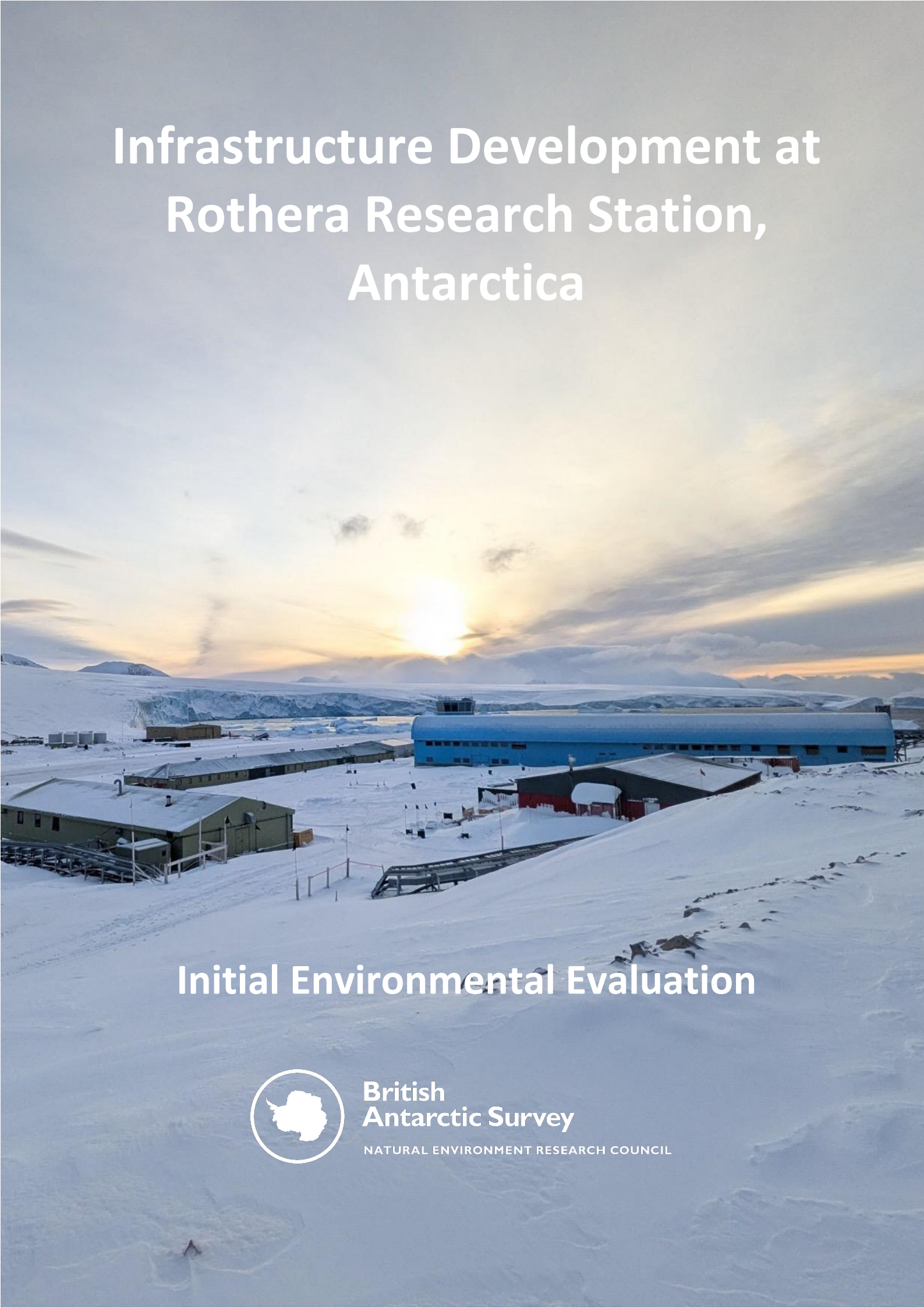
Infrastructure Development at Rothera Research Station, Antarctica



Initial Environmental Evaluation

British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

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List of Acronyms and Abbreviations

AC	Alternating current
AIMP	Antarctic Infrastructure Modernisation Programme
ATCM	Antarctic Treaty Consultative Meeting
ATCPs	Antarctic Treaty Consultative Parties
asl	Above sea level
ASMA	Antarctic Specially Managed Area
ASPA	Antarctic Specially Protected Area
AVCAT	Aviation Carrier Turbine Fuel
BAS	British Antarctic Survey
BESS	Battery Energy Storage System
BMPV	Building-mounted photovoltaic
BMS	Building management system
BP	Before present
CCAMLR	Convention on / Commission for the Conservation of Antarctic Marine Living Resources
CEE	Comprehensive Environmental Evaluation
CEP	Committee for Environmental Protection
CHP	Combined Heat and Power
COMNAP	Council of Managers of National Antarctic Programs
CO_2	Carbon dioxide
DPM	Damp Proof Membrane
EIA	Environmental Impact Assessment
FCDO	Foreign Commonwealth and Development Office
FRBS	Fuel-reel bunker station
GCA	Ground contamination assessment
GHG	Greenhouse gas(es)
GMPV	Ground-mounted photovoltaic
GPS	Geographical Positioning System
GRP	Glass reinforced plastic
HSM	Historic Site or Monument
IBA	Important Bird Area
IBBA	Important Bird and Biodiversity Area
IMMA	Important Marine Mammal Area
ISO	International Organisation for Standardisation
IEE	Initial Environmental Evaluation
kg	Kilogram(s)
kWh	Kilowatt hours
kWp	Kilowatt-peak, representing the maximum power output a solar photovoltaic (PV) system can produce. It is used to measure the capacity of solar panels rather than the energy generated over time (which is measured in kWh)
LFP	Lithium Iron Phosphate (battery)
MGO	Marine Gas Oil
NERC	Natural Environment Research Council
OSCP	Oil spill contingency plan
PEE	Preliminary environmental evaluation
pH	Potential of hydrogen (measure of acidity or alkalinity)
PMP	Plant management plan
POP	Persistent organic pollutant(s)
PV	Photovoltaic
PVR	Project variation register
RAF	Royal Airforce
RENEW	BAS' renewable energy programme
RIBA	Royal Institute of British Architects
RO	Reverse osmosis
RPA	Remotely Piloted Aircraft
SCAR	Scientific Committee on Antarctic Research
SDA	Royal Research Ship (RRS) Sir David Attenborough
STP	Sewage treatment plant
SWS	Site-wide services
UK	United Kingdom
UKAHT	United Kingdom Antarctic Heritage Trust
UKRI	United Kingdom Research and Innovation
VME	Vulnerable Marine Ecosystems
WAIS	West Antarctic Ice Sheet
Wp	Watt peak
WWTP	Wastewater treatment plant
^oC	Degrees Celsius
Hz	Hertz
Km^2	Square kilometres
L / l	Litres
ms^{-1}	Metres per second
m	Metres
mm	Millimetres
m^2 / m^3	Square metres / cubic metres
mph	Miles per hour
Mya	Million years ago
t	Tonnes (metric)
UV	Ultraviolet
UOM	Unit of Measure
VDV	Vibration dose value
%	Percent(age)

Non-Technical Summary

Introduction

This Environmental Impact Assessment has been prepared to evaluate the actual or potential impacts of a package of infrastructure projects at the British Antarctic Survey's Rothera Research Station over the Antarctic summer seasons 2026–27 to 2029–30. Most of the described projects form part of the British Antarctic Survey's Antarctic Infrastructure Modernisation Programme, which aims to modernise station infrastructure, improve operational resilience and safety, support future scientific research, and contribute to the long-term environmental sustainability of British Antarctic Survey's Antarctic operations. Some of the described work is undertaken by British Antarctic Survey's Estates Department.

The proposed works include resurfacing of the wharf, improvements to fuel-handling infrastructure, installation of renewable energy systems, redevelopment of the hangar, runway maintenance activities, ground investigations, slipway development and removal of old infrastructure. This assessment examines the potential environmental impacts of these activities, identifies measures to avoid or mitigate adverse impacts, and evaluates whether the projects can be undertaken in a manner consistent with the environmental protection requirements that apply in Antarctica.

Statutory Requirements for the Environmental Impact Assessment

Activities undertaken in Antarctica are regulated by the Protocol on Environmental Protection to the Antarctic Treaty, which is implemented in UK law through the Antarctic Act 1994. These requirements establish environmental protection as a fundamental consideration in the planning and conduct of Antarctic activities and require environmental impacts to be assessed before activities proceed.

This assessment has been prepared in accordance with the provisions of Article 8 of and Annex I to the Environmental Protocol. Its purpose is to determine whether the proposed activities are likely to have more than a minor or transitory impact on the Antarctic environment and to identify appropriate measures to mitigate identified environmental impacts.

Applicable decisions taken by the Antarctic Treaty Consultative Meeting and guidance material prepared by the Council of Managers of National Antarctic Programs, have also been considered in this assessment.

Scope of the Environmental Impact Assessment

The spatial scope of the assessment is for the most part restricted to Rothera Point and the surrounding nearshore marine environment. Temporally the assessment covers the next four austral summer seasons 2026–27 to 2029-30; though most of the planned work will occur in the first two summers.

The assessment considers both the direct and indirect impacts of individual projects and the cumulative effects arising from multiple projects occurring during the same period.

The assessment covers the planned construction activities, supporting logistics, fuel handling, waste management, transport operations as well as the transport and accommodation of additional personnel required to undertake the works.

Potential impacts associated with routine Station activities and associated science support from Rothera are excluded from the assessment.

Description of Planned Activities and Alternatives

The principal projects assessed include resurfacing the station wharf, installation of permanent fuel transfer pipelines between the wharf and the fuel farm, installation of renewable energy infrastructure including solar power systems and battery energy storage, and the construction of a larger replacement aircraft hangar and associated works.

Additional activities include removal of redundant infrastructure, runway maintenance works, establishment of a slipway in North Cove, ground contamination investigations, and rock processing and stockpiling activities.

Most of the planned projects over the next two summer seasons involve earthworks, including the wharf resurfacing, trenching for the fuel pipelines and cabling, slipway development, ground contamination assessment, new building foundations and roading.

Alternatives to the planned activities were considered in most cases, including alternative locations, alternative construction methods or designs and the option of not proceeding with the works. The preferred approaches were selected after considering operational requirements, environmental protection objectives, engineering constraints, safety requirements and long-term sustainability outcomes.

The environmental aspects arising from each of the planned activities are described prior to assessing their potential impacts.

Existing Environmental State

Rothera Research Station is located within a region of notable environmental and intrinsic values. The surrounding environment of Rothera Point includes breeding bird populations, nearshore marine habitats, ice-free terrestrial environments with important vegetation cover, long-term scientific monitoring sites and important wilderness qualities. Although Rothera has supported logistical and research operations for several decades, much of the surrounding environment remains sensitive to disturbance.

The assessment records that the Antarctic Peninsula region is experiencing rapid environmental change associated with climate change, including glacier retreat, changes in sea ice conditions, ecological shifts and increasing environmental variability. These changes increase the importance of maintaining resilient infrastructure while continuing to protect the environmental values that make the region scientifically and environmentally significant.

Assessment of Environmental Impacts

The assessment identified a range of environmental aspects that will or could arise during implementation of the proposed projects, including emissions of noise, ground borne vibration, dust generation, artificial light emissions, disturbance of ice-free ground, emission of exhaust gases including greenhouse gases, and increased human activity. The assessment also considered the potential for accidental releases of fuel or other contaminants, increased waste generation and the inadvertent introduction of non-native species.

Particular attention has been given to potential impacts on breeding birds, nearshore marine environments, terrestrial habitats, scientific activities, air quality and wilderness values. The assessment of the significance

of the identified impacts found that several activities have the potential to cause environmental disturbance if not appropriately managed.

In almost all cases, mitigation measures have been identified, which if implemented are considered likely to reduce the significance of the impact to acceptable levels. Mitigation measures include controls on construction activities, fuel handling and waste management procedures, spill prevention and response measures, biosecurity controls, as well as noise and lighting management, where appropriate. These mitigation measures are consistent with those employed throughout previous infrastructure activities at Rothera which have been shown to be effective.

Following implementation of these measures, the assessment concludes that residual impacts are expected to be localised, temporary and limited in extent. No impacts were identified that are expected to exceed the 'more than minor or transitory' threshold established under the Protocol on Environmental Protection to the Antarctic Treaty.

Cumulative Environmental Impacts

The assessment considered the combined effects of all projects included within the programme and other reasonably foreseeable activities.

The principal cumulative impact pathways identified relate to breeding birds, terrestrial ice-free areas, the marine environment, scientific research values, greenhouse gas emissions and wilderness qualities. Breeding birds, particularly skuas, were identified as one of the more sensitive environmental receptors because they may be exposed to multiple sources of noise, vibration and artificial light during the construction period.

The cumulative impacts assessment concluded that the combined effects of the programme can be effectively managed through coordinated planning, implementation of mitigation measures and ongoing environmental monitoring. Cumulative impacts are not expected to result in more than minor or transitory effects.

Monitoring and Record Keeping

Environmental monitoring forms an important component of the management approach for the proposed activities. The proposed monitoring programme is consistent with, and a continuation of the monitoring that has been undertaken over the last few seasons. Monitoring will focus on noise, ground borne vibration and dust with threshold levels set in each case, which if exceeded, will require a review of activities.

Long-term monitoring programmes already established at Rothera, including monitoring of the local Skua population, will continue to provide important information on environmental conditions and trends.

Environmental incidents, as well as project performance information, such as waste and fuel use, will be recorded and reviewed throughout the programme.

Gaps in Knowledge and Uncertainties

As with any environmental assessment, several uncertainties remain at the time of preparation of this assessment. These include weather and snow conditions which may result in project delays, as well as the nature and extent of unidentified, buried infrastructure or redundant services that may be encountered during excavation activities. Procedures have been developed to ensure that any such discoveries can be managed appropriately.

The assessment concludes that these uncertainties do not prevent a robust evaluation of the proposed activities and can be effectively managed during project implementation.

A project variation register will be maintained to record any changes that are made to the planned work.

Summary and Conclusions

This Environmental Impact Assessment has assessed a coordinated programme of infrastructure improvements intended to modernise critical station infrastructure, improve operational resilience and safety, support future scientific research and contribute to the long-term environmental sustainability of Rothera Research Station.

The assessment considered the potential environmental effects of construction activities, infrastructure upgrades, fuel handling improvements, renewable energy installations, runway maintenance works and associated support activities. Potential impacts were identified for wildlife, terrestrial and marine environments, air quality, scientific activities, and wilderness values.

A comprehensive range of mitigation measures has been incorporated into project planning. These measures include controls to minimise disturbance to wildlife, prevent pollution, manage waste and fuel, protect sensitive environmental features, reduce the risk of introducing non-native species and monitor environmental performance throughout the programme.

The assessment found that most impacts will be localised and temporary. The cumulative impacts assessment concluded that the combined effects of the proposed projects and ongoing station operations can be effectively managed through coordinated planning and implementation of mitigation measures.

The programme is also expected to deliver several environmental benefits, including improved fuel transfer systems, with reduced risk of spills, removal of redundant infrastructure, and a reduction in fuel consumption and greenhouse gas emissions over time.

While some uncertainties remain, particularly regarding the extent of historical contamination that may be encountered, these uncertainties can be appropriately managed through routine project management controls.

Overall, the assessment concludes that, with the proposed mitigation, monitoring and environmental management measures in place, the planned activities are expected to result in impacts that are no more than minor or transitory. Further assessment at the level of a comprehensive environmental evaluation is not considered to be required.

1. Introduction

1.1. LAYOUT OF THIS ENVIRONMENTAL IMPACT ASSESSMENT

This environmental impact assessment (EIA) assesses the actual or potential impacts that will or could arise from a number of infrastructure projects that are planned to be undertaken at the British Antarctic Survey's Rothera Research Station in Antarctica, including as part of its Antarctic Infrastructure Modernisation Programme (AIMP).

This Chapter provides the background to the British Antarctic Survey and to Rothera Research Station. It also provides an overview of the AIMP and summarises the planned programme of works for the next four austral summer seasons of 2026-27 to 2029-30; though with most of the planned work taking place in the 2026-27 and 2027-28 seasons.

Chapter 2 addresses the international and national statutory framework within which the EIA has been prepared and under which the works will be undertaken.

Chapter 3 describes the spatial and temporal scope of the EIA and summarises the activities that are included within the assessment as well as those that have been excluded with justification.

Chapter 4 sets out the detail of the planned infrastructure work and identifies the environmental aspects that will or could arise. This Chapter also reviews alternatives to the planned work that were considered during the planning phase including the option of not proceeding.

Chapter 5 describes the current environmental state based on the peer reviewed academic literature and identifies the environmental sensitivities and values that need to be taken into account in this impact assessment, and for which mitigation measures will or may be required.

Chapter 6 describes the impact assessment methodology that has been applied and the findings of the impact assessment including the assessment of impact significance as well as the outcome to the cumulative impacts assessment.

Chapter 7 summarisies the monitoring and record keeping that has been identified as being needed based on the predicted impacts.

Chapter 8 records the gaps in knowledge and uncertainties that remain after completion of the impact assessment.

Chapter 9 summarises the findings of the impact assessment and draws a conclusion as to the overall impacts of the planned work against the criteria of Article 8 of the Environmental Protocol to the Antarctic Treaty.

1.2. BRITISH ANTARCTIC SURVEY

British Antarctic Survey (BAS)[1] is a component body of the Natural Environment Research Council (NERC). NERC is part of UK Research and Innovation (UKRI[2]).

Established in 1962 BAS delivers and enables world-leading interdisciplinary research in the Polar Regions. Through its extensive logistical capability and know-how BAS facilitates access for the British and international science community to the Polar Regions (see Text Box below for BAS Vision and Mission).

