

6.9.6 The water quality and biodiversity of the EZI has an important environmental value, however no biodiversity receptors are expected to be impacted by residual fuel for nominal launches. Increases in oxygen due to input of residual liquid oxygen propellant are predicted to be present over an extremely short timescale (i.e., hours to days). Biodiversity receptors with the potential to be

impacted by residual liquid oxygen propellant, plankton, are not predicted to experience any adverse effects as a result of exposure to residual fuel. Given this and the abundance and turnover of plankton, the sensitivity of these receptors is negligible.

6.9.7 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 Proposed Project operations. However, within this timeframe, launches are only anticipated to occur once per year. It is noted that, due to the large spatial extent over which the launch vehicles could return, it is extremely unlikely that the receptors would be exposed to multiple launch vehicles, further reducing the frequency at which they could be exposed to residual propellant. It is also noted that the risk of exposure to propellant is unlikely as in most cases there will be no residual fuel. The zone of effect of liquid oxygen spills is anticipated to be spatially limited to within several meters of the launch vehicles. Therefore, overall exposure of the receptors to the effect is low.

6.9.8 Direct effects on the oxygen concentration of the sea water is unlikely to be measurable above natural variability. Similarly, potential impact to the water quality is unlikely to be measurable above the baseline. The magnitude of the impact is therefore low.

6.9.9 Negligible sensitivity, combined with low exposure and low magnitude, means that the risk to these receptors is negligible, which is equivalent to **no likely significant effect**.

Effects on Water and Sediment Quality and Ecological Receptors from Metal Corrosion and Toxic Contamination

6.9.10 As detailed in Table 6.8 above, the metals that have the potential to enter the marine environment are aluminium and stainless steel, in the nose cone and connector ring. With the exception of the nose cone module and potential broken fins, all components will be recovered within a 12h period; therefore, no metals or toxins will be present in the marine environment for extended periods of time.

6.9.11 The nose cone is comprised of inert materials (glass fibre, epoxy resin, cork, steel, Pertinax and paint), therefore the marine environment of the EZI is described in terms of these specific materials.

6.9.12 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). As an alloy metal, stainless steel is not naturally present in the marine environment. However, many anthropogenic structures and vessels present within the Norwegian Sea 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, the effects of introducing stainless steel into the environment are expected to be negligible.

6.9.13 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 (unrecovered nose cone of the SR75 Launch Vehicle) is expected to pass through the water column and then rest on the seabed. Biodiversity receptors are unlikely to be exposed to increased contaminants as the nose cone of the SR75 Launch Vehicle is constructed from inert materials. Water quality is unlikely to be affected. Given the unlikely increase in contaminants by the long-term presence of the nose cone, it is anticipated that biodiversity and water quality

receptors will be able to recover within very short timescales (almost immediately). The sensitivity of these receptors is therefore low.

6.9.14 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 Proposed Project operations. However, within this timeframe, launches are anticipated to occur only once per year. It is noted that, due to the large spatial extent over which the launch vehicles could return, it is extremely unlikely that the receptors would be exposed to multiple impacts from the SR75 Launch Vehicle, 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 SR75 Launch Vehicle. Therefore, overall exposure of the receptors to the effect is low.

6.9.15 Any impact is likely to be small and within the range of natural variation in the marine environment. However, 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 not expected to be measurable above the present baseline, and for biodiversity it is anticipated that potential effects will not affect the baseline. The magnitude of the impact is therefore low.

6.9.16 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 Water Quality and Sediment and Ecological Receptors from Returning Components and Microplastics (Including Ingestion)

6.9.17 As detailed in Table 6.6 and Table 6.8 above, there is the potential for plastic to enter the marine environment. However, components containing plastics will be recovered within 12 hours. The nose cone and fins contain materials that may fragment upon impact (e.g. glass fibre and epoxy resin) and may subsequently be ingested by marine organisms. Fragmented glass fibre and epoxy resin from the nose cone have been considered a source of microplastics for the purposes of this assessment.

6.9.18 Plastic pollution is recognised as having the potential to negatively impact both marine organisms and habitats (Barnes *et al.*, 2009; Browne *et al.*, 2011).

6.9.19 The durable structure of most plastics results in their ability to persist in the marine environment for decades to centuries or more, particularly in deep sea and polar latitudes (Barnes *et al.*, 2009; Welden and Cowie, 2017). Polar latitudes may also act as a marine plastic “sink” due to the convergence of currents (Halsband and Herzke, 2019). Microplastics may be stored and frozen in sea ice, to later be released in high quantities into the marine environment when melting occurs (Collard and Ask, 2021, Halsband and Herzke, 2019).

6.9.20 Over time, macroplastics may decay into secondary microplastics through a variety of processes including embrittlement, cracking, reduction in mechanical properties, weathering and fragmentation (Arthur *et al.*, 2009; Mckeen, 2013; Welden and Cowie, 2017). Degradation may occur in the form of thermal degradation, chemical degradation, or photodegradation (Pourebrahimi and Pirooz, 2023, Zhang *et al.*, 2021). The rate of degradation is influenced by both the molecular structure of the macroplastic and the surrounding environment (Zhang *et al.*, 2024). The density of different macroplastics will also affect their fate in the marine environment (e.g., nylon and epoxy resin will sink, whereas polypropylene and high-density polyethylene are likely to float). This exposes the plastics to different environmental conditions, with varying degradation rates and impact receptors.

6.9.21 Macroplastics may be ingested by marine organisms, potentially leading to choking, injury, or starvation (Barnes *et al.*, 2009, Kruse *et al.*, 2023, Provencher *et al.*, 2017). Retention times after ingestion vary across and within species, however longer retention times may increase the risk of transfer of harmful chemicals (Ryan, 2016). Entanglement may cause disturbance and disruption to natural behaviours, injury, or death (Laist, 1987).

6.9.22 Microplastics are readily ingested by marine organisms either through direct ingestion or indirectly by trophic transfer from contaminated prey (Halsband and Herzke, 2019, 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). Filter-feeders, such as mussels, ingest microplastics but are unable to digest them, depositing them within their body (Kruse *et al.*, 2023). 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.

6.9.23 Studies on the biological effects of microplastics in the field are rare, and the long-term consequences are not fully understood (Botterell *et al.*, 2019). In smaller organisms, microplastic ingestion has been shown to cause detrimental physiological impacts such as reducing feeding capacity, energy reserves, reproductive output, and organ toxicity (Ali *et al.*, 2024, Nelms *et al.*, 2018). The effects on high trophic-level marine organisms are not well known, particularly with Arctic species (Halsband and Herzke, 2019). 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). However, chronic exposure is more likely to cause long-term harm through accumulation between trophic levels (Ali *et al.*, 2024, Chae and An, 2017, Galloway *et al.*, 2018).

6.9.24 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 SR75 Launch Vehicle entering the marine environment. As a result of this potential ingestion and subsequent change plankton could be noticeably affected. One potential source of some microplastics (e.g., plastic in the nose cone or fins) will be of unknown size upon entering the marine environment, though it is hypothesized that they will enter as predominantly macroplastics and will sink through the water column and then rest on the seabed. Biodiversity and water quality receptors may be exposed to increased microplastics as the nose cone breaks down on passage through the area of the water column that they 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 medium timescales (1-5 years). The sensitivity of these receptors is therefore low.

6.9.25 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 Proposed Project operations. Within this timeframe, launches are anticipated to occur up to a maximum of once per year. It is noted that there are two factors which reduce the frequency of exposure to an individual, the large spatial extent over which the SR75 Launch Vehicle could return, and that plastics only represent a minimal proportion of the materials of the nose cone. 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 nose cone. Therefore, overall exposure of the receptors to the effect is low.

6.9.26 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. The impact on water quality is expected to be measurable above the present baseline, at a highly local scale, though for biodiversity it is anticipated that potential impacts will not affect the baseline. The magnitude of the impact is therefore low.

6.9.27 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**.

6.9.28 It is noted that there are elements of uncertainty in the overall impact assessment of returning components and microplastics, particularly with regards to the assessment envelope. However, the conclusion 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. NASA (2020) assessed significantly larger launch vehicles than the SR75 Launch Vehicle associated with the Proposed Project and still concluded no likely significant effect.

Smothering of Marine Organisms, Habitat Alteration (Including Reef Effects) and Habitat Loss via Deposition of Material on the Seabed

6.9.29 The EZI is poorly understood in terms of its benthic habitats, as described in Appendix 6.1. It is likely that the most species rich group is arthropods, followed by polychaetes and molluscs. Vulnerable Marine Ecosystems (VMEs) are also present in the EZI. VMEs are sensitive to benthic pressures, though protection measures from these pressures are only applicable where they arise from fishing. Much of the Impact Dispersion Area is an MPA that has designated benthic habitat features; therefore, the benthic habitats receptor is considered to have a high value.

6.9.30 The landing of the nose cone at the seabed may directly impact benthic habitats in the EZI. The footprint of the impact will be significantly smaller than the full extent of the benthic habitat in any given area. Therefore, it is likely that the impacted zone will be recolonised, though this can happen over a long timescale. There is also the possibility that the nose cone surface could be colonised whilst intact on the seabed i.e., act like an artificial reef. However, it is unlikely that the scale of an artificial reef effect associated with the nose cone would be sufficient to alter the existing ecosystem. The sensitivity is therefore high.

6.9.31 For the purposes of this AEE an operational period of 30 years has been assumed, with a maximum of one launch per year. Although the operational phase is considered to have high longevity, the likelihood of the subsequent nose cone s impacting the same area of benthic habitat is extremely low, considering the total extent over which the SR75 Launch Vehicle could enter the marine environment. Therefore, the longevity of the impact has been reduced to low to reflect this short time period per impact.

6.9.32 Vulnerable Marine Ecosystems (VMEs) 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 any component of the SR75 Launch Vehicle is extremely small in comparison to the areas of sensitive and/or protected benthic habitats. Therefore, the spatial extent of the impact is low.

6.9.33 An overall low longevity and spatial extent result in a low exposure of benthic habitats to direct loss caused by the nose cone resting on the seabed.

6.9.34 Any potential impact to benthic habitats is likely to result in a small measurable change to the baseline in the immediate vicinity of the nose cone. 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.

6.9.35 High sensitivity, combined with low exposure and low magnitude, mean that the risk to benthic habitats from direct loss caused by the nose cone on the seabed is minor. **No likely significant effect**.

Direct Strike

6.9.36 Marine ecological receptors that have the potential to be present at, above, or just below the sea surface, concurrent with the returning components of the SR75 Launch Vehicle, 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.

6.9.37 In the nominal case, the parachutes will deploy and slow the descent of the SR75 Launch Vehicle, and therefore it is not expected that any ecological receptors (described below in Section 6.9.36), will experience serious injury or mortality from direct strike of the SR75 Launch Vehicle. There is the

potential for the nose cone to strike a receptor, however, as it does not have an associated parachute.

6.9.38 The maximum (i.e., worst-case) mass of the nose cone is anticipated to not exceed 200 kg. The Nose cone may be travelling at considerable speed at the point of entry into the marine environment. Based on other, larger launch vehicles, it is anticipated that the return speed will not exceed 1,000 m/s (The Conservation, 2016).

6.9.39 The impact of the Nose cone has the potential to cause injury and/or death to marine ecological receptors which are in the impact flightpath. The Nose cone of the SR75 Launch Vehicle may collide with species that spend time at, above, or just below, the sea's surface.

6.9.40 The ecological receptors and their specific behaviours which may lead to them being affected by a descending Nose cone 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;
- Cetacean species, which may be at or just below the water surface;
- Basking shark and sunfish, which may be at or just below the water surface; and,
- Designated seabird features of MPAs, behaving as described above.

6.9.41 Given the speed at which the Nose cone could return, it is anticipated that receptors 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.

6.9.42 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 the returning SR75 Launch Vehicle components within the EZI.

6.9.43 For the purposes of this AEE an operational period of 30 years has been assumed, with a maximum of one launch per year. Although the longevity of the operational phase of the Proposed Project is high, the frequency of the impact is low. 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 descending SR75 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.

6.9.44 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 SR75 Launch Vehicle components.

6.9.45 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.

6.9.46 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 SR75 Launch Vehicle components is negligible. **No likely significant effect**.

Acoustic Disturbance (Including Underwater Noise) from the Impact of the Jettisoned Objects Hitting the Sea Surface

6.9.47 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 the SR75 Launch Vehicle 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 SR75 Launch Vehicle when the noise occurs, therefore these are not considered further.

6.9.48 In the nominal case, the parachutes will deploy and slow the descent of the SR75 Launch Vehicle, and therefore it is not expected that the booster module impacting the sea surface will result in a large impulsive noise output. There is the potential for the Nose cone to strike a receptor, however, as it does not have an associated parachute.

6.9.49 The characteristics of the acoustic emission produced by the Nose cone hitting the water is not known. Taking into consideration the speed at which the component will be travelling (up to 1,000 m/s; The Conversation, 2016), the maximum size (1.5 m length × 0.64 m diameter), and the weight (<200 kg), it is likely that the sound will comprise a single pulse, of high intensity and short duration (impulsive). Whilst the majority of components will be slowed by parachutes, the acoustic properties of the Nose cone hitting the sea surface are expected to be 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 precautionary proxy for the sound emitted by the returning SR75 Launch Vehicle in this assessment.

6.9.50 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).

6.9.51 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.

6.9.52 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).

6.9.53 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.

6.9.54 For the purposes of this AEE an operational period of 30 years has been assumed, however there will only be a maximum of one launch per year. Although the operational phase of the Proposed Project is considered to have high longevity, the frequency of the impact is low. The returning SR75 Launch Vehicle components will create an impact zone with a radius of tens 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.

6.9.55 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 payload.

6.9.56 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 Nose cone returning would not affect the baseline nor be detectable above the natural variability. Therefore, the magnitude of effect is negligible.

6.9.57 A high sensitivity, combined with low exposure, and negligible magnitude, mean that the risk to ecological receptors (plankton, fish, marine megafauna, seabirds) in the EZI from disturbance by the returning nose cone is negligible. **No likely significant effect**.

Thermal Effects of Jettisoned Objects

6.9.58 While it is likely that any SR75 Launch Vehicle component will have associated thermal energy, any heating of the marine environment will be highly localised. 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.

6.9.59 Thermal effects are therefore considered negligible. **No likely significant effect**.

Visual Disturbance

6.9.60 Once a SR75 Launch Vehicle component has impacted the surface of the marine environment, it will likely remain at the water surface for between six and 12 hours before either recovery or (in the case of the nose cone) sinking through the water column. Whilst the component is at the surface or in the water column there is the potential for visual disturbance to marine ecological receptors. The SR75 Launch Vehicle 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 any SR75 Launch Vehicle component will be a maximum of 13 m length × 0.64 m diameter.

6.9.61 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 SR75 Launch Vehicle component 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 SR75 Launch Vehicle component would cause any impacts, therefore marine mammals are also not considered further for visual disturbance.

6.9.62 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 SR75 Launch Vehicle Component. 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 a SR75 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 a SR75 Launch Vehicle component, with an associated high degree of visibility/sightlines above relative sea level, it is anticipated that the disturbance zone for a SR75 Launch Vehicle component would be several orders of magnitude smaller than this i.e., in the tens of metres.

6.9.63 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.

6.9.64 Given the predicted noise produced by a SR75 Launch Vehicle component hitting the sea surface, there is the potential for injury to occur in individuals in the immediate vicinity (up to 227 m for the most sensitive marine mammal hearing group). At greater distances from the impact source, the effect experienced by marine mammals and fish will comprise disturbance. Zooplankton may be lethally impacted up to 1.2 km from the source. Individual marine ecological receptors are not tolerant, adaptable, or able to recover from mortality events. Seabirds are predicted to experience a disturbance effect only within tens of metres from the source, with no associated mortality. To this they are adaptable.

6.9.65 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 SR75 Launch Vehicle components within the EZI.

6.9.66 For the purposes of this AEE an operational period of 30 years has been assumed, with a maximum of one launch per year. Although the operational phase is considered to have high longevity, the frequency of the impact is moderate. The returning SR75 Launch Vehicle component will create an impact zone with a radius of tens 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.

6.9.67 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 SR75 Launch Vehicle component.

6.9.68 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 a SR75 Launch Vehicle component returning would not affect the baseline nor be detectable above the natural variability. Therefore, the magnitude of effect is negligible.

6.9.69 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 SR75 Launch Vehicle component is negligible. **No likely significant effect**.

Displacement of Fish

6.9.70 The commercial fishing activity in the EZI is described in Appendix 6.1. The EZI comprises an important area for commercial fisheries from several different nations, with primarily benthopelagic and pelagic fish targeted. As the fisheries industry in the EZI is valuable and culturally important to several countries, the receptor is considered to have a high value.

6.9.71 The landing of a SR75 Launch Vehicle component on the sea surface may indirectly impact commercial fisheries. If the SR75 Launch Vehicle 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 an adverse effect, it is possible that this impact will act as mitigation against the displacement of fishing vessels. If the landing of the SR75 Launch Vehicle 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.

6.9.72 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 SR75 Launch Vehicle component passing through. Therefore, the recoverability of fish stocks is high.

6.9.73 Despite the high value, a high tolerance, adaptability, and recoverability result in fish stocks (including priority marine features (PMFs) such as diadromous salmonids) having a low sensitivity to displacement caused by the SR75 Launch Vehicle component entering the marine environment.

6.9.74 For the purposes of this AEE an operational period of 30 years has been assumed, with a maximum of one launch per year. Although the operational phase of the Proposed Project is considered to have high longevity, the frequency of the impact is low. As such displacement to fishing stock is predicted to happen only on a short-term scale during recovery of the SR75 Launch Vehicle. Therefore, the longevity of the impact has been reduced to low to reflect this short time period per impact.

6.9.75 As evidenced by AIS data), fishing grounds in the EZI are widespread and of high spatial extent. The impact zone around a SR75 Launch Vehicle component is extremely small in comparison to the fishing grounds. Therefore, the spatial extent of the impact is low.

6.9.76 A low frequency, longevity, and spatial extent result in a low exposure of fish stocks to displacement caused by the returning SR75 Launch Vehicle component.

6.9.77 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 SR75 Launch Vehicle component is of small spatial and temporal scale, the magnitude of impact in terms of baseline and natural variability is negligible.

6.9.78 Low sensitivity, combined with low exposure and negligible magnitude, mean that the risk to fish stocks from displacement caused by the returning SR75 Launch Vehicle component is negligible. **No likely significant effect**.

Damage to Human Infrastructure (Subsea Cables/Pipelines)

6.9.79 As described in Appendix 6.1 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 EZI supply nearby countries with hydrocarbons, and so is also of significant value. Accordingly, subsea cables and pipelines in EZI as a whole has been ascribed a high value.

6.9.80 The landing of the Nose cone at the seabed may directly impact subsea cables and pipelines in the EZI. However, due to the small size and mass of the Nose cone, it is unlikely that the integrity of the cable or pipeline would be compromised, or that structural damage would occur, from the Nose cone settling on the seabed. The likelihood of this is further 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).

6.9.81 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.

6.9.82 For the purposes of this AEE an operational period of 30 years has been assumed, with a maximum of one launch per year. Although the operational phase of the Proposed Project is considered to

have high longevity, with a high combined number of launches, the likelihood of nose cones impacting the same subsea cable or pipeline is extremely low, considering the total extent over which the nose cone could enter the marine environment. Therefore, the frequency of the impact has been reduced to low to reflect this.

6.9.83 Subsea cables and pipelines are restricted in their distribution in the EZI. It is anticipated that the maximum size of the Nose cone that comes to rest on the seabed will be a maximum 1.5 m × 0.64 m, to which the footprint of the impact will be limited. The receptor will therefore be impacted over a limited spatial scale.

6.9.84 An overall low longevity and spatial extent result in a low exposure of benthic habitats to direct loss caused by the returning Nose cone.

6.9.85 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 Nose cone may return, the likelihood of the impact occurring is negligible. Therefore, the magnitude of impact is low.

6.9.86 High sensitivity, combined with low exposure and low magnitude, mean that the risk to subsea cables and pipelines from direct impact of returning nose cone is minor. **No likely significant effect**.

Interference with Military Exercise Areas

6.9.87 As described Appendix 6.1, 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.

6.9.88 Any military activity that occurs in the EZI concurrently with the return of SR75 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 SR75 Launch Vehicle component. As the return to Earth of the SR75 Launch Vehicle component is monitored, communication with vessels operating nearby will be maintained to provide updates on the location and predicted impact zone of the component.

6.9.89 If the impact zone of a SR75 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.

6.9.90 Once the SR75 Launch Vehicle component has been retrieved 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.

6.9.91 A high value, and high tolerance, adaptability, and recoverability, mean the sensitivity of military exercises within the EZI to displacement from returning SR75 Launch Vehicle component is low.

6.9.92 For the purposes of this AEE an operational period of 30 years has been assumed, with a maximum of one launch per year. Although the operational phase of the Proposed Project is considered to have high longevity, the exclusion zones will only be in place for the duration of the return of the SR75 Launch Vehicle component, 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.

6.9.93 In order to be precautionary, it is assumed that SR75 Launch Vehicle component could return anywhere within the EZI (Drawing 6.1). There is therefore the potential that the SR75 Launch Vehicle component 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 SR75 Launch Vehicle component 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.

6.9.94 A low frequency, high longevity, and low spatial extent result in a low exposure of military activity to displacement from returning SR75 Launch Vehicle components.

6.9.95 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 SR75 Launch Vehicle components is of small spatial and temporal scale, the magnitude of impact in terms of baseline and variability is negligible.

6.9.96 Low sensitivity, combined with low exposure and negligible magnitude, mean that the risk to military activities from interference arising from potential impact of SR75 Launch Vehicle components is negligible. **No likely significant effect**.

Impacts to Vessel Navigation Including Floating Returned Components, Changes to Topography and Re-routing of Vessel Traffic

6.9.97 As described in Appendix 6.1, shipping and commercial fishing activity within the EZI is relatively high. Due to this level of activity, it is possible for returning SR75 Launch Vehicle 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.

6.9.98 It is anticipated that, to ensure navigational safety, an exclusion zone will be implemented around the predicted landing position of the returning SR75 Launch Vehicle component. Most returning SR75 Launch Vehicle components will be recovered, with the exception of the Nose cone. As the return of the SR75 Launch Vehicle components are monitored, communication with vessels operating nearby will be maintained to provide updates on the location and predicted impact zone of the component.

6.9.99 If the impact zone of a SR75 Launch Vehicle component 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.

6.9.100 Once the SR75 Launch Vehicle component has entered the marine environment and been recovered (or the Nose cone has sunk to the seabed), 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.

6.9.101 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 SR75 Launch Vehicle components is low.

6.9.102 For the purposes of this AEE an operational period of 30 years has been assumed, with a maximum of one launch per year. Although the operational phase of the Proposed Project is considered to have high longevity, the exclusion zones will only be in place for the duration of the return of the SR75 Launch Vehicle components, and therefore the longevity of the impact has been reduced to moderate to reflect this short time period per launch.

6.9.103 In order to be precautionary, it is assumed that SR75 Launch Vehicle components could return anywhere within the EZI. There is therefore the potential that the SR75 Launch Vehicle 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 SR75 Launch Vehicle 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.

6.9.104 A low frequency, moderate longevity, and low spatial extent result in a low exposure of shipping and commercial fishing activity to displacement from the returning SR75 Launch Vehicle component.

6.9.105 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 the returning SR75 Launch Vehicle component is predicted to be of small spatial and temporal scale, the magnitude of impact in terms of baseline and variability is negligible.

6.9.106 Low sensitivity, combined with low exposure and negligible magnitude, mean that the risk to shipping and commercial fishing activities from returning SR75 Launch Vehicle components is negligible. **No likely significant effect**.

Damage to Marine Archaeology/Shipwrecks

6.9.107 As described in Appendix 6.1, 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.

6.9.108 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.

6.9.109 The landing of the Nose cone at the seabed may directly impact marine archaeological features in the EZI. If the Nose cone 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.

6.9.110 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.

6.9.111 For the purposes of this AEE an operational period of 30 years has been assumed, with a maximum of one launch per year. Although the operational phase of the Proposed Project is considered to have high longevity, the likelihood of the Nose cone impacting the same marine archaeological features is negligible considering the total extent over which the Nose cone could enter the marine environment. Therefore, the frequency of the impact has been reduced to low to reflect this.

6.9.112 It is anticipated that the maximum size of the Nose cone that comes to rest on the seabed will be a maximum 1.5 m × 0.64 m, to which the footprint of the impact will be limited. The Nose cone is 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 Nose cone footprint. As such, the receptor will therefore be impacted over a limited spatial scale.

6.9.113 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 nose cone will not be monitored. In addition, it is noted that, considering the small footprint of the impact, and the total area over which the nose cone may return, the likelihood of the impact occurring is extremely low. Therefore, the magnitude of impact is low.

6.9.114 High sensitivity, combined with low exposure and low magnitude, mean that the risk to marine archaeological features from direct impact of the nose cone is minor. **No likely significant effect**.

Accidental Aeronautical Events - Failure During Flight

6.9.115 Chapter 7 (Accidents and Disasters) of this AEE considers major accidents that could occur during the project life cycle, in terms of those with serious effects on the environment. One such event would be an off-nominal flight failure resulting in impact of the SR75 Launch Vehicle with the marine environment. The predicted magnitude of effects for this type of accidental aeronautical event are not considered 'major', therefore an assessment of the effects of failure during flight has been considered in this chapter, rather than Chapter 7.

6.9.116 There is the potential for failure of the launch vehicle during flight. The worst-case scenario would be the loss of the entire SR75 Launch Vehicle before any of the routine separation phases, as this would lead to the maximum quantity of material potentially entering the marine environment at a single location, i.e., impact zone.

6.9.117 Due to northerly trajectory, the SR75 Launch Vehicle does not pass over land once it has left SaxaVord Spaceport, therefore it is assumed that any failure during would result in the SR75 Launch Vehicle entering the marine environment rather than coming down over land. The receiving marine environment of any flight failures is described in Appendix 6.1.

6.9.118 A summary of the approximate parameters associated with the SR75 Launch Vehicle is provided in Table 6.6. The worst-case scenario is to assume that the SR75 Launch Vehicle parts do not separate and that no parachutes deploy, resulting in the launch vehicle entering the marine environment whole. As recovery procedures will be in place and due to the 6 - 12 hour calculated buoyancy window, under this scenario it is likely that the launch vehicle would be recovered, resulting in a lower total input of material into the marine environment. However, as a precautionary measure, the potential for no recovery has also been assessed as a worst-case scenario.

6.9.119 Under this worst-case scenario, the impacts predicted to be greater than the nominal case are:

- effects on water and sediment quality and ecological receptors from fuel/propellent spillage,
- effects on water and sediment quality and ecological receptors from metal corrosion and toxic contamination,
- effects on water quality and sediment and ecological receptors from returning components and microplastics (including ingestion), and,
- smothering of marine organisms, habitat alteration (including reef effects) and habitat loss via deposition of material on the seabed.

6.9.120 All other impacts are covered under the precautionary approach taken in the assessment of the nominal case, that assumes that individual marine ecological receptors are not tolerant, adaptable, or able to recover from mortality events.

6.9.121 Under the flight termination scenario there is the potential for input of a non-empty fuel tank (and thus larger quantity of propellant than under the nominal case) into the marine environment. However, the boiling point of the liquid oxygen propellant is -183°C and is therefore predicted to evaporate upon any entry to the marine environment. The assessment and conclusions for effects on water and sediment quality and ecological receptors from fuel/propellent spillage are therefore consistent with the nominal assessment.

6.9.122 There is the potential for input of a greater variety of metals and other components in the scenario of input of the intact SR75 Launch Vehicle. 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 seals, fish, and birds was several orders of magnitude lower than in plankton, 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. 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.

6.9.123 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 input of the SR75 Launch Vehicle components would increase aluminium concentration to levels where a toxic effect occurred.

6.9.124 Copper (Cu) is present in the marine environment naturally and via anthropogenic sources at a mean concentration of 145 ng/kg (ppt) (Rauch and Graedel, 2007), however this varies greatly by region, and is elevated in coastal areas influenced by anthropogenic activities (Leal *et al.*, 2018). 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 is 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).

6.9.125 Copper is an essential nutrient in the marine environment (Stern, 2010); hence it is typically present in high concentrations in all marine life across all trophic levels and does not bioaccumulate (Campbell *et al.*, 2005). Many organisms produce organic ligands that bind copper to reduce its free ionic form (Cu^{2+}) and reduce its toxicity (Sueur *et al.*, 1982; Gledhill *et al.*, 1999). 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 major coastal anthropogenic inputs. Copper alloys also present in the launch vehicle (e.g. brass and bronze), are similarly unlikely to result in significant impacts to marine life (Sclodnick *et al.*, 2020), and have no added toxicity above that of the pure metals (Earley *et al.*, 2020). With several years of degradation these metals may act as a substrate for marine life (MacLeod, 1982). 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.

6.9.126 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. Biodiversity receptors will be exposed to increased contaminants as the SR75 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.

6.9.127 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. However, it is extremely unlikely that the receptors would be exposed more than once, 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 Launch Vehicle components. Therefore, overall exposure of the receptors to the effect is low. 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.

6.9.128 Under the scenario of failure during flight and non-recovery, the input of the parachutes and associated rigging has the potential to contribute to effects on water quality and sediment and ecological receptors from returning components and microplastics (including ingestion), and smothering of marine organisms, habitat alteration (including reef effects) and habitat loss via deposition of material on the seabed. The input of these components could lead to increased microplastic deposition, as well as increased risk of ingestion, entanglement, and/or smothering of marine organisms leading to mortality or mortal injury. Furthermore, these components are expected to persist within the marine environment for extended periods of time. However, as there are only 30 planned flights over the duration of the current spaceport licence, and as the input of this component depends first on occurrence of failure during flight, then subsequently of failure to recover the components, the likelihood of input is considered to be very low. Additionally, there is a strong potential for the plastic components to remain within the SR75 Launch Vehicle under this scenario, greatly reducing their potential for adverse effects on marine life.

6.9.129 Therefore, the assessment and conclusions for the impact and non-recovery from the intact SR75 Launch Vehicle are consistent with the nominal assessment. A high ecological and cultural value, combined with no tolerance, adaptability, and recoverability, results in the aforementioned ecological receptors having a high sensitivity to failure during flight of the intact SR75 Launch Vehicle within the EZI.

6.9.130 However, for the purposes of this AEE an operational period of 30 years has been assumed, with a maximum of one launch per year. Furthermore, as this is an off-nominal scenario with multiple failures considered, it is considered to be highly unlikely to occur. Although the operational phase is considered to have high longevity, the frequency of the impact is low. The spatial extent of the impact zones is low when compared to the total available habitat within the EZI for these marine ecological receptors. A low frequency and spatial extent, combined with a high longevity, result in a moderate exposure of ecological receptors to direct strike and/or acoustic disturbance from the intact SR75 Launch Vehicle. Therefore, there is predicted to be minor risk to the environment as a result of Direct Strike or Acoustic Disturbance due to SR75 Launch Vehicle flight failure. **No likely significant effect**.

6.9.131 An increase in plastics and debris is likely to be slightly above the range of natural variation in the marine environment. This is considered a precautionary estimate as there is minimal information on natural variation within the impact area. The impact on marine receptors is expected to be measurable above the present baseline, at a highly local scale, though for biodiversity it is anticipated that potential impacts will not affect the baseline. The magnitude of the impact is therefore low.

6.9.132 High sensitivity, combined with low exposure and low magnitude, means that the risk to these receptors due to SR75 Launch Vehicle flight failure is low, which is equivalent to minor risk. **No likely significant effect**.

6.10 Additional Mitigation

6.10.1 No additional mitigation has been proposed to mitigate the effects from the aforementioned pathways.

6.11 Residual Effects

Effects on Water and Sediment Quality and, Ecological Receptors from Fuel Spillage

6.11.1 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 Water and Sediment Quality, and Ecological Receptors from Metal Corrosion and Toxic Contamination

6.11.2 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 Water and Sediment Quality, and Ecological Receptors from Returning Components and Microplastics (Including Ingestion)

6.11.3 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

6.11.4 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

6.11.5 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

6.11.6 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**.

Toxic Contaminants from Jettisoned Objects

6.11.7 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**.

Thermal Effects from Jettisoned Objects

6.11.8 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**.

Visual Disturbance

6.11.9 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**.

Displacement of Fish

6.11.10 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)

6.11.11 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

6.11.12 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**.

Impacts to Vessel Navigation Including Floating Returned Components, Changes to Topography and Re-routing of Vessel Traffic

6.11.13 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

6.11.14 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**.

Accidental Aeronautical Events - Failure during Flight

6.11.15 As stated above, no additional mitigation is required to mitigate this impact. The likelihood of an accidental aeronautical event is extremely low due to the embedded safety procedures, and any effects will also be mitigated through the standard mitigation (detailed in Section 6.8). The residual risk of the impact pathway is minor. **No likely significant effect**.

6.12 Cumulative Assessment

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

6.12.2 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. 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.

6.12.3 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. Although there is no significant interaction between environmental disciplines that could generate intra-project effects in the marine and transboundary assessment, it is acknowledged that multiple launches through time may give rise to additive effects (e.g., multiple landings in the same location). The potential for such additive interactions has already been discussed in this chapter and as such is not repeated in this section.

Identification of Projects and Plans

6.12.4 The key sources utilised to provide a long list of reasonably foreseeable plans and projects are:

- 4C Offshore Global Offshore Wind Map;
- Scotwind Leasing Round;
- 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.

6.12.5 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 6.10 below.

Plans and projects have been identified for offshore wind, marine renewables, oil and gas, and subsea cables. With regard to the sectors of military, recreation and tourism, and disposal sites, no proposed plans or projects have been identified.

6.12.6 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 study areas, 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.

6.12.7 Table 6.10 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 6.10 All reasonably foreseeable plans and projects

Plan/Project	Description	Location	Stage	Source
Sutherland Spaceport	The Sutherland Spaceport is being developed by Highlands and Islands Enterprise (HIE) in northern Scotland. Vertical launches from this site will overlap with the EZI for SaxaVord.	A' Mhòine, northern Scotland. EZI of spaceport overlaps with SaxaVord EZI	Pre-construction	The Highland Council (2023)
Hywind Tampen Floating Offshore Wind Farm	The Hywind Tampen is being developed by Equinor ASA in Norwegian waters and became operational in August 2023. The windfarm capacity is 88 MW and it comprises 11 floating turbines.	Norway, adjacent to the south-east corner of the EZI	Commissioning / early operation	4COffshore (2020) and Equinor (2024)
Celtic Norse Subsea Cable	The Celtic Norse cable is due for completion in 2025. 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. 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)

Plan/Project	Description	Location	Stage	Source
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)
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)
ScotWind 2019 Leasing Site: NE1	A total of 16 potential leasing sites have been identified around the coasts of Scotland, including a 775.6 km^2 Draft Plan Option site located southeast of the Shetland Islands (NE1). The leasing round aims to increase Scotland's offshore wind capacity by 8-10 GW to 15-17 GB by 2030. Many of the sites are in water depths exceeding 60 m and therefore are likely to appeal to floating offshore wind projects. Any development within the NE1 site will be required to consider cumulative effects with the Shetland Space Centre project.	South-east of the EZI	Pre-application	Marine Scotland (2020); Offshore Wind Scotland (2020)
Shetland Tidal Array extension	The Shetland Tidal Array, developed by Nova Innovation Ltd, was installed in March 2016-August 2017 was the first tidal array in Scotland. Nova Innovation Ltd aim to expand the current three turbine generators to six under the European Union's Enabling Future Arrays in Tidal project. The project is already in operation and has been considered in the baseline, however the expansion is currently pre-construction, having been approved by the European Commission and granted the lease by Crown Estate Scotland.	Bluemull Sound, south-west of the centre of the EZI	Pre-construction	Nova Innovation Ltd (2018a-b; 2020)

Table 6.11 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
Sutherland Spaceport	✓	✓	✓	✓	✓	✓
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	✓	✓	✓	✓	✓	×
Faroese Licensing Round for Oil and Gas	✓	✓	✓	✓	✓	×
Jan Mayen oil exploration	✓	✓	✓	✓	✓	×
Faroe Islands marine renewable energy	×	✓	×	✓	✓	×
ScotWind 2019 Leasing Site: NE1	×	✓	×	✓	✓	×
Shetland Tidal Array extension	×	✓	×	✓	✓	✓

Methodology

6.12.8 The potential cumulative effects of the plans and projects listed in Table 6.10 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.

6.12.9 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.

6.12.10 The assessment of cumulative effects between the project and the associated study areas 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

6.12.11 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 6.4) 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

6.12.12 Section 6.9 provides a risk assessment of the potential impacts from the Proposed Project, including those on the water quality environment. The potential effects on water quality are the increase in hydrocarbons from fuel spills, metal from corrosion, and microplastics.

6.12.13 With the exception of Sutherland Spaceport, the projects and plans detailed in Table 6.11 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. While Sutherland Spaceport will be constructed on land, the input of discarded components from launch vehicle launches will have effects on water quality in the EZI. 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. 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**.

6.12.14 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**.

6.12.15 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

6.12.16 The potential effects on biodiversity receptors are the increase in contaminants (hydrocarbons, metal, microplastic), direct strike from launch vehicle components, disturbance and displacement from launch vehicle components, payloads and vessels, and direct loss of seabed habitat.

6.12.17 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**.

6.12.18 The other projects and plans that also have the potential to result in direct strike of marine ecological receptors are tidal arrays and impacts from launch vehicle components associated with Sutherland Spaceport. 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 study areas would comprises such a large array of turbines. Launches from SaxaVord Spaceport and Sutherland Spaceport will not occur at the same time, therefore there is no pathway for combined effects of direct strike for these projects. The subsequent low number of affected individuals is anticipated to comprise a negligible proportion of the marine ecological receptor populations in the study areas. 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**.

6.12.19 The projects and plans detailed in Table 6.10 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 a returning launch vehicle or payload, due to the safety issue of being nearby a returning launch vehicle or payload. Therefore, the area of displacement is unlikely to increase due to two potential sources of effects within a single disturbance zone. There is the potential that the disturbance zones around projects in the study areas 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 study areas, this is determined to have negligible risk at the population-level. **No likely significant effect**.

6.12.20 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 6.10 above will have a limited seabed footprint as they comprise 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

6.12.21 The potential effects on humans and human activities are direct impact from launch vehicle components at the seabed and disturbance and displacement from launch vehicle components, payloads and vessels.

6.12.22 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 6.10 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 6.10 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.

6.12.23 The human and human activities in the study areas that utilise vessels have the potential to be affected via disturbance. Disturbance from the Proposed Project can arise during the return of SR75 Launch Vehicle components. It is anticipated that an exclusion zone will be implemented around returning launch items, 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**.

Conclusion

6.12.24 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**.

6.13 Summary

6.13.1 This chapter considers the marine and transboundary effects from the proposed operations at the Proposed Project. Effects on the marine environment may arise from the return of SR75 Launch Vehicle components to earth. Such marine effects may occur in Scottish waters or in the waters of other countries (i.e., transboundary effects), specifically Denmark (Faroe Islands) and Norway.

6.13.2 For the purposes of this AEE, the EZI is based on the proposed sub-orbital launch flight corridors (based on azimuths of 000°) and corresponding launch areas of the SR75 Launch Vehicle. The impact dispersion area is a circle contained within the larger area demarcated as the SR75 Environmental Zone of Influence (EZI), as presented in Drawing 6.1.

6.13.3 The EZI comprises mostly deep water with a small amount of continental shelf and many bathymetric features. The water quality of these study areas is high, in that they do not have significant local input of anthropogenic contaminants such as metals, microplastics, and hydrocarbons. The study areas support numerous marine biota such as plankton, benthic habitats, fish and shellfish, seabirds, and marine mammals. The EZI has few marine protected areas (Drawing 6.2).

6.13.4 In the EZI, human activities are concentrated in the southern portion (close to the coast). This includes shipping and navigation, oil and gas cables and pipelines, and commercial fishing (Drawing 6.3). There is occasional use of the area for military activities. Marine archaeology is poorly known and so assumed to be present. Presence of oil and gas infrastructure, subsea cables and pipelines, marine renewable energy, dredge disposal sites, tourism, and marine archaeological features is shown on Drawings 6.3 – 6.5.

6.13.5 Several standard operating procedures are included as part of the project design which reduce the risk to human receptors from the proposed operations. It is anticipated that an exclusion zone will be implemented around the precited returning SR75 Launch Vehicle component impact zones. Communications to other maritime users of the location of SR75 Launch Vehicle component impact zones will comprise Notice to Mariners, NAVTEX warnings and Sécurité messages.

6.13.6 SR75 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 SR75 Launch Vehicle components and associated materials, such as metals, microplastics, and hydrocarbons; impacts from direct strike; impacts from disturbance/displacement associated with presence of the component and associated exclusion zones; and impact at the seabed from when the cone comes to rest.

6.13.7 The potential impacts on water quality, biodiversity (including Priority Marine Features), and human activities in the study areas have been assessed. All pathways have a negligible or minor risk of a likely significant effect on the receptors. **No likely significant effect**.

6.13.8 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**.

6.14 References

4C Offshore (2020). *Global Offshore Wind Map.* Available at: https://www.4coffshore.com/offshorewind/. Accessed July 2024.

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.

Air Products (2015). *Liquid oxygen*. Available at: http://www.airproducts.com/~/media/Files/PDF/company/safetygram-6.pdf. Accessed July 2024.

Aiken, J., Bruce, R.H., and Lindley, J.A. (1977). *Ecological Investigations with the Undulating Oceanographic Recorder: The Hydrography and Plankton of the Waters Adjacent to the Orkney and Shetland Islands.* Marine Biology, 39: pp.77-91.

Albores-Barajas, Y.V., Soldatini, C., Ramos-Rodríguez, A., Alcala-Santoyo, J.E., Carmona, R., and Dell'Omo, G. (2018). *A new use of technology to solve an old problem: Estimating the population size of a burrow nesting seabird.* PLoS ONE, 13: p.e0202094.

Alfonso-Dias, I.P., and Hislop, J.R.G. (1996). *The reproduction of anglerfish* Lophius piscatorius *Linnaeus from the north-west coast of Scotland.* Journal of Fish Biology, 49 (Supplement A): pp.18-39.

Ali, S.S., Elsamahy, T., Al-Tohamy, R. and Sun, J., (2024). *A critical review of microplastics in aquatic ecosystems: Degradation mechanisms and removing strategies*. Environmental Science and Ecotechnology, p.100427.

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.

Arthur, C., Baker, J. and Bamford, H., (2009). *Proceedings of the international research workshop on the occurrence, effects, and fate of microplastic marine debris*. September 9-11, 2008.

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.

Barnes, D.K., Galgani, F., Thompson, R.C. and Barlaz, M., (2009). *Accumulation and fragmentation of plastic debris in global environments*. Philosophical transactions of the royal society B: biological sciences, 364(1526), pp.1985-1998.

Barton, C., and Pollock, C. (2004). Review of divers, grebes and seaduck distribution and abundance in the SEA 5 area. Report to the DTI as part of SEA 5. Greystones, Cork, Republic of Ireland.

Bailey, M.C., Maravelias, C.D., and Simmonds, E.J. (1998). *Changes in the spatial distribution of autumn spawning herring (*Clupea harengus *L.) derived from annual acoustic surveys during the period 1984-1996.* ICES Journal of Marine Science, 55: pp.545-555.

Barr, J.R., Green, M.C., DeMaso, S.J., and Hardy, T.B. (2020). *Drone Surveys Do Not Increase Colony-wide Flight Behaviour at Waterbird Nesting Sites, But Sensitivity Varies Among Species.* Scientific Reports, 10: pp.1-10.

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.

Barreto, E., and Bailey, N. (2015). *Fish and Shellfish Stocks: 2015 Edition.* Marine Scotland, Edinburgh. Available at: https://www.gov.scot/publications/fish-shellfish-stocks-2015-edition/. Accessed July 2024.

Barton, J. (2018). *SHETLAND'S LITTORAL ZONES: An Art-Science Project Revealing the Legacies of Plastic Pollution on Beaches in the North of Scotland.* In Jokela, T., and Coutts, G. (Eds) Relate North: Practising Place, Heritage, Art & Design for Creative Communities, University of Lapland, Finland. pp.150-163. Available at: https://lauda.ulapland.fi/bitstream/handle/10024/63228/RN_2017_2_edition_Lapland%20University%20Press.pdf?sequence=1#page=151. Accessed July 2024.

BBC News (2018). *Braer: The huge oil spill that Shetland survived.* Available at: https://www.bbc.co.uk/news/uk-scotland-42577914. Accessed July 2024.

Bergstad, O.A., Høines, Å.S., and Jørgensen, T. (2002). *Growth of sandeel,* Ammodytes marinus*, in the northern North Sea and Norwegian coastal waters.* Fisheries Research, 56: pp.9-23.

BOEM (2014). *Atlantic OCS Proposed Geological and Geophysical Activites; Mid-Atlantic and South Atlantic Planning Areas Final Programmatic Environmental Impact Statement Volume III: Appendices B-M.* U.S. Department of the Interior Bureau of Ocean Energy Management Gulf of Mexico OCS Region, New Orleans, USA.

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.

Brisson-Curadeau, É., Bird, D., Burke, C., Fifield, D.A., Pace, P., Sherley, R.B., and Elliott, K.H. (2017). *Seabird species vary in behavioural response to drone census.* Scientific Reports, 7: pp.1-9.

Browne, M.A., Crump, P., Niven, S.J., Teuten, E., Tonkin, A., Galloway, T. and Thompson, R., (2011). *Accumulation of microplastic on shorelines worldwide: sources and sinks*. Environmental science & technology, 45(21), pp.9175-9179.

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.

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.

Canmore (2020a). *Hms/m* E49*: Balta Sound, Unst, North Sea.* Available at: https://canmore.org.uk/site/102956/hmsm-e49-balta-sound-unst-north-sea. Accessed July 2024.

Canmore (2020b). Wrangles Palais*: Bound Skerry, Out Skerries*. Available at: https://canmore.org.uk/site/71037/wrangels-palais-bound-skerry-out-skerries. Accessed July 2024.

Canmore (2020c). Kennermerland*: Stoura Stack, Out Skerries*. Available at: https://canmore.org.uk/site/1401/kennemerland-stoura-stack-out-skerries. Accessed on July 2024.

Capper, A., Tait, C., Layfield-Caroll, R., Bell, M., Hartl, M.G.J., and Henry, T.B. (2018). *Microplastic Monitoring in the Orkney Islands, Scotland.* MASTS: Annual Science Meeting 31 October-2 November 2018.

Carey, M.J. (2009). *The effects of investigator disturbance on procellariform seabirds: A review.* New Zealand Journal of Zoology, 36: pp.367-377.

Checkley, D.M.J. (1982). *Selective Feeding by Atlantic Herring (*Clupea harengus*) Larvae on Zooplankton on Natural Assemblages.* Marine Ecology Progress Series, 9: pp.245-253.

Chae, Y. and An, Y.J., (2017). *Effects of micro-and nanoplastics on aquatic ecosystems: Current research trends and perspectives*. Marine pollution bulletin, 124(2), pp.624-632.

Chen, F., Shapiro, G.I., Bennett, K.A., Ingram, S.N., Thompson, D., Vincent, C., Russell, D.J., and Embling, C.B. (2017). *Shipping noise in a dynamic sea: a case study of grey seals in the Celtic Sea.* Marine Pollution Bulletin, 114: pp.372-383.

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 on July 2024.

Collard, F. and Ask, A., (2021). *Plastic ingestion by Arctic fauna: a review*. Science of the Total Environment, 786, p.147462.

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.

DW (2018). *What is NATO's Trident Juncture 2018 operation?* Available at: https://www.dw.com/en/what-is-natos-trident-juncture-2018-operation/a-46037061. Accessed on July 2024.

EC (2020). *Names of Sub-areas and Divisions of DAE Fishing areas 27 and 37.* Available at: https://ec.europa.eu/fisheries/sites/fisheries/files/docs/body/fishing_areas_en.pdf. Accessed on July 2024.

Eleftheriou, A. (2003). *Synthesis of information on the shallow benthos of the SEA 4 area.* Report to the Department of Trade and Industry. 42pp.

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 July 2024.

EMODnet (2020). *Geoviewer.* Available at: https://www.emodnet.eu/geoviewer/#!/. Accessed on July 2024.

EMU Ltd (2012). *South Coast Marine Aggregate Regional Environmental Assessment, Volume 1 and 2.* Report for the South Coast Dredging Association. Version 2. Report No. J/1/06/1870.

Eriksen, M., Lebreton, L.C.M., Carson, H.S., Thiel, M., Moore, C.J., Borerro, J.C., Galgani, F., Ryan, P.G., and Reisser, J. (2014). *Plastic Pollution in the World's Oceans: More than 5 Trillion Plastic Pieces Weighing over 250,000 Tons Afloat at Sea.* PLoS ONE, 9: p.e111910.

ESCA and Seafish (2019). *KIS-ORCA Interactive Subsea Cables Map*. Available at: https://kis-orca.org/subsea-cables/. Accessed on July 2024.

ESGOSS (1994). *The environmental impact of the wreck of the* Braer. The Scottish Office, Edinburgh. ISBN: 0 7480 0900 0.

Evans, P.G.H., Weir, C.R., and Nice, H.E. (1990). *Temporal and spatial distribution of harbour porpoises in Shetland waters, 1990-95.* European Research on Cetaceans - 10: Proceedings of the tenth Annual Conference of the European Cetacean Society, Lisbon, Portugal, 1996: pp.234-237.

Ewins, P.J. (1990). *The diet of black guillemots* Cepphus grylle *in Shetland.* Ecography, 13: pp.90-97.

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 July 2024.

FAO (2020b). *Handling and Processing Blue Whiting.* Available at: http://www.fao.org/3/x5952e/x5952e00.htm#Contents. Accessed on July 2024.

FIRMS (2009). *Northeast Atlantic NEAFC high seas fisheries.* Available at: http://firms.fao.org/firms/fishery/479/156951/en. Accessed July 2024.

FishSource (2019). *FishSource Profiles.* Available at: https://www.fishsource.org/about. Accessed on July 2024.

Fish Farming Expert (Shetland). *Shetland*. Available at: https://www.fishfarmingexpert.com/article/shetland/#:~:text=The%20main%20salmon%20producers%20on,active%20at%20any%20one%20time.. Accessed on July 2024.

Fliessbach, K.L., Borkenhagen, K., Guse, N., Markones, N., Schwemmer, P., and Garthe, S. (2019). *A Ship Traffic Disturbance Vulnerability Index for Northwest European Seabirds as a Tool for Marine Spatial Planning.* Frontiers in Marine Science, 6: pp.129.

Frederiksen, M., Edwards, M., Richardson, A.J., Halliday, N.C., Wanless, S. (2006). *From plankton to top predators: bottom-up control of a marine food web across four trophic levels.* Journal of Animal Ecology, 75: pp.1259-1268.

Frederiksen, M., Moe, B., Daunt, F., Phillips, R. A., Barrett, R. T., Bogdanova, M. I, Boulinier, T., Chardine, J.W., Chastel, O., Chivers, L.S., Christenson-Dalsgaard, S., Clement-Chastel, C., Colhoun, K., Freeman, R., Haston, A.J., Gonzalaz-Solis, J., Goutte, A., Gremillet, D., Guilford, T., Jensen, G.H., Krasnov, Y., Lorentsen, S-H., Mallory, M.L., Newell, M., Olsen, B., Shaw, D., Steen, H., Strom, H., Systad, G.H., Thorarinsson, T.L., and Anker-Nilssen, T. (2012). *Multicolony tracking reveals the winter distribution of a pelagic seabird on an ocean basin scale.* Diversity and distributions, 18(6): pp.530-542.

Frischmuth, R.W. (1966). *Investigation of thin films as floating liners for fiber-glass cryogenic propellant tanks.* NASA technical note. Available at: https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19660005418.pdf. Accessed July 2024.

Furness, R.W., and Todd, C.M. (1984). *Diets and feeding of Fulmars* Fulmarus glacialis *during the breeding season: a comparison between St Kilda and Shetland colonies.* IBIS, 126: pp.379-387.

Gabrielson, G.W., and Strøm, H. (2004). *Seabird Research and Monitoring on Jan Mayen.* Jan Mayen Island Scientific Focus, pp.181-194.

Galloway, T.S., Cole, M. and Lewis, C., (2017). *Interactions of microplastic debris throughout the marine ecosystem*. Nature ecology & evolution, 1(5), p.0116.

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 July 2024.

Gledhill, M., Nimmo, M., Hill, S. J. and Brown, M. T. (1999). The Release of Copper-Complexing Ligands by the Brown Alga Fucus Vesiculosus (Phaeophyceae) in Response to Increasing Total Copper Levels. Journal of Phycology, 35: pp. 501-509.

González-Irusta, J.M., and Wright, P.J. (2016). *Spawning grounds of Atlantic cod (*Gadus morhua*) in the North Sea.* ICES Journal of Marine Science, 73: pp.304-315.

Grafix Plastics (2020). *What is Mylar Plastic Film?* Available at: https://www.grafixplastics.com/grafix-plastics/plastic-film-plastic-sheet-faq/mylar_what/. Accessed July 2024.

Halsband, C. and Herzke, D., (2019). *Plastic litter in the European Arctic: what do we know?*. Emerging Contaminants, 5, pp.308-318.

Hammond, P.S., Lacey, C., Gilles, A., Viquerat, S., Börjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M.B., Scheidat, M., Teilmann, J., Vingada, J., and Øien, N. (2017). *Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys.* Available at: https://scans3.wp.st-andrews.ac.uk/files/2021/06/SCANS-III_design-based_estimates_final_report_revised_June_2021.pdf. Accessed July 2024.

Hann, S., Jamieson, O., Thomson, A., and Sherrington, C. *Understanding Microplastics in the Scottish Environment: The sources, fate and environmental impact of microplastic in the Scottish terrestrial, freshwater and marine environment.* Eunomia Research & Consulting Ltd, Bristol. 148pp. Available at: https://eunomia.eco/reports/understanding-microplastics-in-the-scottish-environment/. Accessed on July 2024.

Hansen, B., and Jákupsstovu, S.H.í. (1992). *Availability of blue whiting (*Micromesistius poutassou*) in Faroese waters in relation to hydrography.* ICES Marine Science Symposia, 195: pp.349-360.

Hátún, H., Payne, M.R., and Jacobsen, J.A. (2009). *The North Atlantic subpolar gyre regulates the spawning distribution of blue whiting (*Micromesistius poutassou*).* Canadian Journal of Fisheries and Aquatic Sciences, 66: pp.759-770.

Hayes, H., Godley, B.J., Nimak-Wood, M., and Witt, M.J., 2018. *Basking shark breaching behaviour observations west of Shetland.* Marine Biodiversity Records, 11: 17.

Hedger, R., McKenzie, E., Heath, M., Wright, P., Scott, B., Gallego, A., and Andrews, J. (2004). *Analysis of the spatial distributions of mature cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) abundance in the North Sea (1980-1999) using generalised additive models.* Fisheries Research, 70: pp.17-25.

Heinis, F., De Jong, C., Ainslie, M., Borst, W., and Vellinga, T. (2013). *Monitoring programme for the Maascvlakte 2 Part III: The effects of underwater sound.* Terra et Aqua, 132: 12pp.

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.

Howson, C. (1999). *Marine Nature Conservation Review. Sector I. Shetland Area Summaries.* Joint Nature Conservation Committee, Peterborough.

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 July 2024.

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 July 2024..

ICES (2020). *Dataset Collections: Catch Statistics*. Available at: https://www.ices.dk/data/dataset-collections/Pages/Fish-catch-and-stock-assessment.aspx. Accessed July 2024.

Ioakeimidis, C., Fotopoulou, K.N., Karapanaguiti, H.K., Geraga, M., Zeri, C., Papthanassiou, E., Galgani F., and Papatheodorou, G. (2016). *The degradation potential of PET bottles in the marine environment: An ATR-FTIR based approach.* Scientific Reports, 6: 23501.

Jakobsson, J., and Stefánsson, G. (1999). *Management of summer-spawning herring off Iceland.* ICES Journal of Marine Science, 56(6): pp.827-833.

Jansen, T., Campbell, A., Kelly, C., Hátún, H., and Payne, M.R. (2012). *Migration and Fisheries of North East Atlantic Mackerel (*Scomber scombrus*) in Autumn and Winter.* PLoS ONE, 7: p.e51541.

Jardfeingi (2019). *5th Licensing Round*. Available at: http://jf.fo/en/olju-og-gassleiting/undanfarnu-utbjodingarumfor/5-utbjodingarumfar/. Accessed July 2024.

JNCC (2020a). *MPA Mapper*. Available at: https://jncc.gov.uk/mpa-mapper/. Accessed July 2024.

JNCC (2020b). *Pobie Bank Reef Special Area of Conservation (SAC).* Available at: https://sac.jncc.gov.uk/site/UK0030385. Accessed July 2024.

JNCC (2020c). *Faroe-Shetland Sponge Belt MPA.* Available at: https://jncc.gov.uk/our-work/faroe-shetland-sponge-belt-mpa/#site. Accessed July 2024.

JNCC (2020d). Black guillemot (*Cepphus grylle*). Available online at: https://jncc.gov.uk/our-work/black-guillemot-cepphus-grylle/. Accessed July 2024.

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.

Kastelein, R.A., Wensveen, P., Hoek, L., and Terhune, J.M. (2009). *Underwater hearing sensitivity of harbour seals (*Phoca vitulina*) for narrow noise bands between 0.2 and 80 kHz.* The Journal of the Acoustical Society of America, 126: pp.476-483.

Kober, K., Webb, A., Win, I., Lewis, M., O'Brien, S., Wilson, L., and Reid, J. (2010). An analysis of the numbers and distribution of seabirds within the British Fisheries Limit aimed at identifying areas that qualify as possible marine SPAs. JNCC Report No. 431. JNCC, Peterborough, UK.

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.

Kruse, K., Knickmeier, K., Brennecke, D., Unger, B. and Siebert, U., (2023). *Plastic debris and its impacts on marine mammals*. In Marine mammals: a deep dive into the world of science (pp. 49-62). Cham: Springer International Publishing.

Laurenson, C.H., Johnson, A., and Priede, I.G. (2005). *Movements and growth of monkfish* Lophius piscatorius *tagged at the Shetland Islands, northeastern Atlantic.* Fisheries Research, 71: pp.185-195.

Leal, P.P., Hurd, C.L., Sander, S.G., Armstrong, E., Fernández, P.A., Suhrhoff, T.J. and Roleda, M.Y., (2018). *Copper pollution exacerbates the effects of ocean acidification and warming on kelp microscopic early life stages*. Scientific Reports, 8(1), p.14763.

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 July 2024.

Lorenz, C., Roscher, L., Meyer, M.S., Hildebrandt, L., Prume, J., Löder, M.G.J., Primpke, S., and Gerdts, G. (2019). *Spatial distribution of microplastics in sediments and surface waters of the southern North Sea.* Environmental Pollution, 252: pp.1719-1729.

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 July 2024.

Marine Scotland (2020). *National Marine Plan Interactive*. Available at: https://marinescotland.atkinsgeospatial.com/nmpi/default.aspx. Accessed July 2024.

Marine Vessel Traffic (2020). *Vessel cruise finder*. Available at: https://www.marinevesseltraffic.com/2013/06/vessel-cruise-finder.html. Accessed July 2024.

Martin, A.R. (1989). *The diet of Atlantic Puffin* Fratercula arctica *and Northern Gannet* Sula bassana *chicks at a Shetland colony during a period of changing prey availability.* Bird Study, 36: pp.170-180.

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.

McKeen, L.W., (2019). *The effect of UV light and weather on plastics and elastomers*. Third Edition. William Andrew.

Minesto (2020). *Faroe Islands / DGIM.* Available at: https://minesto.com/projects/faroe-islands. Accessed July 2024.

Mitchell, P.I., Newton, S.F., Ratcliffe, N., and Dunn, T.E. (2004). Seabird Populations of Britain and Ireland: results of the Seabird 2000 census (1998 2002). T and A.D. Poyser, London, UK.

Mitson, R.B., and Knudsen, H.P. (2003). *Causes and effects of underwater noise on fish abundance estimation.* Aquatic Living Resources, 16: pp.255-263.

MMO (2019). *UK Sea Fisheries Statistics 2018.* Available at: https://www.gov.uk/government/statistics/uk-sea-fisheries-annual-statistics-report-2018. Accessed July 2024.

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.

Murphy, F., Russell, M., Ewins, C., and Quinn, B. (2017). *The uptake of macroplastic & microplastic by demersal & pelagic fish in the Northeast Atlantic around Scotland.* Marine Pollution Bulletin, 122: pp.353-359.

NAMMCO (2019). *Pinniped management areas*. Available at: https://nammco.no/wp-content/uploads/2017/09/management-areas_pinnipeds_sc26_2019.pdf. Accessed July 2024.

NAMMCO (2020). *North Atlantic Marine Mammal Commission. An Intergovernmental Organisation.* Available at: https://nammco.no/. Accessed July 2024.

Natural England (2017). *Marine recreation evidence briefing: non-motorised watercraft including paddlesports.* Available at: http://publications.naturalengland.org.uk/file/5298151744864256. Accessed July 2024.

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 July 2024.

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 July 2024.

NBN Atlas (2020). *Species accounts.* Available at: https://species.nbnatlas.org/. Accessed July 2024.

Neat, F.C., Wright, P.J., Zuur, A.F., Gibb, I.M., Gibb, F.M., Tulett D., Righton, D.A., and Turner, R.J. (2005). *Residency and depth movements of a coastal group of Atlantic cod (*Gadus morhua *L.)*. Marine Biology, 148: pp.643-654.

Nelms, S.E., Galloway, T.S., Godley, B.K., Jarvis, D.S., Lindeque, P.K. (2018). *Microplastic Toxicity in Aquatic Organisms and Aquatic Ecosystems: a Review*. Water Air and Soil Pollution 328: pp.999-1007.

NERC (2013). *Wave & Tidal Consenting Position Paper Series: Marine Mammal Impacts.* Available at: http://www.marineenergywales.co.uk/wp-content/uploads/2016/01/RenewableUK-Marine-Mammal-Impacts2010.pdf. Accessed July 2024.

NOAA (2012). *Arctic Sea Ice Maximum 2012.* Available at: https://earthobservatory.nasa.gov/images/77513/arctic-sea-ice-maximum-2012. Accessed July 2024.

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 July 2024.

NOAA (2020a). *What are microplastics?* Available at: https://oceanservice.noaa.gov/facts/microplastics.html. Accessed July 2024.

NOAA (2020b). *Bathymetric Data Viewer*. Available at: https://www.ncei.noaa.gov/maps/bathymetry/. Accessed July 2024.

NOAA (2020c). *Annual temperature [°C] climatology at the surface (one-degree grid).* Available at: https://www.ncei.noaa.gov/access/world-ocean-atlas-2018f/index.html. Accessed July 2024.

NOAA (2020d). *Annual salinity at the surface (one-degree grid).* Available at: https://www.ncei.noaa.gov/access/world-ocean-atlas-2018f/index.html. Accessed July 2024.

Nordregio (2020). *Sea Routes and Ports in the Arctic*. Available at: https://nordregio.org/maps/sea-routes-and-ports-in-the-arctic/. Accessed July 2024.

Norwegian Offshore Directorate (2024). *FactMaps.* Available at: https://www.sodir.no/en/about-us/open-data/factpages-and-factmaps-technical-information/. Accessed July 2024.

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 August 2021.

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 August 2021.

Nova Innovation Ltd (2020). *Bluemull Sound; Shetland Tidal Array, Scotland*. Available at: https://www.novainnovation.com/bluemull-sound. Accessed August 2021.

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 July 2024.

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 July 2024.

Offshore Mag (2004). *Faroe Islands hold exploration potential.* Available at: https://www.offshore-mag.com/geosciences/article/16756976/faroe-islands-hold-exploration-potential. Accessed July 2024.

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 July 2024.

Oil and Gas Authority (2024). *Licensing Rounds*. Available at: https://www.ogauthority.co.uk/licensing-consents/licensing-rounds/. Accessed July 2024.

Ona, E., Godø, O.R., Handegard, N.O., Hjellvik, V., Patel, R., and Pedersen, G. (2007). *Silent research vessels are not quiet*. The Journal of the Acoustical Society of America, 121: pp.EL145-EL150.

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 July 2024.

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 July 2024.

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 July 2024..

OSPAR (2024). *The North-East Atlantic*. Available online at: https://www.ospar.org/convention/the-north-east-atlantic. Accessed July 2024..

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 July 2024.

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).

Philips, N.D., Harrod, C., Gates, A.R., Thys, T.M., and Houghton, J.D.R. (2015). *Seeking the sun in deep, dark places: mesopelagic sightings of ocean sunfishes (Molidae).* Journal of Fish Biology, 87: pp.1118-1126.

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.

Pope, E.C., Hays, G.C., Thys, T.M., Doyle, T.K., Sims, D.W., Queiroz, N., Hobson, V.J., Kubicek, L., and Houghton, J.D.R. (2010). *The biology and ecology of the ocean sunfish* Mola mola*: a review of current knowledge and future research perspectives.* Reviews in Fish Biology and Fisheries, 20: pp.471-487.

Popper, A.N., and Fay, R.R. (1999). *The Auditory Periphery in Fishes.* In Fay, R.R., and Popper A.N. (eds) Comparative Hearing: Fishes and Amphibians: pp.43-100.

Popper, A.N., Fay, R.R., Platt, C., and Sand, O. (2003). *Sound Detection Mechanisms and Capabilities of Teleost Fishes.* In Collin S.P., and Marshall N.J. (eds) Sensory Processing in Aquatic Environments, Springer Verlag, New York, USA: pp.3-38.

Popper A.N., Hawkins, A.D., Fay, R.R., Man, D.A., Barto, S., Carlson, T.J., Coomb, S., Ellison, W.T., Gentry, R.L., Halvorsen, M.L., Løkkeborg, S., Rogers, P.H., Southall, B.L., Zeddies, D.G., and Tavolga, W.N. (2014). *Sound Exposure Guidelines.* In ASA S3/SC1.4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI, Springer, Berlin.

Pourebrahimi, S. and Pirooz, M., (2023). *Microplastic pollution in the marine environment: A review*. Journal of Hazardous Materials Advances, 10, p.100327.

Press and Journal (2018). *Oil industry dumping tons of microplastics into North Sea each year.* Available at: https://www.pressandjournal.co.uk/fp/news/aberdeen/1580301/oil-industry-dumping-tons-of-microplastics-into-north-sea-each-year/. Accessed July 2024.

Provencher, J.F., Bond, A.L., Avery-Gomm, S., Borrelle, S.B., Rebolledo, E.L.B., Hammer, S., Kühn, S., Lavers, J.L., Mallory, M.L., Trevail, A. and Van Franeker, J.A., (2017). *Quantifying ingested debris in marine megafauna: a review and recommendations for standardization*. Analytical Methods, 9(9), pp.1454-1469.

Rauch, J. N. and Graedel, T. E. (2007). *Earth's anthrobiogeochemical copper cycle*. Global Biogeochemical Cycles*,* 21.

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 July 2024.

Roscher, L. (2017). *Microplastic Occurrence in North Sea Surface Waters - Analyzed using Fourier Transform Infrared Spectroscopy.* Master thesis, Universität Hamburg.

RSPB (2020). *Find a bird.* Available at: https://www.rspb.org.uk/birds-and-wildlife/wildlife-guides/bird-a-z/. Accessed July 2024.

Ryan, P.G., (2016). *Ingestion of plastics by marine organisms*. Hazardous chemicals associated with plastics in the marine environment, pp.235-266.

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 July 2024.

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.

Sclodnick, T., Sutton, S., Selby, T., Dwyer, R. and Gace, L. (2020). *Environmental impacts of brass mesh nets on open ocean aquaculture pens in tropical marine environments*. Aquaculture*,* 524**:** pp. 735266.

Scottish Government (2024). *Seal Haul Out Maps.* Available at: https://marine.gov.scot/maps/446. Accessed July 2024.

Scottish Government (2015). *Scotland's National Marine Plan.* Available at: https://www.gov.scot/publications/scotlands-national-marine-plan/. Accessed July 2024.

Scottish Government (2017a). *Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017.* Available at: https://www.legislation.gov.uk/ssi/2017/102/contents. Accessed July 2024.

Shetland Islands Council (2019a). *Sea Mammals.* Available at: https://www.shetland.org/things/explore-nature/sea-mammals. Accessed July 2024.

Shetland Islands Council (2019b). *Economy.* Available at: https://www.shetland.org/about/economy. Accessed July 2024.

Shetland Islands Council (2019c). *Fisheries and Aquaculture.* Available at: https://www.shetland.org/invest/fisheries-and-aquaculture. Accessed July 2024.

Shucksmith, R. (2017). *Shetland Islands Marine Region State of the Marine Environment Assessment.* NAFC Marine Centre UHI, Scotland: 172pp.

Sims, D.W. (2008). *Chapter 3 Sieving a Living: A Review of the Biology, Ecology and Conservation Status of the Plankton-Feeding Basking Shark* Cetorhinus Maximus*.* Advances in Marine Biology, 54: pp.171-220.

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.

Sueur, S., Van den Berg, C.M.G. and Riley, J.P., (1982). Measurement of the metal complexing ability of exudates of marine macroalgae. Limnology and Oceanography, 27(3), pp.536-543.

NatureScot (2019). *Minke whale.* Available at: https://www.nature.scot/plants-animals-and-fungi/mammals/marine-mammals/minke-whale. Accessed July 2024.

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 July 2024.

NatureScot (2020c). *Protected Areas.* Available at: https://www.nature.scot/professional-advice/protected-areas-and-species/protected-areas. Accessed July 2024.

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 July 2024.

Southall, B.L., Southall A.E., Bowles, W., Ellison, T., Finneran, J.J., Gentry, R.L., Greene, Jr.C.R., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A., and Tyack, P.L. (2007). *Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations.* Aquatic Mammals, 33: pp.273-275.

Southall, B.L., Finneran, J.J., Reichmuth, C., Nachtigall, P.E., Ketten, D.R., Bowles, A.E., Ellison, W.T., Nowacek, D.P., and Tyack, P.L. (2019). *Marine Mammal Noise Exposure criteria: Updated Scientific Recommendations for Residual Hearing Effects.* Aquatic Mammals, 45: pp.125-232.

Sueur, S., Van Den Berg, C. M. G. and Riley, J. P. (1982). Measurement of the metal complexing ability of exudates of marine macroalgae. Limnology and Oceanography, 27: pp. 536-543.

TeleGeography (2020). *Submarine Cable Map.* Available at: https://www.submarinecablemap.com/#/. Accessed July 2024.

Thomsen, F., McCully, S., Wood, D., Pace, F., and White, P. *A generic investigation into noise profiles of marine dredging in relation to the acoustic sensitivity of the marine faunal in UIK waters with particular emphasis on aggregate dredging: PHASE 1 Scoping and review of key issues.* Marine Aggregate Levy Sustainability Fund (MALSF)/Marine Environmental Protection Fund (MEPF), MEPF Ref. No.: MEPF/08/P21. 61pp.

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 July 2024.

The Conservation (2016). *How to launch a rocket into space … and then land it on a ship at sea.* Available at: https://theconversation.com/how-to-launch-a-rocket-into-space-and-then-land-it-on-a-ship-at-sea-57675. Accessed July 2024.

Todd, V.L.G., Todd, I.B., Gardiner, J.C., Morrin, E.C.N., MacPherson, N.A., DiMarzio, N.A., and Thomsen, F. (2015). *A review of impacts of marine dredging activities on marine mammals.* ICES Journal of Marine Science, 72: pp.328-340.

Todd, G., and Runciman, D. (2018). *Long-Term Monitoring Study of Beaches Oils Around the Shetland Isles, United Kingdom.* In Stout, S.A., and Wang, Z. (eds) Oil Spill Environmental Forensics Case Studies, Butterworth-Heinemann, Oxford, UK: pp.378-386.

Treasurer, J.W., Hannah, F., and Cox, D. (2003). *Impact of a phytoplankton bloom on mortalities and feeding responses of farmed Atlantic salmon,* Salmo salar*, in west Scotland.* Aquaculture, 218: pp.103-110.

van Deurs, M., van Hal, R., Tomczak, M.T., Jónasdóttir, S.H., and Dolmer, P. (2009). *Recruitment of lesser sandeel* Ammodytes marinus *in relation to density dependence and zooplankton composition*. Marine Ecology Progress Series, 381: pp.249-258.

Vasconcelos, R.O., Amorim, M.C.P., and Ladich, F. (2007). *Effects of ship noise on the detectability of communication signals in the Lusitanian toadfish.* Journal of Experimental Biology, 210: pp.2104-2112.

Veirs, S., Veirs, V., Wood, J.D. (2016). *Ship noise extends to frequencies used for echolocation by endangered killer whales.* PeerJ, 4: p.e1657.

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 July 2024.

Weimerskirch, H., Shaffer, S.A., Mabille, G., Martin, J., Boutard, O., and Rouanet, J.L. (2002). *Heart rate and energy expenditure of incubating wandering albatrosses: basal levels, natural variation, and the effects of human disturbance.* Journal of Experimental Biology, 205: pp.475-483.

Welden, N.A. and Cowie, P.R., (2017). *Degradation of common polymer ropes in a sublittoral marine environment*. Marine pollution bulletin, 118(1-2), pp.248-253.

Wilding, T.A., Hughes, D.J., and Black, K.D. (2005). *The benthic environment of the North and West of Scotland and the Northern and Western Isles: sources of information and overview.* Report 1 to METOC. Scottish Association for Marine Science, Oban.

Wilson, C.M., Wilding, C.M., and Tyler-Walters, H. (2020. Cetorhinus maximus *Basking shark.* In Tyler-Walters H., and Hiscock, K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews. Marine Biological Association of the United Kingdom, Plymouth, UK. Available at: https://www.marlin.ac.uk/species/detail/1438. Accessed July 2024.

Witt, M.J., Hardy, T., Johnson, L., McClellan C.M., Pikesley, S.K., Ranger, S., Richardson, P.B., Solandt, J-L., Speedie, C., Williams, R., and Godley, B.J. (2012). *Basking sharks in the northeast Atlantic: spatio-temporal trends from sightings in UK waters.* Marine Ecology Progress Series, 459: pp.121-134.

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.

Wysocki, L.E., Ladich, F., and Dittami, J. (2006). *Ship noise and cortisol secretion in European freshwater fishes.* Biological Conservation, 128: pp.501-508.

Zhang, K., Hamidian, A.H., Tubić, A., Zhang, Y., Fang, J.K., Wu, C. and Lam, P.K., (2021). *Understanding plastic degradation and microplastic formation in the environment: A review*. Environmental Pollution, 274, p.116554.

Zhang, X., Yin, Z., Xiang, S., Yan, H. and Tian, H., (2024). *Degradation of polymer materials in the environment and its impact on the health of experimental animals: a review*. Polymers, 16(19), p.2807.

CHAPTER 7 ACCIDENTS AND DISASTERS

7. Accidents and Disasters

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7. Accidents and Disasters

7.1 Introduction

7.1.1 This chapter considers the potential for the Proposed Project (preparation and launch of the HyImpulse SR75 Launch Vehicle) 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.

7.1.2 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.

7.1.3 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.

7.1.4 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.

7.1.5 The SR75 is assumed to be launched from Launch Pad 2 at SaxaVord Spaceport. Any difference in environmental risks and impacts from subsequent relocation to another Launch Pad will be minimal.

7.2 Legislation, Policy & Guidelines

Legislation

7.2.1 The treatment of major accidents and disasters within an AEE is a requirement since the Space Industry Regulations 2021 (Government, 2021) came into force. Guidance document 'Guidance for the Assessment of Environmental Effects' (CAA, 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).'

7.2.2 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.

7.2.3 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 (liquid oxygen and paraffin fuel) will not be exceeded.[1]

[1] *The lower tier COMAH threshold is 2500 tonnes for alternative fuels serving the same purpose to petroleum in Schedule 1 Part 2 Section 34(e) of the COMAH Regulations.*

Guidance

7.2.4 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).

7.2.5 The Health and Safety Laboratory (HSL) has produced the guidance document "Spaceports – Keeping People Safe" (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.

7.3 Assessment Methodology and Significance Criteria

7.3.1 Under the guidance and regulations accompanying the Space Industry Act 2018, a safety case and quantitative operational risk assessments are 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.

7.3.2 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.

7.3.3 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.

7.3.4 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 the HyImpulse SR75 Launch Vehicle. 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.

7.3.5 For context, a single launch of the SR75 Launch Vehicle per year is proposed by HyImpulse.

Environmental Zone of Influence

7.3.6 A one-kilometre buffer area around Launch Pad 2 has been 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, beyond the stated one-kilometre buffer.

Assessment of Significance

7.3.7 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.

7.3.8 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 toxic 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.

Requirement for Mitigation

7.3.9 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

7.3.10 The residual effects are intended to be the management of the risk of a major accident or disaster to a level that is As Low as Reasonably Practical (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

7.3.11 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.

7.4 Baseline Conditions

7.4.1 Baseline conditions are assumed to be routine launch vehicle operations at the SaxaVord Spaceport Launch Pad 2, rather than any physical description.

7.5 Receptors Brought Forward for Assessment

7.5.1 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 SaxaVord Spaceport AEE V3. 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., Launch Pad 2. Employees and contractors working on the Proposed Project will therefore be the nearest human receptors considered.

7.6 Standard Mitigation

7.6.1 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 the HyImpulse Safety Operations Manual (document reference to be advised to the CAA once finalised);
- 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 HyImpulse 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
- Oxidant transfer and storage on hardstanding with integral containment (i.e. a sump of sufficient volume to hold a spillage indefinitely or until volatilisation occurs).

7.7 Potential Effects

7.7.1 Major accident and disaster events which were screened out of assessment are shown in Table 7.1, along with reasons for no further consideration. They are generally natural disasters and extreme weather events with no serious risk of occurrence.

Table 7.1 – Effects 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. (British Geological Survey, 2020).
Extreme temperature	Highly unlikely under the most pessimistic climate change scenarios given Unst's latitude (see Chapter 5)
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.

7.7.2 Climate-related risks are discussed in more detail in Chapter 5 of this AEE Report.

7.7.3 Events taken forward for assessment are summarised in Table 7.2. The events have been grouped into failure of oxygen containment, ignition of fuel and off-nominal launch scenarios. The nature of the hazards is discussed in the following sections.

7.7.4 The SR75 requires a maximum of approximately 460 kilograms of paraffin-based fuel and 1,090 kg of liquid oxygen (LOx) as primary fuel and oxidant. The fuel is a waxy solid which is pre-installed aboard the LV. Small quantities of other gases (nitrogen and helium) are used on board the LV but do not present a major accident hazard and are not considered further.

Failure of liquid oxygen containment

7.7.5 Liquid oxygen 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.

7.7.6 The SR75 Launch Vehicle requires an inventory of 1,090 kg of liquid oxygen. The approximate density of liquid oxygen is ~1.14kg/l hence the volume required for a launch event is ~960 litres.

7.7.7 Following any loss of containment these fluids would rapidly boil off to atmosphere, but in the seconds following the loss may cause cold stress on infrastructure, liquid and vapour burns, and in the case of oxygen, changes to combustibility of nearby fuels.

Ignition of hazardous materials

7.7.8 The SR75's paraffin-based fuel is the only material likely to be used in anything approaching bulk quantities by the Proposed Project (460 kg per launch), although the material is not flammable without the presence of external ignition and an oxidizer to sustain combustion. The fuel is delivered already integrated into the SR75's booster. It should also be borne in mind that the SR75 is a small launch vehicle relative to other expected users of the spaceport.

7.7.9 Several Material Data Safety Sheets (MSDS) for paraffin wax fuel have been consulted and none publish a lower explosive limit for the vapour; possibly this has not been empirically measures or experimentation would return a wide range of values since paraffin wax is a mixture of long-chain aliphatic compounds.

7.7.10 The combustion kinetics of solid paraffin fuel rely on a spray of oxidant to form small droplets of melted paraffin wax which are then combusted. In the absence of this intentional acceleration of combustion in case of an accidental ignition, the fuel gradually burns in situ until extinguished or entirely combusted. The rate of formation of the vapour cloud necessary for a deflagration will be much slower than would be the case with a liquid fuel.

7.7.11 Uncontrolled combustion of paraffin fuel during launch vehicle delivery or preparation is not considered as the fuel is integrated into the LV and would require a deliberate there is ignition source to initiate any combustion.. The paraffin fuel has a zero TNT equivalent for the reasons discussed.

7.7.12 The Net Equivalent Weight (of TNT) used by HyImpulse in their casualty and injury area calculations is estimated as 20kg for the SR75; this is due to the presence of pressurised helium tanks rather than combustible material. The calculation is made according to the FAA Flight Safety Handbook and CAA Guidelines.

Off-nominal Launch Scenarios

7.7.13 Any deflagration following ignition of propellant during active application of liquid oxygen during a launch failure would potentially create a short-lived initial fireball extending only single metres from the pad, with the residual propellant rapidly burning off in a matter of seconds as soon as losing contact with the oxidiser.

7.7.14 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 hydrocarbon-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). The deflagration radius of liquid propellant LV based on liquid carbons is a worst-case scenario under the limiting case of the spaceport AEE and far greater than would reasonably be expected from the SR75's hybrid propulsion technology.

7.7.15 In addition, the small size and low fuel payload of the SR75 means that the possible overpressure wave and deflagration radius will be correspondingly smaller than the historic NASA observations. The observations were made of kerosene-based launch vehicle incidents carrying fuel with a much higher vapour pressure than paraffin wax.

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

7.7.17 The working expectation is that the risk of ignition of peat will be low following contact with burning paraffin. 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.

7.7.18 The loss of all or part of the SR75 Launch Vehicle to the marine environment are considered in Chapter 6 – Marine and Transboundary Effects of this AEE Report.

7.7.19 The loss of all or part of the SR75 Launch Vehicle to the terrestrial environment on Unst are not considered significant. Uncombusted paraffin will not require any particular handling measures other than gloves if manually recovered from the ground. Liquid oxygen would be expected to rapidly volatilise leaving no permanent change to the area affected. Any launch vehicle debris itself would be recovered if considered safe and practicable to do so by SaxaVord Spaceport and the emergency services.

Table 7.2 – Events Assessed

Event	Receptors	Potential Consequences	Significance	Mitigation
Failure of containment – liquid				
Liquid oxygen (LOx)	Hu, W, Hab	Cryogenic injury and damage to receptors in close proximity to release before rapid evaporation takes place. Temporarily enhanced potential for fire and explosion during evaporation – oxygen enriched atmosphere.	**Minor (Not Significant)**	Maintenance regime for storage, transfer and containment equipment under responsibility of SaxaVord Spaceport. Applicant to comply with all SaxaVord Spaceport operational procedures and controls. Loading operations of LOX into SR75 are performed remotely by the HyImpulse personnel.
Ignition of bulk quantities				
Paraffin-based fuel	Hu, W	It is unlikely that fires could affect human and wildlife receptors within the site boundary, with off-site effects even less likely. Could cause a short-term episode of high air pollutant concentrations near the launch pad and immediate downwind locations.	**Minor (Not Significant)**	Fire risk assessment to inform safe working practices around flammable materials under responsibility of SaxaVord Spaceport. Applicant to comply with all SaxaVord Spaceport operational procedures and controls.
Aeronautical events				
SR75 Launch Vehicle crash – ground strike	Hu, W, Hab	Damage to receptors through impact and loss of propellant containment, and potential ignition of propellant vapour and flammable substrate (peat) can exist but are unlikely.	**Minor (Not Significant)**	All launch trajectories are to the north and have minimal land overflight. Areas around Launch Pad 2 are not peat rich and some peat has been removed. Propellants and oxidants would rapidly volatilise. Combustion of paraffin stops as soon as LOx is removed.
SR75 Launch Vehicle crash – water strike.	W, Hab	Damage to receptors through impact and loss of propellant containment.	**Minor (Not Significant)**	Marine environment (Chapter 6) concludes this is not significant. Propellant load will be fully or partially combusted.