BAS Vision

To be a world-leading centre for polar science and polar operations, addressing issues of global importance and helping society adapt to a changing world.

BAS Mission

BAS is a research-driven organisation recognised for:

- Commitment to excellence in science
- Operational professionalism and innovation in everything we do
- A partner of choice for science, operations and business wherever polar expertise can be applied
- Safely delivering complex operations in extreme environments
- Commitment to environmental stewardship of the polar regions
- Developing our staff to reach their full potential
- Sustaining an active and influential presence in Antarctica on behalf of the UK, and playing a leadership role in Antarctic affairs
- Engagement with policymakers, government and the public

BAS has many decades of experience in supporting field-based research in Antarctica including many international collaborative programmes.

BAS operates three research stations in Antarctica (Rothera, Signy and Halley) and two summer-only field facilities (Fossil Bluff and Sky Blu), as well as research bases on sub-Antarctic Islands to the north of the Antarctic Treaty Area (*Figure 1*).

[1] See: https://www.bas.ac.uk/about/about-bas/

[2] UKRI is a non-departmental public body sponsored by the Department for Business, Innovation, Science and Trade

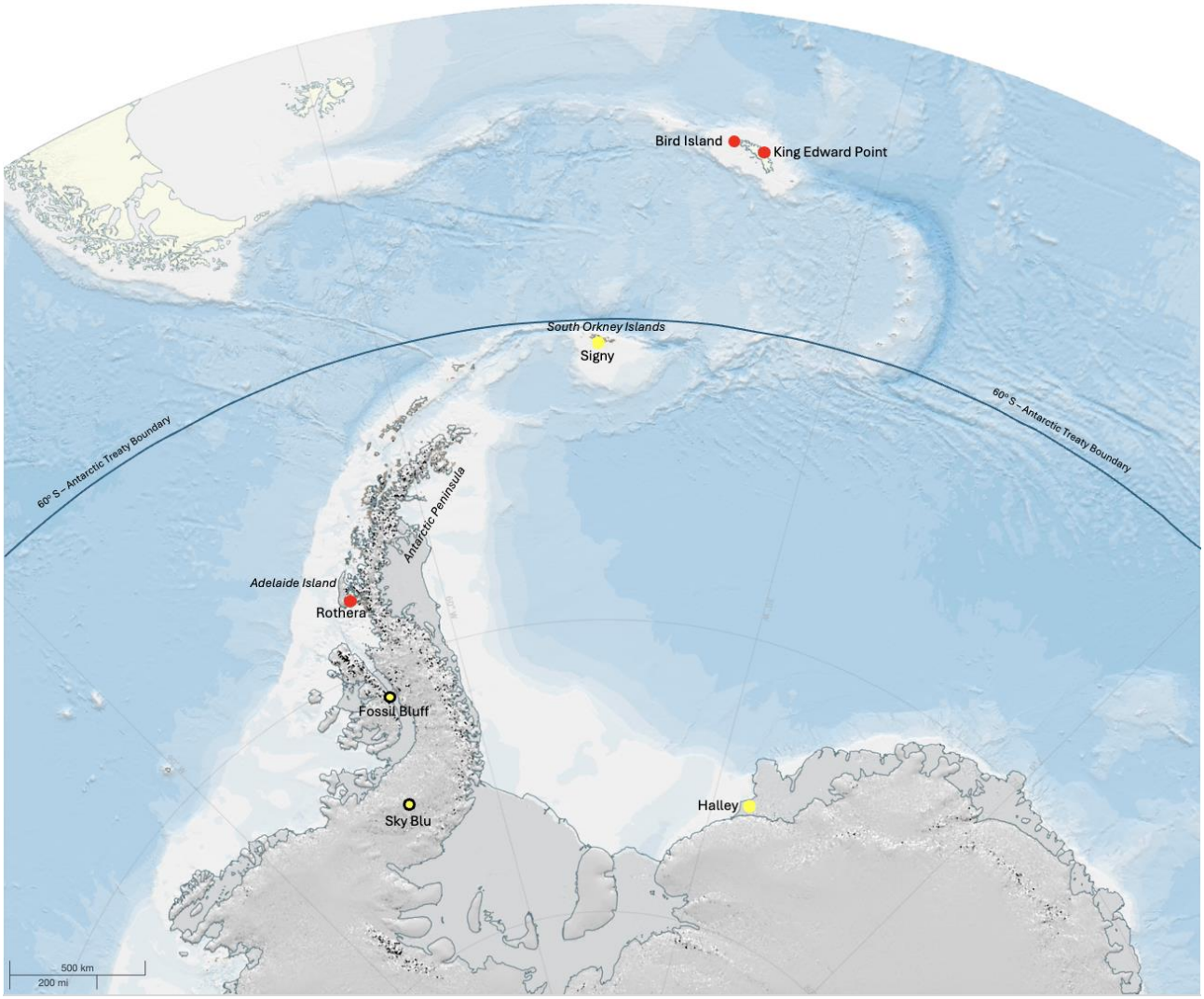

Figure 1. British Antarctic Survey bases in the Antarctic and sub-Antarctic. Red dots indicate current year-round bases. Yellow dots indicated bases currently occupied during the austral summer only. Yellow dots with black outline indicate field support facilities that are variably occupied during the austral summer. Map source: SCAR Antarctic Digital Database.

1.2.1. BAS Sustainability Strategy

BAS fulfils its environmental stewardship role by working to the highest environmental standards in accordance with the requirements of the Environmental Protocol to the Antarctic Treaty. The organisation has established an Environmental Policy and operates an environmental management system that is independently audited and certified to ISO 14001.

The AIMP will deliver critical new and more efficient infrastructure, and a new energy system including renewable energy generation.

When delivering a programme of major construction projects, the programme's impacts on environment, the Antarctic community, and ability to deliver the BAS science programme has to be carefully considered.

The AIMP has a robust approach to sustainability that comprises:

- protecting both the unique local ecosystem in Antarctica and limiting its wider global impacts from its supply chain,

- supporting the community of scientists and field operatives,
- ensuring that BAS science and operations continues with minimal interruption.

In addition, BAS has committed to achieving Net Zero Carbon by 2050 (including the interim 50% reduction by 2030 across NERC)[3].

To support this goal, the Rothera Decarbonisation Strategy aims to achieve zero greenhouse gas (GHG) emissions at the Station by 2050 through directly managed operations. There are six objectives within the Rothera Decarbonisation Strategy:

- Maximise the energy efficiency of the station's buildings;
- Develop a site energy infrastructure;
- Develop a smart grid;
- Electrify the station's fleet (vehicles, boats);
- Achieve extensive carbon neutrality in construction activities; and
- Increase positive impact by influencing supply chain.

The Rothera Decarbonisation Strategy identifies a set of milestones and enabling works that will need to be delivered in order to achieve zero operational GHG emissions by 2050.

1.3. ROTHERA RESEARCH STATION

The works that are the subject of this impact assessment will be undertaken at Rothera Research Station (Rothera), the largest British Antarctic facility. Rothera is a centre for biological research and a hub for air operations in support of deep-field research programmes across the Southern Antarctic Peninsula and West Antarctic Ice Sheet.

The station was established in 1975 on a rock promontory at the southern tip of the Wormald Ice Piedmont on Adelaide Island, to the west of the Antarctic Peninsula (Lat. 67°35'8"S, Long. 68°7'59"W; *Figure 2*). The station includes the new Discovery Building, New Bransfield House, the Bonner research laboratory, offices and workshops, a crushed rock runway, hangar, fuel farm and wharf (*Figure 3*).

Rothera supports a wide range of BAS, UK university and international collaborative researchers and science programmes. International collaboration also includes the Dirck Gerritsz laboratory that is operated by the Netherlands Polar Research Programme.

The scientific research undertaken at or from Rothera spans a wide range of disciplines, including space weather, terrestrial biology, marine biology, oceanography, meteorology, atmospheric chemistry and ozone monitoring.

[3] Aligned with the net zero commitments of the Natural Environment Research Council (NERC) and UK Research and Innovation (UKRI)

Rothera operates throughout the year. In summer, the average peak population is more than 100 people with peak highs of up to 170 people during large construction periods. During the winter months, from April to mid-October, between 22 and 30 people continue the science work and maintain Rothera's infrastructure.

Staff on station include researchers and support staff as well as a station management team.

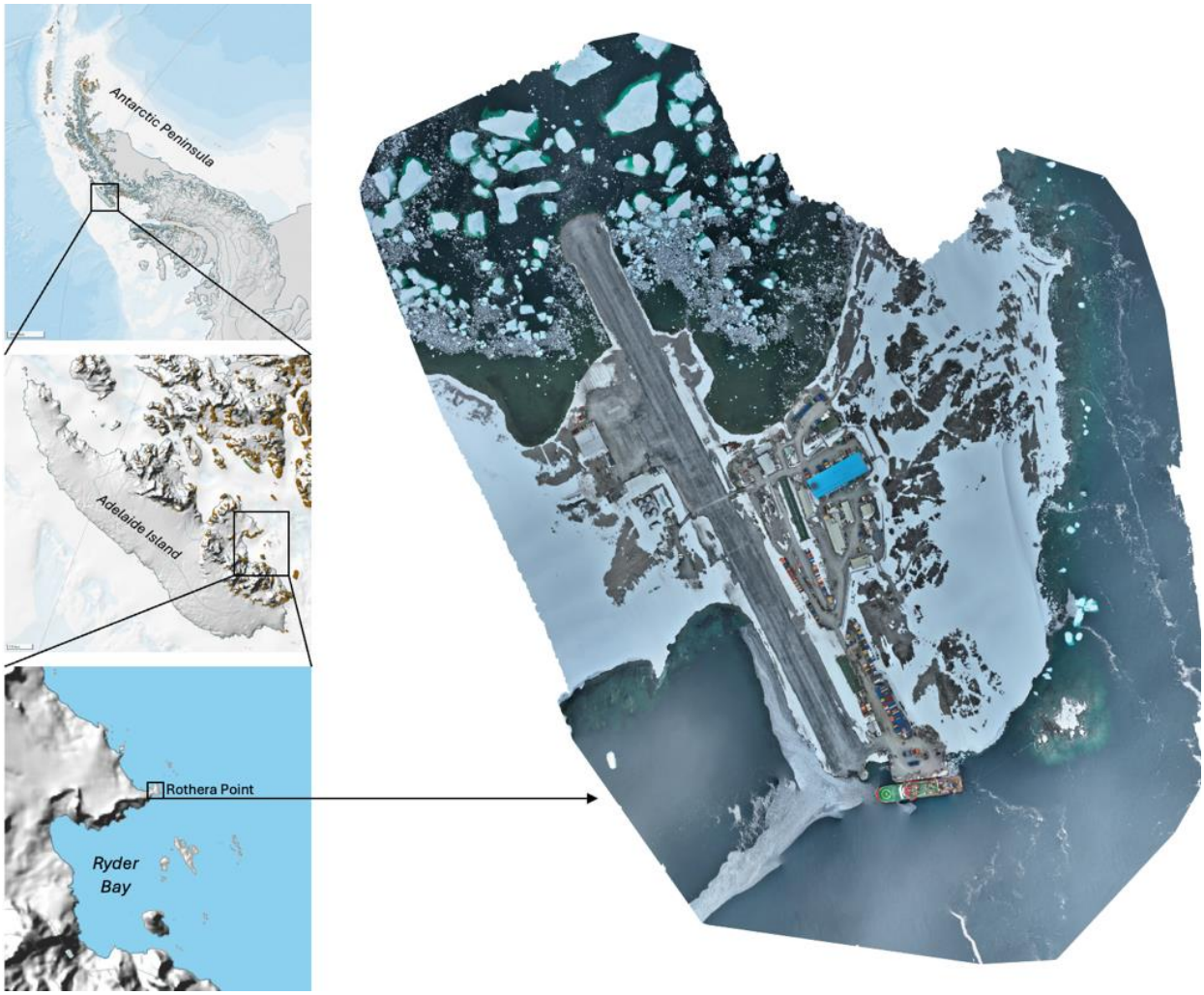

Figure 2. Location of Rothera Research Station on Rothera Point, Adelaide Island, Antarctic Peninsula. Sources: SCAR Antarctic Digital Database; British Antarctic Survey

1.3.1. Air operations

Rothera includes a 900m gravel runway from which BAS operate a fleet of five aircraft, adapted for flying in Antarctic conditions. This fleet is comprised of four De Havilland Twin Otters and one De Havilland Dash-7. Several of the airframes are equipped with modifications to allow them to carry out airborne science surveys. Between them they undertake a wide variety of logistical and science support missions throughout each summer season.

1.3.2. Vehicle operations

Rothera supports a fleet of vehicles for logistical and infrastruture development purposes. Maintenance of vehicles is undertaken by a team of vehicle mechanics and plant operators. The day-to-day coordination of vehicle use is arranged between the Facilities Engineer and the station management team.

Vehicles in operation at Rothera include a fleet of skidoos, tractors, trailers, loaders, excavators and tankers for runway dust suppression.

BAS' construction partner (BAM Nuttall (BAM)) have exclusive use of key plant during construction periods and have responsibility for maintaining it.



Figure 3. Rothera Research Station, Antarctica. Source: British Antarctic Survey.

1.3.3. Vessel and Boat operations

In addition to the airbridge with South Atlantic gateways, Rothera is supported by the *RRS Sir David Attenborough* (SDA), the UK's Antarctic research and resupply vessel. The SDA provides routine logistical support to Rothera, including the delivery of personnel, scientific equipment, fuel, and essential supplies, as well as the removal of waste in accordance with established environmental management procedures.

The SDA ordinarily makes two or three calls to Rothera during the summer season depending upon operational needs and other vessel tasking.

Small boat operations are a vital part of local science and operational activities at Rothera. There are currently five boats within the Rothera fleet.

1.3.4. Fuel storage and management

The primary fuels used at Rothera by volume are Marine Gas Oil (MGO) and Aviation Fuel (AVCAT). These fuels are stored in several fuel tanks across the station, including the main fuel farm adjacent to the Hangar.

Rothera has provision for the bulk storage of 716,200 litres of MGO which is approximately 12.5 months' supply. All the storage tanks are made from steel and are either bunded or double skinned.

1.3.5. Energy

Rothera is primarily powered by four new Combined Heat and Power (CHP) engines, installed on the ground floor of Discovery Building. Electricity is supplied via the CHP engines, with contributions from solar PV panels installed on the exterior of Discovery Building. Thermal generation is also provided via the CHP engines, as well as two MGO boilers, plus a small amount from the PV panels on various buildings at Rothera.

Most of the heating is supplied in conventional heating systems, oil boilers in larger buildings and electric heaters in small buildings. The larger buildings are also equipped with air handling units.

Rothera requires an average of 600m^3 of fuel to maintain serviceability, this is a 60/40 blend of MGO / AVCAT. Additional fuel (an average of 98m^3 / season) is used for construction plant and equipment during major constructions seasons.

1.3.6. Water

Fresh water is produced at Rothera by reverse osmosis (RO) a process that filters salt from sea water to create fresh water through a process of desalination. The RO plants are online 24-hours a day and can produce up to 24 m^3 per day.

A new potable water system was commissioned in January 2025. This utilises new potable water installations (including water tanks) and a distribution system in the Discovery Building, as well as the Site-Wide Services network. The new Discovery Building operates two RO plants.

Potable water is stored in the RO room which currently has three tanks with a total volume of 28m^3. This water is pumped to smaller satellite tanks situated in other buildings. A melt tank is available for emergency use.

1.3.7. Wastewater

Wastewater is managed through a comprehensive treatment process that exceeds the requirements of the Protocol. The system at Rothera has recently undergone a major upgrade to support the station's modernisation and growing summer population.

The station utilizes a multi-stage biological treatment system to handle all sewage and greywater before discharge. Wastewater is collected from various buildings and moved to the treatment plant using macerating pumping stations. A rotating belt filter mesh removes over 50% of total suspended solids. A submerged aerated filtration unit uses microorganisms to break down remaining organic matter. The final liquid effluent is treated with UV light to kill pathogens before being released into the sea.

Sludge is dewatered to approximately 18–22% dry solids content using a screw press. The resulting solid waste is dried and incinerated on-site.

1.3.8. General waste

Rothera Station uses a twin-chamber, high-capacity waste incinerator to manage day-to-day waste. The incinerator is designed to destroy up to 100kg of waste per hour. The unit is pre-installed in two heated 20ft containers. These containers house the primary chamber and an automated ram charger, allowing staff to process waste continuously without exposure to the elements.

The system includes integrated heating elements along fuel lines to prevent freezing and a remote Building Management System (BMS) so operators can monitor performance and fuel levels from the main station facility.

The incinerator primarily handles food waste, medical waste, sewage sludge and non-recyclable day-to-day rubbish.

Other materials like batteries, plastics, chemicals, and metals are separated and returned to the UK for recycling or managed disposal.

1.4. ANTARCTIC INFRASTRUCTURE MODERNISATION PROGRAMME

The work under assessment in this EIA will be undertaken in the context of BAS' Antarctic Infrastructure Modernisation Project (AIMP) and selected Estates projects which require support from AIMP. The AIMP is a long-term infrastructure upgrade of BAS facilities across the Antarctic and the South Atlantic. The AIMP represents the largest UK Government investment in polar science since the 1980s and will enable BAS to continue to deliver world leading science capability in the Polar Regions. BAS have appointed the engineering consultancy Ramboll as the Technical Advisors for the project and BAM Nuttall (BAM) have been contracted as the Construction Partner, who in turn are partnered with design consultants Sweco UK.

The activities that are planned are part of a 10-year programme of works upgrading Rothera. The Rothera Modernisation Project, which is part of AIMP, aims to provide a station that is fit for purpose for the next 25 years. In 2017, a Rothera Modernisation Master Plan Report was developed, detailing the developments planned for the station over the next 25 years. In March 2021, the Master Plan Report was updated to reflect the progress and changes to Rothera since 2017 – this now represents the latest version of the Master Plan. The Master Plan sets out how the Rothera Modernisation Project will achieve ambitions for a research station that is resilient, flexible, and fit for the future.