7.8 Additional Mitigation

7.8.1 Other than where fluid containment and transfer arrangements are required to limit releases to the environment (noted in Table 7.2 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 beyond the measures identified in Section 7.6 are considered necessary.

7.8.2 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 i.e., the HyImpulse SR75 Launch Operations Safety Case.

7.9 Residual Effects

7.9.1 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.

7.10 Cumulative Assessment

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

7.10.2 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.

7.10.3 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, and the expected launch cadence of once per year, 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 SaxaVord Spaceport and confirmed that there are no committed development or infrastructure projects on the Island which should be considered in the assessment.

7.11 Summary

7.11.1 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.

7.11.2 A list of potential events was drawn up based on the Proposed Project activities.

7.11.3 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 5 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.

7.11.4 Accident events were subcategorised into failure of containment of liquid oxygen, 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.

7.11.5 Failures of containment were generally considered to be of minor 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 of the liquid oxygen. 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.

7.11.6 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 paraffin fuel occurred, the deflagration radius would be relatively small (likely within the spaceport boundary) and the fuel load may simply burn in situ until exhausted. Any such blaze would be limited in duration by the small (460 kg) quantities used by any SR75 LV. 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 HyImpulse SR75 Launch Vehicle design process and integrity checks.

7.11.7 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, lack of receptors and exclusively northward launch trajectories to be used. Water strikes were considered of minor significance; wildlife and marine habitat receptors effects are discussed in the Marine Effects Chapter (Chapter 6) of this AEE Report and not considered significant.

7.12 References

CAA et. al. (2021) *CAP2215 Guidance for the Assessment of Environmental Effects* [online]. Available at https://www.caa.co.uk/publication/download/18937

The Health and Safety at Work Act (1974) (UK Government, 1974) https://www.legislation.gov.uk/ukpga/1974/37/contents

Management of Health and Safety at Work Regulations (1999) (UK Government, 1999) https://www.legislation.gov.uk/uksi/1999/3242/contents

The Control of Major Accident Hazards Regulations (2015) (COMAH) (UK Government, 2015) https://www.legislation.gov.uk/uksi/2015/483/contents

Town and Country Planning (Hazardous Substances) (Scotland) Regulations 2015 (Scottish Government, 2017) https://www.legislation.gov.uk/ssi/2015/181/contents

Institute of Environmental Management and Assessment (IEMA, 2020). https://www.iema.net/download-document/48915

Guidance document "Safety at Spaceports" (Health and Safety Laboratory, 2018) on behalf of the Civil Aviation Authority and the UK Space Agency https://assets.publishing.service.gov.uk/media/5c6e87b0e5274a0eca052458/Spaceports_keeping_people_safe.pdf

British Geological Survey records show no recorded earthquake above 4 local magnitude ("light") within 50 km of Unst since records began. (British Geological Survey, 2020) https://www.earthquakes.bgs.ac.uk/earthquakes/dataSearch.html

CHAPTER 8 SUMMARY OF ENVIRONMENTAL EFFECTS

8. Summary of Environmental Effects

8.1	Introduction	8-1
8.2	Summary of Environmental Effects	8-1
8.3	Significant Residual Effects	8-4
8.4	Monitoring	8-4
8.5	Conclusion	8-4

8. Summary of Environmental Effects

8.1 Introduction

8.1.1 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.

8.2 Summary of Environmental Effects

8.2.1 Pre-mitigation and residual environmental effects are summarised in Table 8.1. 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 as well as a cross reference to the relevant mitigation measures identified.

Table 8.1 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
Air Quality							
Effects at sensitive human receptors from launch event emissions	Negligible	n/a	No likely significant effect	None proposed	Negligible	n/a	No likely significant effect
Climate Change							
GHG emissions arising from operation.	Minor	Adverse	No likely significant effect	None proposed	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	Applicant to suspend launch activities in high winds. Future versions of the SR75 will feature guidance systems and Thrust Vectoring Control to compensate for sudden changes in wind speed and direction during both launch and flight	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	Applicant to source materials in Shetland or as close to the Proposed Project as possible, where applicable.	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	SaxaVord Spaceport to maintain drainage system; ditches cut by spaceport operator in the flatter areas to aid drainage into natural streams. Applicant to comply with any relevant operational procedures required to implement and maintain drainage.	Minor	Adverse	No likely significant effect
Water ingress causing failure of electrical equipment (e.g., generators and deluge pumps)	Moderate	Adverse	Potential significant effect	SaxaVord Spaceport to maintain drainage system; ditches cut by spaceport operator in the flatter areas to aid drainage into natural streams. Applicant to comply with any relevant operational procedures required to implement and maintain drainage.	Minor	Adverse	No likely significant effect
High temperatures causing site personnel welfare impacts such as heat stress	Minor	Adverse	No likely significant effect	Applicant to 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	Deluge pumps to be designed and installed by SaxaVord Spaceport. Deluge system to maintained by the Applicant and SaxaVord Spaceport.	Negligible	Adverse	No likely significant effect
Marine and Transboundary Effects							
Effects on Water and Sediment Quality, and Ecological Receptors from Fuel/Propellent Spillage.	Negligible	Adverse	No likely significant effect	None proposed	Negligible	Adverse	No likely significant effect
Effects on 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 Water and Sediment Quality and Ecological Receptors from Returning Components 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.	Minor	Adverse	No likely significant effect	None proposed	Minor	Adverse	No likely significant effect

Description of Effect	Pre-mitigation Effect			Mitigation Measure(s)	Residual Effect		
	Magnitude	Beneficial/ Adverse	Significance		Magnitude	Beneficial/ Adverse	Significance
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.	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 Returned Components, 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
Accidental Aeronautical Events – Failure During Flight	Minor	Adverse	No likely significant effect	None proposed	Minor	Adverse	No likely significant effect
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.							

8.3 Significant Residual Effects

8.3.1 Post mitigation, there are no remaining potentially significant residual effects.

8.4 Monitoring

8.4.1 There are no adverse significant residual effects and therefore no monitoring is required as a result of this AEE.

8.5 Conclusion

8.5.1 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 Proposed Project Location

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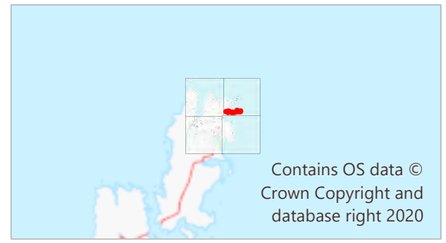
1216000 1215500 1215000 1214500 1214000 1213500 1213000 1212500

N

Burn of Skaw
Skoga Dale
Norva Dale
Ward of Norwick
Lamba Ness
Nor Wick
Mucklepund
Norwick Meadow
Norwick
Northdale
Burn of Norwick
Housi Field
Girt Wick
Feall
Tupton
Sclaten
Hill of Clibberswick
Museum
Haroldswick
Clibberswick
B9086

KEY

Proposed Project Boundary



Coordinate System: British National Grid
Projection: Transverse Mercator

Attributions: <attributions>

0 120 240 480 720 960 m

1:15,000

HyImpulse

ITPENERGISED PART OF SLR

HyImpulse Saxavord
Assessment of Environmental Effects

Drawing 1.1
Proposed Project Location

Date:	Lead:	Review:	Version:
05/08/2024	JH	RF	1.0

Chapter 1 Drawing 1.2 Statutory Environmental Designations

459000 460000 461000 462000 463000 464000 465000 466000 467000 468000 469000 470000

1219000 1218000 1217000 1216000 1215000 1214000 1213000 1212000 1211000

N

The

Hermaness, Saxa Vord and Valla Field

Saxa Vord

Hermaness

Inner Skaw, houses and field system, Unst

Skaw, radar station

Norwick

Burgar Stack, broch 225m NE of Stackhoull

St John's Church, remains of, Norwick, Unst

Norwick Meadows

Valla Field

Petester, abandoned township 530m N of Lee of Petester

Watquey, house and associated structures to E of, Unst

Cross Kirk

Gardie, house and field system 650m N of Little Heog, Unst

Spoull, Norse settlement 80m WNW of, Unst

Crussa Field and the Heogs

Soterberg, settlement and field system, Unst

Hermaness, Saxa Vord and Valla Field

Little Heog, cairn, 605m NW of Hagdale

The Punds to Wick of Hagdale

Crussa Field, cairns

Muckle Heog,two chambered cairns, Baltasound

Keen of Hamar

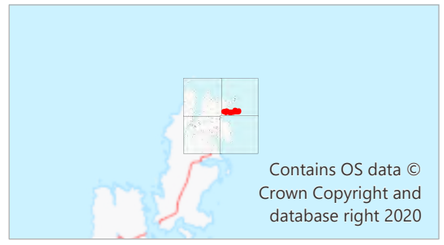
Map data © OpenStreetMap contributors, Microsoft, Facebook, Inc. and its affiliates, Esri Community Maps contributors, Map layer by Esri

KEY

- Proposed Project Boundary
- Sites of Scientific Interest (SSSI)
- Special Protection Area (SPA)
- Important Bird Areas (IBA)
- National Nature Reserves (NNR)
- National Scenic Areas (NSA)
- Scheduled Monuments (SM)

Listed Buildings

- A
- B
- C



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Coordinate System: British National Grid
Projection: Transverse Mercator

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1:34,159

HyImpulse

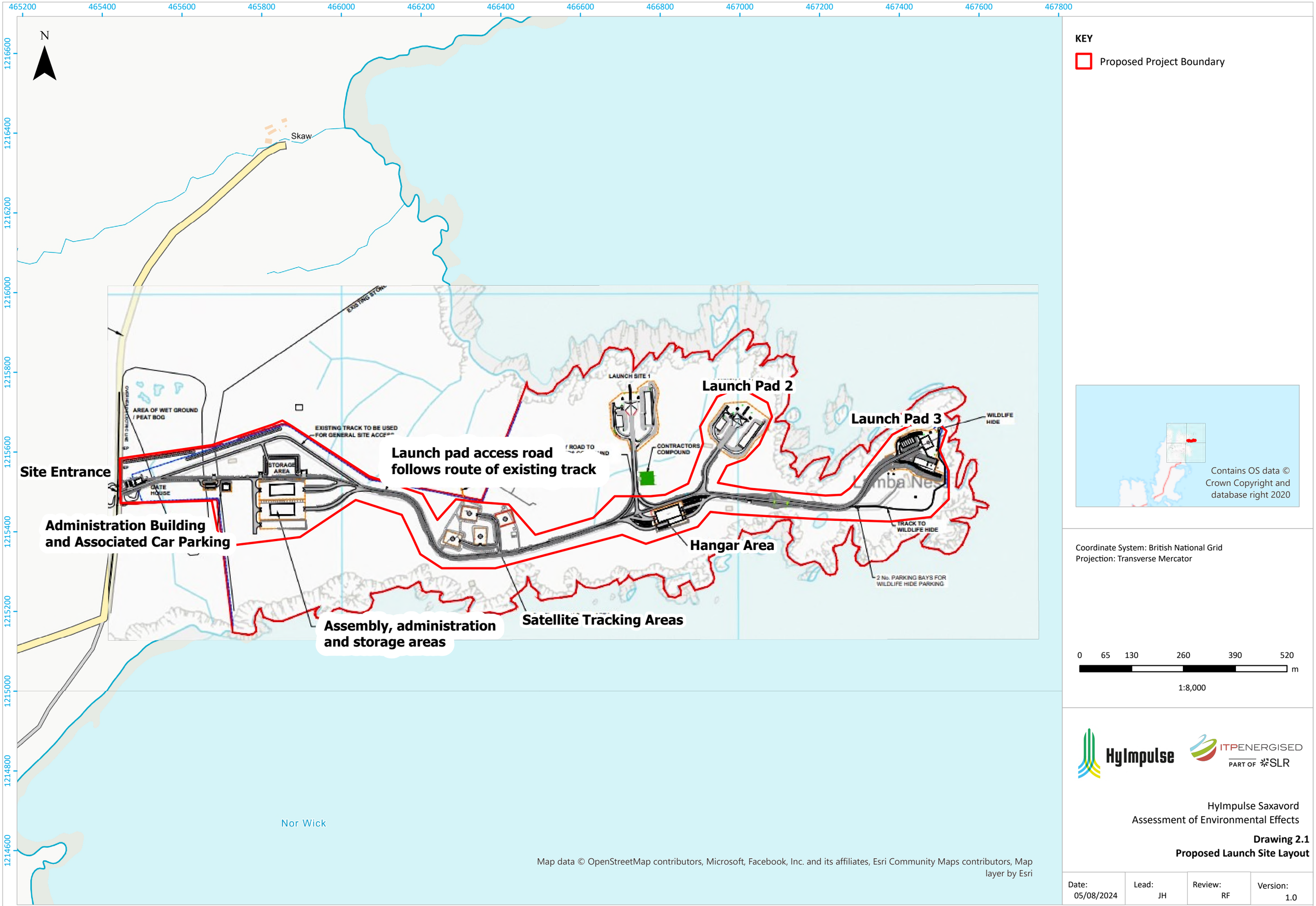
ITPENERGISED PART OF SLR

HyImpulse Saxavord
Assessment of Environmental Effects

Drawing 1.2
Statutory Environmental Designations

Date:	Lead:	Review:	Version:
05/08/2024	JH	RF	1.0

Chapter 2 Drawing 2.1 Proposed Launch Site Layout



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KEY

Proposed Project Boundary

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Coordinate System: British National Grid
Projection: Transverse Mercator

0 65 130 260 390 520 m

1:8,000

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HyImpulse Saxavord
Assessment of Environmental Effects

Drawing 2.1
Proposed Launch Site Layout

Date:	Lead:	Review:	Version:
05/08/2024	JH	RF	1.0

Chapter 2 Drawing 2.2 Environmental Zone of Influence showing Air Quality Study Area

-500000 -250000 0 250000

9000000

8750000

8500000

N

Faeroe (Denmark) - United Kingdom

United Kingdom - Norway

KEY

- SR75 Launch Vehicle Impact Dispersion Area
- SR75 Environmental Zone of Influence (EZI)
- Air Quality - Study Area
- EEZ boundaries

0 32,470 64,940 m

Scale 1:1,250,000 @ A3

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Assessment of Environmental Effects

Drawing 2.2

Environmental Zone of Influence showing Air Quality Study Area

Date:	Drawn by:	Checked by:	Version:
8/5/2024	AN	IW	Draft/V1

Project Number: 3148

Service Layer Credits: World Ocean Base: Esri, GEBCO, Garmin, NaturalVue

Chapter 3 -

Chapter 4 Drawing 4.1 Launch Pad 2, Receptor Locations and Air Quality Study Area

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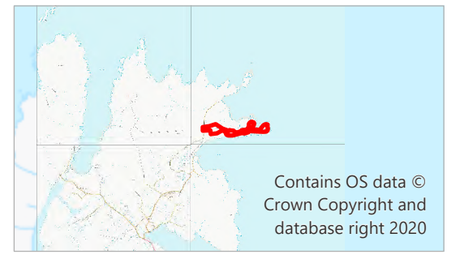
1218000 1217500 1217000 1216500 1216000 1215500 1215000 1214500 1214000 1213500 1213000

N

Lidda Dale
Hill Ness
Inner Stoss
Holm of Skaw
Saxa Vord
Skaw
Burn of Skaw
Skaga Dale
Norna Dale
Ward of Norwick
Lamba Ness
R1 Banks Cottage
Nor Wick
Mucklepund
Norwick Meadow
Norwick
Northdale
Burn of Norwick
Housi Field
Foall
Tuplon

KEY

- Proposed Project Boundary
- 4km Study Area
- Launch Pad 2
- Launch pad 3
- Modelled Receptor



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Coordinate System: British National Grid
Projection: Transverse Mercator

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1:20,000

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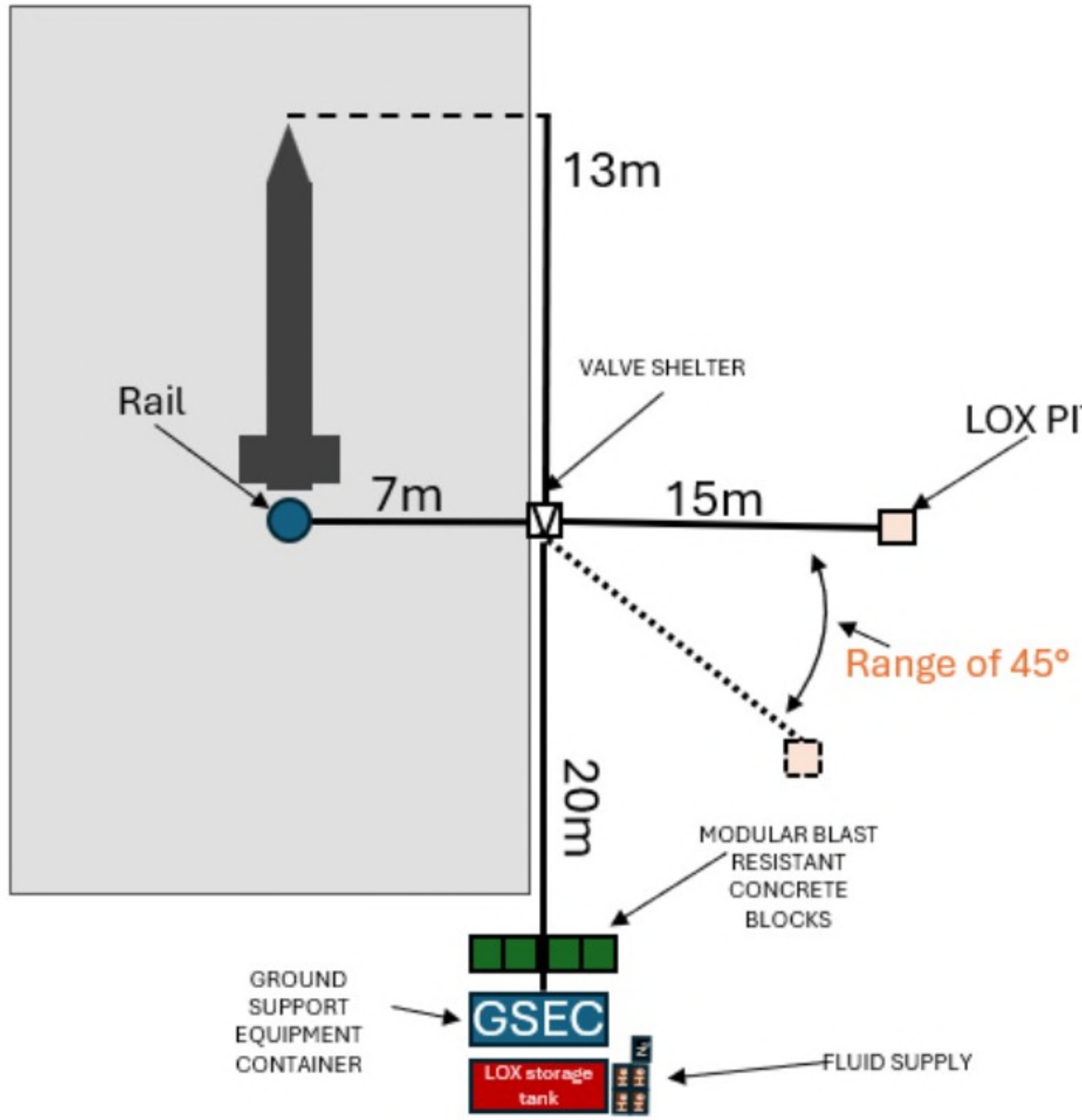
HyImpulse Saxavord
Assessment of Environmental Effects

Drawing 4.1
Launch Pad 2, Receptor Locations and Air Quality Study Area

Date:	Lead:	Review:	Version:
05/08/2024	JH	RF	1.2

Chapter 4 Drawing 4.2 Lauch Pad Layout

N



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HyImpulse Saxavord
Assessment of Environmental Effects

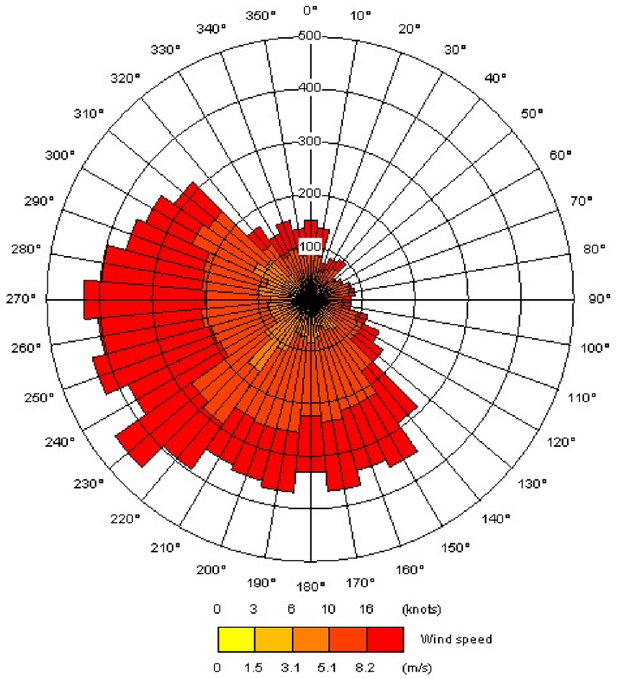
Drawing 4.2
Schematic Launch Pad Layout

Date:	Drawn by:	Checked by:	Version:
06/08/2024	JH	RF	V1

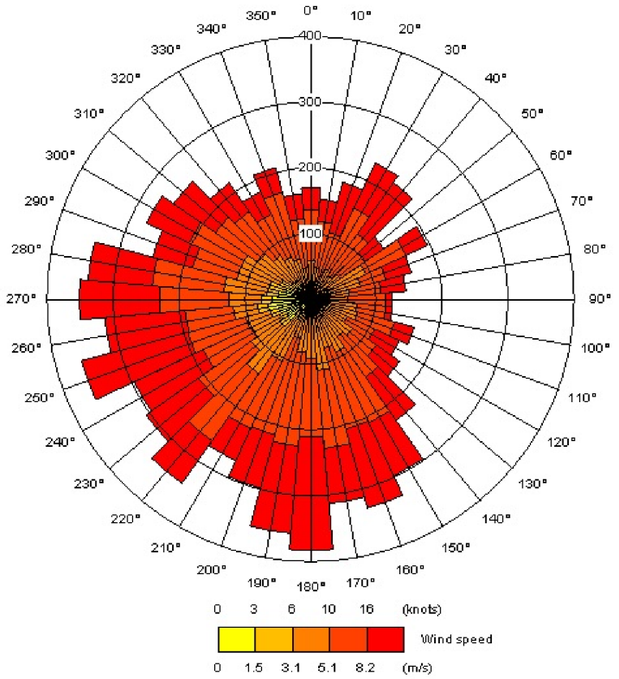
Project Number: XXXXX

Chapter 4 Drawing 4.3 Baltasound Windroses

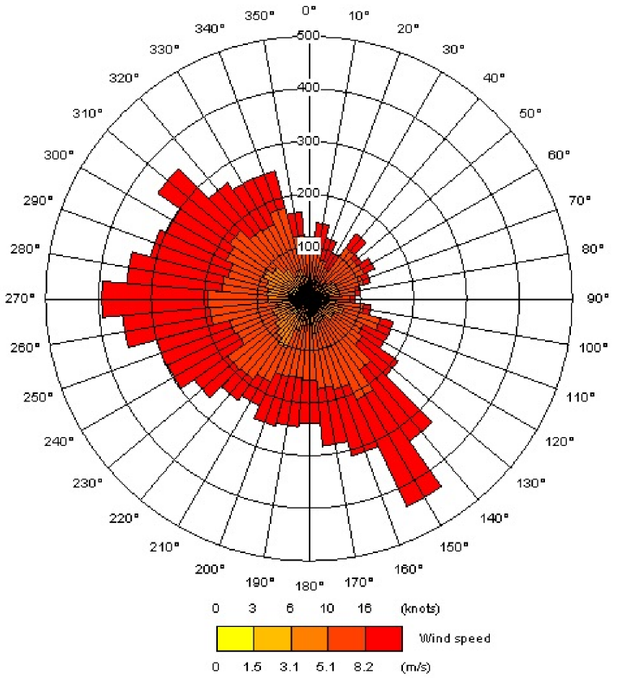
Baltasound 2015 Wind Rose



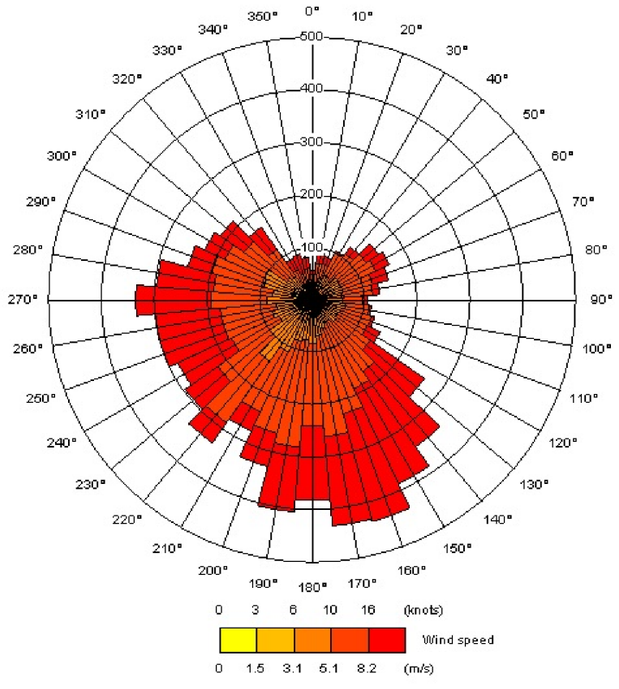
Baltasound 2016 Wind Rose



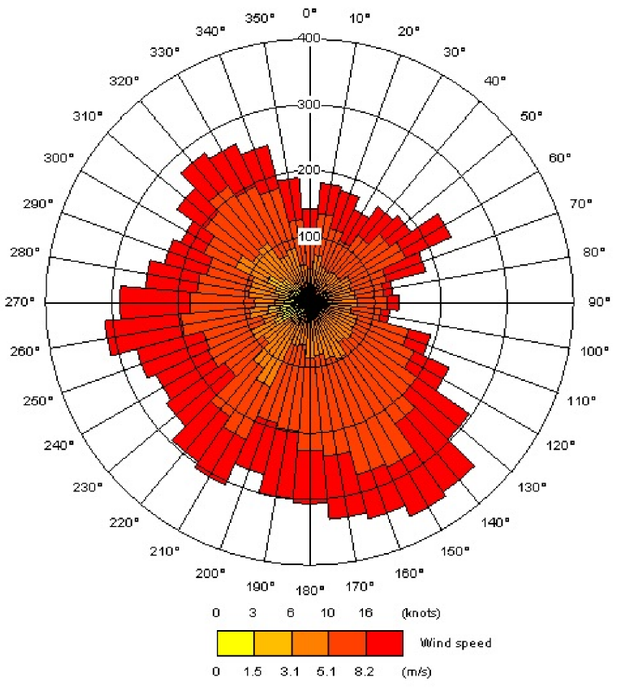
Baltasound 2017 Wind Rose



Baltasound 2018 Wind Rose



Baltasound 2019 Wind Rose



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PART OF SLR

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Assessment of Environmental Effects

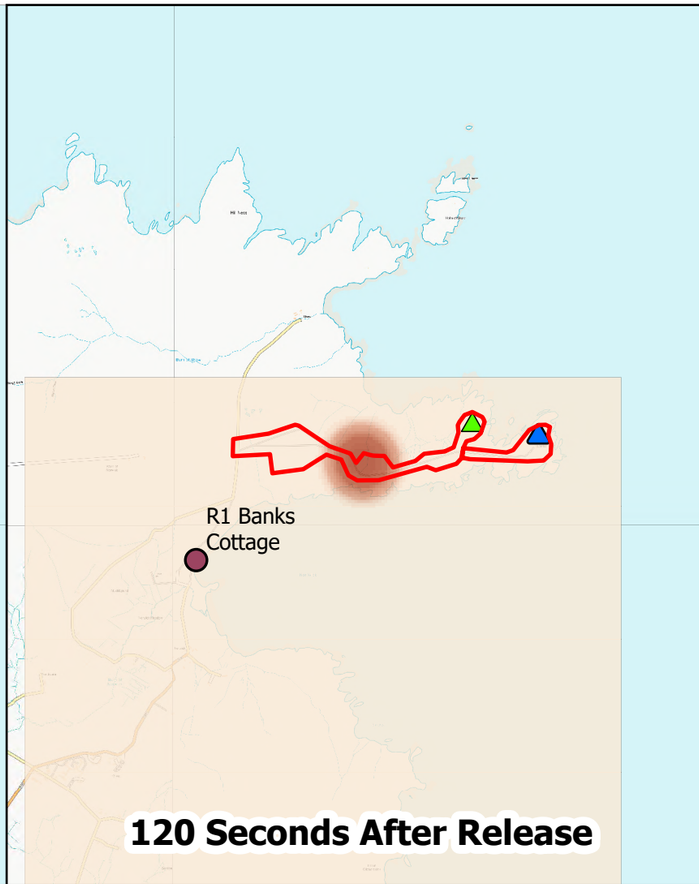
Drawing 4.3
Baltasound, Unst
Hourly Meteorological Data 2015 - 2019

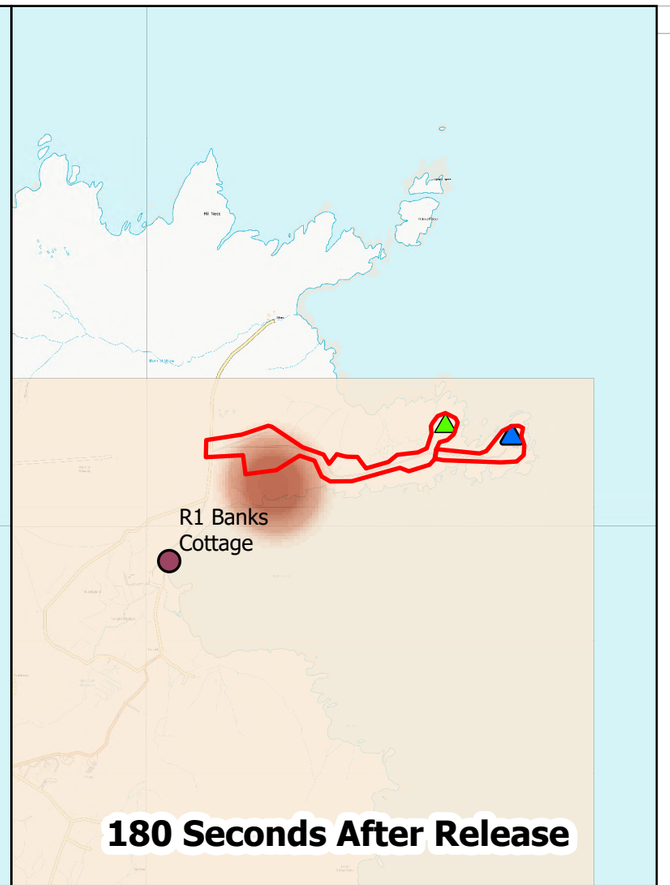
Date:	Drawn by:	Checked by:	Version:
15/07/2024	JH	RF	V1

Project Number: 5651

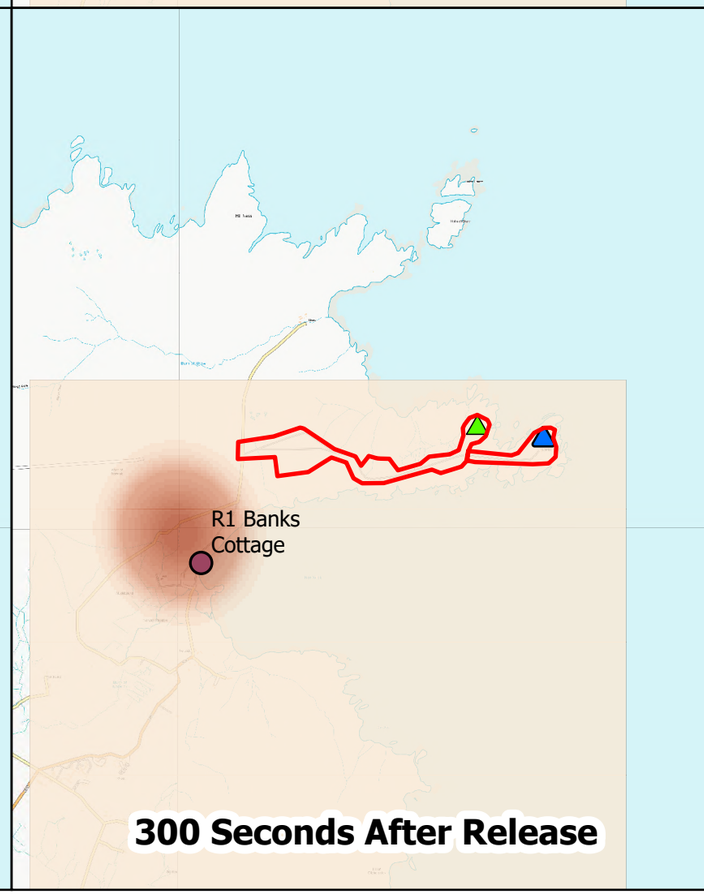
Chapter 4 Drawing 4.4 Concentration of CO After Launch

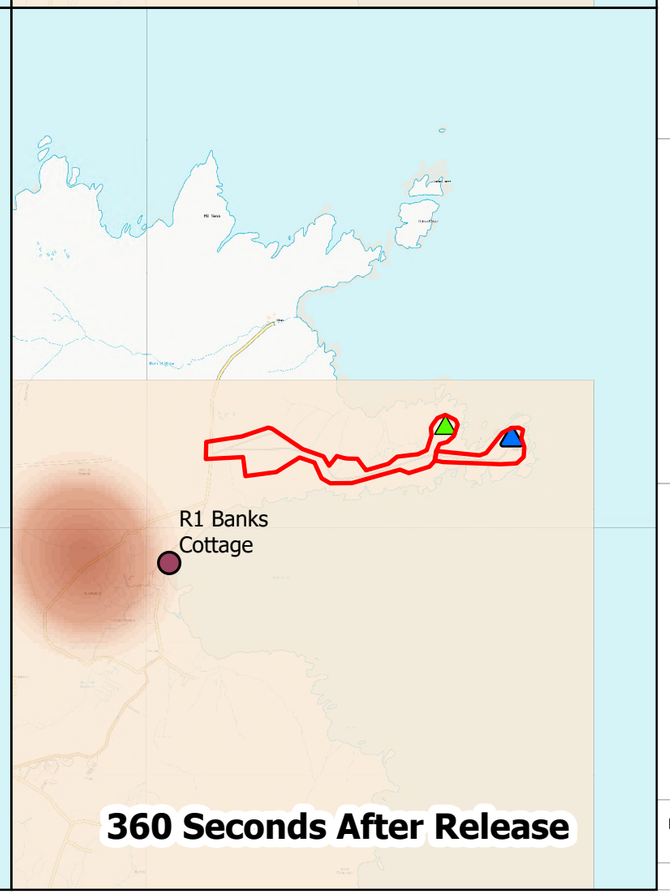










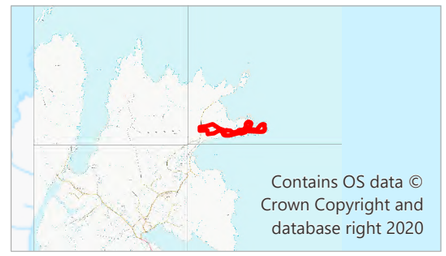


KEY

- Proposed Project Boundary
- Launch Pad 2
- Launch pad 3
- Modelled Receptor

CO (mg/m³)

- 0.051 Background
- 0.052 - 0.053
- 0.053 - 0.054
- 0.054 - 0.055
- 0.055 - 0.056
- 0.056 - 0.057
- 0.057 - 0.058
- 0.058 - 0.059
- 0.059 - 0.06
- 0.06 - 0.065
- 0.065 - 0.07
- 0.07 - 0.075
- 0.075 - 0.08
- 0.08 - 0.085
- 0.085 - 0.09
- 0.09 - 0.095
- 0.095 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- >0.2



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Coordinate System: British National Grid
Projection: Transverse Mercator

0 335 670 1,340 2,010 2,680 m

1:41,000

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Assessment of Environmental Effects

Drawing 4.4
Concentration of CO After Launch

Date:	Lead:	Review:	Version:
06/08/2024	JH	RF	1.0

Chapter 5 -

Chapter 6 Drawing 6.1 Environmental Zone of Influence

-500000 -250000 0 250000

N

9000000

8750000

8500000

Faeroe (Denmark) - United Kingdom

United Kingdom - Norway

-500000 -250000 0 250000

Service Layer Credits: World Ocean Base: Esri, GEBCO, Garmin, NaturalVue

Project Number: 3148

KEY

- SR75 Environmental Zone of Influence (EZI)
- SR75 Launch Vehicle Impact Dispersion Area
- EEZ boundaries

0 32,470 64,940 m

Scale 1:1,250,000 @ A3

HyImpulse

HyImpulse
Assessment of Environmental Effects

Drawing 6.1

Environmental Zone of Influence

Date:	Drawn by:	Checked by:	Version:
7/26/2024	AN	IW	Draft/V1

Chapter 6 Drawing 6.2 Marine Protected Areas

-500000

0

500000

9000000

8500000

N

Faeroe (Denmark) - Norway

Faeroe (Denmark) Straight Baseline

Faeroe (Denmark) - United Kingdom

United Kingdom - Norway

Norway Straight Baseline

Faeroe (Denmark) - United Kingdom

-500000

0

500000

KEY

- SR75 Environmental Zone of Influence (EZI)
- SR75 Launch Vehicle Impact Dispersion Area
- Protected Site Designated Under the Birds Directive
- Protected Site Designated Under the Habitats Directive
- Protected Site Designated Under the Birds and Habitats Directives
- Marine Protected Area
- EEZ boundaries

0 50,000 100,000 m

Scale 1:2,000,000 @ A3

HyImpulse

HyImpulse
Assessment of Environmental Effects

Drawing 6.2

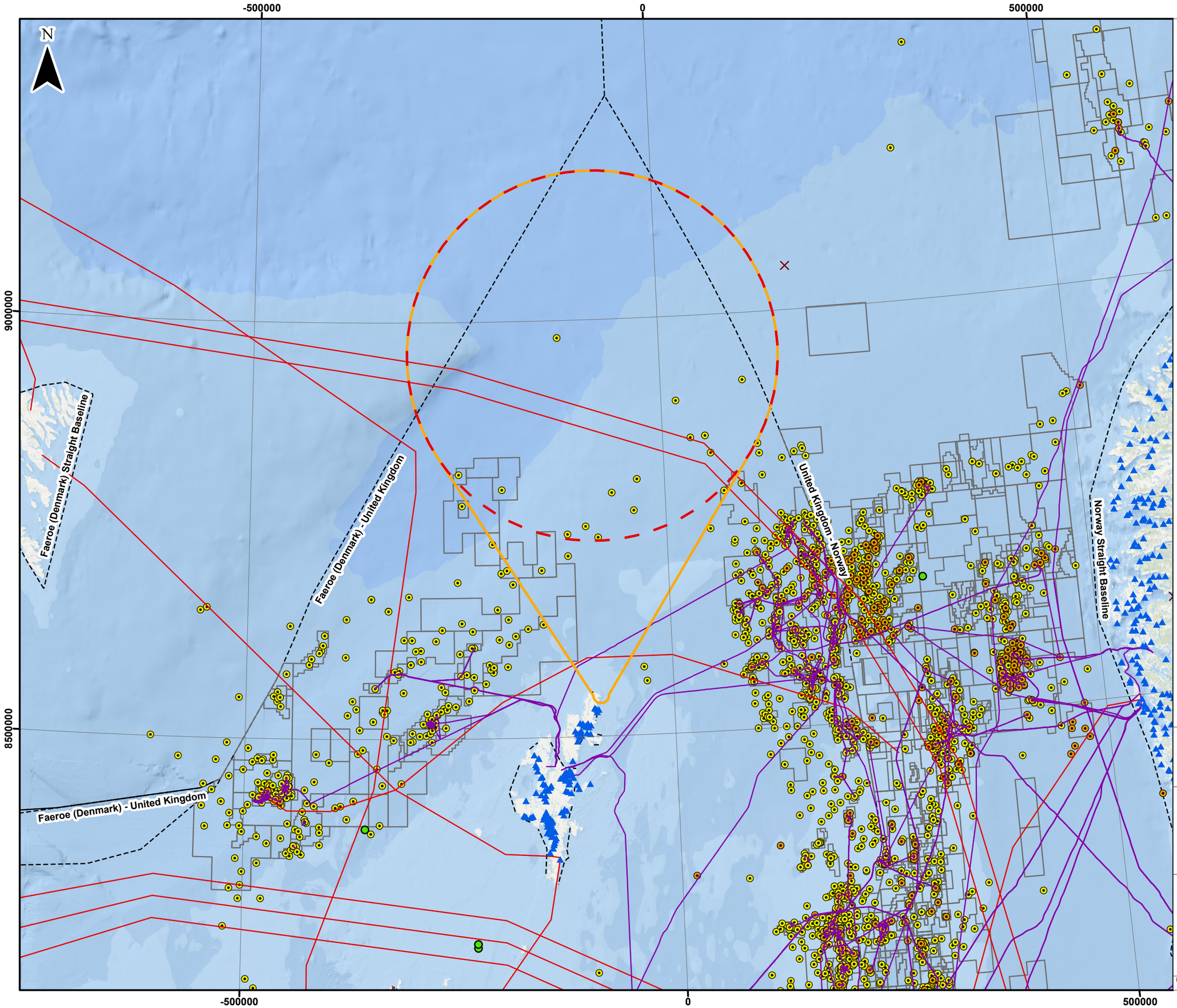
Marine Protected Areas - Environmental Zone of Influence

Date:	Drawn by:	Checked by:	Version:
7/26/2024	AN	IW	Draft/V1

Project Number: 3148

Service Layer Credits: World Ocean Base: Esri, GEBCO, Garmin, NaturalVue

Chapter 6 Drawing 6.3 Other Marine Users



KEY

- SR75 Environmental Zone of Influence (EZI)
- SR75 Launch Vehicle Impact Dispersion Area
- Wind Farm
- Waste Disposal Site
- Nuclear power Plant
- Aquaculture Site
- Offshore Installation
- Borehole
- Pipeline
- Cable
- Hydrocarbon Licence
- EEZ boundaries

0 50,000 100,000 m

Scale 1:2,000,000 @ A3

HyImpulse

HyImpulse
Assessment of Environmental Effects

Drawing 6.3

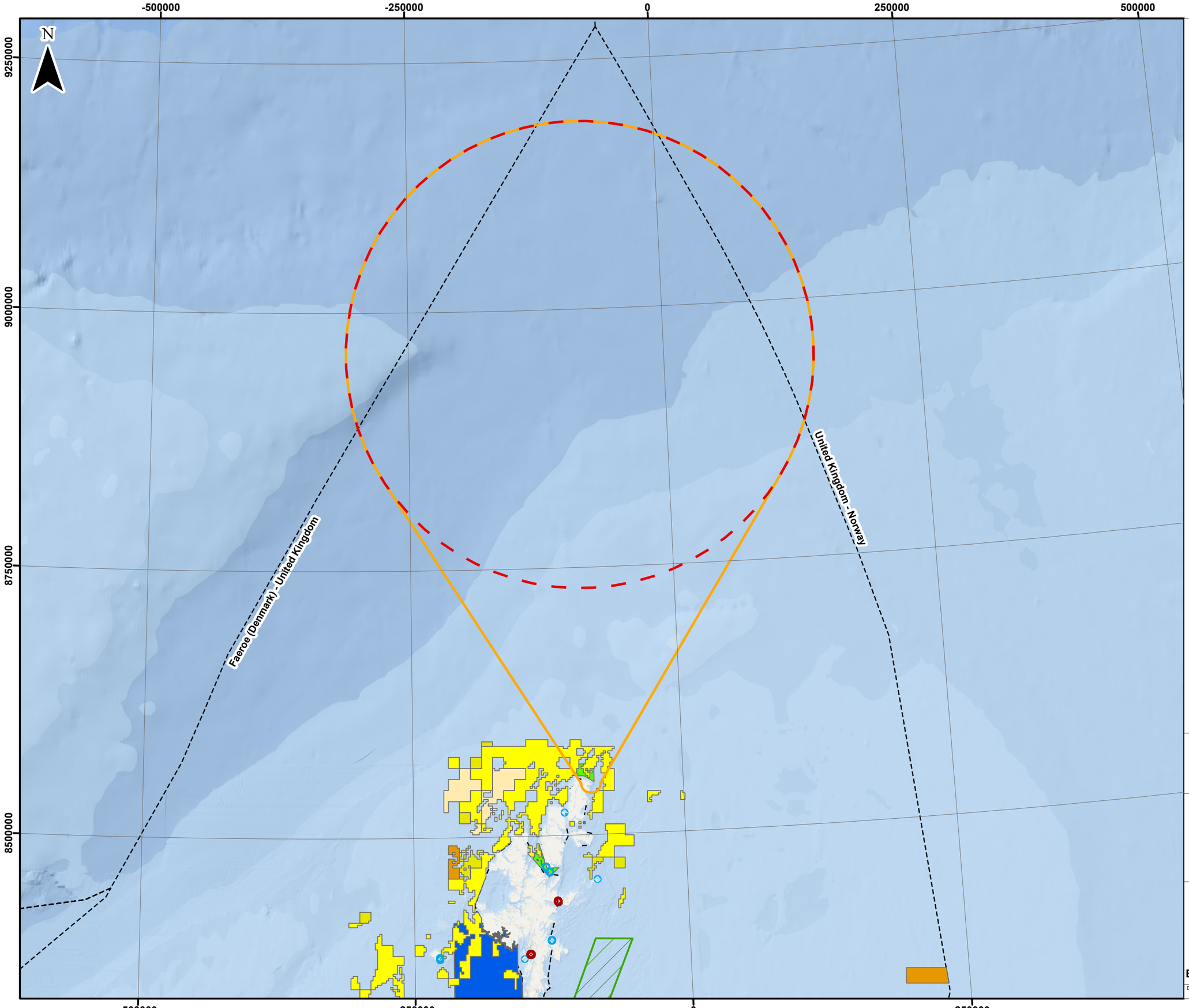
Other Marine Users - Environmental Zone of Influence

Date:	Drawn by:	Checked by:	Version:
7/26/2024	AN	IW	Draft/V1

Project Number: 3148

Service Layer Credits: World Ocean Base: Esri, GEBCO, Garmin, NaturalVue

Chapter 6 Drawing 6.4 Current and Potential Use of Matine Environment



KEY

- SR75 Environmental Zone of Influence (EZI)
- SR75 Launch Vehicle Impact Dispersion Area
- Open Dredge Disposal Spoil Deposit Site
- Disused Dredge Disposal Spoil Deposit Site
- Closed Dredge Disposal Spoil Deposit Site
- Tidal Lease Sites
- Tidal Draft Plan Options
- 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

0 40,000 80,000 m

Scale 1:1,600,000 @ A3

HyImpulse

HyImpulse
Assessment of Environmental Effects

Drawing 6.4

Current and Potential Use of Marine Environment - Environmental Zone of Influence

Date:	Drawn by:	Checked by:	Version:
7/26/2024	AN	IW	Draft/V1

Project Number: 3148

Service Layer Credits: World Ocean Base: Esri, GEBCO, Garmin, NaturalVue

Chapter 6 Drawing 6.5 Oil, Gas and Telecoms Infrastructure

-500000

0

500000

9000000

8500000

N

Faeroe (Denmark) - Norway

Faeroe (Denmark) Straight Baseline

Faeroe (Denmark) - United Kingdom

United Kingdom - Norway

Norway Straight Baseline

Faeroe (Denmark) - United Kingdom

KEY

- SR75 Launch Vehicle Impact Dispersion Area
- SR75 Environmental Zone of Influence (EZI)
- Offshore Installation
- Gas Pipeline
- Mixed Hydrocarbons Pipeline
- Oil Pipeline
- Telecommunication Cable
- EEZ boundaries

0 50,000 100,000 m

Scale 1:2,000,000 @ A3

HyImpulse

HyImpulse
Assessment of Environmental Effects

Drawing 6.5

Oil, Gas and Telecoms Infrastructure - Environmental Zone of Influence

Date:	Drawn by:	Checked by:	Version:
7/26/2024	AN	IW	Draft/V1

Project Number: 3148

Service Layer Credits: World Ocean Base: Esri, GEBCO, Garmin, NaturalVue

Chapter 7 -

Chapter 8 -

Volume IV AEE Technical Appendices

Appendix 1.1 CVs

Ruth Fain, MGeol (Hons.) CSci

MIEnvSc MIAQM



Ruth is a Chartered Scientist and Member of the Institute of Environmental Sciences with over 20 years' experience. Ruth specialises in the assessment of environmental effects (AEE) of UK Spaceflight activities, Environmental Impact Assessment (EIA) for large industrial and infrastructure projects and general environmental regulatory compliance for a wide range of industrial, manufacturing and renewable energy clients.

With a focus on planning and permitting regimes for both the space Industry and terrestrial development, Ruth is experienced in all aspects of environmental regulation and management. She uses this operational knowledge in her development project management, bringing a whole project approach to the planning and design stages. Ruth is Director of Aurora Environmental Consulting Limited.

Education

- MGeol (Hons) Environmental Geology

Selected Project Experience

Space

Planning Application, United Kingdom, SaxaVord Spaceport 2020-2022

Project management and delivery of EIA as part of major planning application for the UK's first 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. Support to the public consultation process and ad hoc technical advice.

AEE in support of Spaceport Operator Licence, United Kingdom, SaxaVord Spaceport 2021-2023

Project management and delivery of Assessment of Environmental Effects (AEE) to the Civil Aviation Authority in support of 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. Similar scopes undertaken for the following Launch Vehicle Operator clients.

AEE in support of Launch Operator Licence (Suborbital), Poland, Lukasiewicz Research Network – Institute of Aviation 2023

AEE in support of Launch Operator Licence (Orbital), USA, ABL Space Systems 2022-2024

AEE in support of Launch Operator Licence (Orbital and suborbital), Germany, Rocket Factory Augsberg 2022-2024

AEE in support of Launch Operator Licence (Orbital and suborbital), United Kingdom, Skyrora 2022-2024

AEE in support of Launch Operator Licence (Orbital and suborbital), United Kingdom, Orbex Express Launch 2025

Environmental Impact Assessment

Electric Arc Furnace, British Steel Teesside, 2023

Project management and delivery of EIA as part of successful planning application for an electric arc furnace conversion project at British Steel.

Billet and Casting Facility, Alvance British Aluminium, 2022

Project management and delivery of EIA for development of a 12,254 m2 billet and casting facility in Fort Willaim. Works included multi-discipline EIA, flood risk management, drainage strategy design and peat management planning billet and peat management planning.

Combined Cycle Power Plant, Sembcorp, 2022

Project management and delivery of EIA Air Quality, Noise and Greenhouse gas assessment works to support DCO variation required by design change to alternative technology.

Impact assessment in support of planning application, Conrad Energy, 2022-2024

Project management and delivery of Environmental Information Reports covering noise, landscape and traffic effects of synchronous condenser developments in Teesside and Suffolk.

Hilthorn Business Park - Sunderland, Legal and General, 2021

Management and delivery of EIA technical input for a large industrial business park.

Distilleries (Scotland), Various, 2019-2024

Project management and delivery of development EIA for proposed distilleries including Glenmorangie, Glenrothes and a new distillery in Jedburgh. Multi-disciplinary assessment of construction and operational effects in accordance with appropriate standards.

Mining Development, Confidential Client, Gabon, 2017-2019

EIA assessment including air quality monitoring (in-field) to support a World Bank standard environmental and social impact assessment for the construction and operational phase of a mine in Gabon, Africa.

Motorway, Kosovo Ministry of Transport, Kosovo, 2014-2017

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.

Consenting – Industrial

PPC / EP permit applications, 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 Group, Gilbertson and Page, and Premier Foods. Support during negotiations with regulatory authorities, coordination of specialist studies and ongoing compliance and stakeholder engagement work.

Long term regulatory compliance support / Environmental Advisor

Provision of long term environmental compliance advice and support to various UK manufacturers including Nestlé UK, Refresco Beverages, Gilbertson and Page. Works 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.

Technial Guidance

Best Practice Guidance on Assessment of Environmental Effects for the Space Industry, CAA / Industry 2024-ongoing

Working group chair and co-author of forthcoming best practice guidance on methodologies for assessment of environmental effects in the space industry.

Guidance on the Assessment of Odour for Planning, Institute of Air Quality Management, 2014 (updated 2018)

Co-author of IAQM document prepared to assist practitioners involved in odour assessment for planning.

Memberships and Associations

- 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)

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.

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.

Dr. Liam Dickson

Managing Marine Consultant - Ecology

Liam is a managing marine consultant in the Ecology group at ERM. He has worked across a range of sectors, including offshore renewables, oil and gas, and the UK space industry. His experience includes authoring of marine mammal EIA and ESIA chapters, Scoping Reports, and EPS risk assessments for offshore wind projects across England, Wales, Scotland, Ireland, and abroad. He has also authored environmental appraisals for decommissioning projects, and EAJs for geophysical surveys for North Sea oil and gas projects.



EXPERIENCE: 6 years' experience in consultancy and marine academia

LINKEDIN: https://www.linkedin.com/in/liam-dickson/

EMAIL: liam.dickson@erm.com

EDUCATION

- Doctor of Philosophy, Marine Spatial Ecology
- Master of Science, Marine Environment and Resources
- Bachelor of Science (Honours), Wildlife Biology

FIELDS OF COMPETENCE

- Assessments of Environmental Effects (AEE)
- Environmental Appraisal (EA) and Environmental Assessment Justification (EAJ) reports
- Environmental assessment (EIA and HRA)
- European Protected Species (EPS) risk assessments, licensing and legislation
- Basking shark risk assessments, licensing and legislation
- Nature conservation legislation and policy

KEY INDUSTRY SECTORS

- Aerospace (Marine and Transboundary)
- Renewable Energy (Offshore wind)
- Oil and Gas

PUBLICATIONS

- Dickson, L.C., Katselidis, K.A., Eizaguirre, C., Schofield, G. Incorporating Geographical Scale and Multiple Environmental Factors to Delineate the Breeding Distribution of Sea Turtles. Drones 2021, 5, doi:10.3390/drones5040142.

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- Schofield, G., Dickson, L.C., Westover, L., Dujon, A.M., Katselidis, K.A. COVID - 19 disruption reveals mass - tourism pressure on nearshore sea turtle distributions and access to optimal breeding habitat. Evolutionary Applications 2021, doi:10.1111/eva.13277.
- Dickson, L.C., Tugwell, H., Katselidis, K.A., Schofield, G. Aerial drones reveal the dynamic structuring of sea turtle breeding aggregations and minimum survey effort required to capture climatic and sex-specific effects. Frontiers in Marine Science 2022. doi:10.3389/fmars.2022.864694
- Schofield, G., Papafitsoros, K., Chapman, C., Shah, A., Westover, L, Dickson, L.C., Katselidis, K. More aggressive sea turtles win fights over foraging resources independent of body size and years of presence. Animal Behaviour 2022. doi: 10.1016/j.anbehav.2022.05.006

KEY PROJECTS

Rocket Factory Augsburg Assessment of Environmental Effects (AEE)

Author of Marine and Transboundary chapter, follow-up consultation with CAA and requests for information (RFI)

HyImpulse AEE

Author of Marine and Transboundary chapter, follow-up consultation with CAA and requests for information (RFI)

ABL AEE

Author of Marine and Transboundary chapter, follow-up consultation with CAA and requests for information (RFI)

ILOT AEE

Author of Marine and Transboundary chapter, follow-up consultation with CAA and requests for information (RFI)

Skyrora AEE

Author of Marine and Transboundary chapter, follow-up consultation with CAA and requests for information (RFI)

SaxaVord Spaceport AEE

Co-author of Marine and Transboundary chapter, revisions and requests for information

bp FLORA and bp MORVEN OWF EPS License Risk Assessments

Author of EPS license Risk Assessments, including basking shark impact scoping.

Celtic Sea Array OWF EIAR Scoping Report

Author for Marine Mammals and Megafauna chapter

White Cross OWF EIA

Co-author for Fish & Shellfish, and Fisheries chapters.

Northland EPS and Basking Shark Risk Assessment Review

Review of methodology and data outlined in the EPS and Basking Shark Risk Assessment for geophysical surveys, produced by SMRU for Northland Power.

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

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Specialisation:	Botanist and ecologist
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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

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
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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.

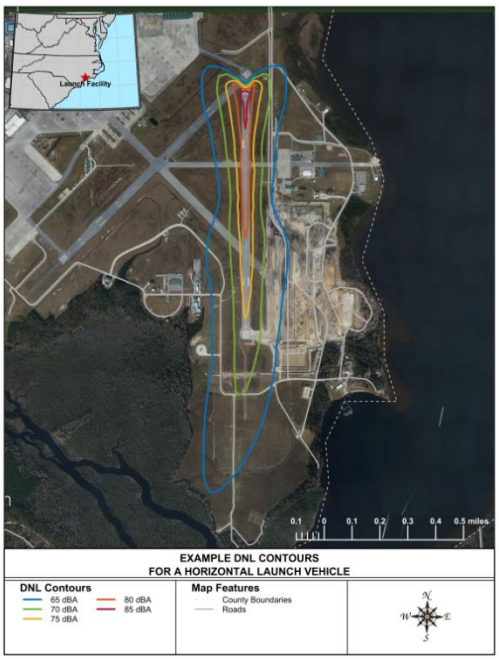
1.2 Related Projects

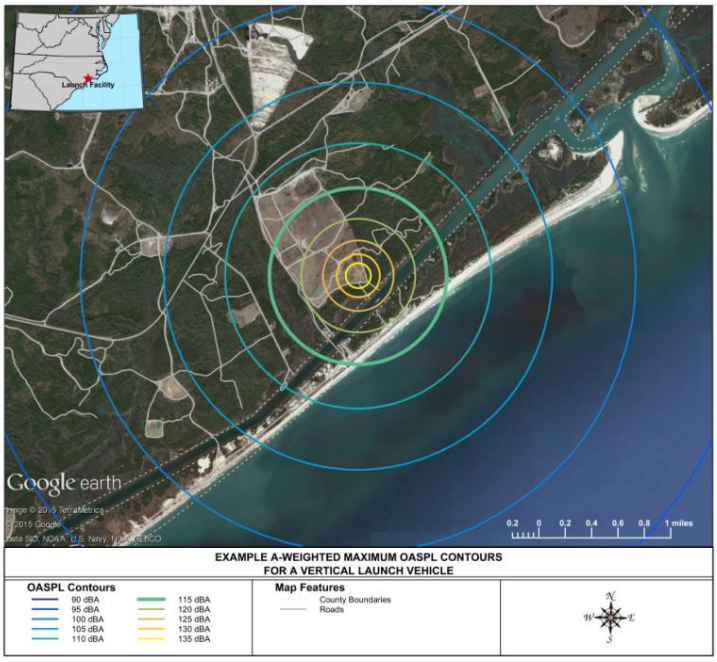
LAUNCH VEHICLE ENVIRONMENTAL NOISE STUDIES
Various Primes *Date: 2010 to Present*

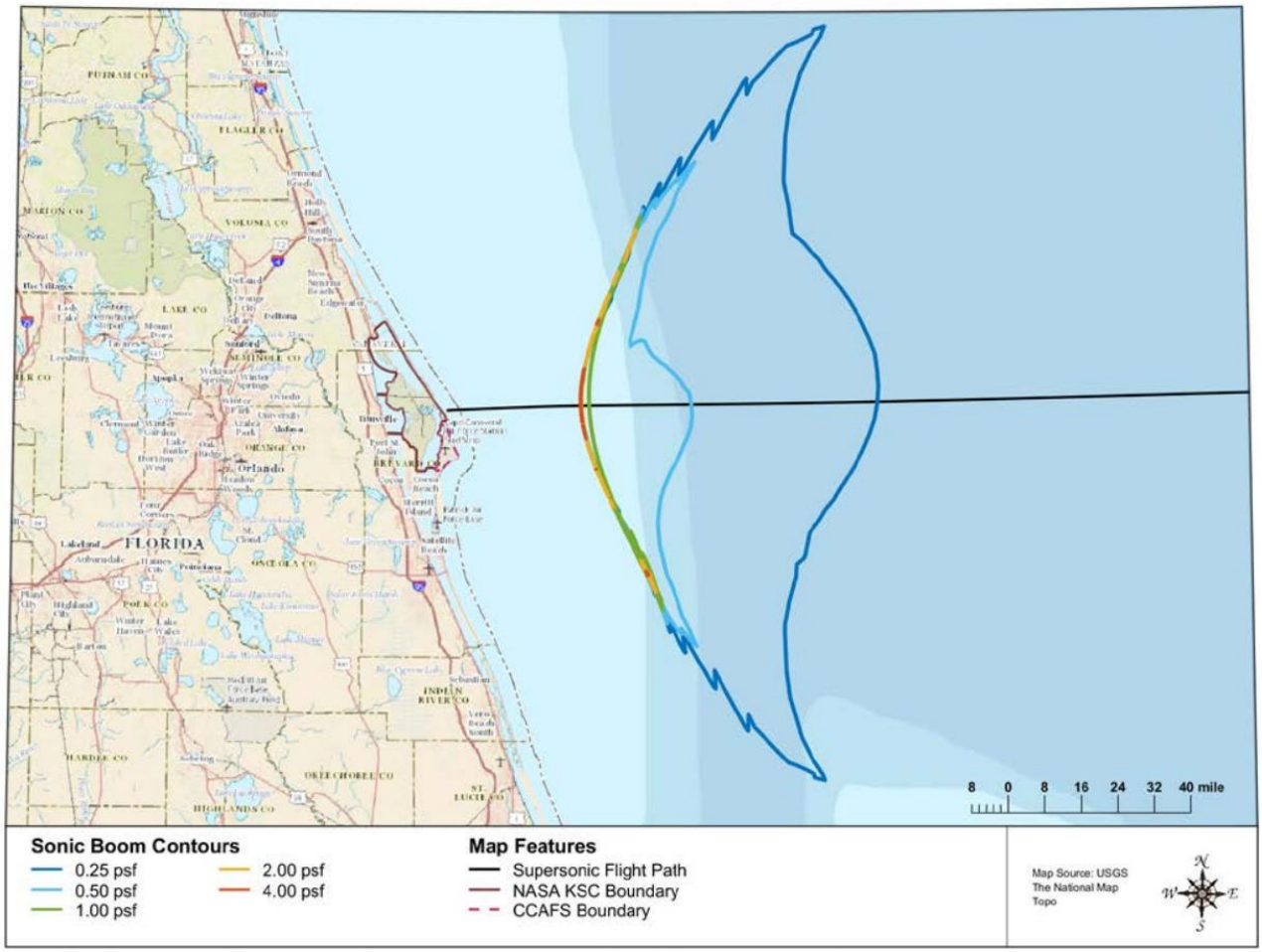
BRRC has provided noise analyses as the prime launch vehicle noise consultant in over twenty-five rocket noise environmental studies. The noise effects on the local communities and environment were evaluated based on the FAA Order 1050.1F, Environmental Impacts: Policies and Procedures, on a cumulative 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).


Launch Facility
0.1 0 0.1 0.2 0.3 0.4 0.5 miles
EXAMPLE DNL CONTOURS
FOR A HORIZONTAL LAUNCH VEHICLE
DNL Contours
65 dBA
70 dBA
75 dBA
80 dBA
85 dBA
Map Features
County Boundaries
Roads

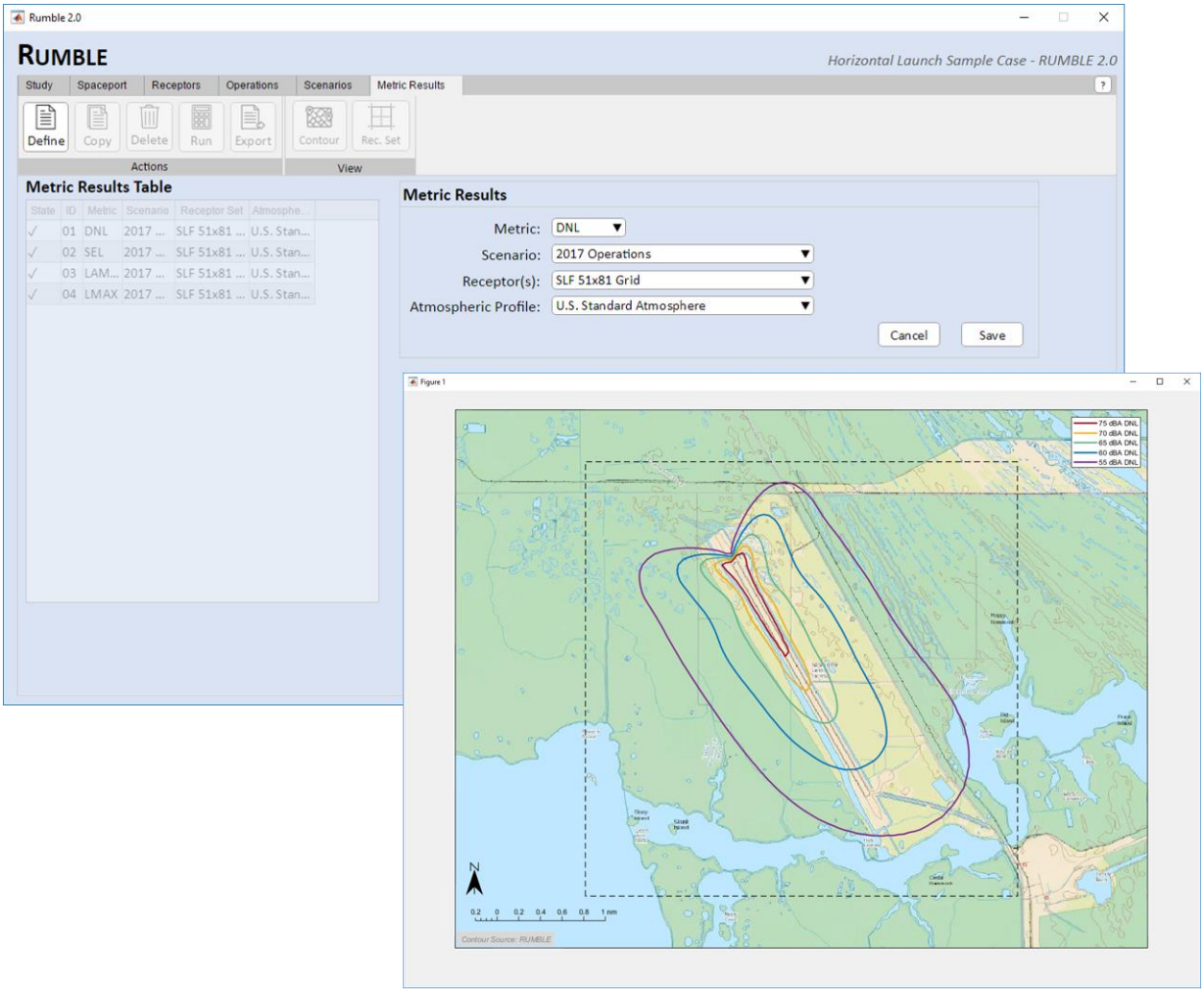

Launch Facility
Google earth
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EXAMPLE A-WEIGHTED MAXIMUM OASPL CONTOURS
FOR A VERTICAL LAUNCH VEHICLE
OASPL Contours
90 dBA
95 dBA
100 dBA
105 dBA
110 dBA
115 dBA
120 dBA
125 dBA
130 dBA
135 dBA
Map Features
County Boundaries
Roads


FLORIDA
Orlando
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
Map Source: USGS
The National Map
Topo

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.



PROPRIETARY

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.

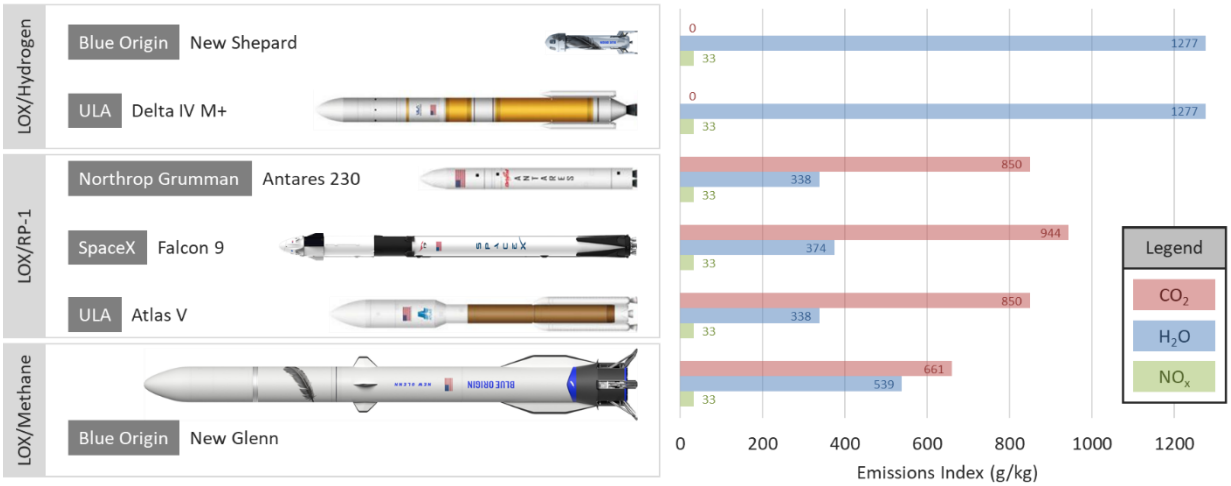




ACRP 02-85: COMMERCIAL SPACE VEHICLE EMISSIONS MODEL

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.



PROPRIETARY

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

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.

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.

Chapter 2 -

Appendix 3.1 SaxaVord Spaceport AEE V3 Chapter 4 Population and Human Health

CHAPTER 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 This chapter sets out the effects of the Proposed Project on population and human health, and in particular focuses on the socio-economic effects including the economic impacts associated with its operation.

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. In this context, the Proposed Project represents a transformational and much needed economic development opportunity for Unst and for the Shetland Isles.

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 sub-orbital 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 space ports, 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 2015 the Scottish Government published the Scottish Government Economic Strategy (Scottish Government, 2015). In order to make Scotland a more successful country over a range of dimensions, the strategy has at its core increasing sustainable economic growth. This relies on simultaneously boosting competitiveness and reducing inequality.

4.2.4 Four themes have been identified as key to generating sustainable economic growth: internationalisation, innovation, inclusive growth and investment.

4.2.5 The innovation and high-value activities carried out by the space sector, the potential to attract investment and international companies in the small satellite sector and, the possibility to support local economic growth, are all in line with the four themes identified in the Scottish Government's Economic Strategy.

4.2.6 In the summer of 2021, the Scottish Government established a new Advisory Council to develop a new 10 year national strategy for economic transformation. Whilst that has not yet been published the Scottish Government's priorities can be seen in the Programme for Government.

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

4.2.7 The Scottish Government's Programme for Government 2021-22 (Scottish Government, 2021) sets out the strategic aims and ambitions for a 'fairer, greener Scotland' over the next parliamentary term, and also 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 space ports 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 launch activity taking place from the Proposed Project could diversify the portfolio of visitor attractions that the Shetland Islands can offer. The fact that launch activity 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 CAA document "Guidance for the Assessment of Environmental Effects"(July 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 (e.g., EIAs provided as part of a planning application) and whether they are being used in support of the AEE;
- 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 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 Chapter 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 Generator emissions are predicted to have no perceptible impact at any identified receptors. The emissions from generators are predicted to have an effect of negligible significance on local air quality, therefore resulting in **no likely significant effect**. Emissions are also expected to reduce over the lifetime of the Proposed Project due to the Applicant's intention to secure a permanent three phase power supply in time.

4.3.5 Launch event 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 28% of the relevant air quality standard for human health. Emissions from launch events are therefore considered to have an effect of negligible significance on air quality**,** therefore resulting in **no likely significant effect**.

Noise

4.3.6 Potential noise and vibration effects associated with the Proposed Project have been robustly assessed with regard to static engine tests, launches and non-launch activities.

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

4.3.8 Noise during engine tests 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.

4.3.9 Of the proposed 30 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 up to four launches. Given the proposed frequency of launches and the short duration of the noise events associated with launches, 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**.

4.3.10 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 effects associated with engine tests and launches have therefore been assessed as not significant, resulting in **no likely significant effect**.

4.5 Population Effects: Assessment Methodology and Significance Criteria

Environmental Zone of Influence

4.5.1 The study areas (equivalent to the EZI) considered in the population and human health assessment are:

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

Assessment of Socio-Economic Benefits

4.5.2 The assessment of socio-economic (population) 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.

4.5.3 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.

4.5.4 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.

4.5.5 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 operations of the Proposed Project;
- temporary workers' spending on accommodation and subsistence; and,
- the spending of visitors viewing the launches.

4.5.6 The analysis relied on data from publicly available statistics, on conversations with the Applicant and previous experience. When assumptions were made throughout the analysis, these have been set out clearly and justified.

4.5.7 To estimate the impacts associated with the Proposed Project, the value of contracts carried out or the employment supported by them has been estimated from information given by the Applicant. 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.

4.5.8 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.

4.5.9 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).

4.5.10 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.

4.5.11 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).

4.5.12 In estimating net economic benefits, the analysis followed the guidance on additionality as set out in the Homes & 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.

4.5.13 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

4.5.14 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.

4.5.15 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.

4.5.16 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.

4.5.17 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 %.

4.5.18 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

4.5.19 Since there are no existing satellite space ports located in the UK or across Europe, it is not possible to rely on any evaluation carried out on the impacts from a similar development.

4.6 Population Effects: Baseline Conditions

Economic Context

4.6.1 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.

4.6.2 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.

4.6.3 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.

4.6.4 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

4.6.5 Baseline socio-economic characteristics have been determined for three study areas: Unst, The Shetland Islands and Scotland.

4.6.6 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

4.6.7 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).

4.6.8 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)

4.6.9 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.

4.6.10 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)

4.6.11 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

4.6.12 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)

4.6.13 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 & 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

Source: (Shetland Islands Council, 2018b)

4.6.14 As shown in 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.

4.6.15 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.

4.6.16 According to recent data from Her Majesty's Revenues and Customs (HMRC, 2020a) detailed in Table 4.6 below, by June 2020 at least 3,100 people in the Shetland Islands had been put on furlough due to COVID-19. The recipients of help from the Government support scheme for the self-employed totalled 600 people (HMRC, 2020b). The share of those placed on furlough with respect to the eligible population was higher in Scotland on average (30 %) than in the Shetland Islands (25 %). Similarly, in the Shetland Islands 68 % of those who could benefit from the Self-Employment Support Scheme applied for it, compared to 75 % across Scotland.

Table 4.6 Population on COVID-19 Government Support Scheme

	Shetland Islands		Scotland	
	Value	Eligible (%)	Value	Take-up rate
Coronavirus Job Retention Scheme	3,100	25 %	736,500	30 %
Self-Employment Income Support Scheme	600	68 %	155,000	75 %

Source: (HMRC, 2020a) (HMRC, 2020b)

4.6.17 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

4.6.18 Education qualification levels in the Shetland Islands are significantly lower than in Scotland as a whole as shown in Table 4.7 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 4.7 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)

4.6.19 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

4.6.20 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

4.6.21 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 4.8 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)

4.6.22 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.

4.6.23 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.

4.6.24 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

4.6.25 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).

4.6.26 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.

4.6.27 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).

4.6.28 The Proposed Project and the launch activity associated with it provide 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.

4.6.29 The launch activity associated with the Proposed Project is also expected to lead to an increase in business tourism, as the launch activity will require temporary staff from the launch companies to be on-site for a minimum of six weeks per launch event.

4.6.30 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 launch activity as well as to expand existing provision.

4.6.31 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.

4.6.32 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.

4.7 Receptors Brought Forward for Assessment

4.7.1 The following receptors were brought forward for assessment:

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

4.9 Potential Effects

4.9.1 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

4.9.2 Once built, the Proposed Project will allow for launches by multiple Launch Operators using a range of different launch vehicles. The Applicant is looking to achieve a maximum of 30 launch events per year.

4.9.3 The Applicant anticipates that there will be three high skilled jobs linked to the operation of the Proposed Project, as well as a series of supporting roles including security, maintenance and provision of accommodation for the Launch Operators temporary staff, who will be present prior to and immediately after each launch.

4.9.4 Each of the jobs identified has been allocated to an industrial sector and the anticipated location of the job established. Of the 98 jobs to be supported by full operation of the Proposed Project, 63 are expected to be based in Unst and 35 elsewhere within the Shetland Islands.

4.9.5 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).

4.9.6 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.

4.9.7 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.

4.9.8 Summing these elements together, it is estimated employment associated with operation of the Proposed Project will generate £3.3 million GVA and support 68 jobs in Unst. For the Shetland Islands this increases to £5.3 million GVA and 119 jobs, and for Scotland, £6.2 million GVA and 137 jobs as shown in Table 4.9 below.

[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).

Table 4.9 Economic Impact – Employment associated with the Proposed Project

	Unst	Shetland Islands	Scotland
Employment	68	119	137
GVA (£m)	3.3	5.3	6.2

4.9.9 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

4.9.10 Launch Operators will need to accommodate their own staff locally during preparation and decommissioning works prior to each launch. It is envisaged that some staff may also be permanently located in Unst, if Launch Operators find that they are using the Proposed Project on a frequent basis.

4.9.11 Launch Operators 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.

4.9.12 The Applicant anticipates that up to 50 Launch Operator workers will be stationed on Unst for around four weeks during the lead-up to any given launch event. By multiplying staff days required by the number of launches it is estimated that Launch Operator workers will stay on Unst for up to 42,000 days per year when the target of 30 launches per year is achieved.

4.9.13 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.

4.9.14 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 £2.1 million, discounted by 8 % to account for spending on VAT.

4.9.15 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.

4.9.16 It is estimated that spending on food and accommodation from the temporary launch workers will generate £1.2 million GVA and support 55 jobs on Unst. For the Shetland Islands this increases to £1.4 million GVA and 59 jobs, and for Scotland £1.6 million GVA and 64 jobs as shown in Table 4.10 below.

Table 4.10 Economic Impact - Accommodation Spending

	Unst	Shetland Islands	Scotland
Employment	55	59	64
GVA (£m)	1.2	1.4	1.6

4.9.17 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

4.9.18 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.

4.9.19 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.

4.9.20 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 Operator workers as described in the previous section. In addition, 20 of the visitors are anticipated to be senior staff from the Launch Operators. Consequently, it has been assumed that there will be capacity to accommodate 160 visitors per launch.

4.9.21 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 event, 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.

4.9.22 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. During the first year, when 10 launches are anticipated, visitor numbers are therefore estimated at 3,922. For future years when the target of 30 launches per year is achieved, this is estimated to rise to 7,677 visitors.

4.9.23 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.

4.9.24 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.

4.9.25 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.

4.9.26 It is estimated that tourism due to the Proposed Project will generate £0.4 million GVA and support 17 jobs on Unst. For the Shetland Islands this increases to £0.8 million GVA and 30 jobs, and for Scotland £1.5 million GVA and 54 jobs as shown in Table 4.11 below.

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

Table 4.11 Tourism Impact

	Unst	Shetland Islands	Scotland
Employment	17	30	54
GVA (£m)	0.4	0.8	1.5

4.9.27 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 of Operational Effects

4.9.28 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 4.12 below, it is considered that the Proposed Project will generate:

- £4.9 million GVA and 139 jobs in Unst (representing a substantial increase in employment);
- £7.5 million GVA and 209 jobs across the Shetland Islands; and,
- £9.3 million GVA and 255 jobs across Scotland.

Table 4.12 Total Economic Impact from Operation of Proposed Project

	Unst	Shetland Islands	Scotland
Employment	139	209	255
GVA (£m)	4.9	7.5	9.3

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.

4.9.29 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 providing a location from which launch activity could be carried out. 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 investment. Once the Proposed Project is fully operational, it may become convenient for some launch companies to have permanent staff on the Shetland Islands, instead of dispatching temporary workers for each launch. Investment may also come from businesses supporting the operations of the space

centre, as a reliable stream of work may encourage them to invest or lead to the emergence of new businesses seeking to benefit from space-related contracts.

- Encouraging investment in the tourism sector, as launch activities extend the tourism season and provide additional visitors to Unst and to the Shetland Islands with another reason to spend time there.

4.10 Mitigation and Further Studies

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

4.10.2 The Applicant is committed to a further study of the socio-economic effects of the Proposed Project as part of its preparations for operation. The Applicant has partnered with the Open University to research development of socio-economic opportunities arising from the Proposed Project beyond the usual indicators.

4.10.3 The Open University study will develop a stakeholder analysis framework to assess the socio-economic benefits of the Proposed Project as part of the UK's Launch UK spaceflight programme. It is recognised that space ports can involve highly sensitive, rural areas, and consultations for stakeholder input analysis regarding socio-economic benefit assessments must be carefully planned (and tailored to the specific locale) in collaboration with local partners. Working with the Applicant, the Open University team will determine the stakeholders involved in the space port and define the most appropriate consultation and analytical process, thus enabling the Open University's socio-economic benefits evaluation framework to be applied. The focus of the framework is on determining the less tangible socio-economic benefits that arise from such activities, beyond the traditional financial analyses performed to date.

4.10.4 The study is currently in progress and will be reported as appropriate on completion.

4.11 Residual Effects

4.11.1 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 14.6 above, as summarised below.

4.11.2 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.

4.12 Cumulative Assessment

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

4.12.2 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 other existing or proposed developments with the potential to influence cumulative effects in the local EZI (Unst). The relative effect of the Proposed Project on the regional and national scale EZI has been assessed within this chapter already.

4.12.3 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. Whilst human health effects from the air quality and noise impacts are considered within this chapter, none of the effects directly impact between the disciplines and therefore there are no potential intra-project cumulative effects.

4.12.4 It is noted, however, that if the Proposed Project 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 further increase the economic impacts in the Unst and Shetland Islands economies, having a positive additive effect.

4.13 Summary

4.13.1 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.

4.13.2 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.

4.13.3 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 from the launch companies who will then utilise local shops, hospitality and other amenities; and,
- attracting tourists who will visit to watch launches and/or explore the Proposed Project (including outside the current summer tourism season).

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

4.13.5 Full operation of the Proposed Project 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.

4.13.6 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.

4.13.7 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.

4.13.8 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.

4.13.9 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.

4.13.10 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.

4.13.11 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 providing a location from which launch activity could be carried out.
- 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 launch activities extend the tourism season and provide additional visitors to Unst and to the Shetland Islands.

4.14 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*

Department for Transport 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.*

HMRC. (2020a). Coronavirus Job Retention Scheme (CJRS) Statistics: June 2020.

HMRC. (2020b). *Self-Employment Income Support Scheme Statistics: July 2020.*

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. (2015). *Scotland's Economic Strategy.*

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 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/

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Appendix 3.2 SaxaVord Spaceport AEE V3 Chapter 6 Ecology

CHAPTER 6 ECOLOGY

6. Ecology and Biodiversity

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6. Ecology and Biodiversity

6.1 Introduction

6.1.1 This AEE Report chapter considers the likely effects of the Proposed Project on ecological receptors at the site and surrounding study areas. 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 Ltd. led on all aspects of the ecological 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 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 EcIA Reports, Habitat Regulations Assessments and Habitat Management Plans.