The work that has been undertaken at Rothera to date, as part of the modernisation programme, has been the subject of a series of environmental impact assessments. This includes:

- 2018 – a CEE titled 'Rothera Wharf Reconstruction and Coastal Stabilisation'. The works undertaken under this CEE included reconstruction and extension of the Rothera wharf and associated coastal stabilisation works.
- 2019 – an IEE titled 'Rothera Modernisation Phase 1 IEE'. The works undertaken under this IEE included, construction of the new Discovery Building, replacement of the site wide services, construction of an interim waste management facility; and demolition and decommissioning of older buildings.
- 2022 – an IEE titled 'Rothera Runway Resurfacing and Lighting, site investigation and Condition Survey Works 2022-2023'. The works undertaken under this IEE included resurfacing the runway and improving the runway lighting, a range of site investigation and survey works to inform any future design of the proposed runway upgrade, condition surveys and environmental monitoring at

various locations considered suitable for renewable energy generation (notably solar and wind) to inform future decision-making on renewable energy infrastructure installation; a range of site investigation works and condition surveys to inform the future redevelopment of the hangar, and future construction of a new fuel farm hut.

- 2024 – an IEE titled 'AIMP 2024-2025 and 2025-2026 Projects'. The works undertaken under this IEE included scope changes and snagging items that had arisen over the course of the AIMP programme, and which were necessary to complete the Discovery Building, Sitewide Services and the runway resurfacing projects.

1.4.1. Planned activities

The main projects for the period 2026-27 to 2029-30, which are addressed by this EIA, are the resurfacing of the wharf, the installation of fixed fuel lines between the wharf and the fuel farm, the installation of a series of solar panels on a number of buildings as well as a trial ground-mounted solar panel array and the rdevelopment of the aircraft hangar and associated works.

Additional works that are also considered in this EIA are, removal of a disused mooring bollard, removal of an old fuel hut and fuel pipelines, works associated with the runway (including replenishing the graded aggregate stockpile and replacing runway lighting electrical cabinet covers), establishing a slipway in North Cove and a contaminated ground assessment.

These works are described in detail in Chapter 4.

2. Statutory Requirements and Guidance Material

2.1. INTRODUCTION

All activities in Antarctica are subject to the provisions of a series of international agreements that constitute the Antarctic Treaty System. These international agreements are enforced through domestic legislation enacted by those countries with active Antarctic involvement.

This Chapter describes the relevant international agreements and domestic legislation that apply to the infrastructure development at Rothera and summarises a number of agreements adopted under the auspices of the Antarctic Treaty System that are applicable to the planned programme of work.

2.2. INTERNATIONAL REQUIREMENTS

2.2.1. Protocol on Environmental Protection to the Antarctic Treaty

The Protocol on Environmental Protection to the Antarctic Treaty (the Protocol) was adopted by the Antarctic Treaty Consultative Parties (ATCPs) in 1991. It entered into force in January 1998.

Article 3 of the Protocol sets out environmental principles for the conduct of all activities in Antarctica. Article 3 provides that the protection of the Antarctic environment and the intrinsic value of Antarctica, including its wilderness and aesthetic values and its value as an area for the conduct of scientific research, in particular research essential to understanding the global environment, shall be fundamental considerations in the planning and conduct of all activities in the Antarctic Treaty area.

Article 3 also requires that activities in the Antarctic Treaty area are planned and borne so as to limit adverse impacts on the Antarctic environment and that those activities must be planned and borne on the basis of information sufficient to allow prior assessments of, and informed judgments about, their possible impacts on the Antarctic environment. Such judgements must take account of:

i. the scope of the activity, including its area, duration and intensity;
ii. the cumulative impacts of the activity, both by itself and in combination with other activities in the Antarctic Treaty area;
iii. whether the activity will detrimentally affect any other activity in the Antarctic Treaty area;
iv. whether technology and procedures are available to provide for environmentally safe operations;
v. whether there exists the capacity to monitor key environmental parameters and ecosystem components so as to identify and provide early warning of any adverse effects of the activity and to provide for such modification of operating procedures as may be necessary in the light of the results of monitoring or increased knowledge of the Antarctic environment and dependent and associated ecosystems; and
vi. whether there exists the capacity to respond promptly and effectively to accidents, particularly those with potential environmental effects.

Article 8 of the Protocol formalises these requirements by requiring an environmental impact assessment to be prepared in advance of any activity taking place in the Antarctic Treaty Area. The level of the environmental impact assessment is determined by whether the activity in question is identified as having less than a minor or transitory impact; a minor or transitory impact; or more than a minor or transitory impact on the environment.

The detailed procedures for preparing and processing environmental impact assessments are set out in Annex I to the Protocol. If a proposed activity is determined, by means of a preliminary assessment, to have less than a minor or transitory impact, then it may proceed. If an activity is determined as being likely to have no more than a minor or transitory impact, then an Initial Environmental Evaluation (IEE) must be prepared. If an IEE indicates the potential for the activity to have more than a minor or transitory impact, or if such an impact is otherwise determined to be likely, then a Comprehensive Environmental Evaluation (CEE) must be prepared.

Preliminary assessments and IEEs are processed within the domestic legal and administrative systems of each Antarctic Treaty Party. Draft CEEs are however, required to be made publicly available, and to be made available for consideration by the Antarctic Treaty System's Committee for Environmental Protection (CEP). The CEP's advice on the quality of a draft CEE is provided to the Antarctic Treaty Consultative Meeting (ATCM). Comments and advice provided by other Antarctic Treaty Parties and the ATCM must be addressed in a final CEE, which is used as the basis for making a decision about whether and how the activity in question will be borne.

Article 2 of Annex I to the Protocol requires that an IEE shall contain sufficient detail to assess whether the proposed activity may have more than a minor or transitory impact and shall include:

- a description of the proposed activity, including its purpose, location, duration and intensity;
- a consideration of alternatives to the proposed activity;
- any impacts that the activity may have, and
- consideration of cumulative impacts in the light of existing and known planned activities.

In 2023 the ATCM agreed that IEEs should also include identification of measures, commensurate with the nature of the activity and the level of environmental impact, to minimise or mitigate the impacts of the proposed activity (Resolution 1 (2023)).

The Committee for Environmental Protection (CEP) has prepared guidance material to assist those preparing EIAs. The most recent version of these guidelines was adopted by the 48th ATCM (Resolution 1 (2026) refers). These guidelines have been consulted in the preparation of this EIA.

The EIA method used to meet these obligations is outlined in Chapter 6.

2.2.2. Applicable ATCM Measures and Resolutions

In addition to the general provisions of the Protocol outlined above, the ATCM has, over time adopted a suite of additional agreements (in the form of Recommendations, Resolutions or Measures) several of which are pertinent to the proposed activities in that they relate specifically to the issue of Antarctic operational activities, or environmental management.

Relevant Recommendations, Resolutions and Measures are highlighted here for completeness and will be taken into account in this environmental impact assessment.

2.2.2.1. LOGISTICAL AND OPERATIONAL ACTIVITIES IN ANTARCTICA

Measures related to logistical and operational activities in Antarctic and relevant to the infrastructure development include:

- Resolution 1 (2014) – Fuel Storage and Handling
- Resolution 7 (2021) – Earthquake Emergency Management System
- Resolution 2 (2023) – Helsinki Declaration on Climate Change and the Antarctic

2.2.2.2. ENVIRONMENTAL MANAGEMENT IN ANTARCTICA

Measures related to environmental management in Antarctica and relevant to the infrastructure development include:

- Recommendation XV-5 (1989) – Environmental Monitoring Activities
- Resolution 1 (2005) – Environmental Impact Assessment: Circulation of information
- Resolution 2 (2005) – Guidelines for Environmental Monitoring
- Resolution 3 (2007) – Long-term Monitoring
- Resolution 5 (2015) – Important Bird Areas in Antarctica
- Resolution 1 (2016) – Revised Guidelines for Environmental Impact Assessment in Antarctica
- Resolution 4 (2016) – Non-native Species manual
- Resolution 1 (2019) – Revised Antarctic Clean-Up Manual
- Resolution 1 (2023) – Consideration of Mitigation Measures in Environmental Impact Assessment

2.3. NATIONAL REQUIREMENTS

The EIA provisions of the Protocol are enacted in United Kingdom (UK) law through the Antarctic Act 1994 and Antarctic Act 2013 and Antarctic Regulations 1995/490 (as amended). The provisions of the legislation apply to any person who is on a British expedition to Antarctica, where a British expedition is defined as an expedition "that is organised in the United Kingdom, or the place of final departure for Antarctica of the persons on the expedition was in the United Kingdom". The Act applies to both governmental and non-governmental activities in Antarctica.

The Act is administered by the Foreign Commonwealth and Development Office (FCDO), and the Secretary of State makes the final determination on whether an activity may proceed taking into account the FCDO's recommendations. It is an offence under the Act to enter Antarctica without a permit issued by the Secretary of State.

The Act also prohibits the following activities unless a permit is obtained:

- undertaking mineral resource activities
- intentionally, killing, injuring, capturing, handling or molesting any native mammal or native bird
- intentionally disturbing native mammals or native birds
- removing or damaging any native plant so as to significantly affect its local distribution or abundance, or significantly damaging a concentration of native plants

- causing significant damage to the habitat of any native mammal, bird, plant or invertebrate
- introducing any species of non-native animal or plant
- entering an Antarctic Specially Protected Area (ASPA), or an area designated as protected by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)
- damaging, destroying or removing a designated historic site or monument

The Secretary of State has discretion under the Act to set conditions regarding the proposed activity. Such conditions may relate to, for example, managing compliance, undertaking environmental monitoring and post-activity reporting. Under the provisions of the Act, non-compliance is an offence carrying a penalty of up to two years imprisonment or a fine or both.

2.4. ADDITIONAL GUIDANCE MATERIAL

The Council of Managers of National Antarctic Programs (COMNAP) provides a forum for cooperation among National Antarctic Programs that have responsibility for delivering and supporting scientific research in the Antarctic Treaty Area on behalf of their respective governments.

COMNAP has developed guidance material that is also relevant, including:

- A Checklist for Supply Chain Managers for the Reduction of Risks of Introduction of Non-native Species
- COMNAP Guide to Emergency Response and Contingency Planning
- COMNAP Best Practice for Energy Management
- COMNAP Guidelines for Environmental Monitoring
- COMNAP – SCAR Antarctic Environmental Monitoring Handbook
- COMNAP Guide to Understanding Risk to National Antarctic Program Operations and Personnel in Coastal Antarctic from Tsunami Events
- COMNAP Fuel Manual

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All of the above obligations and guidance material have been taken into account in the preparation of this EIA and, where relevant, in the various control measures identified to mitigate the impacts of activities planned to be undertaken in Antarctica.

Consideration of the additional provisions of the Protocol as they relate to waste management, prevention of marine pollution and area protection and management are considered in later chapters of this EIA.

3. Scope of the Initial Environmental Evaluation

3.1. INTRODUCTION

To ensure the EIA presents an accurate and comprehensive description of the activity, and that potentially significant environmental impacts are properly assessed, careful consideration is required to determine the full scope of the activity (EIA Guidelines (2026)).

This Chapter describes the spatial and temporal scopes that have been selected for the impact assessment as well as providing the rationale for the activities that have been included within the impact assessment and those that have been excluded.

3.2. SPATIAL SCOPE OF THE IMPACT ASSESSMENT

Predominantly, this impact assessment largely has been spatially constrained to the terrestrial area of Rothera Point on Adelaide Island (*Figure 4*), although some consideration has been given to the potential impacts on the local marine environment in the immediate nearshore area around Rothera Point, as well as to the ice ramp to the west of the runway.

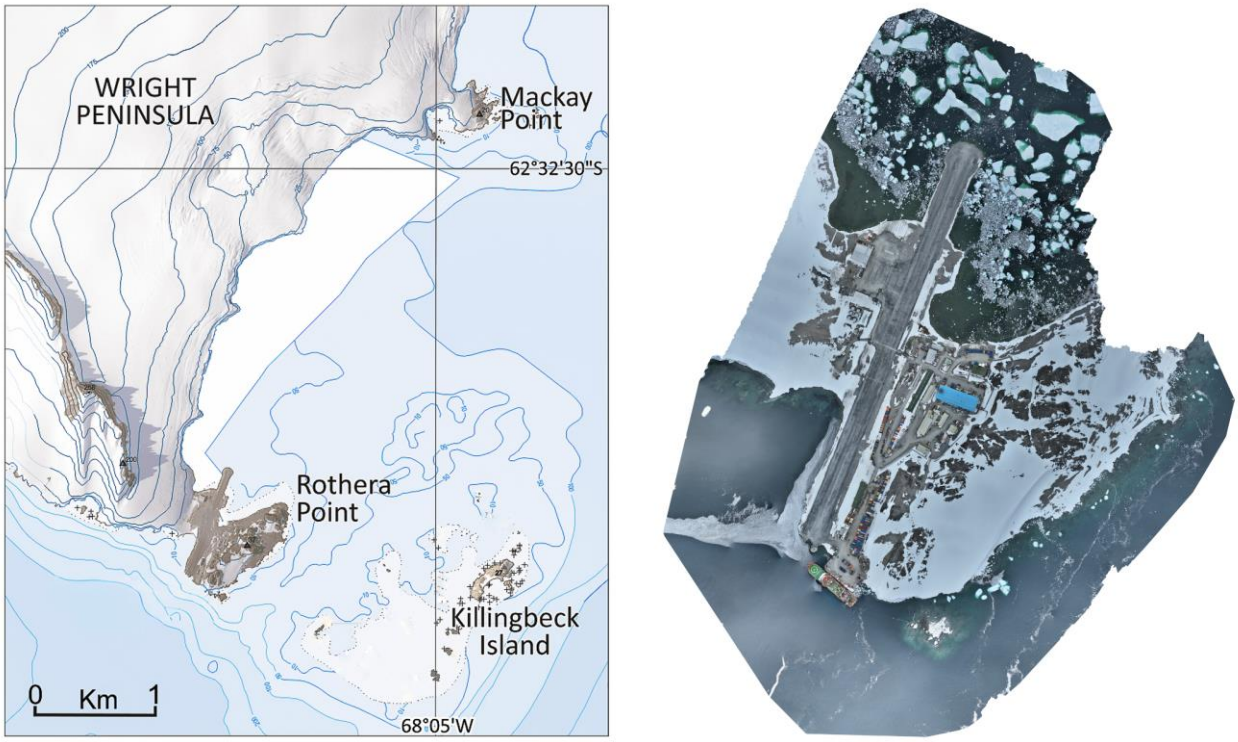

Figure 4. The impact assessment has been spatially constrained to the land area of Rothera Point. Sources: BAS.

With the exception of the installation of a trial solar panel array to the south of the aircraft hangar (see Section 4.4.3.5.), and the diversion of a drainage ditch to the west of the hangar (see Section 4.5.3.7.), the activities that are the subject of this assessment will take place within previously disturbed ice-free areas of Rothera and within the boundaries of the Station.

It is noted that the retreat of the ice ramp to the west of the runway over the last few decades has expanded the ice-free area of Rothera Point. Some of this more recently exposed ice-free ground will be used for installation of the ground-mounted solar panel array (see Section 4.4.3.5.).

3.3. TEMPORAL SCOPE OF THE IMPACT ASSESSMENT

This impact assessment is constrained to four austral summer seasons: 2026-27 to 2029-30 (approximately November to April inclusive in each season).

At the time of preparing this impact assessment the wharf resurfacing work and the installation of the fixed fuel lines are planned be completed within the first austral summer season (2026-27) and the work to install the solar panels is planned for two austral summer seasons (2027-28 and 2028-29).

The smaller-scale works considered in this impact assessment are primarily scheduled for the 2026-27 season (see Section 3.4 below and Chapter 4).

The exceptions to this timescale are the redevelopment of the hangar which will extend into the 2028-29 and 2029-30 seasons (with internal fit out work undertaken during the 2029 winter), and the trial of the ground mounted solar panel arrays, which will be constructed and commissioned over the next two seasons, but the trial itself will extend until the 2029-30 season.

The 2028-29 and 2029-30 seasons will also be used for addressing any defects that may be identified in all of the planned work under consideration in the EIA.

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In reviewing the actual or potential cumulative impacts of the planned infrastructure work, the temporal and spatial scopes also have been expanded to allow consideration to be given to the impacts of the current planned works alongside the impacts of the broader programme of infrastructure development at Rothera over a longer time frame as well as alongside the increasing levels of human activities throughout the Antarctic Peninsula region (see Section 6.7.).

3.4. ACTIVITIES THAT ARE INCLUDED IN THE IMPACT ASSESSMENT

The AIMP covers a range of infrastructure development initiatives that have been or are being planned over several years. Prioritisation of the work is based on multiple factors including operational requirements, safety and environmental factors, budget and science planning.

It is not feasible to attempt to undertake a single EIA for all AIMP activities given the duration and sequencing of the work and the fact that the various projects are planned to varying levels of detail at any one time. However, to the extent possible, projects that will take place within a certain timeframe and for which planning has sufficiently progressed are grouped together within a single impact assessment.