6.1.3 The ecological surveyors used in the study areas 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 SNH 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 6.3: Otter Survey Report and Otter Protection Plan.
- Appendix 6.4: Freshwater Pearl Mussel Survey Report.
- Appendix 5.3: Outline Habitat Management Plan.

6.1.6 This Chapter should be read alongside other Chapters within the AEE Report, particular Chapters 2, 3, 5, 9, 10 and 12.

6.1.7 The assessment involved the following key stages:

- Reference to relevant legislation, policy and guidance.
- Identification Ecology Study Area – a component part of the overall environmental zone of influence (EZI) of 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 process 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 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.

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 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. However, AEE is only relevant to applications for spaceport licences.

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;
- 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);
- 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);
- The Fourth National Planning Framework (NPF4), (2022);
- The Shetland Local Development Plan (2014);
- The Shetland Local Development Plan Supplementary Guidance (2018); and
- Living Shetland Local Biodiversity Action Plan (LBAP) documents.

6.2.5 There is no Scottish or UK specific ecological guidance on satellite launch operations.

6.2.6 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. NPF4 (2022) has recently been re-drafted and is designed to support Scotland's commitment of reaching net zero emissions by 2045 and thereby tackling the climate change emergency.

6.2.7 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.

6.2.8 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 (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.

6.2.9 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.

6.2.10 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

6.2.11 The CAA, with the UK Space Agency, the Department for Business, Energy and Industrial Strategy and the Department for Transport, issued guidance note '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.

6.2.12 The AEE Guidance requires that potential direct and indirect significant effects of proposed spaceflight activities on environmental features, including ecology, 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 ecology and biodiversity.

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

6.2.13 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; and*
- *Protect the marine environment from the impact of spaceflight activities.*

6.2.14 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 ecology 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.

Table 6.1 Consultation relevant to this AEE

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*	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

Consultee	Summary Ecological Response	Where and How Addressed
	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".	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, 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*	Otter surveys, including the pre-construction otter survey are reported in Appendix 6.3b. The Otter Protection Plan is also provided as part of Appendix 6.3a (note that this is a 'live document' and so regularly updated). Otters are considered throughout this chapter.

Consultee	Summary Ecological Response	Where and How Addressed
	under the approved OPP as may be agreed to in writing by the Planning Authority.	

6.3.2 Given the geographical location and habitats present, and in consultation with SNH, 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 SNH nor CIEEM provide 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 SIC 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.

Study Area

6.4.2 The following geographic definitions are used in this Chapter and associated Appendices (Drawings 6.1 and 6.2 and Table 6.2).

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 planning application 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

6.4.3 These geographic areas combined are considered to Ecology Study Area which is included as a component part in the overall EZI for the Proposed Project.

6.4.4 The Proposed Project provides the basic infrastructure for space vehicle launches. The Applicant is looking to achieve a maximum of 30 launch events per year from the Proposed Project.

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

- 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;
- Integration Hangars (three): located on the Lamba Ness peninsula, a building where the launch vehicles are assembled, and the payload (the satellites) prepared and integrated into the launch vehicles; and
- Preparation and launch of launch vehicles.

6.4.6 The he Proposed Project provides the basic infrastructure for space vehicle launches. The Applicant is looking to achieve a maximum of 30 launch events per year from the Proposed Project.

6.4.7 The Ecology Study Area is the area over which ecological receptors may be affected by biophysical changes as a result of the Proposed Project (CIEEM, 2018). The Ecology Study Area will vary for different ecological receptors depending on their sensitivity to, and nature of, an environmental change. The Ecology Study Area can extend beyond the site, particularly in the context of hydrological connectivity and potential pollution events. However, the Ecology Study Area is considered appropriate for the vast majority of ecological receptors.

6.4.8 For habitats, the study area 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).

6.4.9 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.

6.4.10 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.

6.4.11 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.

6.4.12 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 areas (Drawing 6.1) was considerably larger than the Proposed Project boundary area and it was centred on indicative launch pad locations provided by the Applicant during pre-application consultation discussions in 2018.

6.4.13 Surveys 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.

6.4.14 A plan showing the Ecology Study Area for both the habitats and otter assessments is included as Drawing 6.1.

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 grazings.

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 (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. Whilst no systematic Phase 1 Habitat survey was undertaken in 2022, in line with best practice guidance, the Study Area was walked over during summer months by the same experienced habitat surveyor and no substantive changes were recorded other than the construction works commencing and so the 2018-2020 baseline survey and assessment is considered robust.

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. Whilst no systematic NVC survey was undertaken in 2022, in line with best practice guidance, the Study Area was walked over during summer months by the same experienced habitat surveyor and no substantive changes were recorded other than the construction works commencing and so the 2018-2020 baseline survey and assessment is considered robust.

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. Whilst no systematic PCA was undertaken in 2022, in line with best practice guidance, the Study Area was walked over during summer months by the same experienced habitat surveyor and no substantive changes were recorded other than the construction works commencing and so the 2018-2020 baseline survey and assessment is considered robust.

Otter Survey

6.4.23 The Otter study area was surveyed under SNH licence for otters in 2018 and 2020 by Mr Brydon Thomason, a highly experienced and locally based otter surveyor, with unparalleled practical experience of working on otters in Unst (Appendix 6.3a).

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 (Appendix 6.3b) was undertaken in March 2022 by Mr Donald Shields MCIEEM, a highly experienced mammal surveyor and ecologist. Surveys were undertaken around the Development Footprint and in suitable habitat within a 200 m buffer.

6.4.25 The survey methods involve 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 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 6.3a. The pre-construction surveys undertaken in 2022 are provided as an addendum to the previous otter survey report (Appendix 6.3b) and provide an update on the otter European Protected Species baseline (Appendix 5.1b). The existing 2018-2020 survey data and assessment is considered robust in light of the updated 2022 survey data which demonstrates no substantial changes in the baseline conditions.

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 ecological receptors within a study 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.

Term	Definition
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 There is a growing body of policy and guidance that development plans should not just try to avoid causing likely significant effects. Best practice guidance recommends seeking to provide enhancement for important biodiversity over and above design requirements for avoidance, minimisation or compensation (e.g., CIEEM, 2018; NPF4, 2022).

6.4.51 This Chapter considers mitigation in the context of CIEEM guidance and also in relation to local planning authority guidance for protected species. Embedded mitigation has been considered previously in the design layout for the Proposed Project and because of this, 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

6.4.52 After assessing the potential impacts of the Proposed Project, 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

6.4.53 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.

6.4.54 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 6.3). 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 Villa 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*) • 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

Designated Site	Designation Type	Area (ha)	Distance (km) and Direction from Proposed Project	Biological Qualifying Features
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
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 Haroldwick	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 (SIC, 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.

Local Conservation Sites on Unst	Primary Interest	Justification for Local Conservation Site
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.
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 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

Species name	Common name	Taxa	Listing	Closest Record to the Proposed Project	Year of Record
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	Oysterplant	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 to 6.7 inclusive. 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

Phase 1 Habitats	Area (ha)	% of Habitats Study Area
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 site determined that the potential GWDTE were either assessed as not being actual GWDTE or were >250 m from the Proposed Project (Chapter 9).

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 Oysterplant, 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. Evidence of otter activity was also recorded during the 2022 pre-construction surveys.

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 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 use is likely to include at least one male and one female, sometimes with young, around the Otter 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.

Potentially Important Receptor	Evaluation of Potentially Important Receptor Population/Feature within Study Area
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 (Chapter 9). 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 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

Potentially Important Receptor	Evaluation of Potentially Important Receptor Population/Feature within Study Area
	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 *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).

Potentially Important Receptor	Evaluation of Potentially Important Receptor Population/Feature within Study Area
	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) 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 throughout the planning stage of the Proposed Project, design of which has been amended to avoid or minimise effects on ecological receptors as far as possible within the parameters of the project. As such, mitigation has been embedded within the project design 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, 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 According to CIEEM best practice guidance, where design layout impacts on important ecological receptors cannot be avoided, they should be minimised. Minimisation takes many forms, with subsequent design iteration being tweaked and amended where possible to reduce potential ecological impacts.

6.7.6 Minimisation for otters is implemented through the Otter Protection Plan.

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. This is not the case for the Proposed Project, and so no compensatory measures are proposed.

6.7.8 The SaxaVord Spaceport 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.

6.8 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 during operation are assessed within this section. For full details of the proposed scheme refer to Chapter 3.

6.8.2 The potential operational impacts on ecology are outlined in Table 6.11. 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 pads in 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 ten designated ecological sites within ten 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 are excluded.

6.8.4 The closest designated ecology 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 direct habitat loss of the designated site will occur as a result of the Proposed Project.

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 No direct habitat loss of the Norwick Meadows designated site will occur as a result of the Proposed Project and so 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 Potential indirect impacts on Norwick Meadows could arise from pollution events, although it should be noted that Norwick Meadows is ca. 750 m away from the Proposed Project. 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 this and the previous embedded mitigation inherent to the design of SaxaVord Spaceport accounted for, the magnitude of change on designated site as a consequence of pollution form the Proposed Project is assessed as negligible. The indirect impact on designated 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.

6.8.9 All the other terrestrial designated sites are >1.5 km away from the Proposed Project. No direct habitat loss or changes to hydrology will occur within these designated sites as a result of the Proposed Project. 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

6.8.10 This section describes the predicted effects on otters that could arise from operation of the Proposed Project. Mitigation measures, including avoidance and minimisation to reduce potential effects, are described.

6.8.11 The operation of 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 operation; and

- disturbance/damage to hearing caused by noise of operation, including launches.

6.8.12 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.

6.8.13 Baseline otter surveys were completed on multiple occasions, 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 site is relatively well understood.

6.8.14 Numerous otter field signs were recorded including scats, holts, footprints and lay-ups. In the most recent 2020 surveys, eight holts were located in inaccessible boulder scree areas, caves and on the boulder beaches around Lamba Ness. Scats and footprints, including those of adults and young, were also recorded in the abandoned military buildings across the Proposed Project Site. It was considered likely that some of the buildings were used as lay-ups during poor weather conditions.

6.8.15 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. It appears to be disproportionately and functionally important to continued otter use of Lamba Ness. During poor/rough weather this may be the main route used by otters traversing Lamba Ness.

6.8.16 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.

6.8.28 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 occurs, leading to a sudden pulse of pollutant, and if 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 intended implementation of best practice pollution prevention measures (Chapter 9 and Appendix 3.1), it is considered highly unlikely that a serious pollution incident would occur during operation of the Proposed Project. Therefore, in the unlikely event that a pollution incident did occur, it is very doubtful that pollution would substantially affect otter foraging (as the coastline is very extensive). The magnitude of potential impact caused by a pollution event for otter is assessed as negligible. With the embedded mitigation, the impact caused by a pollution event is considered to be unlikely, intermittent, reversible and short-term (event), with a medium-term recovery and **no likely significant effects** are predicted (Table 6.15).

Mortality caused by vehicle traffic during operation

6.8.31 Vehicular traffic on the site will increase during operation of the Proposed Project, meaning that individual otters will have a slightly increased possibility (albeit still very small) of being injured or killed. However, the existing inbuilt design measures (embedded mitigation) and enforced low vehicle speed limits (10 mph) will greatly reduce the likelihood of injury or death occurring during operation. Otter crossing road signs will be located at the entrance to the 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 6.15).

Disturbance caused by noise of operation

6.8.32 There was 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 (Chapter 8). 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 will 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	Static Lamax	Launch Lamax	Static Lamax	Launch Lamax	Static Lamax
0-0.5 km	120-130 dB	110-130 dB	120-130 dB	110-130 dB	120-130 dB	110-130 dB
0.5-1 km	110-120 dB	100-110 dB	110-120 dB	100-110 dB	100-110 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 satellite launch noise will be concentrated in the low frequencies, the satellite launch noise 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 at launch will 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 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 will give otters warning to swim underwater or find refuge in a holt or shelter where noise levels experienced are likely to be reduced. Therefore, it is considered possible that the operational disturbance of satellite launches could disturb otters within their holts.

6.8.37 As part of the SaxaVord Spaceport mitigation commitments a total of 10 artificial otter holts/shelters will be 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 vicinity, 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	Severance	Pollution	Mortality from Traffic/Activities	Operational Disturbance
Beneficial/adverse/neutral	Adverse	Adverse	Adverse	Adverse
Extent	Potential loss of one run linking north and south of Lamba Ness	Watercourse and coastal region around Lamba Ness	Site-wide	Site-wide
Duration	Short-term	Event = short-term Recovery = medium-term	N/A	Short-term noise level, potential for long term hearing damage
Reversibility	Reversible - the underpass will be maintained, and an additional underpass created, with additional shelters/holts at either side	Reversible – pollution prevention measures and incident kits will be used.	Irreversible	Irreversible
Frequency	Never/occasional	Intermittent	Intermittent	Intermittent
Probability	Unlikely	Unlikely	Unlikely	Possible
Magnitude	Negligible	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 operation of 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 are considered in Chapter 9 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, the magnitude of change on habitats as a consequence of pollution 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 6.14).

Table 6.14. Summary of Predicted Impacts on Habitats for the Proposed Project

Parameter	Pollution
Adverse/ beneficial/ neutral	Adverse
Extent	Footprint of the Vertical Launch Space Port on Lamba Ness and into watercourses and the sea.
Duration	Short-term (event) – medium-term (recovery).
Reversibility	Temporary.
Frequency	Intermittent.
Probability	Unlikely.
Magnitude	Negligible.

6.9 Residual Effects

6.9.1 No likely significant effects are predicted on designated sites, habitats or otters in relation to the Proposed Project and therefore no likely significant residual effects are 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 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 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.

6.10.4 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. 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.
- 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 and has provided enhancement opportunities.

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.

Carrs, D. N. (1995). *Foraging behaviour and feeding ecology of the otter* lutra lutra*: a selective review*. Hystrix: the Italian Journal of Mammalogy, 7, pp 179 – 194.

CAA (2021). *Guidance for the Assessment of Environmental Effects*.

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 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 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 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). 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/.

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 lutra*, L. 1758) as determined by auditory brainstem responses*. Hearing Research, 381, pp 107774.

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Appendix 3.3 SaxaVord Spaceport AEE V3 Chapter 5 Ornithology

CHAPTER 5 ORNITHOLOGY

5. Ornithology

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5. Ornithology

5.1 Introduction

5.1.1 This AEE Report chapter considers the likely significant effects of the Proposed Project on birds, both on site and in the surrounding environmental zone of influence (EZI), during operation of the Proposed Project. 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 Ltd. 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 in the study area 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 the following Appendices in Volume III (and associated ornithological drawings 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 Outline 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. This information is not included in the AEE submission as it does not make any material difference to the assessment findings; but, as required, has been shared with relevant statutory authorities during the planning process for the SaxaVord Spaceport.

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 operate a vertical 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

5.2.3 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

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 spaceport/launch facilities.

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. The Fourth National Planning Framework (NPF4) (2022) is designed to support Scotland's commitment of reaching net zero emissions by 2045 and thereby tackling the climate change emergency.

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 '*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 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 ornithology.

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 ornithology 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 5.1.

Table 5.1 Consultation Responses Relevant to 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	The nature and scale of the ornithological study area 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.

Consultee	Summary ornithology response	Where and how addressed
	and possibly gulls and that these species should therefore be surveyed too.	
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 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.	Seabird survey data collected by Alba Ecology is presented in Appendix 5.1.
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 for SaxaVord Spaceport, it has been confirmed by planning condition that no-launch events or static hotfire tests will be carried out 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 It is also noted that the NatureScot consultation response includes a comment that if observations of birds attending the colonies during the pre-laying period (mid-April to mid-May) show that launches do not significantly increase disturbance, then this commitment may be subsequently relaxed/revisited.

5.3.4 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 satellite launches.

5.3.5 Collision risk with birds striking the 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 EIA process beginning with consulting with SNH on the nature and scale of ornithological surveys in February 2018. Draft ornithological survey results and the draft background literature review of noise impacts on birds for the Proposed Project were shared with both SNH and RSPB in June 2020, ahead of formal EIA reporting (Table 5.1).

Environmental Zone of Influence (EZI)

5.4.2 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:

- 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;
- Integration Hangars (three): located on the Lamba Ness peninsula, a building where the launch vehicles are assembled, and the payload (the satellites) prepared and integrated into the launch vehicles; and
- Preparation and launch of launch vehicles.

5.4.3 The Proposed Project provides the basic infrastructure for space vehicle launches. The Applicant is looking to achieve a maximum of 30 launch events per year from the Proposed Project.

5.4.4 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 (EZI) 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.

5.4.5 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 EZI.

5.4.6 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 without taking flight.

5.4.7 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.

5.4.8 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 pad sites. 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.

5.4.9 During initial survey planning, there was no Planning Application red line site boundary, only an indicative boundary area. 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 - 2 kilometres (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 four kilometre 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 Proposed Project site boundary and it was centred on indicative launch pad site locations provided by the Applicant during initial discussions in early 2018.

5.4.10 A plan of the breeding birds study area (EZI) is included as Drawing 5.1.

Desk Study

5.4.11 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.

5.4.12 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.

5.4.13 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

5.4.14 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). The principal land use 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.

Breeding Bird Surveys

5.4.15 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 ECoW support. Repeat breeding bird surveys (moorland, raptor, diver, black guillemot and cliff nesting seabirds) are continuing to be conducted during breeding seasons.

Moorland Breeding Bird Surveys

5.4.16 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.

5.4.17 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 Proposed Project site boundary.

Breeding Raptor Surveys

5.4.18 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 Proposed Project Boundary. Further details are provided in Appendix 5.1.

Breeding Red-throated Diver Surveys

5.4.19 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 Proposed Project Boundary Further details are provided in Appendix 5.1.

Black Guillemot

5.4.20 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

5.4.21 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.

5.4.22 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 to 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).

5.4.23 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.

5.4.24 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.

5.4.25 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

5.4.26 This section defines the criteria used to evaluate the likely significance of predicted effects on important ornithological receptors due to the operation of 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

5.4.27 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).

5.4.28 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.

5.4.29 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.

5.4.30 According to CIEEM (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.

5.4.31 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).

5.4.32 For breeding bird species, SNH 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 "*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.

5.4.33 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.

5.4.34 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.

5.4.35 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

5.4.36 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

5.4.37 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 score. 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 6.4.45 - 6.4.47.

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

5.4.38 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

5.4.39 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

5.4.40 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

5.4.41 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.

5.4.42 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

5.4.43 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

5.4.44 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.

5.4.45 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.

5.4.46 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

5.4.47 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.

5.4.48 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).

5.4.49 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

5.4.50 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

5.4.51 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.

5.4.52 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.
- 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 desk study identified three designated sites (which overlap) where birds were a qualifying feature within the four-kilometre 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 support 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 four kilometre 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. Repeat breeding bird surveys (moorland, raptor, diver, black guillemot and cliff nesting seabirds) are continuing to be conducted during breeding seasons.

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 Proposed Project boundary 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 locations within the study area. 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 observed 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 four kilometre 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 were 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 four kilometre 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 four kilometre 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 were 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 Proposed Project's 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 three to four kilometre 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 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.

Natural Capital

5.5.38 The most easterly headland on Lamba Ness 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

Species	Conservation listing of target species
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)

Species	Shetland (Regional) population	Scotland population	UK (National) population	Europe population (International status)
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)
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 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 & Breininger, 1995), despite being exposed to irregular loud impulsive noise events.

Table 5.7 Behavioural Sensitivity of Potentially Important Study Area Species

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.,	Moderate at sea. Low at nest.

Species	Nature of sensitivity	Sensitivity level
	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.	
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.
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

Species	Nature of sensitivity	Sensitivity level
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
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 show 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

[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/

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 Study Area Species

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]
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 study area 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 Proposed Project. Thus, that Proposed 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 ornithology 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 Study Area Bird Species (breeding pairs unless stated). **Study Area 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 & % of Regional (& where relevant National) population within 4 km of launch pads (max est.)	Population & % of Regional population (& where relevant National) within 2 km of launch pads (max est.)	Population & % 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 & 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 & % of Regional (& where relevant National) population within 4 km of launch pads (max est.)	Population & % of Regional population (& where relevant National) within 2 km of launch pads (max est.)	Population & % 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 & 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 measures have already been in-built as part of the iterative design process (see below), to avoid the higher value species and their habitats.

5.7.2 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 through targeted breeding bird surveys. The Applicant will adhere to any recommendations set out in this document.
- Following the NatureScot consultation response dated 11 March 2021, SaxaVord Spaceport has 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). The Applicant is aware of this operational constraint and will not schedule launches within the defined mid-May to end of June window.
- As applicable, compliance with the SaxaVord Spaceport 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)*	
Merlin		1 pair (2018)	
Arctic skua		2 AON (2016, 2018, 2019), 1 AON (2017)	

Species	Saxa Vord SSSI	Hermaness SSSI/NNR	Valla Field
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) and 80-90 dB for Static LAmax. 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 and 80-90 dB for Static LAmax or lower predicted noise levels the further away from the launch site the birds are.

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 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 four kilometre study area, all will be within the range of elevated noise levels associated with the operation of the proposed Launch Facility. 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	Pad 1		Pad 2		Pad 3	
Black guillemot	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax
13-14 ind, 0-0.5km	120-130dB	110-130dB	120-130dB	110-130dB	120-130dB	110-130dB
8-12 ind, 0.5-1km	110-120dB	100-110dB	110-120dB	100-110dB	100-110dB	100-110dB
25-27 ind, 1-2km	100-110dB	90-100dB	100-110dB	100-110dB	90-110dB	90-110dB
25-26 ind, 2-3km	90-100dB	90-100dB	90-100dB	90-100dB	90-100dB	80-100dB
10-25 ind, 3-4km	90-100dB	80-90dB	90-100dB	80-90dB	90-100dB	80-90dB

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 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, up to four launches could 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 or static tests will be carried out between mid-May and the end of June has subsequently been made and this has been reflected in planning conditions for the Proposed Project.

5.8.15 If a worst-case (*not likely*) scenario is assumed (a failure for all study area 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 combined 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 four kilometre 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	Pad 1		Pad 2		Pad 3	
Common guillemot	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax
27 ind, 1-2km	100-110dB	90-100dB	100-110dB	100-110dB	90-110dB	90-110dB
20 ind, 2-3km	90-100dB	90-100dB	90-100dB	90-100dB	90-100dB	80-100dB
53 ind, 3-4km	90-100dB	80-90dB	90-100dB	80-90dB	90-100dB	80-90dB

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 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 four launches could 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 or static tests will be carried out between mid-May and the end of June has subsequently been made and this has been reflected in planning conditions for the Proposed Project and will be adhered to by the Applicant.

5.8.23 If a worst-case (*not likely*) scenario is assumed (a failure for all study area 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 combined 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 four kilometre 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	Pad 1		Pad 2		Pad 3	
Puffin	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax
2 ind, 0-0.5km	120-130dB	110-130dB	120-130dB	110-130dB	120-130dB	110-130dB
6 ind, 0.5-1km	110-120dB	100-110dB	110-120dB	100-110dB	100-110dB	100-110dB
27 ind, 1-2km	100-110dB	90-100dB	100-110dB	100-110dB	90-110dB	90-110dB
23 ind, 2-3km	90-100dB	90-100dB	90-100dB	90-100dB	90-100dB	80-100dB
67 ind, 3-4km	90-100dB	80-90dB	90-100dB	80-90dB	90-100dB	80-90dB

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 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 could 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 or static tests will be carried out between mid-May and the end of June has subsequently been made and this has been reflected in planning conditions for the Proposed Project and will be adhered to by the Applicant.

5.8.31 If a worst-case (*not likely*) scenario is assumed (a failure for all study area 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 combined 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 four kilometre 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	Pad 1		Pad 2		Pad 3	
Razorbill	Launch LAmax	Static Lamax	Launch Lamax	Static Lamax	Launch Lamax	Static Lamax
2 ind, 2-3km	90-100dB	90-100dB	90-100dB	90-100dB	90-100dB	80-100dB
13 ind, 3-4km	90-100dB	80-90dB	90-100dB	80-90dB	90-100dB	80-90dB

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 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 four launches could 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 or static tests will be carried out between mid-May and the end of June has subsequently been made and this has been reflected in planning conditions for the Proposed Project and will be adhered to by the Applicant.

5.8.39 If a worst-case (*not likely*) scenario is assumed (a failure for all study area 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 combined 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 four kilometre 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	Pad 1		Pad 2		Pad 3	
Shag	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax
1 AON, 0-0.5km	120-130dB	110-130dB	120-130dB	110-130dB	120-130dB	110-130dB
5 AON, 1-2km	100-110dB	90-100dB	100-110dB	100-110dB	90-110dB	90-110dB
24 AON, 2-3km	90-100dB	90-100dB	90-100dB	90-100dB	90-100dB	80-100dB
51 AON, 3-4km	90-100dB	80-90dB	90-100dB	80-90dB	90-100dB	80-90dB

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 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 four launches could 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 or static tests will be carried out between mid-May and the end of June has subsequently been made and this has been reflected in planning conditions for the Proposed Project and will be adhered to by the Applicant.

5.8.48 If a worst-case (*not likely*) scenario is assumed (a failure for all study area 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 combined 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 four kilometre 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	Pad 1		Pad 2		Pad 3	
Kittiwake	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax
50 AON, 1-2km	100-110dB	90-100dB	100-110dB	100-110dB	90-110dB	90-110dB
5 AON, 3-4km	90-100dB	80-90dB	90-100dB	80-90dB	90-100dB	80-90dB

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 study area 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 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 four launches could 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 or static tests will be carried out between mid-May and the end of June has subsequently been made and this has been reflected in planning conditions for the Proposed Project and will be adhered to by the Applicant.

5.8.57 If a worst-case (*not likely*) scenario is assumed (a failure for all study area 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 combined 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 EIA Report 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 four kilometre 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	Pad 1		Pad 2		Pad 3	
Fulmar	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax
430 AON, 0-0.5km	120-130dB	110-130dB	120-130dB	110-130dB	120-130dB	110-130dB
740 AON, 0.5-1km	110-120dB	100-110dB	110-120dB	100-110dB	100-110dB	100-110dB
1,465 AON, 1-2km	100-110dB	90-100dB	100-110dB	100-110dB	90-110dB	90-110dB
2,645 AON, 2-3km	90-100dB	90-100dB	90-100dB	90-100dB	90-100dB	80-100dB
1,707 AON, 3-4km	90-100dB	80-90dB	90-100dB	80-90dB	90-100dB	80-90dB

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 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 could 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 or static tests will be carried out between mid-May and the end of June has subsequently been made and this has been reflected in planning conditions for the Proposed Project and will be adhered to by the Applicant.

5.8.66 If a worst-case (*not likely*) scenario is assumed (a failure for all study area 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 four kilometre 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 combined 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 combined 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 four kilometre 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	Pad 1		Pad 2		Pad 3	
Ringed plover	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax
3 pairs, 0-0.5km	120-130dB	110-130dB	120-130dB	110-130dB	120-130dB	110-130dB
4-5 pairs, 1-2km	100-110dB	90-100dB	100-110dB	100-110dB	90-110dB	90-110dB
1-2 pairs, 2-3km	90-100dB	90-100dB	90-100dB	90-100dB	90-100dB	80-100dB
0-1 pair, 3-4km	90-100dB	80-90dB	90-100dB	80-90dB	90-100dB	80-90dB

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 four kilometre 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 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 could 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 or static tests will be carried out between mid-May and the end of June has subsequently been made and this has been reflected in planning conditions for the Proposed Project and will be adhered to by the Applicant.

5.8.77 If a worst-case (*not likely*) scenario is assumed (a failure for all study area 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 of operational disturbance combined 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 four kilometre 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	Pad 1		Pad 2		Pad 3	
Golden plover	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax
0-1 pair, 0-0.5km	120-130dB	110-130dB	120-130dB	110-130dB	120-130dB	110-130dB
2-3 pairs, 1-2km	100-110dB	90-100dB	100-110dB	100-110dB	90-110dB	90-110dB
1-5 pairs, 2-3km	90-100dB	90-100dB	90-100dB	90-100dB	90-100dB	80-100dB
4 pairs, 3-4km	90-100dB	80-90dB	90-100dB	80-90dB	90-100dB	80-90dB

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 four kilometre 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 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 four launches could 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 or static tests will be carried out between mid-May and the end of June has subsequently been made and this has been reflected in planning conditions for the Proposed Project and will be adhered to by the Applicant.

5.8.84 If a worst-case scenario (*not likely*) is assumed (a failure for all Study Area 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 combined 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	Pad 1		Pad 2		Pad 3	
Dunlin	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax
0-1 pair, 0-0.5km	120-130dB	110-130dB	120-130dB	110-130dB	120-130dB	110-130dB
2 pairs, 1-2km	100-110dB	90-100dB	100-110dB	100-110dB	90-110dB	90-110dB
0-1 pair, 2-3km	90-100dB	90-100dB	90-100dB	90-100dB	90-100dB	80-100dB
1-2 pairs, 3-4km	90-100dB	80-90dB	90-100dB	80-90dB	90-100dB	80-90dB

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 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 could 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 or static tests will be carried out between mid-May and the end of June has subsequently been made and this has been reflected in planning conditions for the Proposed Project and will be adhered to by the Applicant.

5.8.90 If a worst-case scenario (*not likely*) is assumed (a failure for all study area 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 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 four kilometre 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	Pad 1		Pad 2		Pad 3	
Curlew	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax
0-1 pair, 0-0.5km	120-130dB	110-130dB	120-130dB	110-130dB	120-130dB	110-130dB
2-3 pairs, 1-2km	100-110dB	90-100dB	100-110dB	100-110dB	90-110dB	90-110dB
5 pairs, 2-3km	90-100dB	90-100dB	90-100dB	90-100dB	90-100dB	80-100dB
5-8 pairs, 3-4km	90-100dB	80-90dB	90-100dB	80-90dB	90-100dB	80-90dB

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 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 four launches could 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 or static tests will be carried out between mid-May and the end of June has subsequently been made and this has been reflected in planning conditions for the Proposed Project and will be adhered to by the Applicant.

5.8.100 If a worst-case scenario (*not likely*) is assumed (a failure for all study area 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 combined 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 four kilometre 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	Pad 1		Pad 2		Pad 3	
Arctic tern	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax
8-13 pairs, 1-2km	100-110dB	90-100dB	100-110dB	100-110dB	90-110dB	90-110dB
0-1 pair, 2-3km	90-100dB	90-100dB	90-100dB	90-100dB	90-100dB	80-100dB

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 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 could 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 or static tests will be carried out between mid-May and the end of June has subsequently been made and this has been reflected in planning conditions for the Proposed Project and will be adhered to by the Applicant.

5.8.106 If a worst-case scenario (*not likely*) is assumed (a failure for all study area 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 proposed launch pads, 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 combined 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 four kilometre 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	Pad 1		Pad 2		Pad 3	
Arctic skua	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax
1 pair, 0.5-1km	110-120dB	100-110dB	110-120dB	100-110dB	100-110dB	100-110dB
1-2 pairs, 1-2km	100-110dB	90-100dB	100-110dB	100-110dB	90-110dB	90-110dB
2-3 pairs, 2-3km	90-100dB	90-100dB	90-100dB	90-100dB	90-100dB	80-100dB

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 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 four launches could 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 or static tests will be carried out between mid-May and the end of June has subsequently been made and this has been reflected in planning conditions for the Proposed Project and will be adhered to by the Applicant.

5.8.112 If a worst-case scenario (*not likely*) is assumed (a failure for all study area 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 combined 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 study area surveys do not provide sufficient information to comment on annual site occupancy in any detail. At best, the study area 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 four kilometre 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	Pad 1		Pad 2		Pad 3	
Great skua	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax	Launch LAmax	Static LAmax
Low tens of pairs, 3-4km	90-100dB	80-90dB	90-100dB	80-90dB	90-100dB	80-90dB

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 Proposed Project, 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 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 four launches could 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 or static tests will be carried out between mid-May and the end of June has subsequently been made and this has been reflected in planning conditions for the Proposed Project and will be adhered to by the Applicant.

5.8.118 If a worst-case scenario (*not likely*) is assumed (a failure for all study area 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 combined 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 Outline 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, no significant residual effects are predicted.

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 NatureScot 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 EZI and therefore, no significant issues are likely to arise from developments other than the SaxaVord Spaceport.

5.11.4 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.

5.11.5 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 have been assessed for the operational phase of the Proposed Project. The magnitude of predicted operational effects is either 'no effect' or 'negligible' for all bird species except one, a confidential Schedule 1 species. For this species, minor magnitude operational effects were considered likely to be significant in the absence of mitigation; however, after mitigation, all residual effects are predicted likely to be not significant.

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 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

Species	Significance of Residual 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 As regards the existing use of 'Natural Capital' on the site, the Applicant has agreed to provide a purpose built wildlife watching hide within the boundary for locals and visitors to use at the tip of Lamba Ness. The Applicant is willing to consider potential community ownership of the wildlife watching hide and also contribute towards providing an annual maintenance budget for hide repairs and improvements.

5.12.8 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.

CAA. (2021). *Guidance for the Assessment of Environmental Effects*.

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.

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.

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Appendix 3.4 SaxaVord Spaceport AEE V3 Chapter 8 Noise and Vibration

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 on human receptors. Effects from noise and vibration to ecological/ornithological receptors and cultural heritage receptors are considered separately in Chapter 5 (Ecology), Chapter 6 (Ornithology) and Chapter 14 (Cultural Heritage), respectively.

Scope of Assessment

8.1.2 The scope of this assessment has comprised the following:

- Baseline noise survey;
- Evaluation of road traffic noise;
- Modelling of static hotfire testing and launch noise (undertaken by BRRC);
- Evaluation and interpretation of modelling results; and,
- Specification of appropriate mitigation.

8.1.3 Ground-borne vibration effects associated with launches and engine testing will be highly localised and are considered to be negligible at human receptor locations. Potential vibration effects at cultural heritage receptors are considered in Chapter 14 of this AEE, in which precautionary vibration monitoring has been proposed for archaeological receptors. Ground-borne vibration impacts at human receptors will be negligible and have been scoped out.

8.1.4 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.

8.1.5 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.

8.1.6 The BRRC modelling assessment is provided in Volume IV Technical Appendix 8.1. It is recommended that the reader reviews the BRRC report prior to proceeding with this chapter.

8.1.7 With reference to Volume IV Technical Appendix 8.1 Figure 40, the sonic boom from launches 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.

Glossary of Acoustics Terms

8.1.8 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 Technical 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 sub-orbital 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 operate a vertical 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

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

Consultation Response on UK Airspace Policy: A Framework for balanced decisions on the design and use of airspace

8.2.11 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.

8.2.12 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

8.2.13 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

8.2.14 The CAA (July 2021) document Guidance for the Assessment of Environmental Effects explains the process for completing an assessment of environmental effects as part of a licence application under the Space Industry Act.

8.2.15 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 noise.

Guidance to the Regulator on Environmental Objectives Relating to the Exercise of its Functions Under the Space Industry Act 2018

8.2.16 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.*

8.2.17 The guidance identifies that noise from spaceflight activities is anticipated to be one of the greatest environmental concerns for impacts to humans and wildlife.

8.2.18 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.

8.2.19 With regard to appropriate indices for the evaluation of launch 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)."

8.2.20 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.

8.2.21 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.

8.2.22 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

8.2.23 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.

8.2.24 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)

8.2.25 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

8.2.26 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)

8.2.27 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

8.2.28 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

8.2.29 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)

8.2.30 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.

8.2.31 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.

8.2.32 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.

8.2.33 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."

8.2.34 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 that 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'.

8.2.35 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)

8.2.36 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

8.2.37 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 Statutory consultation on noise 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 8.1.

Table 8.1 Consultation Relevant to 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 project footprint at the time).	Shetlands Islands Council confirmed by phone call that Environmental Health Officer (EHO) off sick and unknown when he would return. Noted that a response from Environmental Health unlikely to be issued before survey 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 ITPE's role in the noise and vibration assessment Seeking agreement on method of evaluation of construction, operational non-launch and launch noise.	-
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 our 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

Environmental Zone of Influence

8.4.1 For a new development, a study area or environmental zone of influence (EZI) may be 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) is then 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 EZI.

8.4.2 The Proposed Project comprises the following principal elements:

- launch area at Lamba Ness comprising three launch pads;
- satellite tracking station;
- launch vehicle integration buildings;
- roadways (largely re-using existing roads);
- fuel storage; and
- ancillary infrastructure.

8.4.3 The environmental zone of influence (EZI) 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.

8.4.4 While the AEE guidance notes that the EZI 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 azimuth. As such, there will be no permanent human Noise Sensitive Receptors (NSRs) along the trajectory of the launch vehicles, and a circular EZI is sufficient to consider the worst-case noise impacts. The island of Jan Mayan lies approximately 1,100 km to the north (i.e., down range) of the Proposed Project, however, the island is not permanently occupied and launch vehicles passing will be sufficiently above the atmosphere such that there will be no noise impacts here.

8.4.5 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 EZI buffer.

8.4.6 Where no significant effects are identified at NSRs within the five km buffer, then no significant effects will occur beyond the five km buffer, given that noise attenuates with distance and noise levels will therefore be lower at more remote NSRs.

8.4.7 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).

8.4.8 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 EZI.

8.4.9 A plan showing the five km study area (EZI) and identified receptors within that is included as Drawing 8.1. A single property, Skaw, lies to the north of the Proposed Project, however, this property is unoccupied and will remain so for the duration of the Proposed Project.

Site Visit and Baseline Noise Survey

8.4.10 ITPEnergised undertook a baseline noise survey in the vicinity of the Proposed Project on 19th and 20th July 2018. More than two 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.

8.4.11 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.

8.4.12 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.

8.4.13 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 Technical Appendix 8.3.

Assessment of Potential Effect Significance

Receptor Sensitivity

8.4.14 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

8.4.15 Threshold noise levels have been defined for the operational phase of 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

8.4.16 A previous version to the current iteration of DMRB states that *"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"*, whilst PAN1/2011 advises that a change of three dB(A) is the minimum perceptible under normal conditions.

8.4.17 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.

8.4.18 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

8.4.19 No standard UK or Scottish guidance exists upon which the magnitude of noise impacts associated with launch vehicle engine testing or 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.

8.4.20 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 launches will differ from that associated with conventional civilian or military airfields.

8.4.21 Given the nature of operational noise from static engine tests and 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.

8.4.22 This two-tier approach seeks to set in context the L_{den} levels generated by short-duration noisy events averaged over a year.

8.4.23 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 – static engine testing and launches – likelihood of annoyance (L_{den}) and noise exposure ($L_{EP,d}$)

Likelihood of annoyance threshold, dB L_{den}	Noise exposure, dB$L_{EP,d}$	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

8.4.24 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'.

8.4.25 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.

8.4.26 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

8.4.27 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.

8.4.28 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

8.4.29 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.

[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.

Table 8.6 Operational vibration (air overpressure) impact magnitude criteria matrix – static engine testing and 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

8.4.30 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

8.4.31 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.

8.4.32 All noise sensitive receptors (NSRs) considered in this assessment are considered to have a high sensitivity to noise and vibration.

Limitations to Assessment

8.4.33 This assessment relies on information provided by BRRC. Launch data has been provided by the Launch Operators to BRRC, who undertook verification and predictions of static hotfire engine testing and launch events using proprietary methods as described in their report, *Noise Study for Launch Vehicle Operations at Shetland Space Centre* included in Volume IV as Technical Appendix 8.1.

8.4.34 The assessment considers 30 launches of the RepLV launch vehicle intended for launch as part of the Proposed Project and, as such, represents the worst-case. Smaller launch vehicles will result in lesser noise effects.

8.4.35 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 Technical Appendix 1.2.

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 Technical 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 Technical Appendix 8.3 and field notes, the following observations may be drawn regarding the baseline noise environment:

- Noise levels across the EZI 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. These are shown in Drawing 8.1 and listed in Table 8.9 below.

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:

- Fixed plant will be specified such that it meets appropriate noise limits at NSRs;
- Where necessary, attenuation such as acoustic enclosures will be specified to enable noise limits to be met;
- Where possible, noisy items of plant will be situated such that project infrastructure provides screening (e.g., fans and air handling plant will be situated on the opposite side of buildings from the closest NSRs); and,
- The Applicant will seek to minimise additional vehicle journeys by providing local accommodation for site workers.

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 launches will be advertised 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;
- The Applicant proposes 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. 8.2.35 above).

- Suggestions for appropriate community liaison 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 Technical Appendix 8.1, which should be read in conjunction with this AEE chapter.

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 Proposed Project, comprising launches from all three launch pads and static engine tests, 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
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 The L_{den} metric considers cumulative noise from all static engine tests and launches associated with the Proposed Project over the period of a year. 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.

8.8.6 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 associated with the Proposed Project will offer substantially greater periods of respite for nearby residents than an equivalent airport, given that most of the time the Proposed Project will be inaudible at NSRs. Additionally, residents will be given warning in advance of each launch, such that they can plan accordingly to avoid the noise if they choose.

8.8.7 The predicted $L_{Amax,1sec}$ values for static engine tests and for launches are provided in Drawing 8.3a-c and Drawing 8.4a-c, respectively.

8.8.8 The requirement to undertake static hotfire testing prior to a launch will be determined by the type of launch vehicle used and will therefore be a requirement of the Launch Operators to consider in their AEEs, rather than the spaceport. Where operationally possible, the spaceport will encourage launch operators to undertake hotfire tests during the daytime. Static hotfire tests will comprise a part of the launch procedure of individual launch vehicle and therefore it is considered highly unlikely thathotfire testing would occur at different launch pads on the same day. It is likely, however, that a static hotfire testing of a launch vehicle may occur on the same day as a subsequent launch.

8.8.9 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	Static engine test – time above level (seconds)	Launch – time above level (seconds)
22 dB – representative 24-hour background level in Norwick.	5	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.	5	190
66 dB – level above which speech intelligibility reduces; used to evaluate potential adverse effects of rocket noise within national parks in the USA.	5	70
89 dB – representative of maximum level during overflight by an oil rig shuttle helicopter, as occurs occasionally within the EZI.	0	45

8.8.10 A time-history chart, showing how the predicted noise level changes at the closest NSR throughout a launch is provided in Figure 8.1.

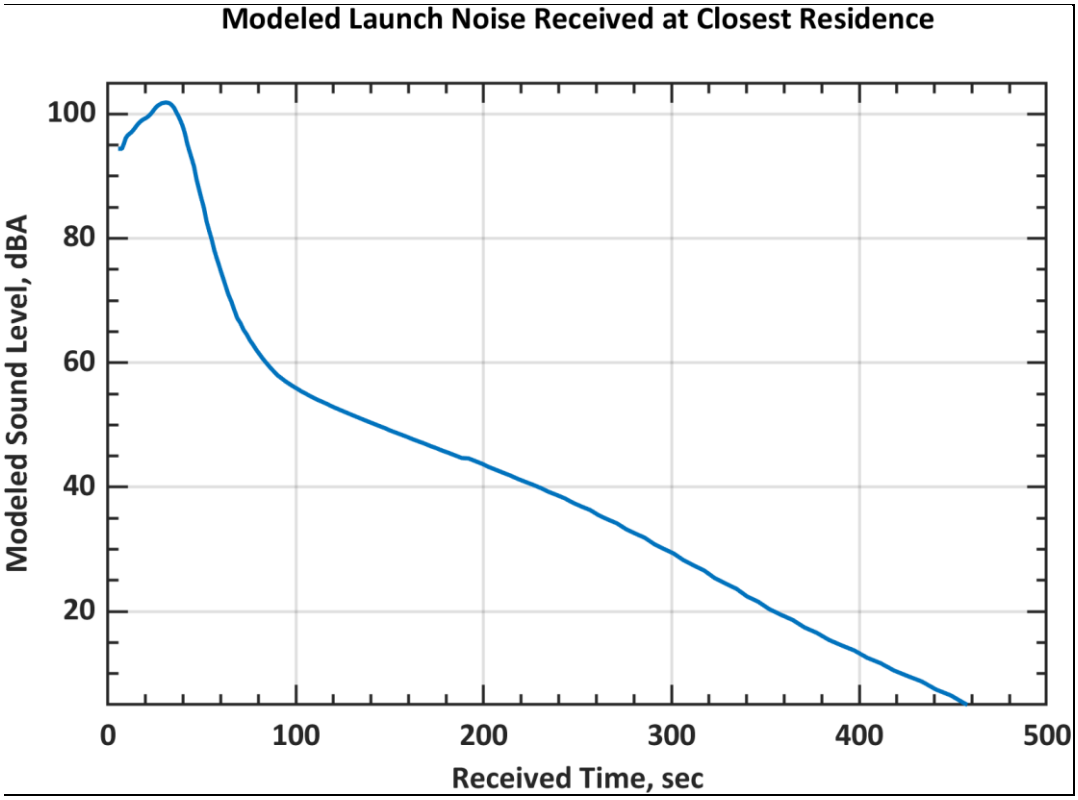


Figure 8.1 Time-history chart of launch noise

8.8.11 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 launch events in terms of noise will therefore be approximately 340 seconds, or just under six minutes.

8.8.12 The BRRC report (Volume IV Technical 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.

8.8.13 With reference to Drawing 8.3, showing the predicted L_{Amax} contours for static engine tests from all three pads of the Proposed Project, the highest predicted level occurs at NSR1, which lies on the 87 dB contour. Given an engine test duration of five seconds, and using the equation provided in para. 8.2.9 above, the resultant $L_{EP,d}$ is 49 dB. This is substantially below the LEAV and the impact magnitude at this worst affected NSR is therefore low.

8.8.14 At all other NSRs the predicted L_{Amax} levels are lower than at NSR1, therefore the resultant $L_{EP,d}$ will be lower, and the impact magnitude is low.

8.8.15 With reference to Table 8.7 above, the resultant effect significance for noise from static engine tests at high sensitivity receptors is slight. Noise effects associated with static engine tests are therefore not significant, resulting in **no likely significant effect**.

8.8.16 With reference to Drawing 8.4, 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.

8.8.17 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**.

8.8.18 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**.

8.8.19 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 led 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 will result in internal noise levels above 45 dBL_{Amax} with resultant potential awakening of sleeping population at all NSRs within the EZI, as per GCN guidance.

8.8.20 Of the proposed 30 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 four launches. Of the 30 launches, up to 10 will be during the night-time period (23:00 – 07:00). Given the limited infrastructure of the Proposed Project the launch cadence will necessarily be restricted, such that multiple launches will not occur in a single day/night.

8.8.21 Given the proposed frequency of launches and the short duration of the noise events associated with launches, 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. 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.

8.8.22 The Applicant will provide residents with advance warning of launches such that they can make preparations to avoid sleep disturbance if they choose to and night-time noise events will not come as a surprise. This will further reduce the likelihood of sleep disturbance and mitigate associated annoyance.

Noise from non-launch activities and plant

8.8.23 The Applicant has committed to meeting boundary noise limits for fixed plant, such that appropriate noise limits derived using BS4142 will be met at all NSRs. The detailed list of fixed plant associated with the Proposed Project has yet to be finalised, however, it is anticipated that the largest and potentially noisiest items of plant will be generators which will provide power to the facility. The generators will be sited within an enclosure and will have internally mounted exhaust silencers. Other potentially significant noise sources will comprise air handling units for the clean rooms, as well as condensers and pumps at the assembly buildings. Lifting equipment, such as cranes, will only operate within the assembly buildings and not outside, and will therefore not be a significant source of noise.

8.8.24 A simple noise model has been run assuming two generators operating simultaneously at each pad (i.e., six in total), with no acoustic enclosure. In reality this situation will never occur. It is simply to consider the worst-case noise level at the closest NSRs arising from fixed plant associated with the Proposed Project. The noise model also includes a source representative of the TEL vehicle, which has been modelled with a source level equivalent to a large lorry and been assumed to be operating in close proximity to the assembly buildings for a duration of 30 minutes.

8.8.25 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.

8.8.26 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.

8.8.27 The predicted worst-case rating level for fixed and mobile plant of 24 dB is three dB below the derived noise limit. With reference to Table 8.5 above, the impact magnitude is therefore low. With reference to Table 8.7 above, 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

8.8.28 Projected traffic flows associated with the Proposed Project total 81 vehicle movements per day, based on an average of monthly traffic movements.

8.8.29 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 Technical 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.

8.8.30 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

8.8.31 Predicted unweighted L_{max} noise contours associated with static engine tests and launches are provided in Drawing 8.5 and Drawing 8.6, respectively. With reference to these drawings 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 No additional mitigation is proposed.

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

8.11.2 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 EZI for noise.

8.11.3 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.

8.11.4 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 none of the other environmental topics considered impact directly on noise levels, 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 noise effects.

8.11.5 It is noted that noise effects are likely to have an impact on the ornithological and ecological response to launch events and as such noise is considered as an intra-project cumulative effect in these assessments. Whilst no significant effects relating to noise have been identified for either ecology or ornithological receptors, the Applicant is committed to undertaking further noise monitoring of launches to inform the ecological monitoring required by the planning conditions for the Proposed Project. More detail on this is provided in Chapter 5 Ornithology and related appendices.

8.12 Summary

8.12.1 Potential noise and vibration effects associated with the Proposed Project have been robustly assessed with regard to static engine tests, launches and non-launch activities.

8.12.2 The assessment of noise and vibration associated with static engine tests and launches 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 and launches will be audible at NSRs within and beyond the EZI 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. 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 associated with engine tests and launches have therefore been assessed as not significant, resulting in **no likely significant effect**.

8.12.5 Vibration (air overpressure) associated with static engine tests and 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**.

8.12.6 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 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.

CAA. (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. *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

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Appendix 3.5 SaxaVord Spaceport AEE V3 Chapter 13 Landscape, Seascape and Visual Impact

CHAPTER 13 LANDSCAPE, SEASCAPE AND VISUAL IMPACT

Landscape, Seascape and Visual Impact

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13. Landscape, Seascape and Visual Impact

13.1 Introduction

13.1.1 This chapter provides an assessment of the effects on landscape resources and visual amenity that are likely to result from the operation and maintenance of the Proposed Project.

13.1.2 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.

13.1.3 This chapter describes: the baseline landscape and visual conditions currently existing within the Proposed Project site and the surrounding LVIA Study Area which lies within the Environmental Zone of Influence (LVIA 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.

13.1.4 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. Consultation was undertaken with Shetland Islands Council and Scottish Natural Heritage (SNH, 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.

13.1.5 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.

13.1.6 The location of the Proposed Project and the extent of the Proposed Project boundary is shown on Drawing 13.1.1. This is also detailed in Chapter 3 (Proposed Project).

LVIA Contents

13.1.7 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 LVIA 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 LVIA Study Area;
- 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 LVIA 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 SNH;
- 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

13.1.8 The LVIA chapter should be read alongside the following plans, photographs and visualisations, which are included in Volume III.

13.1.9 The baseline landscape and visual context is illustrated in: Drawing 13.1.1, LVIA Study Area/EZI; Drawing 13.1.2, Landscape Designations; and Drawing 13.1.3, Landscape/Coastal/Seascape Character Areas. Viewpoint locations are shown in Drawing 13.1.4.

13.1.10 The assessment of landscape and visual effects is supported by the Zone of Theoretical Visibility (ZTV) maps in Drawings 13.2.1 to 13.2.2, and viewpoint photographs and photomontages in Drawings 13.3.1.1 – 13.3.1.10, and 13.3.2.1 – 13.3.2.5.

Appendices

13.1.11 This chapter is accompanied by Appendices 13.1 to 13.6 in Volume IV. These provide greater detail and background information on:

- Appendix 13.1, LVIA Methodology;
- Appendix 13.2, Landscape Character Areas within the 15 km LVIA Study Area;
- Appendix 13.3, Coastal Character Areas within the 15 km LVIA Study Area;

- Appendix 13.4, Seascape Character Areas within the 15 km LVIA Study Area; and,
- Appendix 13.5, Special Qualities Assessment, Shetland National Scenic Area.

Project Description

13.1.12 The assessment covers the operational of the Proposed Project, as described in Chapter 3.

13.1.13 The infrastructure required for the Proposed Project consists of:

- 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;
- Antenna Area: up to four areas on the Lamba Ness peninsula for telemetry, flight termination systems and satellite tracking;
- Integration Hangars (three): located on the Lamba Ness peninsula, a building where the launch vehicles are assembled, and the payload (the satellites) prepared and integrated into the launch vehicles;
- Administration Building, Pyrotechnics Store, and Hazardous Materials Store;
- Support Infrastructure: located on the Lamba Ness peninsula including access, an internal track system and a series of small temporary buildings;
- Gate House, including a tourist information area, located on the Lamba Ness peninsula; and
- Wildlife Hide: located on the Lamba Ness peninsula.

Design Optimisation

13.1.14 Consideration of landscape and visual effects of operation of the Proposed Project has been considered as part of the evolution of 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. As such, all the effects from the operational stage described herein are essentially residual effects.

13.2 Legislation, Policy and Guidance

13.2.1 The legislation, policies and guidance relevant to the LVIA are set out below, and Drawing 13.1.2, Volume III identifies the location and extent of the landscape policy designations.

Legislation

Space Industry Act

13.2.2 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 sub-orbital activities from the UK;
- operate a spaceport in the UK; or
- provide range control services from the UK.

Policy

13.2.3 Whilst there is no policy specific to the assessment of the landscape and visual effects of space ports, 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

13.2.4 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.

13.2.5 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)

13.2.6 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)

13.2.7 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

13.2.8 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

13.2.9 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

13.2.10 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

13.2.11 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

13.2.12 The Department for Transport document "Guidance for the Assessment of Environmental Effects" 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.

13.2.13 The Guidance requires that potential direct and indirect significant effects of proposed spaceflight activities on environmental features, including landscape and visual impact, 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 (e.g., EIAs provided as part of a planning application) and whether they are being used in support of the AEE;
- 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 landscape and visual impacts.

13.3 Consultation

Scoping

13.3.1 Extensive statutory consultation on LVIA was carried out during preparation and determination of the planning application for the SaxaVord Spaceport, where the Proposed Project will be operated. 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

13.3.2 Where directly relevant to this AEE, consultation responses received during the SaxaVord Spaceport planning application period have been summarised in Table 13.1.

Table 13.1 Consultation Relevant to AEE

Consultee	Comment
Shetland Islands Council - Natural Heritage Officer Comments, 1st July 2020	Rather than Assessing the Impacts on Wild Land: Interim Guidance Note, SNH Heritage (2007), please use the current advice, which is Assessing impacts on Wild Land Areas -Technical Guidance note Consultation - SNH Jan 2017

Consultee	Comment
	The standard reference that describes landscape character in Shetland is now the "Scottish Landscape Character Types Map and Descriptions" (SNH, 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 [Proposed Project's] 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 ➢ I confirm that GLVIA3 is the correct framework for the methodology ➢ I am content with the proposed 15 km extent of the LVIA 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.

13.4 Assessment Methodology and Significance Criteria

13.4.1 This chapter is supported by Appendix 13.1, which contains a detailed description of the method of assessment.

Guidance

13.4.2 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 13.1 Volume IV.

Overview of Methodology and Limitations

13.4.3 The general approach to the LVIA includes the following key tasks:

- Desk study: A desk study was undertaken to define the baseline landscape and visual resource within the LVIA Study Area and identify the main users of the area, key viewpoints and key features. Refer to Appendix 13.1 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 13.1 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 LVIA 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 LVIA 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 LVIA 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.

13.4.4 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)

13.4.5 The LVIA Study Area is defined by a 15 km radius oval offset from the outermost edge of the Proposed Project, as shown in Drawing 13.1.1. This extent of LVIA Study Area was determined as appropriate, given the height of the Proposed Project, and agreed in consultation with the relevant consultees. A wider area was considered in terms of the effects of a launch; both areas falling within the overarching EZI for the AEE.

Process of Assessing Effects and their Significance

13.4.6 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.

13.4.7 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 13.1.

Level of Effects and Determination of Significance

13.4.8 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 13.1, Volume IV. The following matrix in Table 13.2 is used as a guide to correlating sensitivity and magnitude to determine the level of predicted effects and their significance.

Table 13.2 - 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
	Moderate	Moderate to Minor	Minor	Minor to None

Low **Negligible**	Moderate to Minor	Minor	Minor to None	Minor to None

13.4.9 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.

13.4.10 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

13.4.11 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.

13.5 Baseline Conditions

13.5.1 This section provides a general description of the landscape and visual context of the Proposed Project site and LVIA Study Area. It briefly describes the historical and cultural context within the LVIA Study Area, identifying both sensitive locations and receptors to be addressed in the subsequent impact assessment.

The Application Site

13.5.2 The location of the Proposed Project is shown in Drawing 13.1.1.

Proposed Project

13.5.3 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).

13.5.4 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 c.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, with 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.

13.5.5 The peninsula lies at c.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 c.60 m at the minor road (Holsens Road), rising steeply beyond to the Ward of Norwick to the west at 181 m AOD.

The Wider LVIA Study Area

13.5.6 The wider LVIA 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 LVIA 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 c.250 m Above Ordnance Datum (AOD).

General Characteristics and Features of the LVIA Study Area

Extent of the LVIA Study Area

13.5.7 The 15 km radius LVIA 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

13.5.8 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), 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 LVIA 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

13.5.9 The LVIA Study Area 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.

13.5.10 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.

13.5.11 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.

13.5.12 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

13.5.13 The LVIA 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.

13.5.14 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.

13.5.15 More information on Material Assets and Cultural Heritage is detailed in Chapter 14, but these features are noted here as visitors are attracted to them and are potential visual receptors.

Built and other Heritage Features

13.5.16 Other important sites which may attract visitors, and hence be of relevance as potential visual receptors within the LVIA Study Area 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 LVIA Study Area 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

13.5.17 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.

13.5.18 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

13.5.19 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.

13.5.20 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

13.5.21 National Cycle Route 1 connects from Sumburgh in the south of Mainland through to Skaw in north-eastern Unst. On Unst, the route follows the main road, A968 and continues on the B9087.

Walking Routes

13.5.22 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.

13.5.23 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

13.5.24 Many tourists travel to Unst as one of their main destinations on Shetland. Opportunities for tourism and recreation within the LVIA Study Area 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.

13.5.25 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 LVIA Study Area include the beaches at Norwick and Skaw.

Baseline Landscape Resources

13.5.26 The character and value of the LVIA Study Area 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, 2020)

13.5.27 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

13.5.28 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.

13.5.29 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 LVIA Study Area are illustrated in Drawing 13.1.3 Volume III and described in detail in Appendix 13.2, Appendix 13.3 and Appendix 13.4 respectively.

13.5.30 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.

13.5.31 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."

13.5.32 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."*

13.5.33 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."

13.5.34 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."*

13.5.35 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."

13.5.36 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."*

13.5.37 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.

13.5.38 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.

13.5.39 The nine remaining LCTs/ SCAs/CCAs have the potential to be significantly affected by the Proposed Project, as listed in Table 13.3 and are included in the detailed assessment reporting in Section 13.7.

Table 13.3 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
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

13.5.40 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 LVIA Study Area.

13.5.41 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 LVIA Study Area are shown in Drawing 13.1.2 and are described below.

National Scenic Areas

13.5.42 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 SNH, 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.

13.5.43 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.

13.5.44 One NSA sub-unit, Hermaness, is located within the LVIA Study Area. 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."

13.5.45 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

13.5.46 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.

13.5.47 Three LLAs are identified within the LVIA Study Area. 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 LVIA Study Area, as follows:

- Colvadale and Muness, Unst LLA: A small are of distant visibility from Muness, at distances of c.15 km; and,

- Gloup Voe and Bluemull Sound LLA: No visibility.

13.5.48 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

13.5.49 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.

13.5.50 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.

13.5.51 Table 13.4 below sets out a summary of the designated landscapes considered in the assessment and their sensitivity to the Proposed Project.

Table 13.4 - 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

13.5.52 A key component of the assessment is the consideration of effects from key locations within the LVIA Study Area. 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

13.5.53 Settlement within the LVIA Study Area is located in sheltered locations close to sheltered voes and sounds, typically comprising open settlements and dispersed aggregations of crofts.

13.5.54 In accordance with the criteria outlined in the detailed methodology in Appendix 13.1, 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.

13.5.55 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 13.2.1-13.2.2. and identifies those settlements which require further assessment.

Table 13.5 - Summary of Settlements within the Zone of Theoretical Visibility

Settlement	Distance and Direction to Proposed Project	Theoretical Visibility of the Proposal
Within 5 km of the Launch Pads		
The Haa, Skaw	c.750 m to Proposed Project boundary	No visibility.
Booths/Houlanbrindy	c.660 m to Proposed Project boundary	Partial visibility to the integration hangars, boundary fencing, tracking station, launch vehicles and lightning masts.
Norwick/Kirkaton	c.1.2 km to Proposed Project boundary	Partial visibility to the gate house, integration hangars, boundary fencing, tracking station, launch vehicles and lightning masts.
Valsgarth/Saxa Vord	c.2.3 km to Proposed Project boundary	Partial visibility to the gate house, integration hangars, boundary fencing, tracking station, launch vehicles and lightning masts.
Haroldswick	c.3.2 km to the Proposed Project boundary	No visibility.
Ungirsta/Stove	c.3.5 km to the Proposed Project boundary	No visibility.
Within 10 km of the Launch Pads		
Burrafirth Cluster	c.4.36 km to Proposed Project boundary	No visibility.
Quoys	c.4.46 km to Proposed Project boundary	Uninhabited.
Baltasound Cluster (closest location at bus garage)	c.5.29 km to Proposed Project boundary	No visibility.
Within 15 km of the Launch Pads		
Westing Cluster	c.13.4 km to Proposed Project boundary	No visibility.

Routes

13.5.56 Vehicular and non-vehicular route corridors within the LVIA Study Area, 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 13.2.1-13.2.2. The table identifies which routes or parts of routes require further assessment.

Table 13.6 - Review of visibility from Routes within the LVIA Study Area

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

13.5.57 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 13.3. 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.

13.5.58 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.

13.5.59 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 SNH, is shown in Table 13.7, and their locations are illustrated in Drawing 13.1.4. Photographs of the existing views from these viewpoints are shown in Drawings 13.3.10.1 – 13.3.2.5. The existing and predicted views of the Proposed Project are described in the assessment of effects in Section 13.8.

Table 13.7 – 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
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

13.5.60 At the time of writing, other significant infrastructure development within the 15 km LVIA Study Area 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 13.7 and 13.8.

13.6 Assessment of Effects

13.6.1 This section comprises the assessment of the effects on landscape and visual resources arising from operation of the Proposed Project.

13.6.2 The Applicant is looking to achieve a maximum of 30 RepLV launch events per year from the Proposed Project. Of the total proposed 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 four RepLV launch events, on the basis that there will likely be a period of a week between launches due to operational constraints within the launch vehicle assembly facilities.

13.6.3 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 has been assumed, aligning with the current land lease for the Proposed Project.

13.6.4 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 Proposed Project, as summarised below.

Existing 'Embedded' Mitigation

13.6.5 Design iteration of the Proposed Project was undertaken as part of the LVIA at the planning stage to reduce the visual effects. The assessment for AEE has, therefore, been completed taking into account the following embedded mitigation measures.

Topography and Landform

13.6.6 The buildings and roads will be sited to minimise the requirement for major ground modelling thereby reducing the extent of earth moving and the need to alter the existing landform within the site. This will have the added benefit of reducing, or indeed, negating the need to remove surplus material from the site.

Massing and Form

13.6.7 Through careful site planning an integrated relationship has been developed between the proposed 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 and fits the Proposed Project sensitively between existing structures.

13.6.8 Visual integration will be secured through orientation, positioning of buildings and structures, profile, colour and facade treatments, design detailing, use of materials, use of land profiling, all selected to give cohesion to the Proposed Project and create an appropriate response to the components of the surrounding landscape and be seen as an appropriate addition in the context of the existing site elements and infrastructure. A summary of the development and design strategy for the main building groups is set out below.

Inner Skaw Assembly Building Cluster

13.6.9 The western sector of the Lamba Ness site at Inner Skaw is set aside for a cluster of buildings which will form the entrance area to the Proposed Project. A new gate house will control access to the site at the western limit of the site and will also provide visitor facilities and information about site access and interpretation. Access will lead from this point from an upgraded road following the existing track to provide general site access. A new side road will lead to an area set aside for the launch vehicle assembly and the storage of materials with associated hard standings. This cluster of buildings will include: an administration building, 6 m high and with a footprint of c. 20 m x 20 m; two adjacent large hangars rising to c. 13 m, with a footprint each of c. 29 m x 63 m; a small pyrotechnics store; a hazardous Materials Store 5 m high, with a footprint of 13 m x 13 m; and a small substation.

13.6.10 The detailing of the gate house differs slightly from the hangar and storage buildings to draw it apart from the main cluster, and to foster a sense of arrival and welcome to the site.

Satellite Tracking Station

13.6.11 Mid-way along the site, a satellite tracking station is proposed. This will include an area of hardstanding and four separate telemetry devices, housed within geodesic radomes.

Integration Hangar

13.6.12 The integration hangar, a large building rising to c.14 m, with a footprint of c.61 m x 41 m, will be 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

13.6.13 Three separate launch pads are proposed. Launch Pad 1 will be positioned to the northern side of the Lamba Ness peninsula, carefully set between the structures of the radar station. Some of the former radar station structures will need to be carefully removed to accommodate the new launch pad structures. Two more launch pads are proposed 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.

13.6.14 Each launch pad will comprise 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 launch cycle. When the launch pad is not in use these temporary building and containers will not be present on the site.

13.6.15 The launch pad will have at its centre a simple permanent pedestal and gantry to receive the launch vehicle. The apparatus used during the launch cycle to erect the launch vehicle will be brought to site as mobile and temporary equipment for each launch.

13.6.16 Permanent lightning masts will be positioned either side of the launch pad, 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.

13.6.17 Adjacent to each launch pad will be a water tank / pump house to deliver water inundation during each launch cycle. 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).

13.6.18 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 will be vegetated with grass turves won from the site. The gabion walls will be filled with locally won rock to ensure effective integration with the surrounding rock type seen in the surrounding landscape and coastline. These measures will ensure that the simple structure of the launch pad sites will recede in views against the wider setting and marry in with the existing structures of the former radar station.

13.6.19 A wildlife hide is proposed to the east of Launch Pad 3 on the eastern edge of Lamba Ness.

Colour

13.6.20 The clusters of new buildings at Lamba Ness will be given unity by use of similar colour themes and colour palettes that draw upon colours seen in buildings across Unst and natural colours occurring within the local Unst landscape. The red hues proposed in buildings are based on those colours seen in the: minerology of the landscape; the tan colours of the surrounding grassland and cut hay meadows; and in local buildings such as the painted barns and the large hangar at Baltasound Airport.

13.6.21 The graduation of colours in the elevations is intended 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

13.6.22 Lighting has been considered as an important element of the Proposed Project. Potential light sources will be associated with flood lighting for the launch pads during launch cycles and cut off lighting within the new network of external spaces around the proposed buildings, including car parking areas.

13.6.23 A sympathetic lighting strategy will be prepared within the context of the design of the buildings to minimise any potential adverse effects. A number of measures will be introduced within the context of the operational requirements of the site to minimise the unwanted effects associated with light sources. These will 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.

13.6.24 These measures are proposed to minimise light pollution and reduce night-time glare, while providing appropriate night-time illumination within the Proposed Project.

Services

13.6.25 All services associated with the Proposed Project will be routed underground and therefore, any visual effects will be limited to directional flood lighting units.

13.6.26 The site drainage strategy will, subject to the necessary agreements, be based upon roadside filtration trenches which are likely to include a combination of open swales and buried pipes/culverts and sustainable drainage systems.

Assessment of Effects on the Landscape Resource

13.6.27 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.

13.6.28 The following assessment of landscape effects addresses:

- Effects on the application sites;
- Effects on Landscape Character; and,
- Effects on Designated Landscapes

13.6.29 Identification of the potential for significant effects has been undertaken following a review of the visualisations provided in Drawings 13.3.1.1 to 13.3.2.5. 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

13.6.30 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

13.6.31 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 launch vehicles, 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 launch vehicle itself however, it is acknowledged that at certain times of year, and particularly during the summer tourist season, the launch of a 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 Sequence

13.6.32 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 launch vehicle is prepared for launch the launch vehicle will be taken from the Integration Hangar to the launch pad, and erected into a vertical position at the launch pad. The launch vehicle will be 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. Close to the launch, as various propellants and fuels are loaded into the launch vehicle, there will be additional effects arising through the emission of occasional vapours from the launch vehicle and surrounding equipment, as well as the presence of activity and lighting. The launch vehicle may be at the launch pad for several days prior to launch and the launch vehicle and launch pad and surrounding structures will be brightly illuminated at night.

13.6.33 The launch of the launch vehicle itself 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 launch vehicle ignites, a process of water inundation is commenced as a measure to both reduce the roar of the launch vehicle but also to protect the 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.

13.6.34 The launch itself will be very quick, with the launch vehicle moving above the strongback within c.3 seconds of the initial launch vehicle firing, the overall noise and emissions reaching a peak up to 10 seconds into the launch, immediately reducing thereafter. The launch vehicle will be seen to speed away from the launch site, reaching an altitude of c.1 km after approximately 23 seconds into the launch, and c.2 km after approximately 30 seconds. There may at times be a visible trail or plume from the launch vehicle, 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 launch vehicle.

13.6.35 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 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 launch vehicle will appear very small, with the 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.

13.6.36 These effects will give rise to short term changes in qualities of tranquillity experienced within the LVIA Study Area, giving rise to very short-term disturbance. It is noted that the LVIA Study Area is characterised by its wild remote qualities, the experience of tranquillity and the ability to 'get away from it all', and that many people living within and visiting the LVIA Study Area choose to visit and live here to find an escape.

13.6.37 The frequency of launches will increase once all three launch pads are operational, and whilst individual launches will be well separated, there will be an overall cumulative effect on general tranquillity within the LVIA Study Area. 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 on issues arising from launch sequences.

13.6.38 Following the 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 site. The launch pad is expected to return to its normal configuration within a few days after launch.

Visitors

13.6.39 As discussed above, in the days running up to launches during the tourist season, there are likely to be a greater number of visitors to the surrounding area in the immediate few hours before and after a launch. This will give rise to short term effects of increased traffic and pedestrian movement, pressure for temporary car parking and localised aggregations of spectators. A Visitor Management Strategy has been developed by the Applicant.

13.6.40 Whilst the effects will be temporary, the increased visitor pressure will inevitably give rise to secondary localised landscape and visual effects at publicly accessible vantage points around the Proposed Project.

Assessment of Direct Effects on the Landscape Resource

Location

13.6.41 The baseline assessment identifies the gently sloping peninsula of land between Inner Skaw and Lamba Ness as the context for the Proposed Project forming the Proposed Project.

13.6.42 The main land use on the site is as 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

13.6.43 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

13.6.44 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

13.6.45 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

13.6.46 The overall magnitude of change to the existing landscape fabric across the site will be Substantial. The factors which have contributed to this judgement are set out below.

Size or Scale

Inner Skaw Assembly Building Cluster

13.6.47 The western sector of the Lamba Ness site at Inner Skaw is set aside for a cluster of buildings which will form the entrance area to the Proposed Project. This will include: a Gate house, 6.3m high, with a footprint of 17 m x 17 m; an administration building, 6 m high and with a footprint of c. 20 m x 20 m; two adjacent large integration hangars rising to c.13 m, with a footprint each of c. 29 m x 63 m; a small pyrotechnics store; a hazardous Materials Store 5 m high, with a footprint of 13 m x 13 m; c.3,250 m² of hard standing; and a small electricity substation.

Satellite Tracking Station

13.6.48 Mid-way along the Proposed Project, a Satellite Tracking Station is proposed. This will include an area of hardstanding and four separate telemetry devices, housed within geodesic radomes.

TEL Hangar

13.6.49 The transporter holding building, a large hangar rising to c.14 m, with a footprint of c.61 m x 41 m, will be located to the south of the three launch pads and the main access track.

Launch Pads

13.6.50 Three separate launch pads are proposed, one at Lamba Ness and two on the northern side of The Garths.

13.6.51 Each launch pad will comprise 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 launch cycle. Each launch pad extends to a footprint of approximately 100 m x 100 m.

13.6.52 A wildlife hide is proposed at the eastern edge of Lamba Ness to the east of Launch Pad 3.

Access Tracks

13.6.53 The disparate elements of the Proposed Project will be connected by an upgraded access track, which will predominantly follow the alignment of the existing track, with some further sections of new track connecting the launch pads, etc.

Geographical Extent

13.6.54 The Proposed Project occupies an area of approximately 80.8 ha.

Significance of Effect

13.6.55 The combination of the individual judgements of medium sensitivity and substantial magnitude of change on the landscape fabric of the site at the operational stage of the Proposed Project, 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 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

13.6.56 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 (the components most likely to be visible) within the LVIA Study Area is therefore provided below.

General Appraisal of Visibility

13.6.57 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 Proposed Project on the promontory of land at Lamba Ness, which extends c.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, where terrain allows, the proposed hangar buildings which rise to c. 14 m, the launch vehicles when temporarily in launch configuration rise up to c.30 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.

13.6.58 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.

13.6.59 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.

13.6.60 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.

13.6.61 To the north-west visibility extends across the upland flank on the eastern side of Saxa Vord, 284 m AOD.

13.6.62 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.

13.6.63 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 c.8 km and beyond 10 km the Ward of Houlland, 156 m AOD, and the Byre of Scord, 216 m AOD.

13.6.64 Drawings 13.2.1 - 13.2.2 indicate the zone of theoretical visibility of the Proposed Project within a 15 km radius, based on the maximum potential visibility of the Proposed Project during the launch configuration and the baseline visibility of the Proposed Project when not in operation.

Assessment of Effects upon Landscape, Coastal and Seascape Character Areas (LCTs/CCAs/SCAs)

13.6.65 This section assesses effects upon LCTs/CCAs/SCAs within 15 km of the Proposed Project, as defined in the Scottish Landscape Character Types Map and Descriptions Online (SNH, 2020), the Shetland Coastal Character Assessment, 2016, and Scottish Seascape Areas defined in the NatureScot Report No.103, 2005.

13.6.66 The location of the LCTs/CCAs/SCAs is presented in Drawing 13.1.3. The ZTV of the Proposed Project overlaid with the LCTs/CCAs/SCAs and landscape designations is shown in Drawings 13.2.1 - 13.2.2 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.

13.6.67 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.

13.6.68 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 13.3, where potentially significant effects may occur, as set out in Tables 13.8 – 13.16.

Table 13.8 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 LVIA Study Area: ➢ 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 below as a new large-scale man-made feature in the landscape, 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 launch cycles at the individual launch pads, the extended lightning masts, the 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 13.3.3 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 13.9 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 LVIA Study Area: ➢ 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 launch cycles, the extended lightning masts, the 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 c.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 c.4.5 km, and from the Keen of Hamar at c.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 hangars will be seen at Inner Skaw. Viewpoint 1.7, Drawing 13.3.1.7 from the Hill of Clibberswick is representative of the typical views within this LCT, at c.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 13.10 Effects on LCT 352 Inland Valleys

Location

Within the LVIA Study Area 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 launch cycles, the extended lightning masts, the 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, over at c.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 13.11 Effects on LCT 353 Farmed and Settled Lowlands and Coast

Location

Within the LVIA Study Area 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 launch cycles, the extended lightning masts, the 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 13.12 Effects on LCT 354 Farmed and Settled Voes and Sounds

Location

Within the LVIA Study Area 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 launch cycles, the extended lightning masts, the 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 13.13 Effects on LCT 355 Coastal Edge

Location

Within the LVIA Study Area 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 as well as the wildlife hide 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 launch cycles at the individual launch pads, the extended lightning masts, the 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 13.3.1.1 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 c.1.1 km from the application site. Viewpoint 1.7, Drawing 13.3.1.7 illustrates a more distant view from the Hill of Clibberswick. Viewpoint 1.8, Drawing 13.3.1.8 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 13.14 Effects on CCA 20: Skaw

Location

Within the LVIA Study Area 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 as a new large-scale man-made development, 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 and the proposed wildlife hide at the end of the peninsula.

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 launch cycles at the individual launch pads, the extended lightning masts, the 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 13.3.1.1 from the peninsula above Bluejibs and the Wick of Skaw to the north, at from Viewpoint 1.2, Drawing 13.3.1.2 at Skaw Beach to the north west, are representative of the typical nature of close views within this CCA, at c.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 13.15 Effects on CCA 16: East Unst

Location
Within the LVIA Study Area 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 as a new large-scale man-made development, 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 and the proposed wildlife hide will be partially visible across the headland at Lamba Ness, influencing the perception of scale in wider views. During the short duration of launch cycles at the individual launch pads, the extended lightning masts, the 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 c.6 km.

Viewpoint 1.4, Drawing 13.3.1.4 from The Taing at Nor Wick is representative of the typical nature of views within this CCA, at c.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 13.16 Effects on Seascape Character Type 13 D: Islands, Sounds and Voes

Location

Within the LVIA Study Area 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 as a new large-scale man-made development 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 launch cycles at the individual launch pads, the extended lightning masts, the 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

Table 13.17 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 13.17 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	Medium	Locally Moderate Elsewhere Slight	Locally Moderate Elsewhere Minor	Not significant

Landscape/ Coastal/ Seascape Character Areas	Overall Sensitivity to Change	Magnitude of Change	Level of Effect	Significance
and Moorland				
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 significant Elsewhere Not significant
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

13.6.69 This section considers the implication of the Proposed Project on designated landscapes falling within the LVIA Study Area. 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 13.4).

- Hermaness sub-unit of the Shetland NSA

- Haroldswick and Skaw, LLA

13.6.70 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 13.2.1 – 13.2.2 overlaid with the ZTVs of the respective components of the Proposed Project to a 15 km radius.

Shetland NSA

13.6.71 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

13.6.72 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.

13.6.73 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."

13.6.74 Drawings 13.2.1 – 13.2.2 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 13.3.1.8 illustrates the nature of views from the headland within the NSA.

13.6.75 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 13.3.1.8.

13.6.76 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 13.5.

13.6.77 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

13.6.78 Designation statements for Local Landscape Areas (LLAs) in Shetland are set out in the Shetland Islands Council Report, Local Landscape Designations Review (LLDR), 2011.

13.6.79 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."*

13.6.80 The LLA comprises an extensive area of hills and headlands and the north-eastern extent of Unst. Drawings 13.2.1 – 13.2.2 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.

13.6.81 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.

13.6.82 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.

13.7 Assessment of Effects on the Visual Resource

13.7.1 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

13.7.2 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 LVIA Study Area. 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.

13.7.3 In accordance with the criteria outlined in the detailed methodology in Appendix 13.1, residential receptors, within settlements in the LVIA Study Area, 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.

13.7.4 An indication of the predicted extents of visibility for the Proposed Project across the settlements is provided within the visibility mapping in Drawings 13.2.1 to 13.2.2. 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.

13.7.5 The settlements in the LVIA Study Area with potential views of the Proposed Project, as identified in Table 13.5, are assessed below.

Table 13.18 Effects on settlement at Booths/Houlanbrindy

Location
The cluster of settlement at Booths/Houlanbrindy, c.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 hangars; site fencing; partial view to the southern radome of the tracking station; the lightning masts; launch vehicles on pad 3, will be seen as a new man-made development appearing above the cliffs to the north of Nor Wick, influencing the perception of scale in wider views.

During the short duration of launch cycles, the extended lightning masts, the 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 13.19 Effects on settlement at Norwick/Kirkaton

Location

The cluster of settlement at Norwick/Kirkaton, c.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 hangars; boundary fencing; the southern radomes of the tracking station; the Integration/TEL Building; launch vehicles and lightning masts, will be seen as a new man-made development appearing above the cliffs to the north of Nor Wick, influencing the perception of scale in wider views.

During the short duration of launch cycles at each of the launch pads, the extended lightning masts, the launch vehicles 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 13.20 Effects on settlement at Valsgarth/Saxa Vord

Location

The cluster of settlement at Valsgarth/Saxa Vord, c.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 hangars; boundary fencing; the southern radomes of the tracking station; the integration/TEL building, launch vehicles and lightning masts, will be seen as a new man-made development 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 launch cycles at each of the launch pads, the extended lightning masts, the launch vehicles 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 13.21 Effects on settlement at Clibberswick

Location
The cluster of settlement at Clibberswick, c.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 13.21 Effects on settlement at Haroldswick

Location
The cluster of settlement at Haroldswick, c.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 13.22 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, c.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

13.7.6 Table 13.23 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 13.23 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

Settlement	Sensitivity to Change	Magnitude of Change	Level of Effect	Significance
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

13.7.7 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 LVIA Study Area, 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.

13.7.8 In accordance with the criteria outlined in the detailed methodology in Appendix 13.1, 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.

13.7.9 An indication of the predicted extents of visibility route corridors is provided within the visibility mapping in Drawings 13.2.1 to 13.2.2.

13.7.10 The principal effects on these routes with potential views of the Proposed Project, as identified in Table 13.6, are assessed below.

Table 13.24 Operational Effects on A968/National Cycle Route 1

Route Description
The A968/NCR1 connects through the LVIA Study Area between Gunnister in mid-Unst at c.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 c.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 buildings 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 c.4.5 km. The new man-made development will be seen to contrast slightly with the scale of the existing development and with the soft hues of the moorland hills.

Geographical Extent

The ZTV indicates that there will be the potential for partial visibility over a short c.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 13.25 Operational Effects on B9086

Route Description

The B9086 connects between Burrafirth and Haroldswick through the study area at c.3.9 km from the Proposed Project and c.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 c.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 buildings 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 c.3.9 km.

Geographical Extent

The ZTV indicates that there will be the potential for partial visibility over a short c.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 13.26 Operational Effects on B9087

Route Description

The B9087 connects between Haroldswick and Norwick through the LVIA Study Area with areas of closest visibility over c. 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 hangars; boundary fencing; the southern radomes of the tracking station; the integration hangar/TEL building; launch vehicles and lightning masts, will be seen as a new man-made development appearing above the cliffs to the north of Nor Wick, influencing the perception of scale in wider views.

During the short duration of launch cycles at each of the launch pads, the extended lightning masts, the launch vehicles 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 c.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

13.7.11 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 study area. The selection of viewpoints is discussed at paragraph 13.5.60.

13.7.12 The predicted views from each of the 15 viewpoint locations are illustrated using photomontages in Drawings 13.3.1.1 to 13.3.1.10 in respect of the Proposed Project and, as relevant, and in Drawings 13.3.2.1 – 13.3.2.5 for the LRCC. The visualisations are accurate graphic representations in terms of the positioning, spatial distribution and size of the Proposed Project.

13.7.13 For the purposes of assessing the effects on visual amenity, the sensitivity of the receptors is as defined in Appendix 13.1.

13.7.14 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 13.1.

Duration and Reversibility of the Visual Effects

13.7.15 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.

13.7.16 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 13.27 Effects at Viewpoint 1.1, Bluejibs above the Wick of Skaw

Viewpoint 1.1, Bluejibs above the Wick of Skaw Drawing 13.3.1.1 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

Viewpoint 1.1, Bluejibs above the Wick of Skaw Drawing 13.3.1.1 existing view and a panoramic photomontage of the Proposed Project.	
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.