Within the spatial and temporal scopes outlined above, this EIA assesses the actual or potential environmental consequences arising from:

- resurfacing the wharf at Rothera with additional processed aggregate to respond to the emergence of a number of potholes due to subsidence and the settling of aggregate into the substructure of the wharf;
- installing two subsurface fuel lines from the wharf to the fuel farm and a fuel-reel bunker station on the wharf, so as to improve the efficiency of refuelling the station and remove the use of temporary hoses and fuel lines;
- mounting a series of solar panels on target buildings, establishing a trial ground-mounted photovoltaic system in the vicinity of the aircraft hangar and installing a battery energy storage system in a dedicated building;
- redeveloping the aircraft hangar and associated works including investigations on the condition of the current hangar, diverting a meltwater drainage ditch, establishing a graded roadway, relocating aircraft tie downs, relocating a lighting kiosk, establishing a crane pad and establishing a temporary hangar.
- removing a disused concrete mooring bollard;
- removing a number of old fuel pipes and a disused refuelling hut;
- tasks in support of the maintenance of the runway, including replenishing the stockpile of graded rock material that is used for runway surface repairs and replacing stainless steel cases around the runway lighting electrical cabinets;
- creation of a slipway to provide boating access to North Cove;
- digging soil pits and sampling for a ground contamination assessment around the hangar and fuel farm area.

In addition, and in keeping with the practice established in earlier infrastructure EIAs, the following support activities that are generic to most construction projects are also included with the scope of this assessment:

- Shipping Cargo to and from Rothera;
- Transport of Personnel to and from Rothera;
- Provision of accommodation, power and domestic services to construction personnel;
- Site Set-Up and Presence of Personnel;
- Fuel Management and Refuelling;
- Vehicle movements across Rothera;
- Waste management.

All of the above activities are described in more detail in Chapter 4.

3.5. ACTIVITIES THAT ARE EXCLUDED FROM THE IMPACT ASSESSMENT

As noted above, the AIMP encompasses a range of infrastructure development projects over multiple seasons. Some of these have been subject to earlier impact assessments (see Section 1.4) and others have not yet been sufficiently developed to enable an assessment of their impacts realistically to be undertaken. For this reason, those projects that have yet to be confirmed have been excluded from this EIA and will be grouped into future EIAs as planning progresses.

Routine activities that are considered 'business as usual' for the ongoing operation and maintenance of Rothera as well as scientific research at, or supported from Rothera, also have been excluded from the scope of this impact assessment.

4. Description of the Planned Activities

4.1. INTRODUCTION

This Chapter of the EIA sets out the background to and the details of the planned work for each of the AIMP and BAS Estates projects. In describing the work that will be undertaken, this Chapter also identifies the environmental aspects that will or may arise from each of the projects. An aspect is a physical change (*e.g.,* movement of sediments by vehicle passage or noise) or an entity (*e.g.,* emissions, an introduced species) imposed on or released to the environment as the result of an action or an activity and which may lead to an impact (EIA Guidelines, 2026).

The EIA process also needs to consider options and alternatives that have the potential to eliminate or reduce the potential impacts on the Antarctic environment.

Examples of alternatives may include the use of different locations or sites for the activity; the use of different technologies to reduce the outputs (or the intensity of the outputs) of the activity, and a different timing for undertaking the activity (*e.g.,* to avoid the main part of the breeding season).

The alternative of not proceeding with the proposed activity should always be included in any analysis of environmental impacts of the proposed activity (EIA Guidelines, 2026).

Alternatives that have been considered for each of the projects are included in this Chapter.

4.1.1. OVERVIEW OF PLANNED WORK

The planned work for the 2026-27 season through to the 2029-30 season comprises four main projects and several ancillary projects.

The main projects are:

- The resurfacing of the wharf to remove a series of potholes (Section 4.2.);
- The installation of fixed fuel pipelines between the wharf and the fuel farm coupled with the installation of a hose reel bunker station on the wharf (Section 4.3.);
- The installation of a series of solar panels on several buildings as well as two, trial, ground-mounted solar panel arrays, coupled with the installation of a battery energy storage system (Section 4.4.);
- The construction of a new aircraft hangar and associated works (Section 4.5.).

The ancillary projects are:

- The removal of a disused concrete mooring bollard (Section 4.6.);
- The removal of a disused refueling hut as well as the removal of some old fuel pipelines (Section 4.7.);
- Runway maintenance work including replacement of stainless-steel covers on the runway lighting electrical cabinets and the topping up of the stockpile of graded rock material that is used for runway resurfacing (Section 4.8.);
- Establishment of a slipway to provide boating access to North Cove (Section 4.9.);

- Ground contamination assessment at key locations within the Station boundaries (Section 4.10.);
- Preparatory work for the aircraft hangar redevelopment (Section 4.5.);
- Rock processing and stockpiling in support of multiple projects (Section 4.11.).

The aspects arising from transporting construction workers to and accommodating them at Rothera are considered in Section 4.12.

4.2. WHARF RESURFACING

4.2.1. BACKGROUND

A wharf was first established at Rothera in the early 1990s. This was rebuilt and extended to a width of 76m during the 2018-19 and 2019-20 austral summer seasons so as to facilitate safe operations of the then new *Royal Research Ship Sir David Attenborough* (SDA); a much larger vessel than those it replaced (*Figure 5*).

On completion the wharf had a predicted useful lifespan of at least 25 years. The construction of the new wharf was subject to a comprehensive environmental evaluation, the final version of which was published, and circulated internationally in September 2018.



Figure 5. The RRS Sir David Attenborough alongside the new Rothera wharf. Source: BAS

The new wharf was constructed from a series of steel frames sitting between an outer sheet piled wall, a tubular pile mid wall and a sheet piled anchor wall. 65,000 – 80,000 tonnes (24,000 - 30,000m^3) of locally derived and graded rock fill was placed between the piled walls and built up to create the wharf surface.

Over the last five years, potentially as a result of settlement of the graded rock infill, several potholes have appeared on the wharf (*Figure 6*). These pose an operational as well as a safety risk for vehicles and personnel working on the wharf.

To address this issue, the wharf will need resurfacing with additional processed aggregate so as to eliminate the holes and provide a flat and reliable surface for ongoing operations.

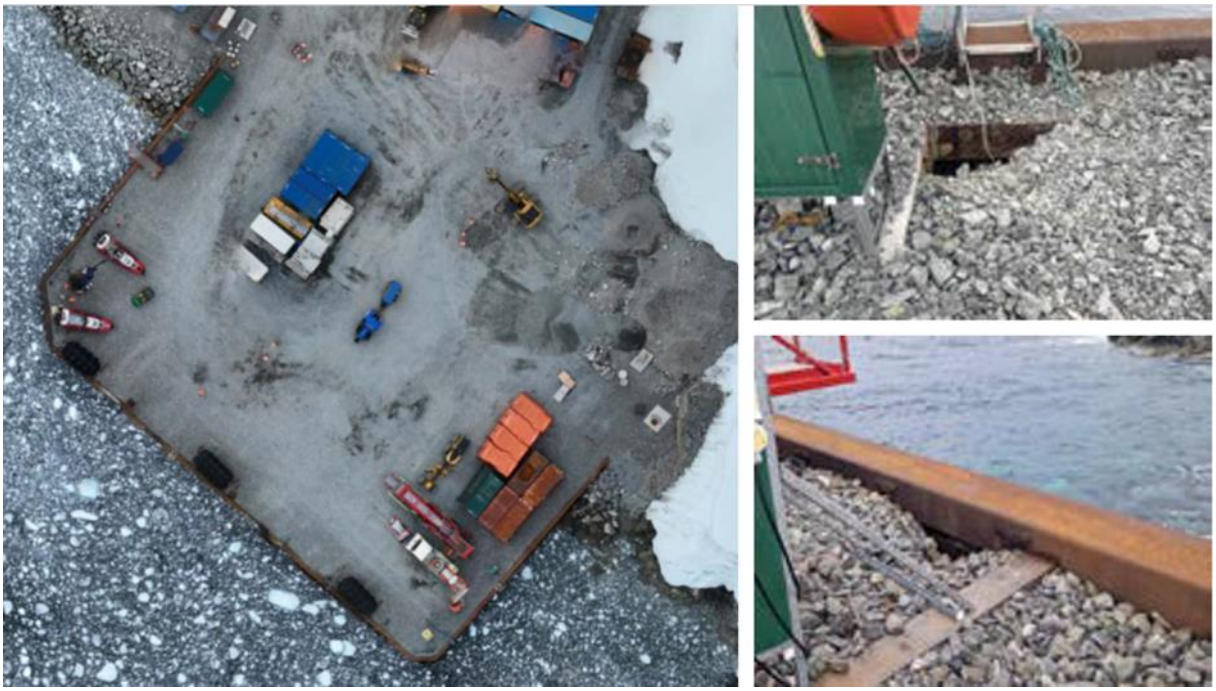


Figure 6. Rothera wharf and insets showing emerging potholes. Source: BAS

4.2.2. Alternatives considered

There are few alternatives available for addressing the potholes, though the following were considered:

4.2.2.1. Do nothing

Doing nothing would avoid the actual or potential impacts identified in this EIA. However, the uneven wharf surface would remain, as would the safety risks to vehicles and personnel operating in the area. Further, it is anticipated that the potholes may become more pronounced over time with additional voids appearing.

Doing nothing was therefore rejected in favour of removing the operational and safety risks and providing a longer-term solution.

4.2.2.2. DO MINIMUM

The minimum amount of work needed could be undertaken. This would involve filling the existing voids that have appeared in the wharf surface with graded fill material. This would have the advantage of, at least temporarily removing the operational and safety risks and eliminating or reducing the actual or potential impacts from more extensive works.

However, this approach may not fully resolve the underlying subsidence problem, and an ongoing maintenance regime would need to be developed, and resources would need to be routinely allocated to support this.

Some rock processing would still be required for this option, but this carries the additional risk of different grades of surface material across the wharf surface resulting in a non-uniform surface which is not ideal for an active work site.

For these reasons, the do minimum option was rejected in favour of a full resurfacing of the wharf.

4.2.2.3. USE GEOTEXTILES

Consideration was given to using geotextile material. Geotextiles are permeable synthetic fabrics used in civil engineering and construction for separation, filtration, drainage, and reinforcement. They can be used to stabilize soft ground, prevent soil layers from mixing, and control erosion in infrastructure projects.

However, this option was rejected due to the limited appetite for introducing artificial material into the environment where not absolutely necessary, with the risk of further release of fibres of artificial materials, as well as presenting future decommissioning challenges.

The planned approach is instead to use a soil plug, an intermediary size of fill between a finer grade and a larger grade of fill that prevents them from mixing (see below). As a result, introduction of geotextiles to the wharf were deemed not necessary.

4.2.3. PLANNED WORK – THE PREFERRED APPROACH

The preferred approach is to resurface the entire wharf over the area shaded orange in *Figure 7*.

This will be achieved by excavating the current wharf surface to a depth of 700mm below the current surface and replacing the removed material with fill of a finer grade (30mm – 80mm). The finer graded material will be obtained by crushing the material removed from the wharf surface.

As noted above, a 'soil plug' system will be used. The soil plug will be constructed using aggregate already available at Rothera, forming an engineered barrier that limits the ability for fines to migrate down into the wharf structure. While there is a risk this barrier may degrade over time, the wharf is an exposed surface which can be managed through routine monitoring and maintenance.

Returning the excavated material at a finer grade will reduce the overall volume and additional, graded material will be required to bring the wharf surface back to the desired height. The additional material will be sourced from stockpiled rock that has been previously claimed from local rock adjacent to the wharf (*Figure 7*). This will be crushed to the same grade. The calculated additional fill that will be needed from stockpiled material is 1,685 tonne or 937m^3 (see calculations in Text Box 1).

The current surface of the wharf will be removed using an excavator and stockpiled prior to grading. The removed and additional rock material will be crushed to the required grade by using a jaw crusher and/or a cone crusher and screener (see Section 4.11.), prior to resurfacing the wharf using the excavator and a dozer (*Figure 8*).

It is emphasised that all aggregate will be derived from locally sourced material. No aggregate will be imported.

As the resurfacing progresses the new fill material will be compacted using a vibrating roller.

A dump truck will be used to transport material between the wharf and the crushing / screening area.

Early morning or late evening work may require the use of artificial lighting, particularly so in the earlier and later parts of the season.

Text Box 1. Volume calculations for wharf resurfacing.

Volume of materials for 700mm removal, re-crushing and return:
Total Area = 5,350m^2
Volume excavated = 5,350m^2 x 0.7m = 3,745m^3
Tonnage (assuming 1.5t / m^3) = 5,618t
Post crushing volume (assuming 1.8t / m^3 for denser material) = 3,121m^3
Depth achieved from returned fill = 3,121 / 5350m^2 = 583mm depth (minus 10% loss) = 525mm

Volume of additional material required:
Additional fill needed to fill a depth of 175mm
Volume required = 5,350m^2 x 0.175m = 936.3m^3
Tonnage required (assuming 1.8t / m^3) = 1,685t

TOTAL volume to place back on the wharf: 3,121m^3 + 937m^3 = 4,058m^3
TOTAL tonnage to place back on the wharf: 5,618t + 1,685t = 7,303t

4.2.3.1. INTEGRITY TESTING

A series of tests will be performed as the resurfacing work is undertaken to confirm that the new surface meets the required specification. Test strips (measuring 10m x 5m) will be excavated up to 0.7m deep with an excavator. Suitable locations will be selected within the area of the wharf due for resurfacing. Aggregate will be placed in the excavations in layers made up of different size aggregate. Each layer will be compacted with a wacker plate or a bomag roller. A series of density tests and moisture tests will be completed on the areas to confirm the specifications. The tests will consist of Lightweight deflectometer, Particle size tests, moisture content, and sand replacement testing. The specifications or aggregate size may be adjusted subject to the results of the testing.

Compaction testing and plate bearing testing will be undertaken at required intervals. Compaction testing involves manually taking a sample core of the ground to test for density of the material. The sample is returned *in situ* after the test.

Bearing testing is a non-destructive test that uses a force pushing a plate onto the wharf to determine hardness of the compacted material. This will be undertaken at various points across the wharf and at various times of the season (*i.e.,* early season, melt, mid-season and onset of winter).

Moisture content and particle size distribution tests will be performed across the wharf surface. This involves soaking a sample of the new surface in water, baking the aggregate and then weighing it. Approximately 100 of these tests will be performed.

Light Weight Deflectometer testing. This is a non-intrusive method for measuring the stiffness or deformation response of aggregate. A falling weight is used to apply a short-duration dynamic load to the aggregate surface. The instrument measures the resulting surface deflection which is used to assess whether the material has been compacted adequately and whether it has sufficient bearing capacity for the intended use. Approximately 225 of these tests will be performed across the new wharf surface.

Sand replacement testing involves digging a small hole by hand in the newly laid aggregate then filling the hole with sand and taking weights of the sand and removed aggregate to determine the density of the aggregate. The information gained is used to inform the extent of further compaction that may be required. Approximately 50 of these tests will be performed across the wharf. For this test kiln dried sand will need to be imported to Rothera.

Whilst the sand will be removed as far as reasonably practicable after the testing and disposed of in a controlled manner, it is inevitable that small quantities of sand will remain in the holes after testing.

For most of these tests, no environmental aspects have been identified. The one exception to this is the importation of sand. The testing will result in the release (albeit very small quantities) of introduced geological material into the environment. The importation of the sand also carries an element of risk of introducing non-native species. However, kiln dried sand will be used for this testing (and indeed is crucial for the testing itself) which is devoid of organic material.[4]

[4] Kiln dried sand is a very fine, specially processed silica sand that contains absolute zero moisture. Organic material is removed from the sand during the pre-wash and kiln drying stages of preparation. Kiln drying occurs at temperatures between 100°C and 200°C. While the primary goal of kiln drying is evaporating water, this intense heat thoroughly destroys organic matter.



Figure 7. Rothera wharf will be resurfaced over the area shaded in orange. Source: BAM Nuttall.



Figure 8. Excavators in use on the original Biscoe wharf at Rothera, January 2019. Source: BAS.

4.2.3.2. SCHEDULE

The resurfacing work is estimated to start in late December 2026 and take 6 to 7 weeks to complete, inclusive of site set-up and demobilisation.

The additional graded material that is required (see Text Box 1) will be prepared during the earlier part of the season when the rock crusher and screener will be used to prepare graded material for all of the projects covered by this EIA that require it (see Section 4.11).

4.2.3.3. PERSONNEL AND EQUIPMENT

The work will be undertaken by BAM. In addition to the rock crushing and screening plant, the following personnel and equipment are expected to be required for the wharf resurfacing work:

Personnel:

- 1 x Engineer
- 1 x Rock Processing Manager
- 4 x Plant Operators
- 2 x Plant Mechanics

Plant and equipment:

- 1 x Loading Shovel
- 1 x Vibrating roller
- 1 x 36T Excavator
- 1 x Dozer
- 1 x Articulated Dump Truck

4.2.3.4. ANTICIPATED FUEL USE

The anticipated volumes of fuel required for the wharf resurfacing are shown in *Table 1*.

Table 1. Anticipated fuel volume required for the wharf resurfacing based on a six-day working week and a 10-hour working day.

Plant Name	Duration (weeks)	Est. Fuel Consumption (l/ hr)	Total Fuel Consumption litres (10 hr days)
Jaw Crusher	2	28.2	3,384
Cone Crusher	2	20.7	2,481
Screener	3	12.7	2,286
Loading shovel	5	12.1	3,630
Roller	3	6.1	1,099
Excavator (36T)	6	23.1	8,326
Dozer	3	12.7	2,314
ADT	6	8.5	3,060
		TOTAL	26,853

4.2.4. ENVIRONMENTAL ASPECTS

The aspects from resurfacing the wharf that will or may interact with the environment are identified as (see also *Figure 9*):

Normal operations

- **Emissions of dust** from excavating the existing wharf surface, crushing and grading the rock and fill material to the required size and relaying the graded material back on to the wharf;
- **Emissions of exhaust gases and heat** from burning fossil fuels in vehicles used to support the wharf resurfacing works;
- **Emissions of noise and the potential propagation of noise to the local marine environment** from the excavation and resurfacing work and the use of machinery on the wharf;
- **Ground borne vibrations and the potential propagation of sub-audible vibrations to the local marine environment** arising from the excavation, backfilling and compaction of the fill material;
- **Mechanical action** on ice-free ground due to excavation and resurfacing, vehicle movements, rock stockpiling;
- **Light emissions,** if artificial lighting rigs are required;
- **The release of imported geological material (kiln dried sand) into the environment.**

Unplanned or emergency situations

- The risk of **fuel spills to the terrestrial and local marine environment** because of an emergency event on a vehicle (e.g. hydraulic hose failure) or during the refuelling of vehicles;
- The risk of **accidental release of fines or graded material to the local marine environment** during the excavation and resurfacing works;
- The importation of kiln dried sand may carry a degree of risk of **importing non-native species**.

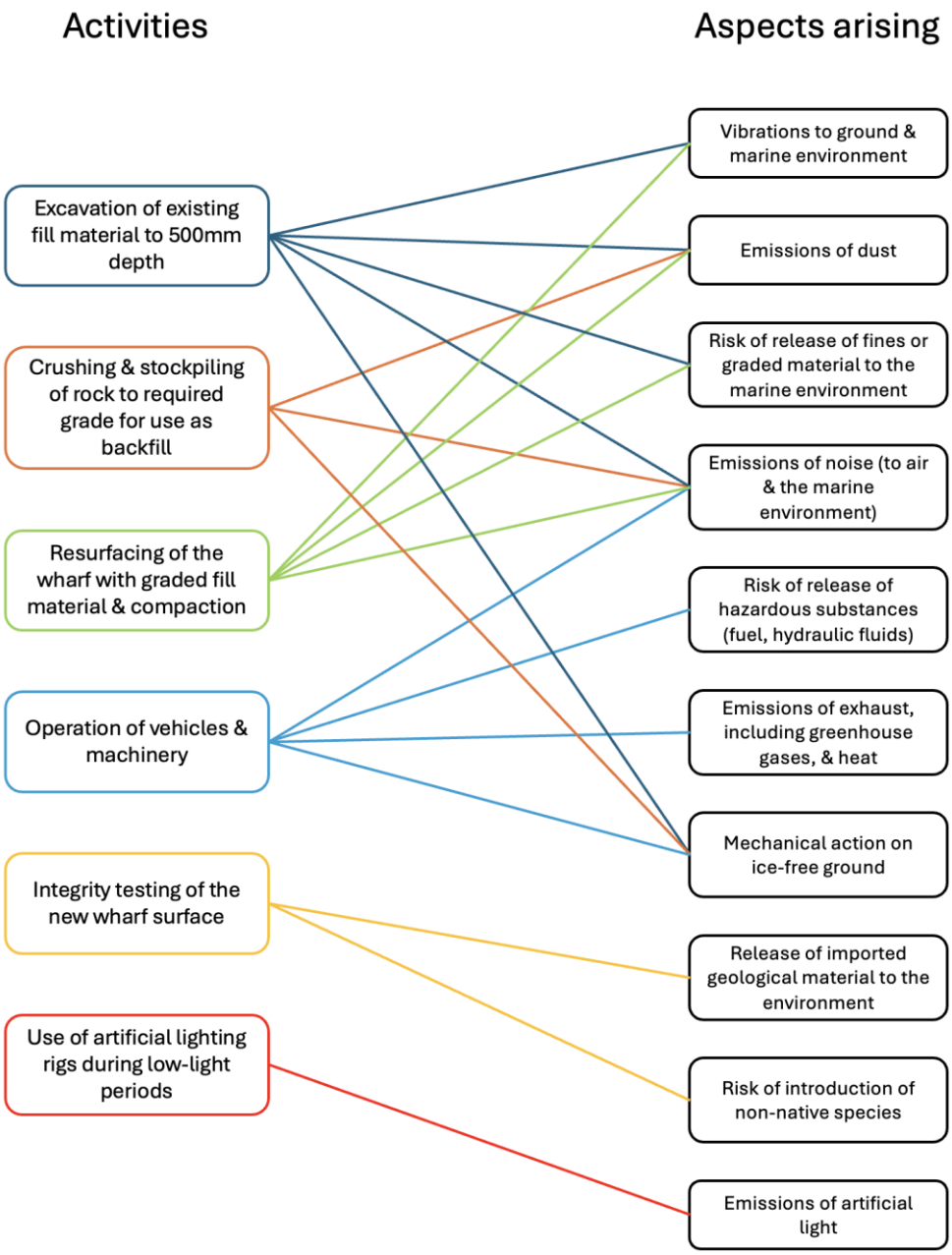


Figure 9. Diagrammatic overview of the aspects arising from the wharf resurfacing work.

4.2.5. Decommissioning

The resurfacing of the wharf is not considered to be an activity that in and of itself requires a decommissioning plan. At some future point it may be necessary to decommission the wharf as a whole. This was addressed in the CEE prepared by BAS (refer section 3.12 of the Final CEE), which recorded that the wharf could be deconstructed by reversing the construction process. The impacts arising from any deconstruction would need to be considered by means of separate EIA at the time.

4.3. FUEL PIPELINES INSTALLATION

4.3.1. BACKGROUND

During refuelling of Rothera station, fuel needs to be pumped from the resupply ship at the wharf at the southern end of the station, to the fuel farm which is adjacent to the Hangar on the northern side of the station (*Figure 10*).

Current practice requires a flexible fuel hose to be run from the ship to the fuel farm with multiple connection points (*Figure 11*). This is a labour and time intensive process. Refuelling can take up to 24 hours and requires at least 12 station staff to lay out and recover the hose, constantly walk the fuel line checking for leaks, monitor the levels at the fuel farm and manage the cleaning of the fuel line once refuelling is complete.

It is noted that fixed fuel lines had been previously installed at Rothera, but these were (mostly) removed during the wharf construction works (refer Section 4.3.3.4.).

To improve the efficiency of refuelling the station and to reduce the risk of spills, it is proposed to re-establish two below-ground fixed fuel lines from the wharf to the fuel farm; one dedicated to Marine Gas Oil (MGO) and one to aviation fuel.

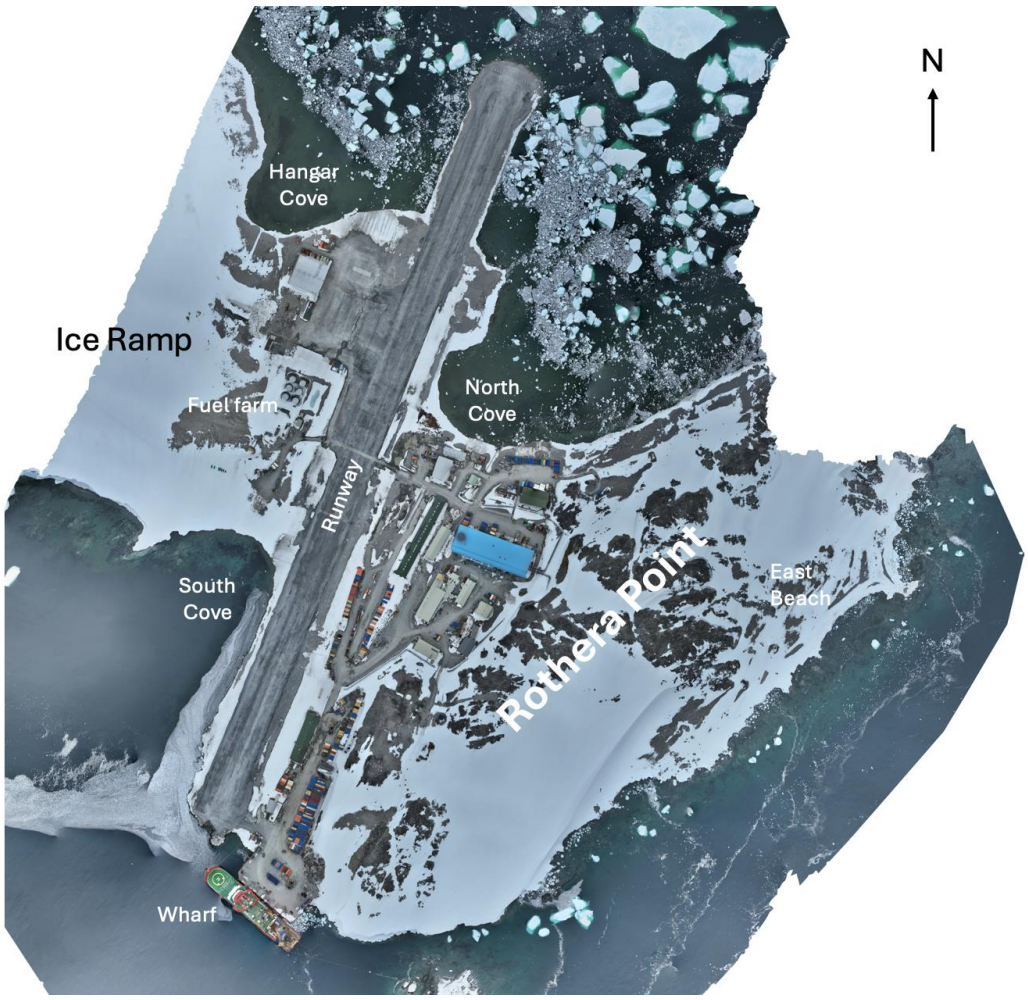


Figure 10. Aerial image of Rothera showing the location of the wharf and the fuel farm. Source: BAS



Figure 11. Current refuelling procedures requires a flexible hose to be run from the ship to the fuel farm. Source: Steph Walsh / BAS

4.3.2. Alternatives considered

4.3.2.1. Do Nothing

Taking no action to address refuelling practices would remove the impacts identified in this EIA. However, the operational inefficiencies and environmental risks (from potential fuel spills) would remain if current practice is retained.

In this case, doing nothing potentially undermines the ability to reduce environmental risk given the ongoing potential for spills to occur from the current practice of using flexible hosing with multiple connection points.

Accordingly, the 'do nothing' option was rejected in favour of upgrading the refuelling infrastructure.

4.3.2.2. Install pipelines above ground

In theory the new pipelines could be installed above ground, either by laying them directly on the ground or raising them slightly above the ground on stanchions. This would avoid the need to dig a trench and potentially reduce the time involved in installing the pipelines.

These options were rejected for three reasons. Firstly, the pipelines will need to be buried at some point anyway in order to transit across the runway. Secondly, above-ground pipelines pose a risk of damage from the multiple ground vehicles that move around the station, not least at times of snow clearing. Thirdly, raised pipelines adjacent to the runway present a significant safety hazard to air operations.

For these reasons this option was rejected in favour of burying the pipelines.

4.3.2.3. PIPELINE DESIGN

A range of alternative pipe materials and systems were considered, including welded carbon steel and plastic pipework. However, the options that were considered did not provide dual containment nor integrated leak detection, and in some cases introduced additional installation and durability risks.

Further, the selected system is already proven at Rothera as part of the site-wide services (SWS) project[5].

For these reasons the selected pipeline type, which is described in Section 4.3.3.2., was preferred.

4.3.2.4. ALTERNATIVE LOCATIONS FOR THE FUEL-REEL BUNKER STATION

A fuel-reel bunker station (FRBS) will be installed on the wharf. The FRBS is a modified 20-foot shipping container incorporating a length of flexible fuel hose on a reel (*Figure 12*). This length of hose is reeled out at times of refuelling to make the final connection between the fixed fuel lines and the ship alongside the wharf.

Options for locating the FRBS are shown in *Figure 13*. The preferred location in turn influences the routing of the below ground pipelines as shown by the red or green dotted lines in *Figure 13*.

While both options were considered viable in principle, stakeholder feedback demonstrated a clear and consistent preference for a location on the eastern side of the wharf (the green option in *Figure 13*). This location was assessed as providing the most robust balance of operational efficiency, safety, environmental protection and long-term compliance.

The eastern location offers shorter and more direct hose runs to the ship, which reduces manual handling and minimises interaction with cargo operations, vehicles and pedestrian movements. It also supports simultaneous refuelling and boating operations without materially constraining use of the crane on the western side of the wharf, thereby preserving operational flexibility.

From a safety and environmental perspective, the eastern location places fuel infrastructure further from the saltwater intake (for the Station's reverse osmosis plant). Air Operations feedback also supports this option, as it sits well outside of the Runway Protection Area.

Given this preference, an alternative route for the pipeline than the one shown in *Figure 13* has been identified. The final routing for the pipelines is described in Section 4.3.3.1. below.

[5] The AIMP includes a suite of site-wide services, such as a distribution network of hot water, seawater and fuel pipework, data and power cables. The pipework that has been selected for the new fuel line is already in use at Rothera as part of these site wide services.

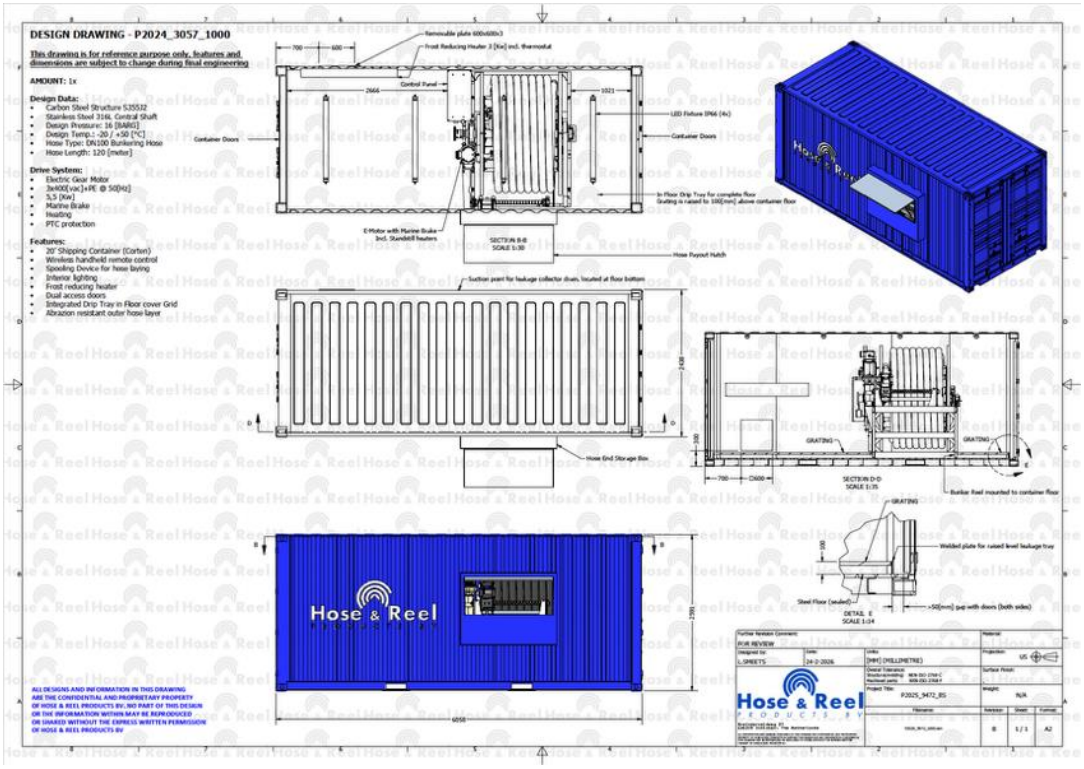


Figure 12. Example of a containerised fuel reel bunker station. Source: Hose & Reel provided by BAS.



Figure 13. Options for siting the bunker station container (red or green blocks). The selection of the 'green' location for the fuel-reel bunker station has allowed for an alteration in the pipelines routing to that shown in this image. The pink block shows the location of a waste incinerator that has now been installed. Source: BAM Nuttall.

4.3.3. PLANNED WORK – THE PREFERRED APPROACH

Installation of the fixed fuel pipelines is planned for the 2026-27 season. Commencement of the work is dependent upon the arrival of pipeline and ductwork materials as part of cargo during the first ship call of the season. Works are programmed to align with wharf resurfacing activities, enabling the efficient sharing of plant, resources and logistics.

4.3.3.1. PIPELINE ROUTE

There are few options available for the routing of the fixed pipelines as they must tie into the fuel farm and utilise the previously installed runway crossing.

From the FRBS on the Wharf the pipelines will run to the east of the Gerritsz Laboratory until they reach the site-wide services crossing point where they will turn west. They will then turn north again to run parallel to the runway until they reach the runway crossing point to the east of Admirals House.

On the western side of the runway crossing point the pipelines will again run parallel to the runway before turning west and connecting in to the fuel farm (*Figure 14*).



Figure 14. Aerial view of Rothera Station showing the proposed route for the underground fuel pipeline (red line) – not to scale. SWS = site wide services. Source: BAS.

4.3.3.2. PIPELINE DESIGN

The system has been designed to minimise the number of joints or couplings, following a philosophy that all fixed infrastructure should be permanent and fully closed, with the only operational connections made at the supply vessel.

The pipeline system itself is a Brugg Flexwell Safety Pipe system. The pipeline is specially designed for the underground transport of flammable, water-hazardous fluids. It comprises a double walled structure consisting of a corrugated stainless steel inner medium pipe, a reinforcing band and a corrugated outer containment pipe made of stainless steel. External corrosion protection is provided by a polyethylene casing covering the outer pipe. The annular gap between the inner and outer pipes can be permanently monitored by means of suitable leak detectors (*Figure 15*).

The selected pipeline has an outer diameter of 134mm and an internal diameter of 98mm.



Figure 15. Overview of the Brugg Flexwell Safety Pipe system. Source: Brugg Pipes

The surveillance space between the inner and outer pipes is permanently monitored by means of positive or negative pressure leak detectors. Leak detection display panels will be installed in the FRBS and the Polishing Hut.

Given the short duration of bunkering operations each season, insulation and heat tracing are not required. The pipelines will be evacuated of fuel once refuelling has been completed by sending a foam plug (known as a 'pig') through the pipeline using compressed air to propel it (a process known as 'pigging').