Viewpoint 1.1, Bluejibs above the Wick of Skaw Drawing 13.3.1.1 existing view and a panoramic photomontage of the Proposed Project. 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 launch vehicle and strongback erected and the lightning masts extended in full. The wildlife hide will be seen as new small-scale structure at the eastern edge of the Lamba Ness peninsula. 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 c.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 13.28 Operational Effects at Viewpoint 1.2, The Haa, Wick of Skaw

Viewpoint 1.2, The Haa, Wick of Skaw Drawing 13.3.1.2: 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 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 c.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 13.29 Effects at Viewpoint 1.3, The Garths, Lamba Ness

Viewpoint 1.3, The Garths, Lamba Ness **Drawing 13.3.1.3 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 visible, with the large-scale hangars, 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 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 c.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 s**ignificant**.

Table 13.30 Effects at Viewpoint 1.4, Car Park at The Taing, Norwick

Viewpoint 1.4, Car Park at The Taing, Norwick Drawing 13.3.1.4 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 hangars 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 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 13.31 Effects at Viewpoint 1.5, The Cemetery, Norwick

Viewpoint 1.5, The Cemetery, Norwick **Drawing 13.3.1.5 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 hangars 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 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 13.32 Effects at Viewpoint 1.6, B9087 Norwick

Viewpoint 1.6, B9087 Norwick **Drawing 13.3.1.6 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

Viewpoint 1.6, B9087 Norwick Drawing 13.3.1.6 shows: a) 90° existing view and a panoramic photomontage of the Proposed Project.	
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.

Viewpoint 1.6, B9087 Norwick Drawing 13.3.1.6 shows: a) 90° existing view and a panoramic photomontage of the Proposed Project. Magnitude of Change
The overall magnitude of change on receptors at this viewpoint will be a **moderate**. ***Size or Scale*** The hangars 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 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 13.33 Effects at Viewpoint 1.7, Hill of Clibberswick

Viewpoint 1.7, Hill of Clibberswick Drawing 13.3.1.7 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 c.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 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 c.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 13.34 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 13.3.1.8 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 c.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 13.2.1a 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 13.35 Effects at Viewpoint 1.9, A968 beneath Little Hoeg

Viewpoint 1.9, A968 beneath Little Hoeg **Drawing 13.3.1.9 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 and LRCC

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 c.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 hangars 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 c.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**.

Table13.35 Effects at Viewpoint 1.10, Hermaness Hill

Viewpoint 1.10, Hermaness Hill **Drawing 13.3.1.10 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 c. 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 13.2.1a 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.

LRCC Viewpoints, Viewpoints 2.1 – 2.5

Table 13.36 Operational Effects at Viewpoint 2.1, Minor road at Valsgarth

Viewpoint 3.1, Minor road at Valsgarth Drawing 13.3.2.1 existing view and a panoramic photomontage of the Proposed Project.	
Distance and Direction to the LRCC	LRCC: 400 m to the west
LCT/CCA and Designations	LCT 354. Farmed and Settled Voes and Sounds Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Cyclists / Residents – High Road Users - Medium
Theoretical visibility	Proposed Project and LRCC
Location and Rationale for Selection	
The viewpoint is located on the minor road at Valsgarth to the south-east of the former RAF base at Saxa Vord. The viewpoint is representative of the range of view in and around Saxa Vord for Residents and Road Users. The following development currently influences the existing baseline: ➢ The complex of buildings associated with the former Saxa Vord RAF base, now forming part of the Saxa Vord Resort. ➢ The clusters of radar equipment on the Sothers Field.	
Description of Existing View	
The existing view looks north west to the southern edge of the Saxa Vord Resort, the pastures and scattered properties at Valsgarth are seen in the foreground. The Shetland Reel Distillery and the former Valhalla Brewery buildings are seen to their rooflines, set at a slightly lower level than the main resort buildings. The moorland hills at Housi Field and Sothers Field rise to the rear.	
Determination of Visual Sensitivity	
The sensitivity to change associated with the Proposed Project at this location is considered to be **high** for Residents and Cyclists 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.
- 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 **negligible**.

Size or Scale

There will be no significant change to the view.

Geographical Extent

Views to the refurbishment works will be experienced from Valsgarth.

Potential for In-Combination Effects

There will be no combined effects from this viewpoint.

Significance of Effects

No effects.

Table 13.37 Effects at Viewpoint 2.2, Methodist Church, Valsgarth / Saxa Vord

Viewpoint 3.2, Methodist Church, Valsgarth/Saxa Vord **Drawing 13.3.2.2 existing view and a panoramic photomontage of the Proposed Project.**	
Distance and Direction to the LRCC	LRCC: 520 m to the south west
LCT/CCA and Designations	LCA 354. Farmed and Settled Voes and Sounds Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Residents/Visitors/Walkers – High
Theoretical visibility	LRCC only
Location and Rationale for Selection	
The viewpoint is located on elevated ground adjacent to the Methodist Church at Sunnyside, beside the Saxa Vord Resort. The viewpoint is representative of the range of views in and around Saxa Vord for Residents. The following development currently influences the existing baseline: ➢ The complex of buildings associated with the former Saxa Vord RAF base, now forming part of the Saxa Vord Resort.	

Description of Existing View
The existing view looks west to the rear of the clusters of development at the Saxa Vord Resort, pastures and the Saxa Vord games court are seen in the foreground. The moorland hills at Housi Field and Sothers Field rise to the rear. The low-lying farmland art Ungirsta extends to the left of the view.
Determination of Visual Sensitivity
The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for residents who are more susceptible to changes in the view: ***Value*** *– Medium* ***Susceptibility to Change*** *– High* ➢ Residents/Visitors are highly likely to be aware of any changes to their existing visual amenity. ➢ Walkers will be engaged in the experience of the landscape, with a strong awareness of their surroundings.
Magnitude of Change
There will be no effect on this view as the former Valhalla Brewery Building is screened from view behind the buildings of Saxa Vord Resort.
Potential for In-Combination Effects
There will be no combined effects from this viewpoint.
Significance of Effects
There will be no effect on this Viewpoint.

Table 13.38 Operational Effects at Viewpoint 2.3, B9087 adjacent to the Unst Heritage Centre, Haroldswick

Viewpoint 3.3, B9087 adjacent to the Unst Heritage Centre, Haroldswick **Drawing 13.3.2.3 existing view and a panoramic photomontage of the Proposed Project.**	
Distance and Direction to LRCC	LRCC: 850 m to the north east
LCT/CCA and Designations	LCT 354. Farmed and Settled Voes and Sounds Haroldswick and Skaw LLA

Receptor and Sensitivity to Change	Cyclists / Residents – High Road Users - Medium
Theoretical visibility	LRCC only

Location and Rationale for Selection

The viewpoint is located on the B9087 adjacent to the Unst Heritage Centre. The viewpoint is representative of the range of views between Haroldswick and Saxa Vord/Valsgarth for Residents and Road Users.

The following development currently influences the existing baseline:

- The complex of buildings associated with the former Saxa Vord RAF base, now forming part of the Saxa Vord Resort.
- The clusters of radar equipment on the Ward of Norwick.

Description of Existing View

The existing view looks to the north east across the open farmland between Haroldswick and Saxa Vord Resort, beneath the rising moorland flank of Sothers Field and the Ward of Norwick. The settlement at Valsgarth/Saxa Vord Resort extends across the locally elevated middle ground.

Determination of Visual Sensitivity

The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for Residents and Cyclists 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.
- 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 **negligible**.

Size or Scale

No prominent long-term effects are expected.

Geographical Extent

Views will be experienced locally to the south-west of Saxa Vord.

Potential for In-Combination Effects
There will be no combined effects from this viewpoint.
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 Residents, Cyclists and Road Users, which in the context of this assessment is considered to be **not significant**.

Table 13.39 Effects at Viewpoint 2.4, Minor road at Houlanbrindy

Viewpoint 3.4, Minor road at Houlanbrindy **Drawing 13.3.2.4 existing view and a panoramic photomontage of the Proposed Project.**	
Distance and Direction to the LRCC	LRCC: 1 km to the south west
LCT/CCA and Designations	LCA 349. Major Uplands Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Cyclists – High Road Users - Medium
Theoretical visibility	LRCC only
Location and Rationale for Selection	
The viewpoint is located on the minor road which leads above Norwick Meadow to join into Holsens Road. The viewpoint is representative of the range of views in and around Saxa Vord/Northdale for Road Users. The following development currently influences the existing baseline: ➢ The complex of buildings associated with the former Saxa Vord RAF base, now forming part of the Saxa Vord Resort. ➢ The telecommunications masts at Little Hoeg.	
Description of Existing View	
The existing view looks south across the pastures at Northdale to the distinctive rooflines of the former RAF base at Saxa Vord. Views to Saxa Vord are seen against the northern flanks of the Hill of Clibberswick, Little Hoeg and Muckle Hoeg. The North Sea is seen beyond to the left of the view.	

Determination of Visual Sensitivity
The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for Cyclists who are more susceptible to changes in the view, and **Medium** for Road Users: ***Value*** *– Medium* ***Susceptibility to Change*** *– High* ➢ 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
There will be no effect on this view as the former Valhalla Brewery Building is screened from view behind the building of the Shetland Reel Distillery.
Potential for In-Combination Effects
There will be no combined effects from this viewpoint.
Significance of Effects
There will be no effect on this Viewpoint.

Table 13.40 Effects at Viewpoint 2.5, Minor road, off the B9087 at Norwick

Viewpoint 3.5, Minor road, off the B9087 at Norwick **Drawing 13.3.2.5 existing view and a panoramic photomontage of the Proposed Project.**	
Distance and Direction to the LRCC	LRCC: 1.1 km to the west
LCT/CCA and Designations	LCT 354. Farmed and Settled Voes and Sounds Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Cyclists / Residents – High Road Users - Medium
Theoretical visibility	None

Location and Rationale for Selection
The viewpoint is located on the minor road off the B9087, at Norwick Meadow, looking west towards the Saxa Vord Resort and Northdale. The viewpoint is representative of the range of views in and around Norwick for Residents and Road Users.
Description of Existing View
The existing view looks west across the fields of pasture west of Norwick towards the Saxa Vord Resort. The background is framed by the rising hillside at Crussa Field and Valla Field beyond.
Determination of Visual Sensitivity
The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for Residents and Cyclists 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. ➢ 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
There will be no visibility to the LRCC which is contained from view by built form at Saxa Vord and the local ridgeline.
Potential for In-combination Effects
There will be no combined effects from this viewpoint.
Significance of Effects
There will be no effect on this Viewpoint.

Summary of Effects on Viewpoints

13.7.17 Table 13.41 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 13.41 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

13.8 Assessment of Night-time Lighting Effects

13.8.1 The following section provides an overview of the predicted effects of night-time lighting at the Proposed Project.

13.8.2 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. SNH has noted the need to be cautious when proposing lighting in the UK's darker, more sensitive landscapes.

13.8.3 Night-time lighting will be required on the site for safety during launch cycles. The need for lighting will extend visibility of the Proposed Project into hours of darkness. Outside of Launch Cycles the

lighting on site will be reduced to the minimum required for site security and occasional maintenance operations.

Baseline

13.8.4 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

13.8.5 Whilst lighting on the Proposed Project Launch Site will be reduced to a minimum with cut off lighting used wherever possible there will be times when elements of the site and in particular the launch pads and launch vehicles 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.

13.8.6 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 able to be affected by the proposed lighting.

13.8.7 Lighting may also be seen to interfere with natural phenomena such as the Northern Lights, when it occurs.

13.8.8 As such, the effects of lighting on night-time views have the potential to be significant, particularly in closer views and during launch cycles. 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

13.8.9 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

13.8.10 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 13.3.1a: Virse, Norwick – 90° Existing View (Dusk) and 90° Predicted Photomontage View (Cylindrical)
- Night-time Lighting Viewpoint 2: Skulhus, Sunnyside/Saxa Vord Resort
  - Drawing 13.3.2a: Skulhus, Sunnyside/Saxa Vord Resort – 90° Existing View (Darkness) and 90° Predicted Photomontage View (Cylindrical)

13.8.11 The individual assessment from these representative locations is provided below.

Table 13.42 Effects at Night-time Lighting Viewpoint 1, Virse, B9087 Norwick

Night-time Lighting Viewpoint 1, Virse, B9087 Norwick **Drawing 13.3.1 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 launch vehicle, strongback and the lightning masts.
- Low level lighting at the hangars 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 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 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 13.43 Operational Effects at Night-time Lighting Viewpoint 2, Skulhus, Sunnyside/Saxa Vord.

Night-time Lighting Viewpoint 2, Skulhus, Sunnyside/Saxa Vord. **Drawing 13.3.2 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 launch vehicle, strongback and the lightning masts.
- Low level lighting at the Hangars 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 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 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

13.8.12 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 able to be affected by the proposed lighting.

13.8.13 Lighting may also be seen to interfere with natural phenomena such as the Northern Lights when they occur.

13.8.14 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.

13.8.15 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.

13.9 Cumulative Landscape and Visual Assessment Effects

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

13.9.2 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, it is considered that there are no potential inter-project cumulative effects as there are no other existing or proposed developments in the LVIA Study Area s for air quality.

13.9.3 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.

13.9.4 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. In the context of LVIA this is the assessment of in-combination effects, 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. In summary, 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; however, these effects are not significant.

13.10 Summary

13.10.1 A Landscape and Visual Impact Assessment has been undertaken for the Proposed Project. 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.

13.10.2 The assessment includes consideration of effects upon designated landscapes including the Shetland NSA and other locally designated landscapes such the draft LLAs.

13.10.3 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.

13.10.4 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.

13.10.5 The proposed launch pads 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.

13.10.6 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.

Summary of Effects on the Landscape Resource

Effects on Landscape Fabric

13.10.7 Effects on the fabric of the landscape will be limited in extent. The physical changes to the landscape, such as the construction of access tracks, launch pads, and buildings will occupy only a small portion of the overall site area and the existing use of the land for grazing will persist. The Proposed Project will be operated in such a way as to mitigate the extent of any unnecessary damage, potential soil erosion or indirect off-site effects due to changed surface or groundwater conditions.

13.10.8 The landscape is of Medium sensitivity, given the presence of the sensitive remains of the former Skaw Radar Station. Operation the Proposed Project 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

13.10.9 The Proposed Project Launch Site 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.

13.10.10 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.

13.10.11 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.

13.10.12 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.

13.10.13 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.

13.10.14 The Proposed Project between Inner Skaw and Lamba Ness will be seen in partial views, as new structures and buildings protruding above and along the peninsula, reinforcing the influence of development. 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.

13.10.15 During launch cycles the lightning masts, hardbacks and launch vehicles, erected at separate times on each of the launch pads, will be seen as prominent structures which will influence the setting of both LCTs. The launch event 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 temporary locally major/moderate and significant effects. However, it is noted that these effects will be very short term.

13.10.16 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.

13.10.17 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

13.10.18 The Proposed Project 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 introduce additional development 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 and will reinforce the perception of development as a component of the prevailing coastal/seascape character.

13.10.19 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 launch cycles

with the temporary infrastructure of extended lightning masts, strongback and launch vehicles appearing as prominent temporary elements above the low profile of the coastal peninsula.

Effects on Designated Landscapes

13.10.20 Potential effects on the quality and setting of designated landscapes within the LVIA Study Area were assessed, in particular relating to the Shetland NSA, LLAs and Inventory Gardens and Designed Landscapes.

13.10.21 Locally major/moderate and significant effects are predicted upon the coastal edges of the Haroldswick and Skaw Local Landscape Area.

13.10.22 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 a launch cycle, 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 13.5.

13.10.23 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

13.10.24 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 LVIA Study Area.

Effects on Settlements, Transport Corridors and Recreational Routes

13.10.25 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.

13.10.26 During launch cycles the lightning masts, strongbacks and 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 launch cycle will give rise to short term increases in the magnitude of change.

13.10.27 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.

13.10.28 Effects assessed on visual amenity from other settlements, roads and long-distance cycle ways within the LVIA Study Area, are concluded to be not significant.

Effects on Viewpoints

13.10.29 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.

13.10.30 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.

13.10.31 At each of these viewpoints, during launch cycles, the lightning masts, strongbacks and launch vehicles, erected at separate times on each of the launch pads, will be seen as further prominent structures in these views. There will also be associated temporary night-time lighting effects during each launch cycle.

13.10.32 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.

13.10.33 The Proposed Project is focussed away from the scattered settlement and coastal crofting land and is positioned on the Lamba Ness peninsula. The 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. The Proposed Project has been carefully planned to retain the integrity of the remaining Skaw Radar facility, by using the existing site access and by positioning the proposed built forms in less prominent positions within the landscape and, avoiding the remains of the Skaw Radar Station where possible. Whilst the effects 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.

Conclusion

13.10.34 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. However, it is noted that the likely significant landscape effects identified are all inherently associated with the SaxaVord Spaceport infrastructure, rather than operation of the Proposed Project. They carry over into AEE only by LSVIA having been initially scoped into the assessment and by nature of the continued operation of the Spaceport by the Applicant. All 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 this AEE.

13.10.35 As the 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.

13.11 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*. SNH.

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 August 2020.

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 July 2020.

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Appendix 3.6 SaxaVord Spaceport AEE V3 Chapter 14 Material Assets and Cultural Heritage

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'.

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Appendix 4.1 Detailed Modelling Assessment of Launch Event Emissions

APPENDIX 4.1 DETAILED MODELLING ASSESSMENT OF LAUNCH EVENT EMISSIONS

1. Introduction

1.1.1 The scope of the assessment included the following:

- identification of the air quality study area and air quality sensitive receptors within the environmental zone of influence (EZI);
- collection of baseline CO concentrations at the Proposed Project;
- collection of emissions data from the launch of an SR75 Launch Vehicle from the Applicant;
- development of a representative scenarios from Launch Pad 2;
- development of a time-dependant puff model of a jet release with specified duration using the advanced dispersion model ADMS 6 (CERC, 2024) in a range of meteorological conditions and wind directions;
- development of a time-integrated dose model to predict total concentration at the closest residential receptor during the lifetime of the puff release in each scenario using ADMS 6 in a range of meteorological conditions and wind directions;
- conversion of dose concentrations to 8-hour running mean concentrations and comparison with the AQS for CO;
- preparation of contour maps and results tables demonstrating the puff concentration at one-minute intervals after launch for the worst-case meteorological condition;
- specification of mitigation measures required where necessary; and
- residual summary of effects.

2. Study Area and Air Quality Sensitive Receptors

2.1.1 The closest air quality sensitive receptors in each direction from Launch Pad 2 (in the west) and 3 (in the east) were identified, and a study area up to 4 km from each launch position identified to track the puff release until concentrations returned to ambient background levels under a range of meteorological conditions. The closest occupied sensitive receptor to the Proposed Project lies closest to Launch Pad 2 and is Banks Cottage at Norwick which is approximately 2,077 m to the west south-west of the launch site and is shown as R1 on Drawing 4.1.

3. Method of Assessment

3.1 Baseline Carbon Monoxide Concentrations

3.1.1 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 during the AEE application for SaxaVord Spaceport, that no ambient baseline air quality monitoring was necessary. Background concentrations of carbon monoxide (CO) were taken from Defra LAQM background maps (Defra, 2024). The maximum 2024 annual background concentration of CO in the study area is predicted to be 0.051 milligrams per cubic metre (mg/m^3).

3.2 Launch Event Scenarios

3.2.1 The emission rate of exhaust gases from the SR75 Launch Vehicle will vary and decrease with height during the launch event. However, exhaust gases have been modelled as a short-term puff release from ground level at Launch Pad 2 for the duration it takes the launch vehicle to reach an altitude of 1000 ft, the height within which an assessment of effects of an airchange space is required by the CAA (CAA, 2020). The time for an SR75 Launch Vehicle to reach an altitude of 1,000 ft is 1.7 seconds. This is considered to simulate the maximum potential impact of launch event exhaust gas emissions at identified receptors.

3.2.2 The puff model in ADMS 6 (CERC, 2024) enables releases of up to one-hour duration to be modelled and concentrations at chosen downwind distances to be predicted at different timesteps (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 event, the total dose concentration is the most appropriate for further comparison with health based AQSs.

3.2.3 Launch trajectories will be in a northerly direction over the sea. They will not occur simultaneously with any other launch events or from any other Launch Pad.

3.2.4 The Launch Vehicles propellant will be a mixture of solid paraffin and LOx. The majority of emissions from combustion of this propellant are water vapour(H_2O) and carbon dioxide (CO_2) alongside much smaller quantities of carbon monoxide (CO).

3.2.5 The only pollutant that requires assessment with respect to air quality for potential effects on human health is CO.

3.2.6 Launch event greenhouse gas emissions (including CO_2) are quantified and climate impact assessed in Chapter 5.

Emissions Data

3.2.7 The emissions data for each launch were confirmed by the rocket manufacturer engineering teams and are summarised in Table 1.

Table 1 SR75 Launch Emissions Data

Parameter	SR75
Temperature (Kelvin)	2,026
Temperature (Centigrade)	1,753
Exit diameter of Nozzles (m)	0.43
Exit diameter of flame deflector (m)	3
Exhaust gas density (kg/m^3)	0.073
Mass of CO emitted per launch (kg)	23.8
Ignition to 1000 ft altitude (seconds)	1.7
Volume of gas emitted in launch (m^3)	331.1
Volume flow rate (m^3/s)	191.8
Jet velocity at flame deflector (m/s)	27.1

Modelling Assumptions

3.2.8 The launch rig has a flame deflector underneath the SR75 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 6 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 1.7 seconds, with the exhaust gas volume flow rate, temperature and mass emissions of CO as specified in Table 1.

3.2.9 The Launch Pad 2 layout is shown in Drawing 4.2. The direction of the jet from the facility is south as the trajectory of the SR75 Launch Vehicle is due north.

Meteorological Data Used in the Assessment

3.2.10 It is not possible to predict exact meteorological conditions of future launch events. As such, the ADMS 6 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.

3.2.11 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).

3.2.12 It is recognised that the wind speeds on Unst can be considerably higher than the average UK conditions, therefore a detailed analysis of 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 Table 2. The wind roses for each year are shown in Drawing 4.3.

Table 2 Analysis of Baltasound Wind Speed and Direction 2015-2019

Wind Direction (sector °)	Number 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

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)
North-West (292.5-337.5°)	969	11.1 %	6.8	24.7	0.5
Missing	36	0.4 %			
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 %			
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°)	1332	15.2 %	7.6	17.5	0.5
South (157.5-202.5°)	1029	11.7 %	6.8	15.5	0.5
South-West (202.5-247.5°)	1711	19.5 %	8.5	21.1	0.5
West (247.5-292.5°)	1174	13.4 %	8.0	26.3	0.5
North-West (292.5-337.5°)	424	4.8 %	6.8	21.1	0.0
Missing	835	9.5 %			

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 %			
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 %			

Table 3 Average Wind Speeds per Direction from Baltisound Airport Meteorological Station

	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

3.2.13 The number of hours that the wind speed was greater than 5 m/s was between 54 % and 73 % of each year.

3.2.14 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 event 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 (Banks Cottage in Norwick, R1) have been assessed in all meteorological conditions.

3.2.15 The jet has a southerly trajectory, therefore the wind direction will have an impact on the predicted downwind concentrations. The stability A-G meteorological file has therefore been used 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.

3.2.16 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/m^2)	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

3.3 Results

Calculation of Exposure Time to Release at Receptor R1

3.3.1 The closest identified receptor to Launch Pad 2 is Banks Cottage at Norwick which is approximately 2077 m west south-west of the site and shown as R1 in Drawing 4.1.

3.3.2 The maximum period when the ambient CO concentration was predicted to be detectible above background levels (a minimum increase of 0.001 mg/m3, i.e. 2 % of the background level of 0.051 mg/m3) at receptor R1 was 25 minutes in Stability Class A conditions using UK average wind speeds.

3.3.3 Using the Unst average wind speeds, the maximum period when the CO concentration was predicted to be detectible above background at receptor R1 was three minutes in Stability Classes F and G.

3.3.4 The start time and end time after launch of the SR75 Launch Vehicle when the ambient CO concentration is predicted to be above 0.051 mg/m3 at 2077 m downwind is shown in Table 5.

Table 5 Duration of Concentration above Background at R1

Stability Class	Time First above 0.051mg/m^3 (seconds)	Time Last above 0.051mg/m^3 (seconds)	Puff Lifetime Duration (seconds)	Puff Lifetime Duration (minutes)	Fraction of 1-hour
UK Average Wind Speeds					
A	840	2340	1500	25	0.42
B	480	1440	960	16	0.27
C	240	420	180	3	0.05
D	240	360	120	2	0.03
E	240	360	120	2	0.03
F	420	480	60	1	0.02
G	780	900	120	2	0.03
Unst Average Wind Speeds					
A	180	240	60	1	0.02
B	180	300	120	2	0.03
C	180	300	120	2	0.03
D	180	240	60	1	0.02
E	180	240	60	1	0.02
F	180	360	180	3	0.05
G	180	360	180	3	0.05

3.3.5 The most frequently occurring stability condition in the UK is stability D. Figure 2 shows where the concentration at 2077 m downwind of the launch site is first above the background concentration of 0.051 mg/m3 at 240 s (four minutes) after the release and returned to the background concentration value at 420 s (seven minutes) using Unst average wind speeds for stability D.

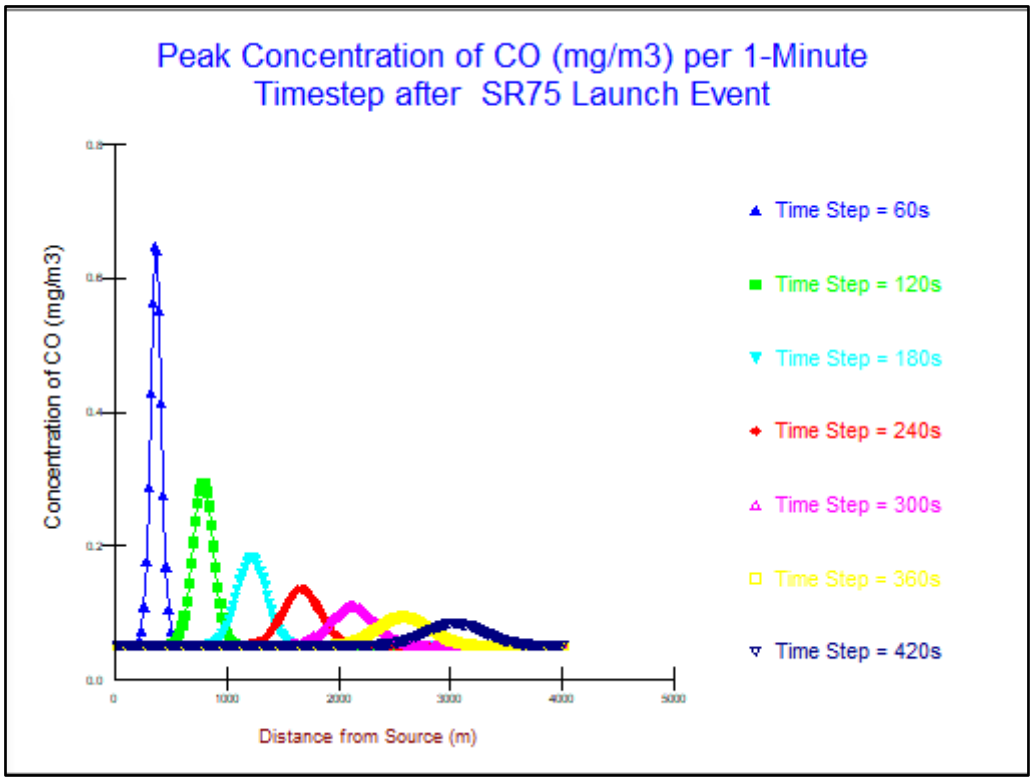


Figure 2 Timestep Concentrations of CO after Release of the SR75 Launch Vehicle from Launch Pad 2

Calculation of 1-hour Average CO Concentration at Receptor R1

3.3.6 The ADMS 6 model was then used to calculate a total dose of CO at receptor R1, i.e. the total concentration that an individual would be exposed to over the lifetime of the puff (as detailed in Table 4) before it dispersed and ambient concentrations returned to normal background levels.

3.3.7 For each stability, the dose in mg.s/m3 was divided by the puff lifetime (s) to calculate the average ambient concentration during the exposure period.

3.3.8 Over one hour, the total concentration was calculated using the average puff lifetime concentration plus existing background for the duration of the puff i.e. for a fraction of 1 hour; and the normal background concentration of 0.051 mg/m3 for the remaining fraction of the hour.

3.3.9 For the most frequently occurring meteorological condition of stability D with Unst average conditions, the puff lifetime was 120s (0.03 of 1 hour). The hourly average concentration was therefore calculated from the following equation:

Hourly average concentration = ((average puff lifetime concentration + 0.051)x 0.03 of hour) + (0.051 x 0.97 of hour).

Calculation of 8-hour Average Concentration at Receptor R1

3.3.10 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 puff lifetime + (7 x 0.051))/8

3.3.11 There will be no more than one test in any 24-hour period so the maximum 8-hour running mean concentration per launch event can only be as above.

3.3.12 The results are summarised in Tables 6 and 7 for wind angles from 45° (north-east), 70° (approximately east north-east to send emissions directly towards R1), and 90° (east). No change above background concentration was predicted at R1 for assessment with any other wind direction.

3.3.13 The maximum predicted dose with UK average wind speeds was at R1 was 8.17 mg.s/m3 CO over three minutes (Stability C).

3.3.14 The maximum predicted dose with Unst average wind speeds was at R1 was 8.82 mg.s/m3 CO over two minutes (Stability C).

3.3.15 Considering both sets of meteorological conditions, the maximum predicted dose at R1 over the lifetime of the jet release of equivalent to 7.1-7.6 parts per million (ppm) over 2-3 minutes. There are no health effects due to this level of exposure to CO over periods of 2-3 minutes (Goldstein, 2008). For context, the UK Health and Safety Executive 15-minute workplace exposure limit (WEL) is 100 ppm (UK HSE, 2020).

3.3.16 The maximum predicted 8-hour concentration at R1 was 0.051 mg/m3, 0.51 % of the AQS, when modelled using UK and Unst average wind speeds and wind directions of 45°, 70° and 90°. These wind directions only occur on Unst for a maximum of 17% of the time. There is therefore no risk that the 8-hour AQS for CO will be exceeded at a sensitive residential receptor during a launch event of the SR75 Launch Vehicle from Launch Pad 2.

3.3.17 Drawing 4.4 shows the concentration contour plots of the puff as it moves downwind from after the start of the release for the most prevailing stability conditions. The concentration scale demonstrates how quickly the puff dilutes and disperses after release, with no concentrations above background levels of CO at receptor R1 at 420 seconds (seven minutes) after launch.

Table 6 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 = 45° NORTH-EAST						
A	5.63	0.004	0.051	0.053	0.051	0.51%
B	2.28	0.002	0.051	0.052	0.051	0.51%
C	0.82	0.005	0.051	0.051	0.051	0.51%
D	0.03	0.0002	0.051	0.051	0.051	0.51%
E	0.01	0.0001	0.051	0.051	0.051	0.51%
F	0.00	0.000	0.051	0.051	0.051	0.51%
G	0.04	0.0003	0.051	0.051	0.051	0.51%
Wind = 70°EAST NORTH- EAST						
A	6.79	0.005	0.051	0.053	0.051	0.51%
B	5.00	0.005	0.051	0.052	0.051	0.51%
C	8.17	0.045	0.051	0.053	0.051	0.51%
D	2.21	0.018	0.051	0.052	0.051	0.51%
E	0.85	0.007	0.051	0.051	0.051	0.51%
F	0.50	0.008	0.051	0.051	0.051	0.51%
G	1.31	0.011	0.051	0.051	0.051	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 = 90° EAST						
A	4.45	0.003	0.051	0.052	0.051	0.51%
B	0.85	0.001	0.051	0.051	0.051	0.51%
C	0.03	0.0002	0.051	0.051	0.051	0.51%
D	0.00	0.000	0.051	0.051	0.051	0.51%
E	0.00	0.000	0.051	0.051	0.051	0.51%
F	0.00	0.000	0.051	0.051	0.051	0.51%
G	0.00	0.000	0.051	0.051	0.051	0.51%

Table 7 Calculated Dose and 8-Hour Average CO Concentrations at Receptor R1 – Unst Average Wind Speeds

Stability Class	Maximum Dose at R1 (mg.s/m³) Unst 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 = 45° NORTH-EAST						
A	1.15	0.019	0.051	0.051	0.051	0.51%
B	0.62	0.005	0.051	0.051	0.051	0.51%
C	0.52	0.004	0.051	0.051	0.051	0.51%
D	0.04	0.001	0.051	0.051	0.051	0.51%
E	0.00	0.000	0.051	0.051	0.051	0.51%
F	0.00	0.000	0.051	0.051	0.051	0.51%
G	0.00	0.000	0.051	0.051	0.051	0.51%
Wind = 70°EAST NORTH- EAST						
A	8.45	0.141	0.051	0.053	0.051	0.51%
B	8.82	0.074	0.051	0.053	0.051	0.51%
C	8.73	0.073	0.051	0.053	0.051	0.51%
D	4.70	0.078	0.051	0.052	0.051	0.51%
E	1.89	0.032	0.051	0.052	0.051	0.51%
F	1.14	0.006	0.051	0.051	0.051	0.51%
G	1.35	0.008	0.051	0.051	0.051	0.51%

Stability Class	Maximum Dose at R1 (mg.s/m^3) Unst 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 = 90° EAST						
A	0.12	0.002	0.051	0.051	0.051	0.51%
B	0.03	0.0002	0.051	0.051	0.051	0.51%
C	0.02	0.0002	0.051	0.051	0.051	0.51%
D	0.00	0.000	0.051	0.051	0.051	0.51%
E	0.00	0.000	0.051	0.051	0.051	0.51%
F	0.00	0.000	0.051	0.051	0.051	0.51%
G	0.00	0.000	0.051	0.051	0.051	0.51%

4. Summary

4.1.1 The assessment has calculated the CO dose and average 8-hour concentration at the closest residential receptor (R1) to Launch Pad 2 at the SaxaVord Spaceport at 1-minute intervals after a launch of a HyImpulse SR75 Launch Vehicle.

4.1.2 The maximum predicted dose with UK average wind speeds was at R1 was 8.17 mg.s/m3 CO over three minutes (Stability C).

4.1.3 The maximum predicted dose with Unst average wind speeds was at R1 was 8.82 mg.s/m3 CO over two minutes (Stability C).

4.1.4 Considering both sets of meteorological conditions, the maximum predicted dose at R1 over the lifetime of the jet release of equivalent to 7.1-7.6 parts per million (ppm) over 2-3 minutes. There are no health effects due to this level of exposure to CO over periods of 2-3 minutes (Goldstein, 2008).

4.1.5 The maximum predicted 8-hour concentration at R1 was 0.051 mg/m3, 0.51 % of the AQS, when modelled using UK and Unst average wind speeds and wind directions of 45°, 70° and 90°. These wind directions only occur on Unst for a maximum of 17% of the time.

4.1.6 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 event and there are no health effects associated with the maximum predicted dose of CO at R1 of 7.6 ppm over 2 minutes.

Appendix 5.1 Greenhouse Gas Calculations

HyImpulse SR75 GHG Calcs **v1.0** **12/07/2024**

1. Launch

Paraffin	460	kg
EF	73.3	kgCO2e/GJ
NCV	0.0415	GJ/kg
CO2e	**1399**	kg

2. Transport

Road distance	Loads	Miles	km	Laden EF (kgCO2e/km)	Unladen EF (kgCO2e/km)	kgCO2e
Heavy duty vehicles				50% laden artic (all)	50% laden artic (all)	
Neuenstadt to Hamburg	2		648	0.83506	0.83506	2164
Lerwick to Toft	2	28	45	0.83506	0.83506	151
Ulsta to Gutcher	2	18	29	0.83506	0.83506	97
Belmont to Skaw	2	15	24	0.83506	0.83506	81
Tankers (All Rigid)				Tanker full EF (kgCO2e/km)	Tanker empty EF (tCO2e/km)	
Bridge of Don to Aberdeen	1	4	6	0.90367	0.66163	10
Lerwick to Toft	1	28	45	0.90367	0.66163	71
Ulsta to Gutcher	1	18	29	0.90367	0.66163	45
Belmont to Skaw	1	15	24	0.90367	0.66163	38
					Road subtotal	**2656**

Ferry distance	Laden	nm	km	Small Container / Ferry EF (kgCO2e/tonne km)	Payload (t)	kgCO2e
All LV equipment: Hamburg to Aberdeen		578	1070	0.03675	9	354
Aberdeen to Lerwick		224	415	0.061	9	228
Toft to Ulsta		2.9	5	0.061	9	3
Gutcher to Belmont		1.25	2	0.061	9	1
	Unladen					
All LV equipment, no LV: Hamburg to Aberdeen		578	1070	0.03675	8	315
Aberdeen to Lerwick		224	415	0.061	8	202
Toft to Ulsta		2.9	5	0.061	8	3
Gutcher to Belmont		1.25	2	0.061	8	1
					Sea subtotal	**1107**
					Transport total	**3763**

	Loads	Tonnes per load
LV	1	1
Launch equipt	1	2
Container mass (avg)		3

Grand total per launch	**5.2**	tCO2e

Distances from Google Maps and ports.com
Factors from 2024 Defra GHG Conversion Factors except paraffin
Paraffin NCV from Engineering Toolbox, EF from CBAM
Container predominates mass so trucks are considered 50% laden whether or not LV on board

Appendix 6.1 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 6
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 6
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 6
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 6
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	N/A - Addressed in other chapters
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 6.9 (subsections 6.9.103-6.9.111), Section 6.12 (subsection
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 6.6 (subsection 6.6.2)
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 6.6 (subsection 6.6.2)
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 6.9, Section 6.11, Section 6.12, Section 6.13
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 6.6 (subsection 6.6.2)
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 6.7, Table 6.10
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 6.9, Subsections 6.9.4-6.9.24
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 6.9, Subsections 6.9.43-6.9.53
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 6.6 (subsection 6.6.2)
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 6
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 6.12
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 6
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	N/A - Not addressed in this chapter
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 6
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 6
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 6.12
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	Section 6.9, Section 6.11, and Section 6.12
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	Section 6.9, Section 6.11, and Section 6.12
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	Subsections 6.9.93-6.9.102
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	Subsection 6.9.69
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	Subsection 6.6.3
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	Subsection 6.6.3, Subsections 6.9.75-6.9.82
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	Section 6.8, Section 6.10
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	Subsection 6.6.4, Table 6.7

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	Subsection 6.6.4, Table 6.7
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	Subsection 6.6.4, Table 6.7
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	Subsection 6.6.4, Table 6.7
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	Subsection 6.6.4, Table 6.7
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	Subsection 6.6.2, Table 6.11
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	Subsections 6.9.93-6.9.102
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	Subsections 6.9.93-6.9.102
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	Subsections 6.9.93-6.9.102
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 6
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 6
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 6
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	Chapter 6

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 6.9, Section 6.11, Section 6.12
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 6.9, Section 6.11, Section 6.12
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 6.9, Section 6.11, Section 6.12
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 6.9, Section 6.11, Section 6.12
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 6.9, Section 6.11, Section 6.12
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 6.9, Section 6.11, Section 6.12
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 6.9, Section 6.11, Section 6.12
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 6.9, Section 6.11, Section 6.12

Appendix 6.2 Baseline

APPENDIX 6.2 MARINE AND TRANSBOUNDARY EFFECTS – BASELINE CONDITIONS

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 6.5). 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 A6.1). The area is characterised by bathymetric features including plateaus, basins, rises, and ridges, including segments of the Mid-Atlantic Ridge (Figure A6.2).