4.3.3.3. INSTALLATION PROCESS

Installation will be undertaken in stages. Installation will commence at the wharf end of the planned route and the pipelines on the eastern side of the runway will be installed first. A continuous trench will be excavated using a 13T excavator. The trench will remain open, securely barriered and managed until pipeline installation is complete.

The trench will be dug to a depth of between 1.25m and 1.28m depending upon the location along the route.

Some of the excavated material will be transported by dump truck to the rock processing area adjacent to the wharf, graded using the jaw crusher (*Figure 49*) to the required specification (2mm to 30mm depending upon the location along the route) and returned to the trench to be used as fill when required.

Where the pipelines run parallel to the runway, they will be installed within protective ducts (drainage piping). All pipe pulling operations will be undertaken using certified winching equipment. Following initial pipe installation, specialist Brugg termination welding (where flange connections need to be made at the runway crossing points and at the FRBS) will be completed by qualified personnel in accordance with approved procedures.

Graded fill will be used to encase the pipelines and ducting and 'as dug' fill material will be used to reinstate the ground back to surface levels. The open trench will be backfilled once the pipelines have been pulled through and terminated within the runway crossing point chamber on the eastern side of the runway.

The runway crossing point chambers (P28 and P29) are already established as is the steel pipe that runs underneath the runway. The new fuel lines will 'plug' into these existing lines. However, the chambers do not have ducts for incoming services so new ones will need to be cored on the east face of chamber P29 and the west face of chamber P28.

Technical details of the design of the pipelines are shown in *Figure 16*.

A vibrating roller will be used to level and compact the backfill and to reinstate the ground to surrounding levels. Any trenching will result in excess material which will be processed and added to existing stockpiles.

Sections of the pipelines running adjacent to the rock crushing area (close to the wharf) will be protected through the installation of precast concrete floor slabs that were surplus to the Discovery Building project, these are to ensure resilience against any future rock blasting and heavy plant activity.

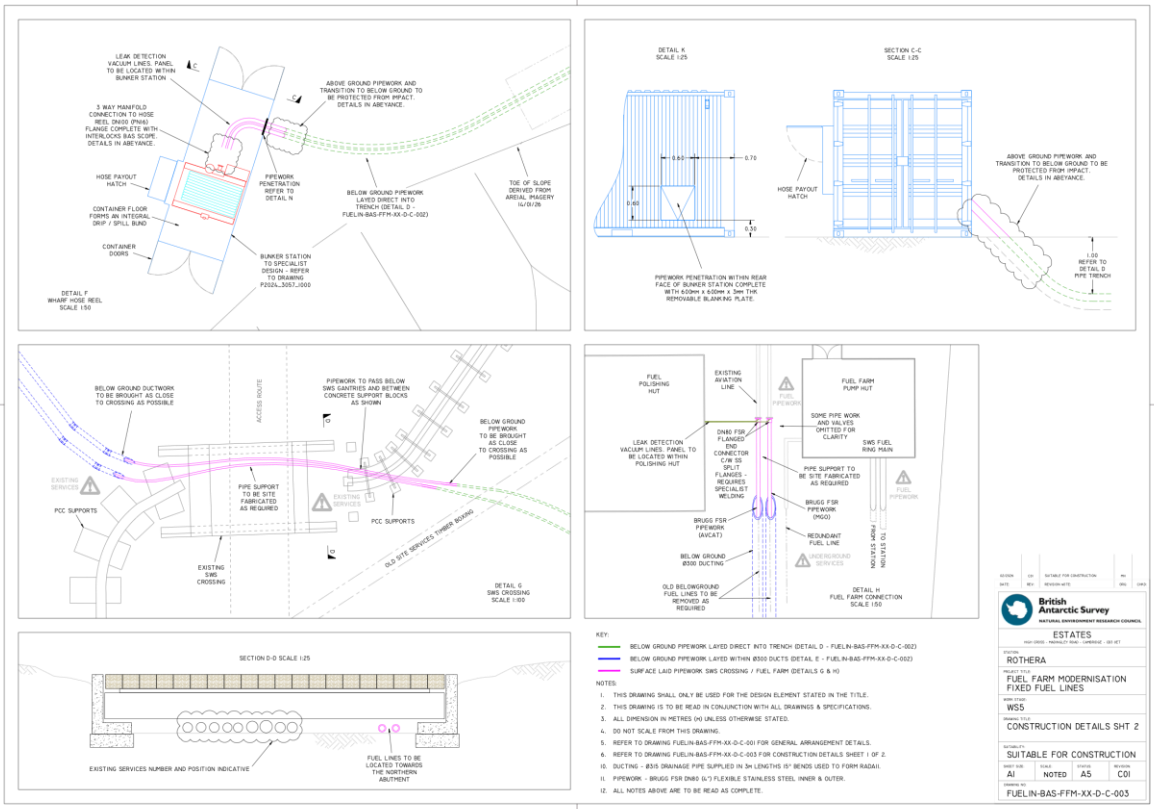
Following completion on the eastern side, works will move to the west side of the runway, where ducting and pipeline installation between the fuel farm and the western runway crossing point chamber will be undertaken under the same controlled approach.

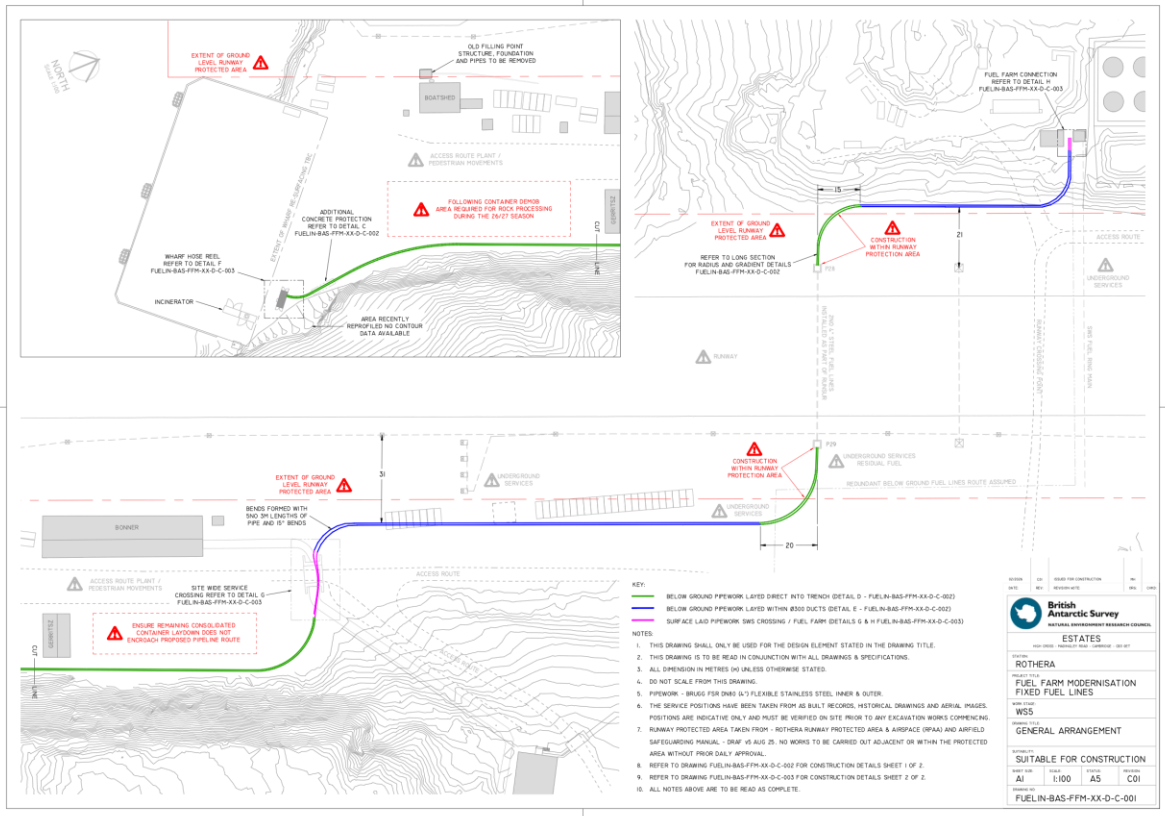
The FRBS will be installed on the wharf, and the pipelines connected in. Some minor ground preparation (levelling only) may be required prior to placing the hose-reel bunker station container.

All work within the runway protection area will necessitate no aircraft activity. A total of six and a half days work within the runway protection area is anticipated.

Pressure testing, mechanical completion, functional testing and commissioning of the pipelines will be undertaken by BAS. All quality assurance documentation, including compaction results, weld records, inspection reports and pressure test certificates, will be compiled within the project handover dossier.

Following successful commissioning, a joint inspection of reinstated areas by BAS Estates and Station Management will be completed prior to formal handover and demobilisation.


LEAK DETECTION VACUUM LINES. PANEL TO BE LOCATED WITHIN BUNKER STATION
ABOVE GROUND PIPEWORK AND TRANSITION TO BELOW GROUND TO BE PROTECTED FROM IMPACT. DETAILS IN ABEYANCE.
3 WAY MANIFOLD CONNECTION TO HOSE REEL DN100 (PN16) FLANGE COMPLETE WITH INTERLOCKS BAS SCOPE. DETAILS IN ABEYANCE.
HOSE PAYOUT HATCH
PIPEWORK PENETRATION REFER TO DETAIL N
BELOW GROUND PIPEWORK LAYED DIRECT INTO TRENCH (DETAIL D - FUELIN-BAS-FFM-XX-D-C-002)
TOE OF SLOPE DERIVED FROM AREIAL IMAGERY 16/09/26
CONTAINER FLOOR FORMS AN INTEGRAL DRIP / SPILL BUND
CONTAINER DOORS
BUNKER STATION TO SPECIALIST DESIGN - REFER TO DRAWING P2024_3057_1000
DETAIL F WHARF HOSE REEL SCALE 1:50
DETAIL K SCALE 1:25
SECTION C-C SCALE 1:25
HOSE PAYOUT HATCH
ABOVE GROUND PIPEWORK AND TRANSITION TO BELOW GROUND TO BE PROTECTED FROM IMPACT. DETAILS IN ABEYANCE.
PIPEWORK PENETRATION WITHIN REAR FACE OF BUNKER STATION COMPLETE WITH 650mm x 650mm x 5mm THK REMOVABLE BLANKING PLATE.
REFER TO DETAIL G PIPE TRENCH
BELOW GROUND DUCTWORK TO BE BROUGHT AS CLOSE TO CROSSING AS POSSIBLE
ACCESS ROUTE
PIPEWORK TO PASS BELOW SWS GANTRIES AND BETWEEN CONCRETE SUPPORT BLOCKS AS SHOWN
BELOW GROUND PIPEWORK TO BE BROUGHT AS CLOSE TO CROSSING AS POSSIBLE
EXISTING SERVICES
PCC SUPPORTS
PIPE SUPPORT TO BE SITE FABRICATED AS REQUIRED
EXISTING SERVICES
PCC SUPPORTS
OLD SITE SERVICES THRUST BOARD
EXISTING SWS CROSSING
DETAIL G SWS CROSSING SCALE 1:100
FUEL POLISHING HUT
EXISTING AVIATION LINE
FUEL FARM PUMP HUT
SOME PIPE WORK AND VALVES OMITTED FOR CLARITY
SWS FUEL RING MAIN
LEAK DETECTION VACUUM LINES. PANEL TO BE LOCATED WITHIN POLISHING HUT
DN80 FSR FLANGED END CONNECTOR C/W SS SPLIT FLANGES - REQUIRES SPECIALIST WELDING
PIPE SUPPORT TO BE SITE FABRICATED AS REQUIRED
BRUGG FSR PIPEWORK (HGO)
BRUGG FSR PIPEWORK (AVCAT)
REDUNDANT FUEL LINE
BELOW GROUND Ø300 DUCTING
OLD BELOWGROUND FUEL LINES TO BE REMOVED AS REQUIRED
TO SWS STATION
DETAIL H FUEL FARM CONNECTION SCALE 1:50
SECTION D-D SCALE 1:25
EXISTING SERVICES NUMBER AND POSITION INDICATIVE
FUEL LINES TO BE LOCATED TOWARDS THE NORTHERN ABUTMENT
KEY:
BELOW GROUND PIPEWORK LAYED DIRECT INTO TRENCH (DETAIL D - FUELIN-BAS-FFM-XX-D-C-002)
BELOW GROUND PIPEWORK LAYED WITHIN Ø300 DUCTS (DETAIL E - FUELIN-BAS-FFM-XX-D-C-002)
SURFACE LAID PIPEWORK SWS CROSSING / FUEL FARM (DETAILS G & H)
NOTES:
1. THIS DRAWING SHALL ONLY BE USED FOR THE DESIGN ELEMENT STATED IN THE TITLE.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL DRAWINGS & SPECIFICATIONS.
3. ALL DIMENSION IN METRES (M) UNLESS OTHERWISE STATED.
4. DO NOT SCALE FROM THIS DRAWING.
5. REFER TO DRAWING FUELIN-BAS-FFM-XX-D-C-001 FOR GENERAL ARRANGEMENT DETAILS.
6. REFER TO DRAWING FUELIN-BAS-FFM-XX-D-C-003 FOR CONSTRUCTION DETAILS SHEET 1 OF 2.
10. DUCTING - Ø315 DRAINAGE PIPE SUPPLIED IN 3m LENGTHS 15° BENDS USED TO FORM RADII.
11. PIPEWORK - BRUGG FSR DN80 (4.") FLEXIBLE STAINLESS STEEL INNER & OUTER.
12. ALL NOTES ABOVE ARE TO BE READ AS COMPLETE.
British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL
ESTATES
ROTHERA
FUEL FARM MODERNISATION FIXED FUEL LINES
WS5
CONSTRUCTION DETAILS SHT 2
SUITABLE FOR CONSTRUCTION
A1
NOTED
A5
C01
FUELIN-BAS-FFM-XX-D-C-003


NORTH
EXTENT OF GROUND LEVEL RUNWAY PROTECTED AREA
OLD FILLING POINT STRUCTURE, FOUNDATION AND PIPES TO BE REMOVED
BOATSHED
ACCESS ROUTE PLANT / PEDESTRIAN MOVEMENTS
FOLLOWING CONTAINER DEMOB AREA REQUIRED FOR ROCK PROCESSING DURING THE 26/27 SEASON
ADDITIONAL CONCRETE PROTECTION REFER TO DETAIL C FUELIN-BAS-FFM-XX-D-C-002
WHARF HOSE REEL REFER TO DETAIL F FUELIN-BAS-FFM-XX-D-C-003
INCINERATOR
AREA RECENTLY REPROFILED NO CONTOUR DATA AVAILABLE
FUEL FARM CONNECTION REFER TO DETAIL H FUELIN-BAS-FFM-XX-D-C-003
EXTENT OF GROUND LEVEL RUNWAY PROTECTED AREA
CONSTRUCTION WITHIN RUNWAY PROTECTION AREA
REFER TO LONG SECTION FOR RADIUS AND GRADIENT DETAILS FUELIN-BAS-FFM-XX-D-C-002
ACCESS ROUTE
UNDERGROUND SERVICES
RUNWAY
EXTENT OF GROUND LEVEL RUNWAY PROTECTED AREA
CONSTRUCTION WITHIN RUNWAY PROTECTION AREA
UNDERGROUND SERVICES RESIDUAL FUEL
REDUNDANT BELOW GROUND FUEL LINES ROUTE ASSUMED
BONNER
BENDS FORMED WITH 5NO 3M LENGTHS OF PIPE AND 15° BENDS
ACCESS ROUTE PLANT / PEDESTRIAN MOVEMENTS
SITE WIDE SERVICE CROSSING REFER TO DETAIL G FUELIN-BAS-FFM-XX-D-C-003
ENSURE REMAINING CONSOLIDATED CONTAINER LAYDOWN DOES NOT ENCROACH PROPOSED PIPELINE ROUTE
GENERATOR
KEY:
BELOW GROUND PIPEWORK LAYED DIRECT INTO TRENCH (DETAIL D - FUELIN-BAS-FFM-XX-D-C-002)
BELOW GROUND PIPEWORK LAYED WITHIN Ø300 DUCTS (DETAIL E - FUELIN-BAS-FFM-XX-D-C-002)
SURFACE LAID PIPEWORK SWS CROSSING / FUEL FARM (DETAILS G & H FUELIN-BAS-FFM-XX-D-C-003)
NOTES:
1. THIS DRAWING SHALL ONLY BE USED FOR THE DESIGN ELEMENT STATED IN THE DRAWING TITLE.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL DRAWINGS & SPECIFICATIONS.
3. ALL DIMENSION IN METRES (M) UNLESS OTHERWISE STATED.
4. DO NOT SCALE FROM THIS DRAWING.
5. PIPEWORK - BRUGG FSR DN80 (4.") FLEXIBLE STAINLESS STEEL INNER & OUTER.
6. THE SERVICE POSITIONS HAVE BEEN TAKEN FROM AS BUILT RECORDS, HISTORICAL DRAWINGS AND AERIAL IMAGES. POSITIONS ARE INDICATIVE ONLY AND MUST BE VERIFIED ON SITE PRIOR TO ANY EXCAVATION WORKS COMMENCING.
7. RUNWAY PROTECTED AREA TAKEN FROM - ROTHERA RUNWAY PROTECTED AREA & AIRSPACE (RPAA) AND AIRFIELD SAFEGUARDING MANUAL - DRAF v5 AUG 25. NO WORKS TO BE CARRIED OUT ADJACENT OR WITHIN THE PROTECTED AREA WITHOUT PRIOR DAILY APPROVAL.
8. REFER TO DRAWING FUELIN-BAS-FFM-XX-D-C-002 FOR CONSTRUCTION DETAILS SHEET 1 OF 2.
9. REFER TO DRAWING FUELIN-BAS-FFM-XX-D-C-003 FOR CONSTRUCTION DETAILS SHEET 2 OF 2.
10. ALL NOTES ABOVE ARE TO BE READ AS COMPLETE.
British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL
ESTATES
ROTHERA
FUEL FARM MODERNISATION FIXED FUEL LINES
WS5
GENERAL ARRANGEMENT
SUITABLE FOR CONSTRUCTION
A1
1:100
A5
C01
FUELIN-BAS-FFM-XX-D-C-001

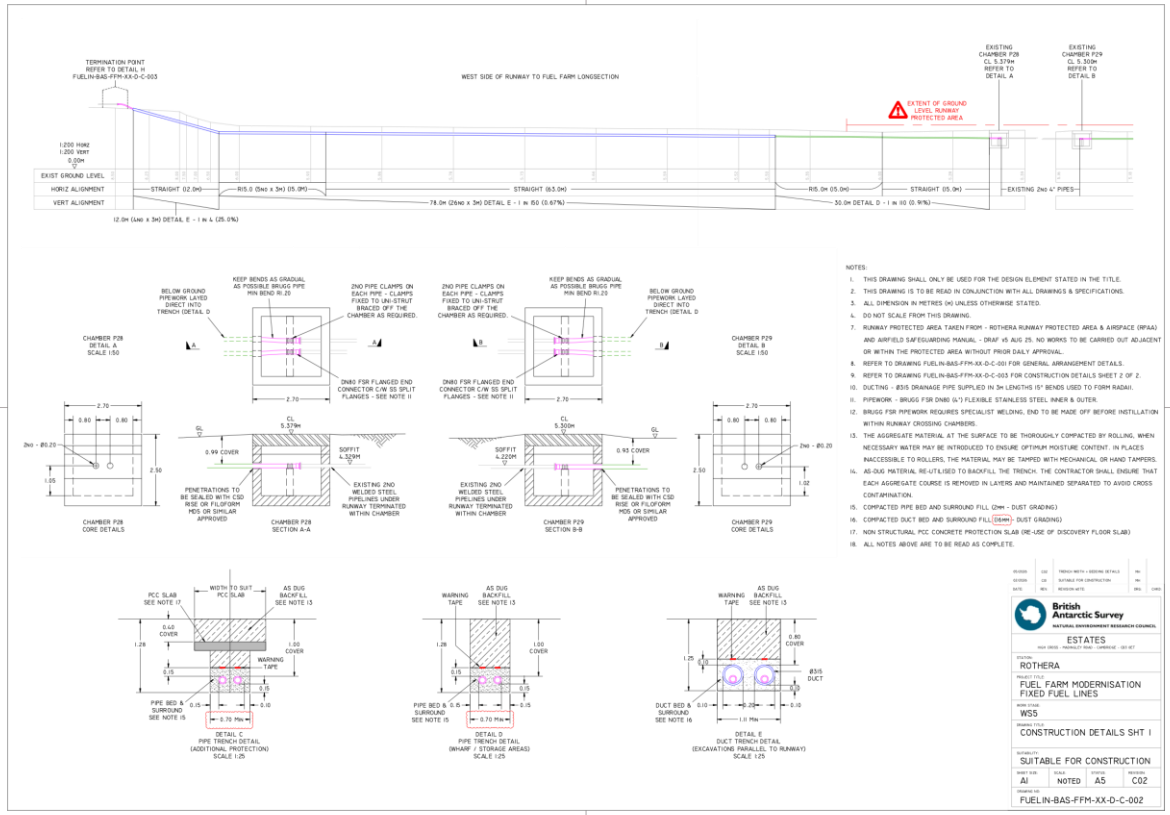


Figure 16. This page and previous page - Technical drawings of the pipeline route showing detail for road and runway crossing points. Source: BAS

4.3.3.4. RESIDUAL PIPES

The majority of the old fuel pipes have been removed from the ground and stockpiled prior to removal back to the UK. There are some residual subsurface sections that require removal; however, the full extent will only become clear during installation of the new pipelines. A plan will be developed to ship all of the redundant material north for recycling or disposal.

The total quantity of redundant fuel pipe is estimated to be approximately 500m of 4-inch pipework (approximately 8 tonnes).

4.3.3.5. SCHEDULE

The installation of the fuel pipelines is planned to be completed in the 2026-27 season.

The excavation and pipeline installation on the eastern side of the runway is scheduled for between late January and late March (following completion of the wharf resurfacing). The excavation and pipeline installation on the western side of the runway is scheduled for between late March and mid-May.

An overview of the current schedule is shown in *Figure 17*.

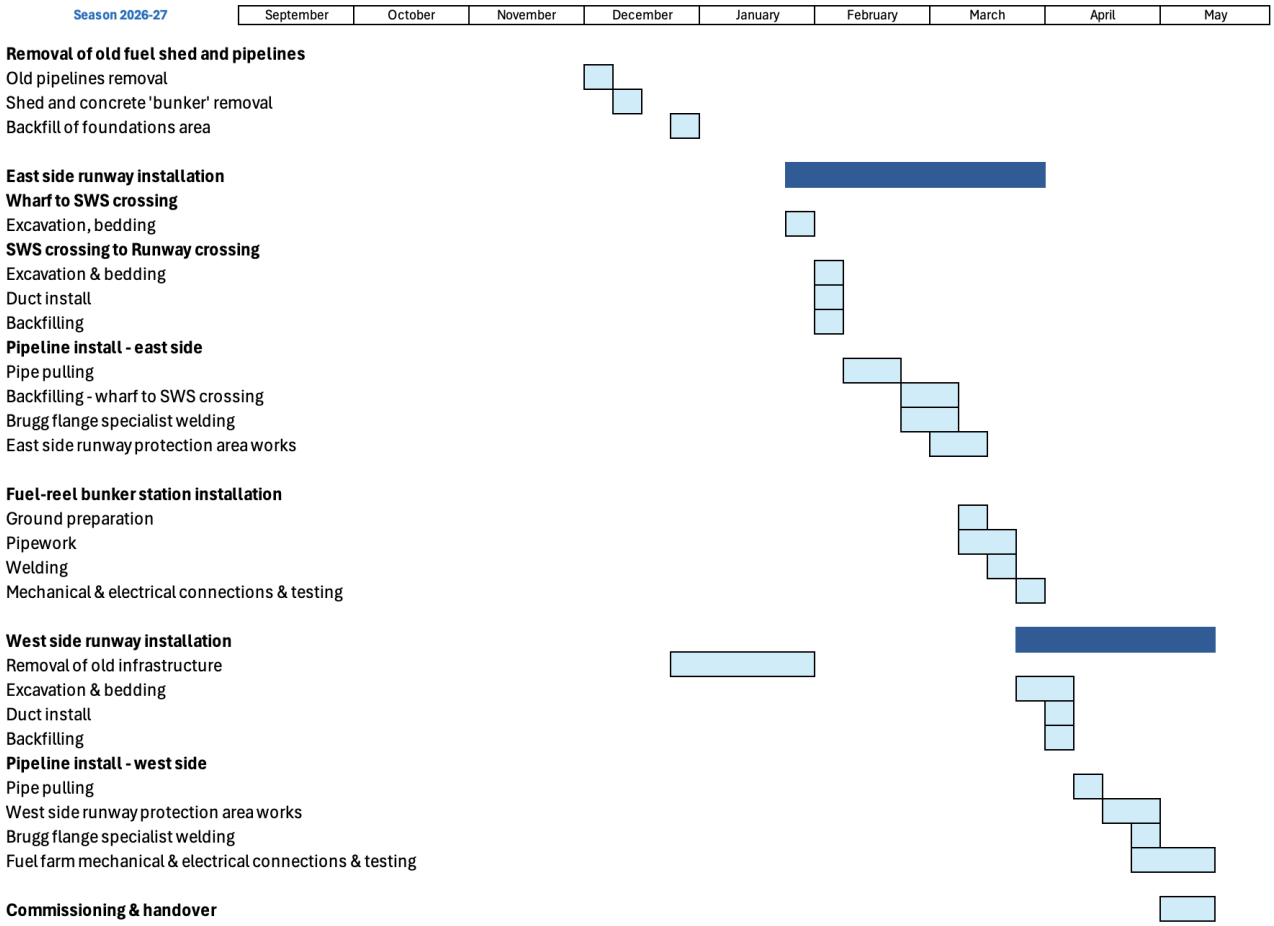


Figure 17. Approximate schedule of works for the pipelines installation. Removal of the old fuel shed, and pipelines is discussed in Section 4.6.

4.3.3.6. PERSONNEL AND EQUIPMENT

Work will be undertaken with a combination of six BAM and seven BAS Estates personnel. Key plant and Equipment that will be required includes:

- 13T Excavator
- Telehandler and trailer
- Vibrating roller
- TIG welding kit
- General mechanical and electrical hand tools

Early morning or late evening work may require the use of artificial lighting, particularly so in the earlier and later parts of the season.

4.3.4. ENVIRONMENTAL ASPECTS

The aspects arising from the installation of the fuel pipelines and the FRBS that will or may interact with the environment are identified as (see also *Figure 18*):

Normal operations

- Importation of materials (*i.e.,* the pipeline and the FRBS container) carries the risk of **introducing non-native species** to Rothera Point;
- **Mechanical action on and physical disturbance to** ice-free ground as a result of the digging of the trenches;
- **Emissions of dust**, arising from the excavation of the trenches, the crushing of excavated material to the required grade, the backfilling of the graded rock material into the trenches following the laying of the pipeline and concrete coring in the runway crossing chambers;
- **Emissions of exhaust gases and heat**, from burning fossil fuels in excavation vehicles and rock crushing equipment;
- **Noise emissions**, arising from the excavation, backfilling and compaction of the trenches, the use of crushing equipment for rock grading;
- **Ground borne vibrations,** arising from the excavation, backfilling and compaction of the trenches;
- **Light emissions,** if artificial lighting rigs are required;
- **Creation of waste materials**, from packaging, construction waste, old / disused piping that may be uncovered and coring the concrete chambers;
- **Establishment of new (visible) infrastructure** at Rothera point (*i.e.,* the FRBS) with potential implications for aesthetic or wilderness values.

Unplanned or emergency event

- The risk of **fuel spills to the terrestrial environment** because of an emergency event on a vehicle (*e.g.,* hydraulic hose failure) or when refuelling vehicles;
- Risk of **penguins or seals falling into open excavations** and becoming trapped.

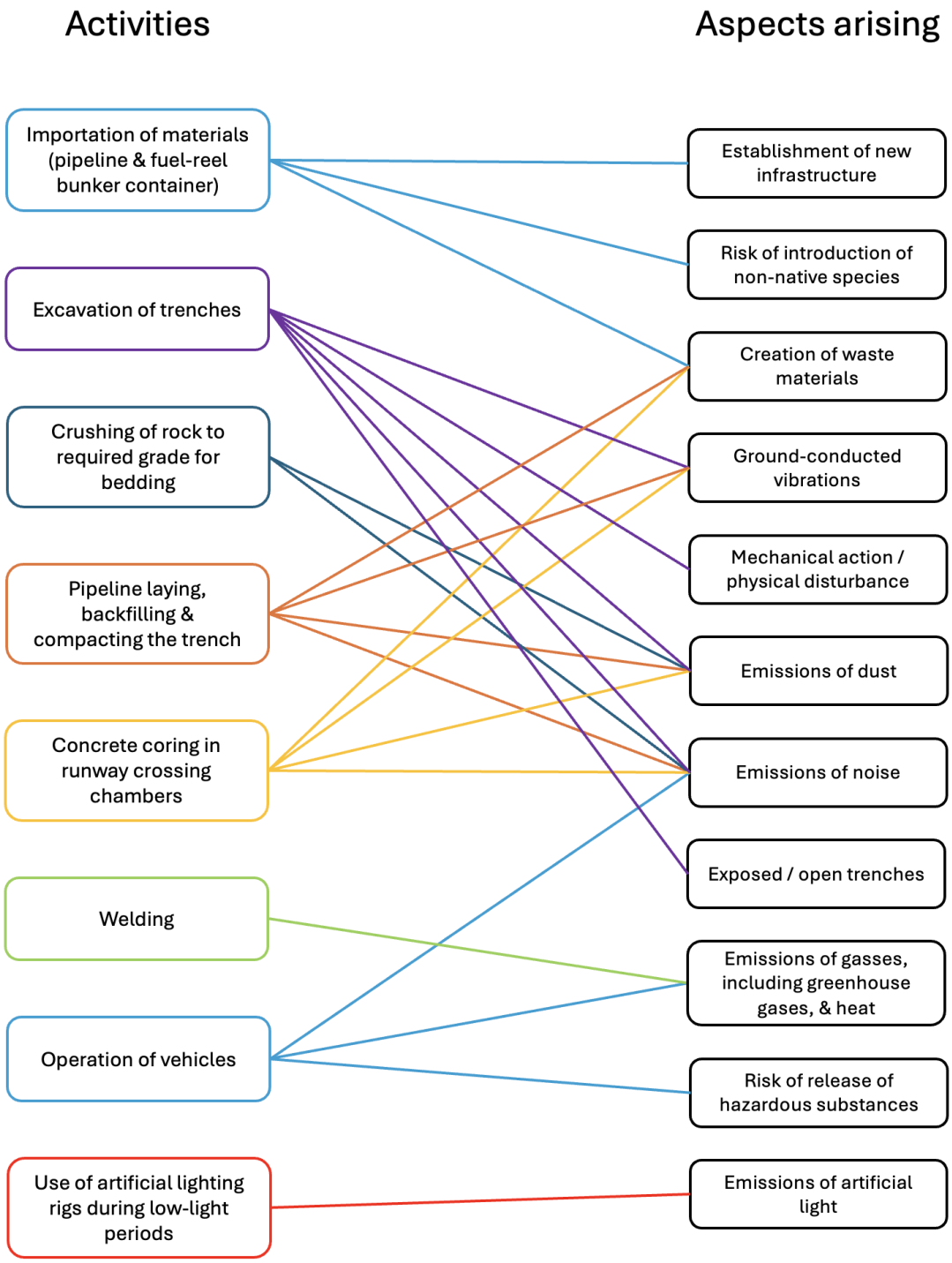


Figure 18. Diagrammatic overview of the aspects arising from the pipeline installation.

4.3.5. Decommissioning and removal

If the fuel pipelines were to be decommissioned in the future, then the reverse of the construction methodology described above will be followed. The way the fuel pipeline methodology has been designed will enable any future decommissioning to be undertaken with relative ease.

4.4. RENEWABLE ENERGY PROJECT

4.4.1. BACKGROUND

As noted above, BAS aims to reduce its carbon emissions from its Antarctic research stations and Cambridge office to net zero by 2050 with a 50% reduction by 2030.

To date Rothera has predominantly relied on fossil fuels to meet the power, space heating and hot water demands. Diesel generators have provided power for lighting, kitchen utilities, potable water production and diesel fired boilers for the central heating system and hot water. Solar photovoltaic (PV) units have already been installed on a number of buildings (including the new Discovery Building). These supply a small amount of power to the station.

The Rothera Renewable Energy Project (RENEW) is part of the efforts to decarbonise the BAS estate in Antarctica and the transition to renewable energy technology over the next ten years.

Over 50 technologies and concepts were investigated in the early stages of the project which looked at both innovative solutions as well as proven technologies. Detailed feasibility studies on wind, solar, energy storage and heat generation were then produced as the most likely commercially viable options. An assessment on sustainable fuels was produced as well as the viability of electrification of the Rothera vehicle fleet. The findings of these investigations have also been shared with other National Antarctic Programs to support their decarbonisation aims. Detailed energy modelling considering the current and future heat, electrical, fuel demand and CO_2 emissions, and installing electrical metering across the whole site, have produced several future energy modelling scenarios representing differing levels of emissions reduction. These scenarios included small and large-scale deployment of wind turbines, building mounted PV and ground mounted PV farms, battery storage systems, air source heat pumps and district heating networks. This has helped to define the future energy system of Rothera based on the best mix of renewables and the newly established Discovery Building and sitewide grid.

A key output of both the energy modelling and the feasibility studies was a road map to decarbonising Rothera. As a key deliverable of the business case, the road map set out the necessary steps, between the time of publication and 2040, that would be necessary to reduce emissions at Rothera as far as possible with the renewable energy systems appropriate for the site and climate. The work included in this IEE is the first step towards that decarbonisation target.

In order to further decarbonise Rothera station, a combination of renewable energy systems, including solar PV and wind turbines, together with different energy storage systems and a smart grid are likely to be required.

The overarching project objectives for RENEW are to:

- Maximise renewable energy capacity at Rothera,
- Minimise energy demands whilst enabling science delivery,
- Invest in innovative and sustainable solutions; and
- Future proof Rothera.

The next phase of RENEW is planned for the 2027-28 and 2028-29 seasons.

4.4.2. Alternatives Considered

4.4.2.1. Do nothing

Doing nothing or at least taking no further action to reduce carbon emissions at Rothera, would eliminate all of the identified impacts that will or may arise as part of the RENEW programme of work.

However, this option would mean BAS would not be able to achieve its aim of reducing carbon emissions at the station to net zero by 2050. Further, BAS' core role is to carry out vital scientific research on the impact of climate change in Antarctica and beyond and to tackle and mitigate the effects of climate change and embed evidence in decision making and climate policy. It would therefore be untenable for BAS not to address and reduce its own emissions portfolio.

A reduced reliance on external fuel supply and an increased reliance on locally produced energy from renewable sources also increases the level of energy security and safety for the Station.

For these reasons the 'do nothing' option was rejected.

4.4.2.2. Alternative energy source and management options

As part of the Rothera Decarbonisation Strategy, BAS has worked with its technical advisor RAMBOLL in order to examine a range of options to achieve the stated objectives.