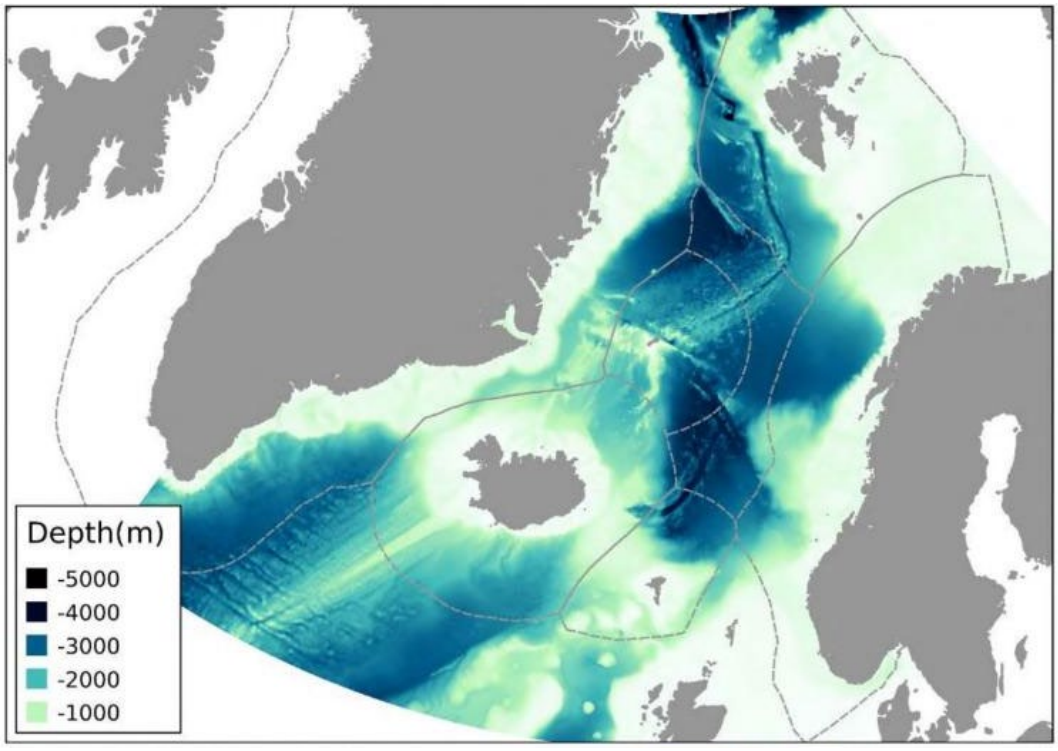


Figure A6.1 Water depth in the northeast Atlantic and Arctic regions (From: Buhl-Mortensen et al.*, 2019)*

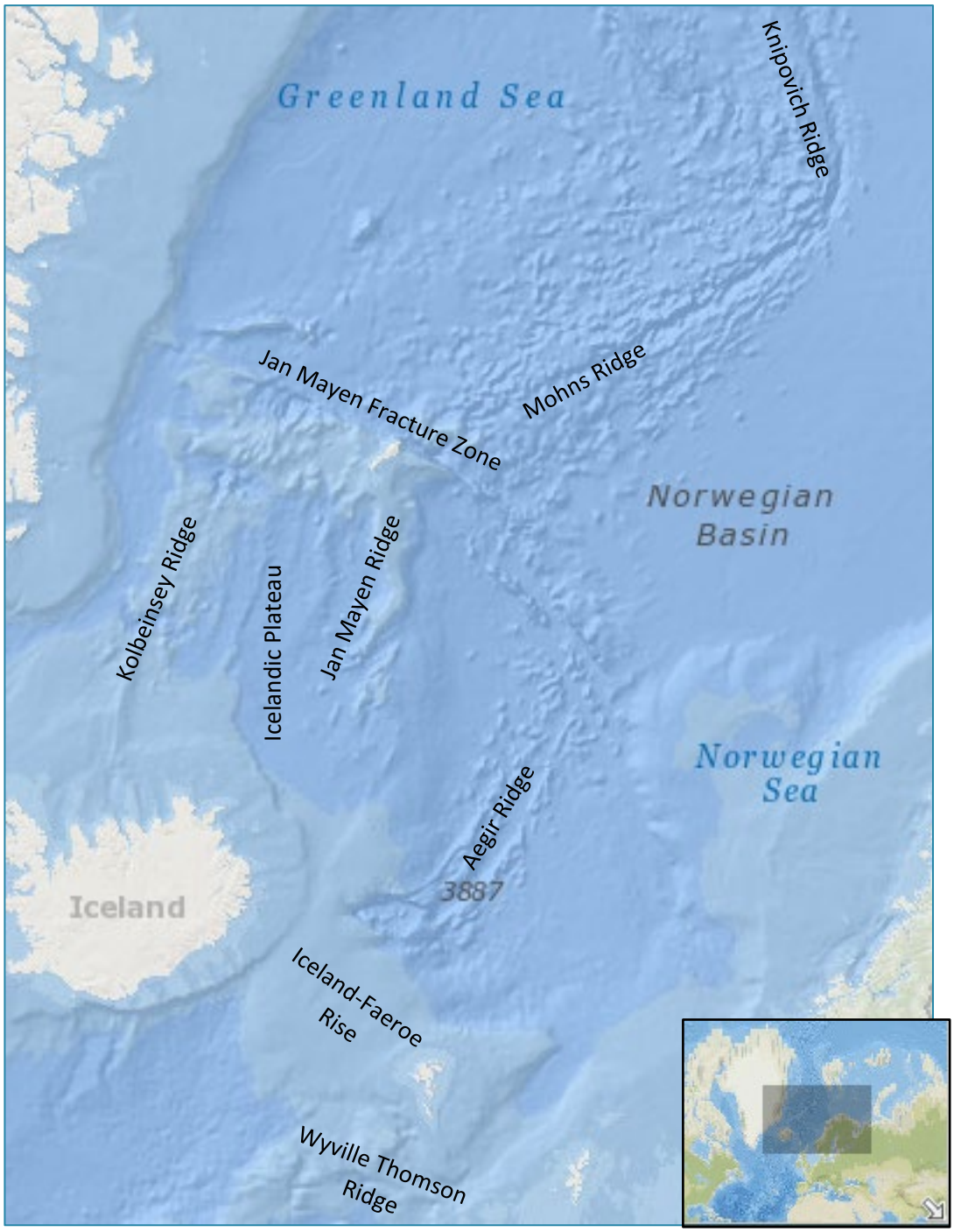


Figure A6.2 Bathymetry and bathymetric features in the vicinity of the EZI (Source: NOAA, 2020b)

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 A6.3). 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).

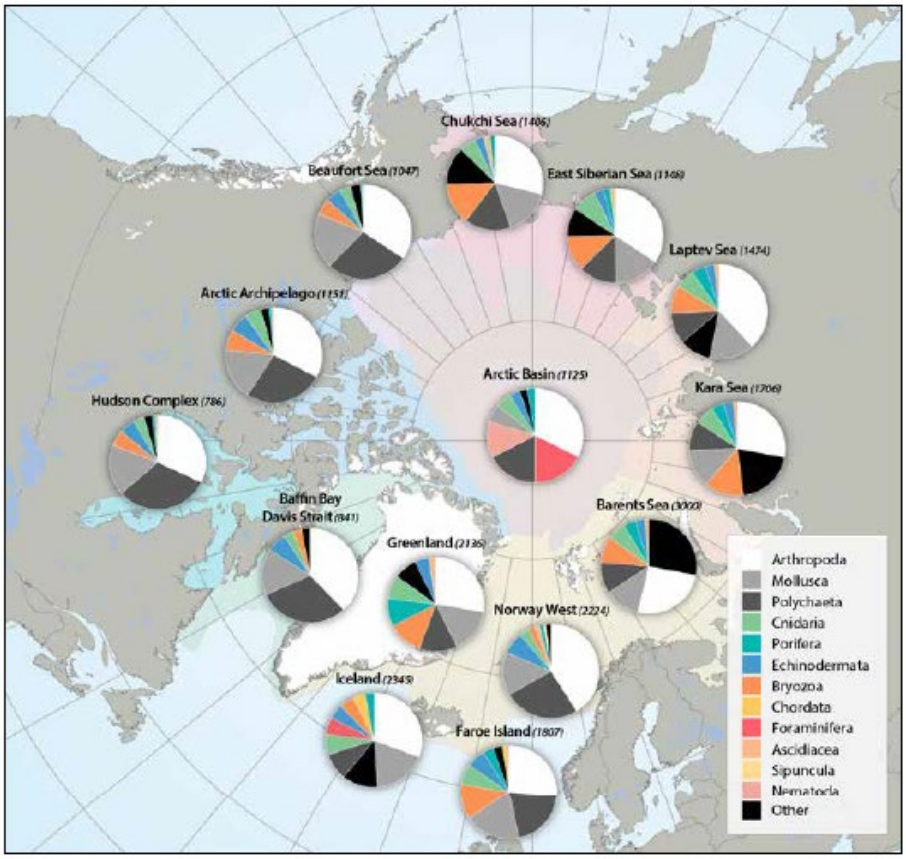


Figure A6.3 Regional pie charts showing the species/taxon number (in brackets) per region and the relative proportion of certain taxa in species richness (From: CAFF, 2017)

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 A6.4, 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.

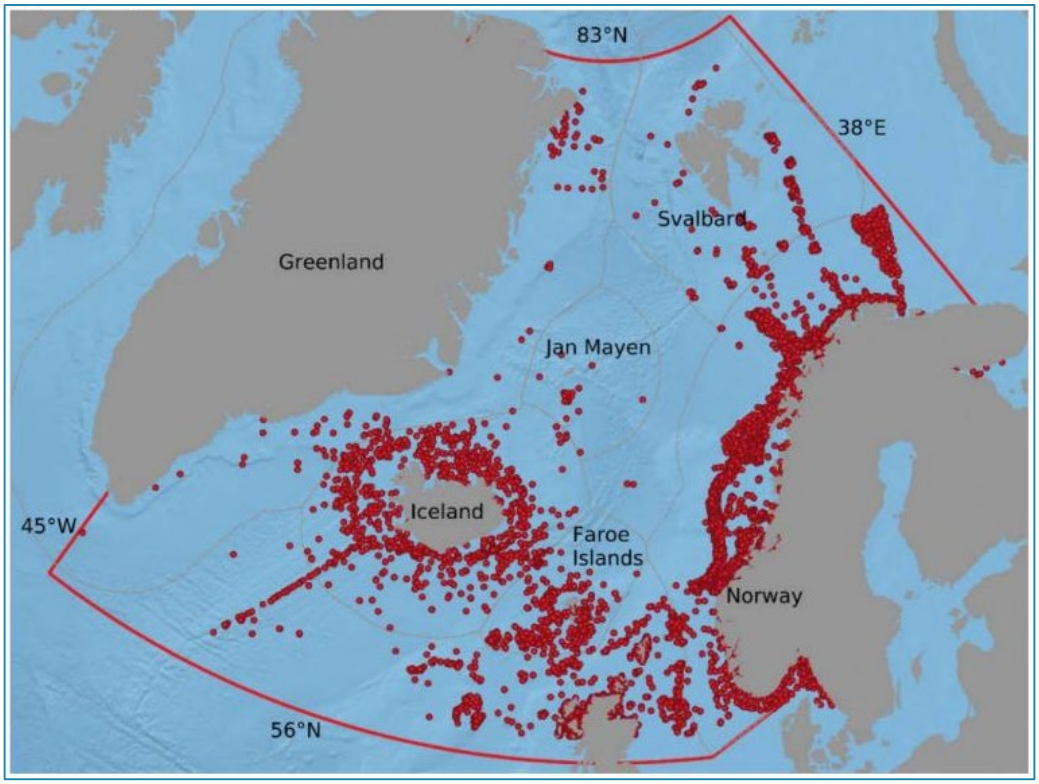


Figure A6.4 The location of Vulnerable Marine Ecosystem (VME) records in the northeast Atlantic (From: Buhl-Mortensen et al.*, 2019)*

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 A6.1. 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 A6.1 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 A6.2 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 A6.2 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 A6.3 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 A6.3 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 within this range	They are generalist predators, 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, shelves surrounding the North Pole.	Primary habitat is the North Polar Basin. Encompassing Arctic Ocean. Using annual sea ice fields/coverage attached to shorelines. Summer	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 June on sea ice. April to	Carnivorous. Primary food source is Ringed Seals *Phoca hispida*, bearded seals *Erignathus barbatus,* hooded seals *Cystophora*

Marine Mammal Species	Abundance	Distribution	Habitat	Key Seasons	Prey
	4 are in decline and 8 are data deficient.		habitat is surrounding land masses. They have a very large range and have been found 100km from the coastline.	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.	*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

Marine Mammal Species	Abundance	Distribution	Habitat	Key Seasons	Prey
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 estimated at 20,500 individuals	Humpback whales in the northeast Atlantic are most common in Icelandic waters, with fewer sightings in offshore areas. Most humpback whales undertake extensive migrations each year, though some remain in the cool waters of the North Atlantic year-round	Humpback whales are largely pelagic, though during the feeding season they occur in highly productive upwelling zones	Mating and calving occur in the warm breeding grounds during winter	Feed mainly on euphausiids (krill) and small schooling fish
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

Marine Mammal Species	Abundance	Distribution	Habitat	Key Seasons	Prey
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
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

Marine Mammal Species	Abundance	Distribution	Habitat	Key Seasons	Prey
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
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

Marine Mammal Species	Abundance	Distribution	Habitat	Key Seasons	Prey
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 continental shelf and seamounts. Migrations are sec-specific, with predominantly males found at higher latitudes	Sperm whales breed and calve in the summer months in tropical waters	Their diet comprises mostly deep-sea cephalopods, with some fish species also taken

Marine Mammal Species	Abundance	Distribution	Habitat	Key Seasons	Prey
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

There are also a range of Marine Protected Areas (MPAs) of different designations and under different jurisdictions in the vicinity of the EZI. Further details on the MPAs in the greater region surrounding the EZI are provided in Table A6.4.

Table A6.4 Details of marine protected areas within the great region surrounding the EZI (Source: JNCC, 2020a; Scottish Natural Heritage, 2020)

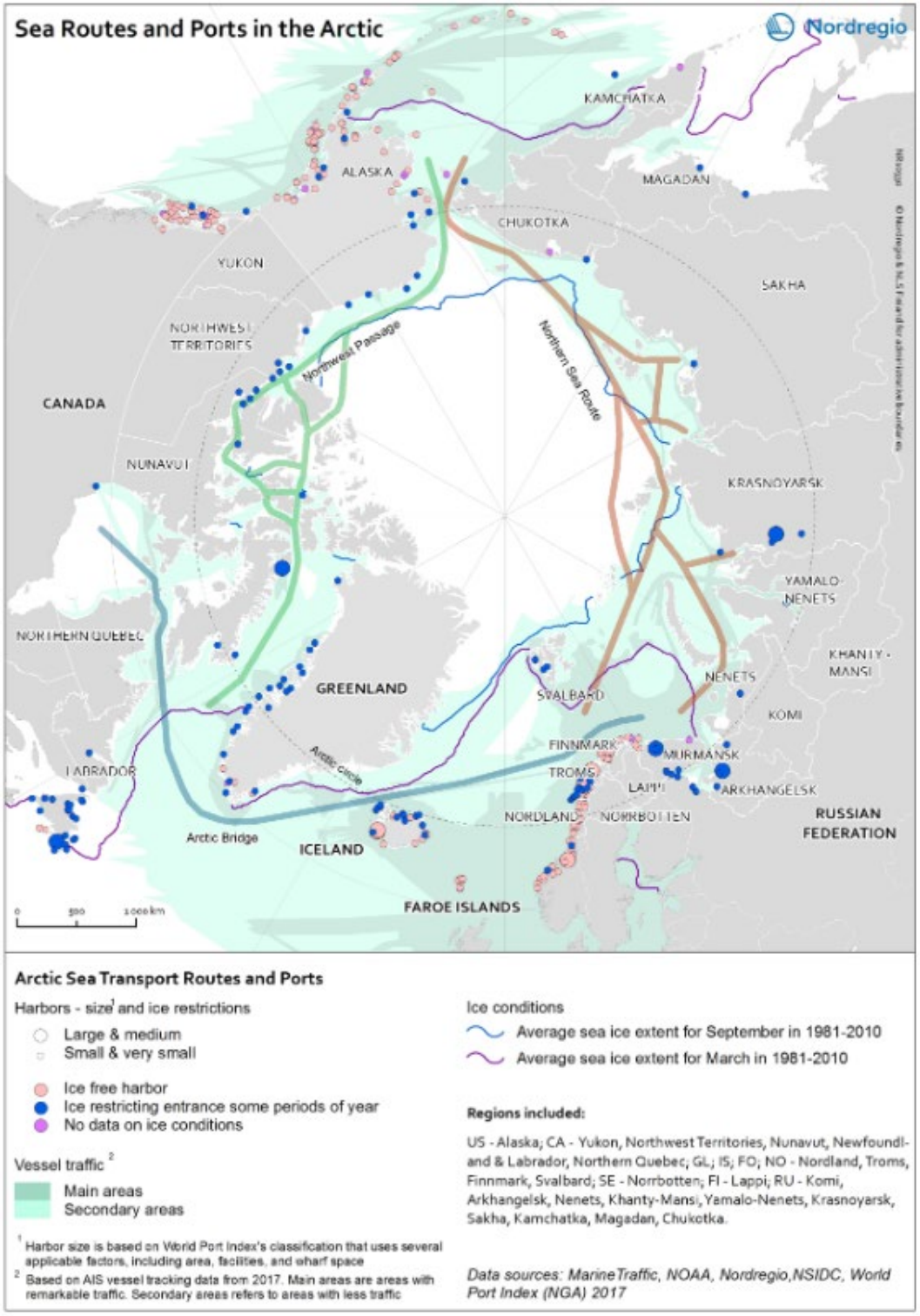
Marine Protected Area	Designated Features
Faroe-Shetland Sponge Belt Nature Conservation Marine Protected Area	Deep sea sponge aggregations Offshore subtidal sands and gravels Ocean quahog aggregations Continental slope Quaternary of Scotland - continental slope channels; iceberg ploughmark fields, prograding 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 A6.5). 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 A6.5). The EZI does not overlap any of the three main Arctic Sea transport routes (Figure A6.5). As displayed for the wider region in Figure A6.6, 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.



FigureA6.5 Sea routes and ports in the Arctic (From: Nordregio, 2020)



Figure A6.6 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 A6.17 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 A6.7, 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).

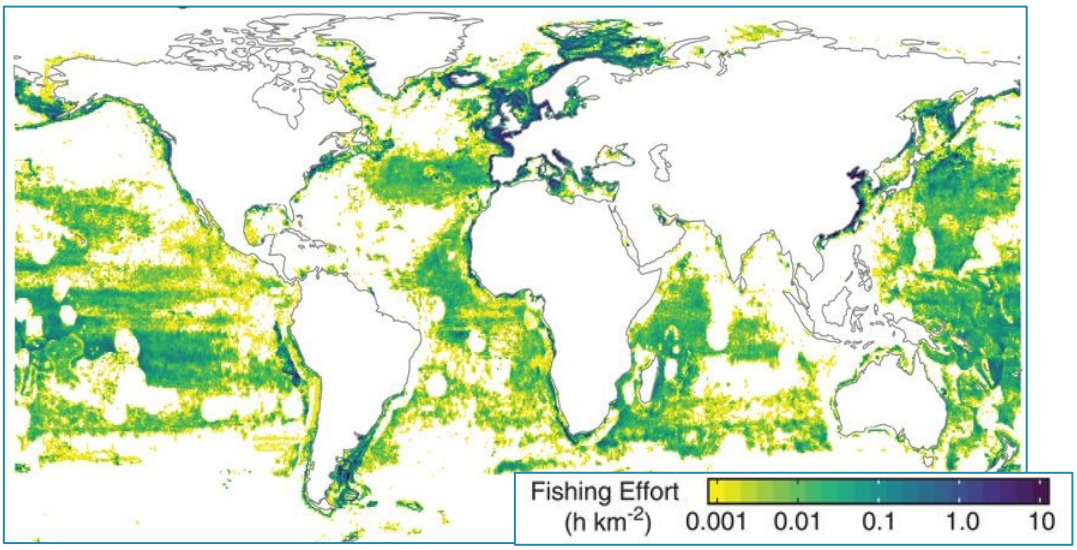


Figure A6.7: Total global fishing effort [hours fished per square kilometre (h/km^2)] in 2016 by all vessels with automatic identification system enabled (From: Kroodsma et al., 2018)

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 A6.5 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 A6.8-Figure A6.12). 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.

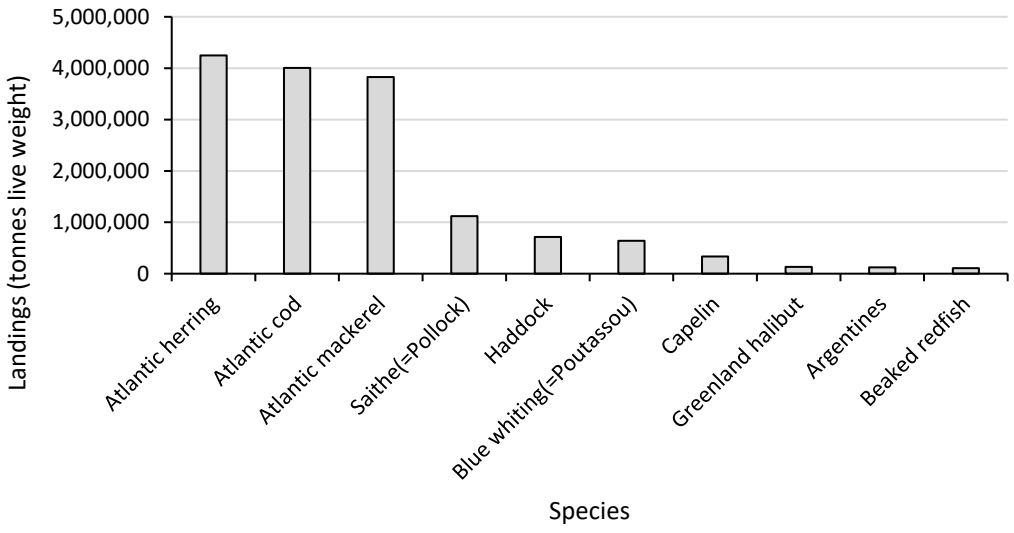


Figure A6.8 Landings weight of the top 10 species landed in Area IIa

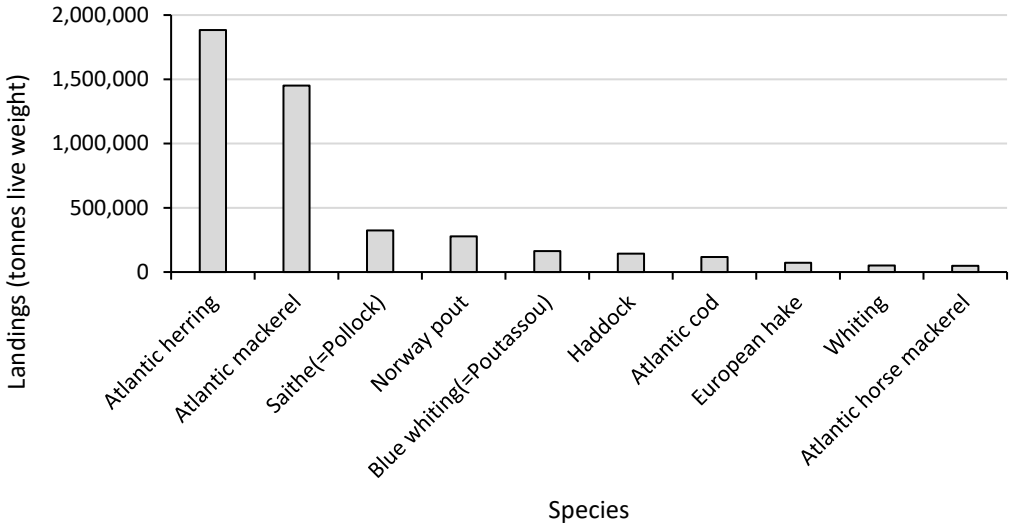


Figure A6.9 Landings weight of the top 10 species landed in Area IVa

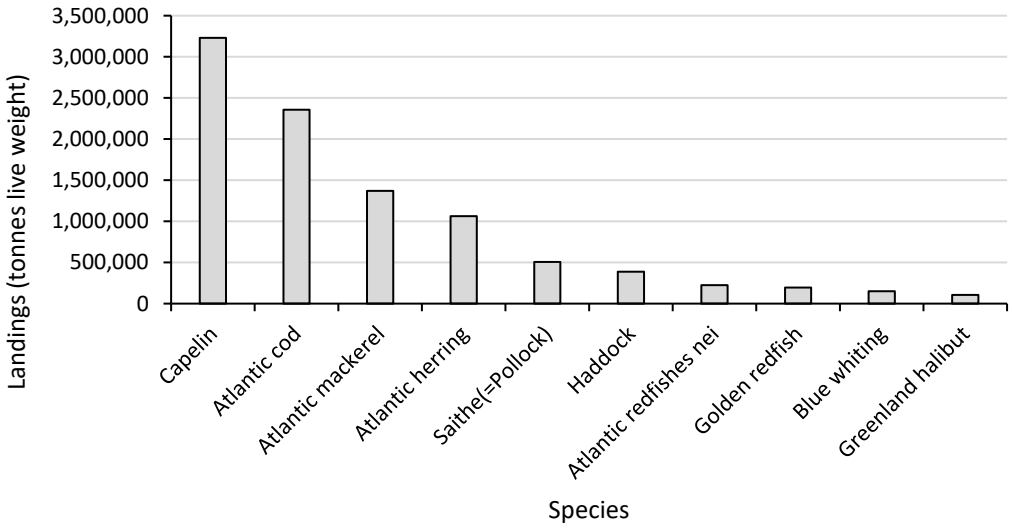


Figure A6.10 Landings weight of the top 10 species landed in Area Va

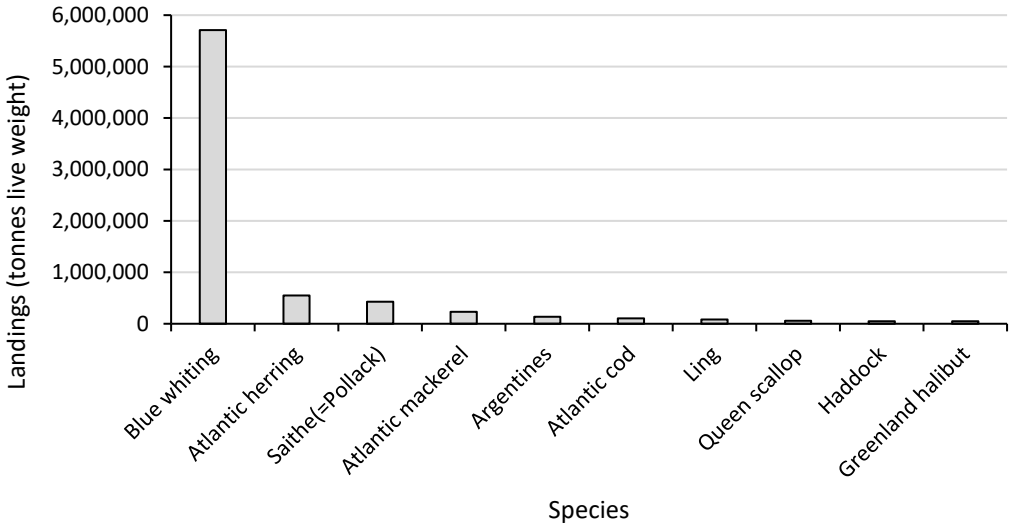
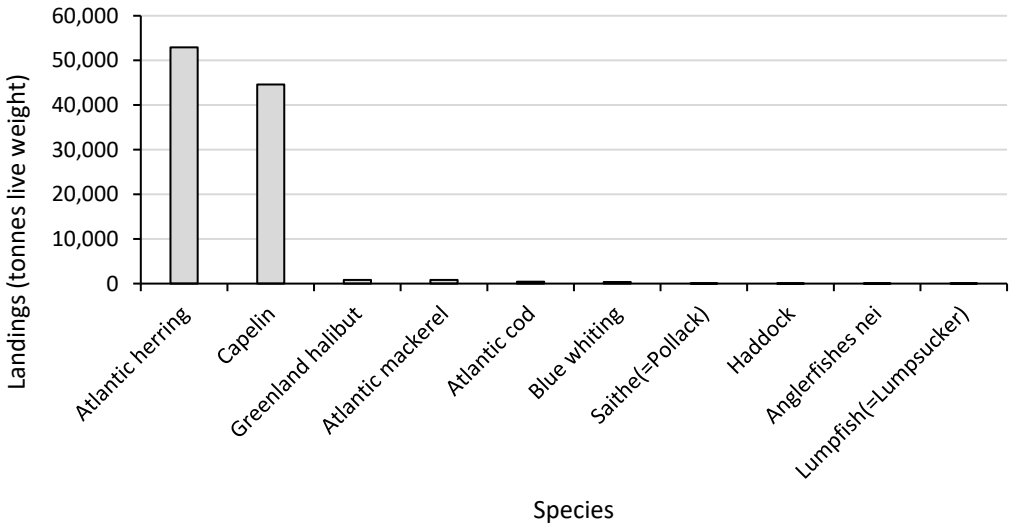


Figure A6.11 Landings weight of the top 10 species landed in Area Vb



FigureA6.12 Landings weight of the top 10 species landed in Area XIVa

Appendix 6.3 Water Quality Risk Matrix

HyImpulse AEE Report Technical Appendix 6.3 - 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	No residual fuel predicted, and fuel is solid state, therefore no notable changes to the water's properties are expected.	0
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		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure	Sea water is not predicted to be affected by exposure to fuel as under nominal launch all solid fuel will be consumed prior to impact. The LV will be retrieved from the marine environment.	0
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		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	The fuel source (LV) will be retreived from the marine environment and no residual fuel is predicted on impact. 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	**3**	**0**

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 limited periods of time, i.e. maximum 12 times over 30 year licence.	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)	There is expected to be up to a maximum of 1 launch 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	All solid fuel is consumed prior to impact under nominal case, and LV will be retrieved from the marine environment.	0
1	Receptor is exposed to impact over limited spatial scales		
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	**1**	**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)	**Negligible**	**0**

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	Sea water exposed to nose cone will lead to local increases in concentration of inert metals unlikely to result in notable changes to the water's properties. All other components will be retrieved.	0
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		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure	Sea water exposed to nose cone will lead to local increases in concentration of inert metals unlikely to result in notable changes to the water's properties. All other components will be retrieved.	0
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		

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 (nose cone) 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 steel and aluminium, which is are some of the least corrosive in the marine environment. Given the longevity of aluminium and steel 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	**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	The receptor is likely to be exposed to impacts over moderate periods of time, i.e. maximum 30 times over 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 a maximum of 1 launch per year.	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 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	Direct impacts to the metal concentration of the sea water is not likely to be measureable above natural variability. Aluminium is the main metal which is occurs naturally in the marine environment but in low concentration.	0
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)		
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 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.	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	**1**	**1**

Overall Risk (sensitivity x exposure x magnitude)	**Low**	**1**

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	Microplastic exposure will lead to local increases in microplastic concentration which could lead to marginal changes to the water's properties.	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	Microplastic exposure will lead to local increases in microplastic concentration which could minimally affect the water's properties.	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)		
1	Receptor will recover entirely within medium timescales (1-5 years)	Microplastics have the potential to be released from resin within the nose cone. Given the small amount of plastics expected, it is anticipated that microplastic levels local to the LV will reach background levels over a medium 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	**6**	**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 receptor is likely to be exposed to impacts over moderate periods of time, i.e. maximum 30 times over 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 a maximum of 1 launch per year.	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 limited impact zone around the nose cones 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	**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		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**	**1**

Appendix 6.4 Biodiversity Risk Matrix

Receptor	Plankton
Pressure Pathway/Impact	Effects from Fuel Spillage/Metal Corrosion/Debris and Microplastics

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	Plankton themselves are not financially or cultural important, but they support other receptors that are.	1
2	Receptor has a medium financial, environmental or cultural value		
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		
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 worst-case scenario of plankton being exposed to hydrocarbons could have lethal effects on individuals in the immediate vicinity of hydrocarbon spills.	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	The worst-case scenario of plankton being exposed to hydrocarbons could have lethal effects on individuals in the immediate vicinity of hydrocarbon spills.	3

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	The source of contaminants (LVs) will pass through the water column and then rest on the seabed. Plankton will predominantly be exposed whilst the LV is in the water column. Given the high turnover of plankton in the ocean and the very small proportion of total plankton in the area predicted to be exposed, it is anticipated that plankton will recover within short timescales.	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 receptor is likely to be exposed to impacts over moderate periods of time, i.e. maximum 30 times over 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 a maximum of 1 launch per year.	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 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	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)	Direct impacts to the contaminant levels of plankton are likely to be measureable above natural variability.	1
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 the contaminant levels of plankton are not likely to affect the plankton baseline, when taking into account the very small spatial scale of effect in the context of the entire EZI and the abundance and high turnover of plankton.	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	1	1

Overall Risk (sensitivity x exposure x magnitude)	Low	2

Receptor	Plankton
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	Plankton themselves are not financially or cultural important, but they support other receptors that are.	1
2	Receptor has a medium financial, environmental or cultural value		
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		
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 worst-case scenario of plankton being exposed to the noise of impact could have lethal effects on individuals in the immediate vicinity.	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	The worst-case scenario of plankton being exposed to the noise of impact could have lethal effects on individuals in the immediate vicinity.	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	The worst-case scenario of plankton being exposed to the noise of impact could have lethal effects on individuals in the immediate vicinity. At an individual level the receptor would not be able to recover from this.	3

Overall Sensitivity of the Receptor	10	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	The receptor is likely to be exposed to impacts over moderate periods of time, i.e. maximum 30 times over 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 a maximum of 1 launch per year.	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 limited impact zone around LVs as they enter the marine environment (up to 1.2 km), 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	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	Direct impacts to the mortality rate of plankton 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 the mortality rate of plankton 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)	Low	0

Receptor	Benthic Habitats
Pressure Pathway/Impact	Effects from Fuel Spillage/Metal Corrosion/Debris and Microplastics

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 seabed habitats within the EZI are well represented in the wider region. However, there is a large MPA in the EZI, though this is protected from the impacts of fishing and not other seabed impacts. There are designated benthic habitat features of MPAs in the region.	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	The benthic communities are likely to be sensitive to change as they have had limited exposure to anthropogenic activities and the introduction of contaminants.	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	Benthic habitats are adaptable to changes in contaminant levels as they can accumulate a certain level before experiencing physiological effects	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 contaminants will be present for different lengths of time, the longest being the metal and associated corrosion, which will be present for extended periods. Once the source of contaminants has broken down benthic habitats will be able to fully recover. The contaminants may remain in the system of benthic species for a notable amount of time.	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 receptor is likely to be exposed to impacts over moderate periods of time, i.e. maximum 30 times over 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 a maximum of 1 launch per year.	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 LVs 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		
1	Impact is measurable above natural variability (0-5% change)	Direct impacts to the contaminant levels of benthic habitats are likely to be measureable above natural variability.	1
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 the contaminant levels of benthic habitats are not likely to affect the benthic habitat baseline, when taking into account the very small spatial scale of effect in the context of the entire EZI.	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	**1**	**1**
Overall Risk (sensitivity x exposure x magnitude)	**Low**	**2**

Receptor	**Benthic Habitats**
Pressure Pathway/Impact	**Direct loss of seabed habitat via deposition of material on the seabed**

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 seabed habitats within the EZI are well represented in the wider region. There is likely presence of VMEs in the EZI, though these are only protected from the impacts of fishing and not other seabed impacts. There are designated benthic habitat features of MPAs in the region. Some species/habitats are listed as Priority Marine Features in Scottish waters	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 worst-case example of VMEs are intolerant of direction deposition of material on them and would experience substantial change.	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	The worst-case example of VMEs are not adaptable to direction deposition of material on them and would be susbstantially affected.	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)	The LV will likely break down in the marine environment. Once this occurs, the receptor will be able to recover i.e. recolonise that area. Given the size of the LV in comparison to the size of the habitat, only a small proportion will be affected so recolonisation from surrounding habtiats is possible.	2
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	**11**	**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	Benthic habitats are 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 a maximum of 30 launches per year. However, the likelihood of LVs repeatedly encountering an MPA with designated benthic feature or a VME is extemely low, taking into account the extent of the study area.	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 LVs 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 v	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability		
1	Impact is measurable above natural variability (0-5% change)	Direct impacts to the benthic habitats are likely to be measureable above natural variability as there is not element of natural variability and the most sensitive habitats are long-lived.	1
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 environr	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 baseline population)	Direct impacts to the benthic habitats are only likely to have a small effect on the baseline, when taking into account the very small spatial scale of effect in the context of the extent of benthic habitats in the EZI.	1
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	**2**	**1**

Overall Risk (sensitivity x exposure x magnitude)	**Low**	**3**

Receptor	Fish
Pressure Pathway/Impact	Effects from Fuel Spillage/Metal Corrosion/Debris and Microplastics

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 number of fish species in the study area is very high. Several of these species are commercially important or listed as Priority Marine Features in Scottish waters.	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	Fish species exposed to increased contaminants may accumulate them, though only in low amounts due to the low amounts predicted to be released and the high mobility of fish species.	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	Fish species that accumulate low levels of contaminants will only be marginally affected and show minimal physiological effects at worst.	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)	The source of contaminants (LVs) will pass through the water column and then rest on the seabed. The most persistent source of contamination is the metal and associated corrosion, which will be present for extended periods on the seabed. However, given the very small amount of exposure predicted, it is expected that fish species can recover within short timescales.	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	The receptor is likely to be exposed to impacts over moderate periods of time, i.e. maximum 30 times over 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 a maximum of 1 launch per year.	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 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		
1	Impact is measurable above natural variability (0-5% change)	Direct impacts to the contaminant levels of fish are likely to be measureable above natural variability.	1
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 the contaminant levels of fish are not likely to affect the fish baseline, when taking into account the very small spatial scale of effect in the context of the entire EZI and the high mobility of fish.	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		**1**	**1**
Overall Risk (sensitivity x exposure x magnitude)		**Low**	**1**

Receptor	**Fish**
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	The number of fish species in the study area is very high. Several of these species are commercially important or listed as Priority Marine Features in Scottish waters.	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 worst-case scenario of fish being exposed to the noise of impact could have injury effects on individuals in the immediate vicinity, which would cause a substantial change.	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	The worst-case scenario of fish being exposed to the noise of impact could have injury effect on individuals in the immediate vicinity, which would affect them substantially.	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	The worst-case scenario of fish being exposed to the noise of impact could have injury effects on individuals in the immediate vicinity. At an individual level the receptor would not be able to recover from this.	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	The receptor is likely to be exposed to impacts over moderate periods of time, i.e. maximum 30 times over 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 a maximum of 1 launch per year.	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 limited impact zone of noise and visual disturbance around the LV 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	**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	Direct impacts to fish 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 fish 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)			**Low**	**0**

Receptor	Marine Megafauna
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 megafauna have a high cultural value and many species are protected by international law. The Arctic Region region is likely to have presence of marine megafauna, though it is not considered a special habitat. There are not anticipated to be any calving or nursery grounds for cetaceans due to the latitude. There is the presence of pupping areas for pinnipeds, 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 megafauna 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 megafauna are considered very adaptable by virtue of their considerable mobility and ability to forage over wide ranges.	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 LV 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	The receptor is likely to be exposed to impacts over moderate periods of time, i.e. maximum 30 times over 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 a maximum of 1 launch per year.	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 limited impact zone from the returning LVs and wide foraging ranges of marine megafauna 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 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 Megafauna
Pressure Pathway/Impact	Direct stike causing mortality/serious injury

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 megafauna have a high cultural value and many species are protected by international law. The Arctic Region region is likely to have presence of marine megafauna, though it is not considered a special habitat. There are not anticipated to be any calving or nursery grounds for cetaceans due to the latitude. There is the presence of pupping areas for pinnipeds, 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 an individual marine megafauna is struck by returning parts of the LV 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 an individual marine megafauna is struck by returning parts of the LV it will likely have lethal or serious injury consequences	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 an individual marine megafauna is struck by returning parts of the LV 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	The receptor is likely to be exposed to impacts over moderate periods of time, i.e. maximum 30 times over 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 a maximum of 1 launch per year. However, the likelihood of such an event occurring is very low, a single individual will only be exposed to this impact pathway a maximum of one time during its 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 LVs and wide foraging ranges of Marine megafauna 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 Marine megafauna 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 Marine megafauna 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 Megafauna

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 megafauna have a high cultural value and many species are protected by international law. There are not anticipated to be any calving or nursery grounds for cetaceans due to the latitude. There is the presence of pupping areas for pinnipeds, 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	The worst-case scenario of marine megafauna being exposed to the noise of impact could have injury effects on individuals in the immediate vicinity, which would cause a substantial change.	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	The worst-case scenario of marine megafauna being exposed to the noise of impact could have injury effects on individuals in the immediate vicinity, which would affect them substantially.	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	The worst-case scenario of marine megafauna being exposed to the noise of impact could have injury effects on individuals in the immediate vicinity. At an individual level the receptor would not be able to recover from this.	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	The water quality receptor is likely to be exposed to impacts over limited periods of time, i.e. maximum 12 times over 30 year licence.	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)	There is expected to be up a maximum of 1 launch per year.	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 limited impact zone of noise and visual disturbance around the LV 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	2	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 megafauna 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 megafauna 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)	Low	0

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 nose cone 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	The water quality receptor is likely to be exposed to impacts over limited periods of time, i.e. maximum 12 times over 30 year licence.	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)	There is expected to be up a maximum of 1 launch per year.	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 limited impact zone from the returning nose cone 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	2	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 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 unavailable 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. 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 LV 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 LV 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 LV 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	The water quality receptor is likely to be exposed to impacts over limited periods of time, i.e. maximum 12 times over 30 year licence.	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)	There is expected to be up to a maximum of 1 launch per year. However, a single individual will only be exposed to this impact pathway a maximum of one time during its 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 LVs 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	2	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. 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 LV 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 LV 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	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	Marine ornithology features are likely to be exposed to impacts over considerable periods of time, i.e. the duration of the 30 year 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)	There is expected to be up to a maximum of 1 launch per year.	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 limited impact zone of noise and visual disturbance around the LV 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	2	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

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 6.5 Humans and Human Activities Risk Matrix

HyImpulse AEE report Appendix 6.5 - 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 study area 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 study areas 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 an LV 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		
3	Receptor is exposed to impact over extensive periods of time	The receptor is likely to be exposed to impacts over moderate periods of time, i.e. maximum 30 times over 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 a maximum of 1 launch per year	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 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 study area 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 LVs. 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 LV 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 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 small spatial extent of the impact zone around returning LVs, 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 LVs 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

HyImpulse AEE report Appendix 6.5 - 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 LV 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 LV 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 LV 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	The receptor is likely to be exposed to impacts over moderate periods of time, i.e. maximum 30 times over 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 a maximum of 1 launch per year. However, the likelihood of LVs repeatedly encountering any given human infrastructure is extemely low, taking into account the extent of the study area.	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 LVs, 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**

HyImpulse AEE report Appendix 6.5 - 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 study area 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 Shetland Space Centre, 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 an LV 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	The receptor is likely to be exposed to impacts over moderate periods of time, i.e. maximum 30 times over 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 a maximum of 1 launch per year	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 LVs 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	**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 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**

HyImpulse AEE report Appendix 6.5 - 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 study area 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 wrt to the location of exclusion zones around the predicting landing area of LVs. 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 LV 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	The receptor is likely to be exposed to impacts over moderate periods of time, i.e. maximum 30 times over 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 a maximum of 1 launch per year.	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 LVs, 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 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**

HyImpulse AEE report Appendix 6.5 - 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 study area.	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 LVs. 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 LV 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	The receptor is likely to be exposed to impacts over moderate periods of time, i.e. maximum 30 times over 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 1 launch 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 LVs, 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 study area 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**

HyImpulse AEE report Appendix 6.5 - 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 study 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	The receptor is likely to be exposed to impacts over moderate periods of time, i.e. maximum 30 times over 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 1 launch per year. However, the likelihood of LVs repeatedly impacting any given marine archaeological site is extemely low, taking into account the extent of the study area.	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 LVs 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 LVs reaching the seabed will have known impact on marine archaeological sites, but if this did occur it would affect the baseline.	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**

Chapter 7 -

Chapter 8 -


aurora