For practical as well as budgetary reasons not all of the identified options can be implemented in one go. For some options further investigation is still required to determine their feasibility. Elements of the Strategy include:

- Renewable Energy Integration: The station is transitioning from diesel generators to a combination of renewable sources, including a growing solar photovoltaic (PV) array and potentially wind turbines (though see below), supported by energy storage systems and a smart grid.
- Infrastructure Modernisation: The AIMP includes the demolition of old, energy-inefficient buildings, upgrading the runway lighting for energy efficiency, and a new, more efficient wharf.
- Energy Efficiency and Demand Reduction: The strategy focuses on reducing energy demand through improved insulation, using modern, efficient facilities, and deploying AI-driven monitoring to manage energy use during both high- and low-occupancy periods.
- Sustainable Logistics and Fuel: Studies are ongoing to utilize sustainable biofuels for backup power and to improve the efficiency of transport and field operations.

At the time of preparation of this EIA, options and scenarios continue to be explored. The preferred approach which is outlined in Section 4.4.3. is regarded as the most effective option within current budget, capacity and design constraints.

Design development of wind turbine solutions has been paused at the time of preparing this EIA to enable BAS to review the advantages and disadvantages of implementing wind energy at Rothera, including considering possible locations for turbine installation.

4.4.2.3. LOCATIONS FOR THE BATTERY ENERGY STORAGE SYSTEM (BESS) BUILDING

Six different BESS location options were analysed in significant detail (*Figure 19*). BAS reviewed the options internally and provided scores based on their internal discussions, as shown in *Figure 19*.

BAS concluded that location 2 (*Figure 19*) was the favoured option. This location was the site of a disused Generator Shed which allows for the ground slab structure to be reused for the BESS building, with cost, time and emissions savings.

This location is deemed to be sufficiently remote from other buildings in the unlikely event of a fire starting in the BESS. Although Lithium Iron Phosphate (LFP) batteries have a low risk of thermal runaway, fire risks associated with chemical batteries are still present due to other factors, such as mechanical damage, faults, or misuse.

Consequently, the BESS system needs to be positioned remotely from other critical systems and buildings; a battery system fire is difficult to extinguish and is often left to burn out.

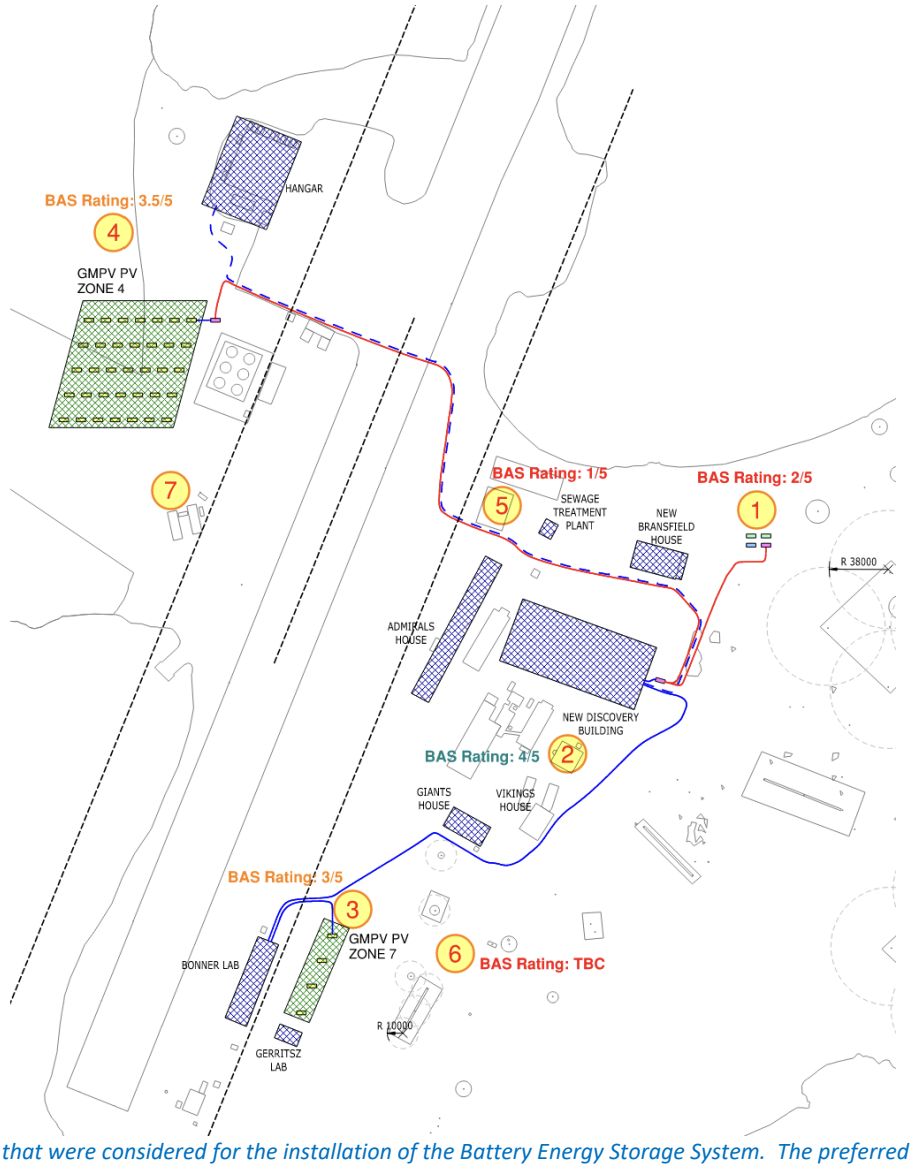


Figure 19. Locations that were considered for the installation of the Battery Energy Storage System. The preferred location is at the site numbered 2; the location of the now disused generator shed. Source: RAMBOLL / BAS.

4.4.2.4. LOCATIONS FOR THE GROUND MOUNTED PV TRIAL

Options were explored for the location of the ground mounted PV (GMPV) trial. Out of an initial seven possible locations, four sites were considered in more detail (*Figure 20*). Following consultations between BAS and the technical advisor (RAMBOLL) it was concluded that a location south of the Hangar (Zone 4) was the most favourable due to space availability and low impact on station activities (*Figure 20*).

It was acknowledged at the time that the slight disadvantages of this site were that some levelling work may be needed prior to constructing the GMPV and an access road will need to be established (refer Section 4.5.3.5.).

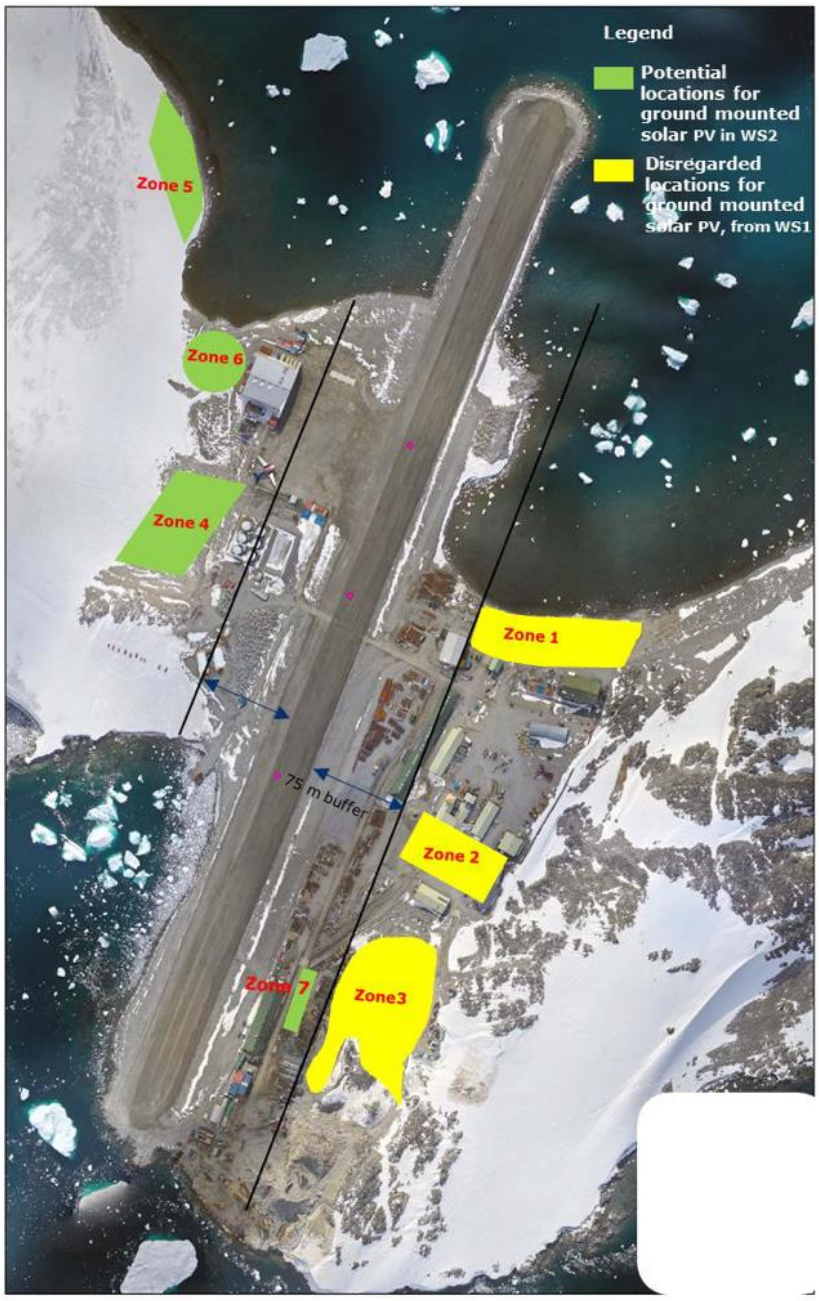


Figure 20. Locations that were considered for the ground mounted PV trials. Source: RAMBOLL / BAS.

4.4.2.5. DESIGN OPTIONS FOR THE GROUND MOUNTED PV TRIAL

Two design options were initially considered for the GMPV trial. The first option comprised PV panels installed on a traditional structural frame, secured in place using precast concrete foundation blocks. The design proposes vertically stacked PV panels; two panels atop one another (*Figure 21a*).

The second option proposed a GMPV system using an ISO shipping container as the supporting structure and onto which a support frame would be mounted to secure the PV panels. The ISO container would be fixed down to precast concrete pads to form the foundation (*Figure 21b*).

In review several factors determined that the preferred approach was to use a traditional structural frame (option 1; *Figure 21a*). A review of potential suppliers revealed the shipping-container approach was becoming less available with some suppliers previously advertising this solution having abandoned it. It was also noted that BAS has a preference to reduce the already large quantity of ISO containers present at Rothera. Further, a solid container façade has the potential to result in greater snow deposition.

Consequently, it was agreed that the GMPV trial would be progressed using two frame-based structures.

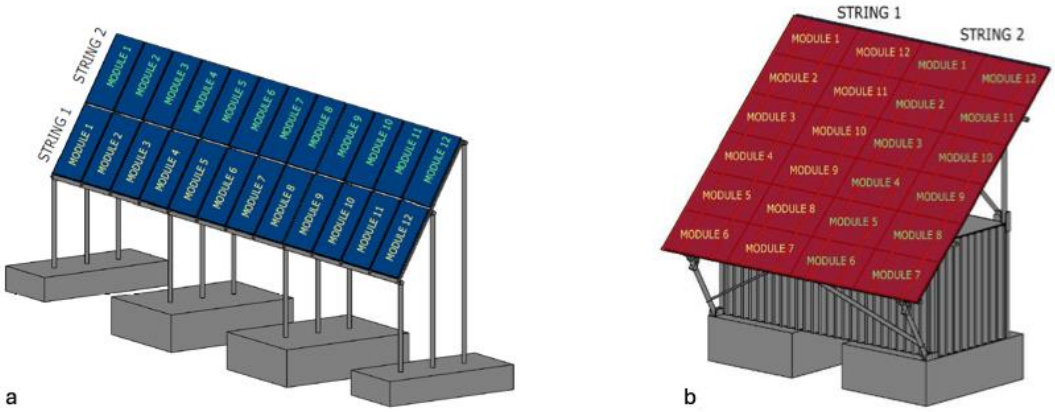


Figure 21. Design options for the GMPV trial array. Source: RAMBOLL.

4.4.3. PLANNED WORK- THE PREFERRED APPROACH

It is noted that the extent to which the RENEW project will be implemented remains uncertain at the time of finalising this EIA. The following sets out the full extent of the project though it may well be scaled back from what is recorded below. See also Section 8.3.5.

4.4.3.1. BUILDING MOUNTED PV

The planned work for the 2027-28 and 2028-29 seasons involves roof strengthening for some buildings and the permanent installation of a series of PV arrays on a number of buildings at Rothera, establishing a battery energy storage system (BESS) and Smart Grid control architecture that will form the basis of the long-term renewable energy infrastructure at Rothera.

The building mounted PV (BMPV) systems are currently planned to be installed across the following buildings (*Figure 22*):

- Gerritsz Lab (replacing existing solar panels)
- Bonner Lab
- Giants House
- the Sewage treatment plant (STP)
- New Bransfield House (NBH)
- Admirals House
- New BESS building (if appropriate)

These installations are designed to have an estimated combined capacity of 162kWp.

The roof strengthening and preparatory work involves replacing the roofing sheets on the Bonner Laboratory, adding additional timber to the trusses and battens of the Giants House roof and removing the existing PV panels and replacing the fixings on the roof of the Gerritsz Laboratory.

PV panels will also be installed on the north facing roof of the new hangar once completed (Section 4.5.3.11.).

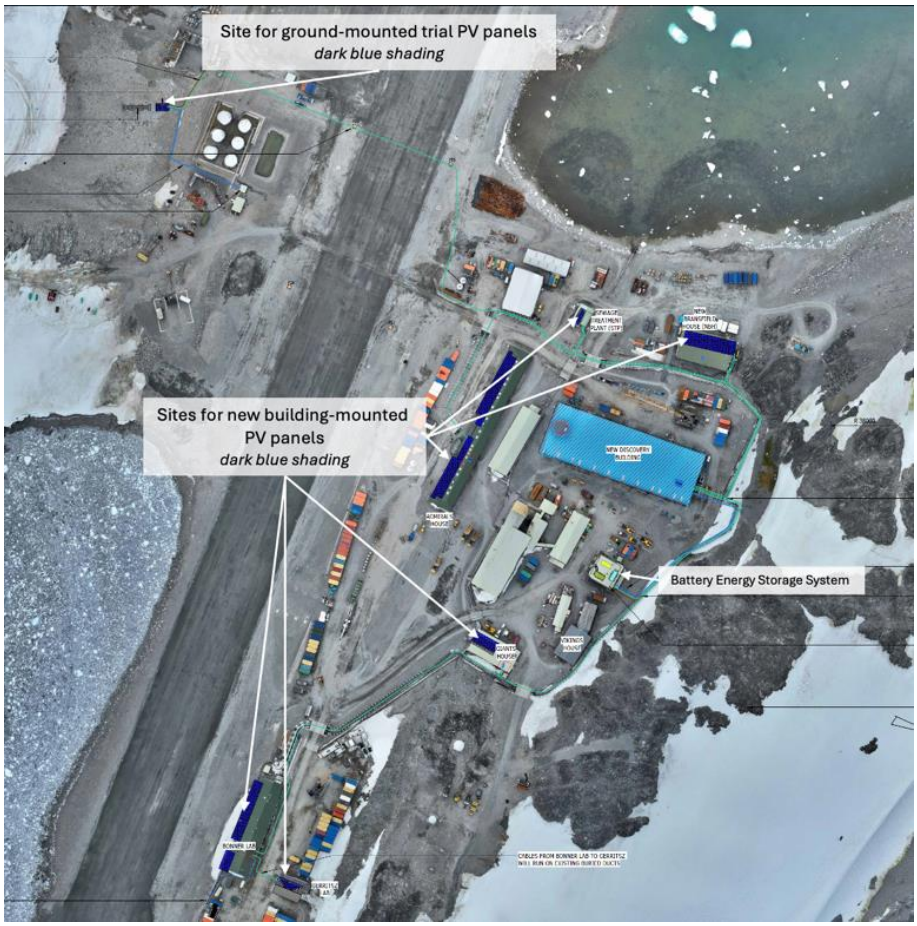


Figure 22. Locations for the building mounted PV systems. The location of the ground mounted trial PV system is shown adjacent to the fuel farm. The location for the battery energy storage system (BESS) is also shown. Source: RAMBOLL / BAS.

4.4.3.2. PV PANEL DESIGN

A comprehensive review of PV technologies was performed to identify appropriate modules, inverters, and mounting systems for the project. Heterojunction (HJT) PV modules and string inverters made by REC Solar Ltd. were chosen based on their suitability for the site conditions. The REC PV modules, with a peak capacity of 400Wp have been assessed as offering the best balance of efficiency and mechanical durability for the Antarctic environment, whilst also meeting the sustainability standards set by the project.

4.4.3.3. SMART GRID

The term 'Smart Grid' describes an electricity network controlled by an intelligent control system capable of intuitively controlling energy generation, energy storage and energy demand so the network can operate at its optimum.

A Smart Grid control system will be installed at Rothera to directly control and monitor the AC coupled BESS, Solar PV renewable power generation and the combined heat and power units (CHP).

The Smart Grid control system will be located within the Discovery Building mezzanine switch room and connected to all generating sources via outstations and interconnecting fibre optic cables. The new BESS, Admirals house, the Sewage Treatment Plant, New Bransfield House, Giants House and Bonner laboratory will have local interfaces.

No environmental aspects are seen as arising from this software upgrade.

4.4.3.4. BATTERY ENERGY STORAGE SYSTEM (BESS)

A BESS stores electrical energy in rechargeable batteries so it can be used at a later time. At its core, a BESS consists of battery cells (commonly lithium-ion, although other chemistries such as flow batteries or sodium-based systems are also used), power conversion systems (inverters), and control software that manages charging and discharging. The system converts electricity into chemical energy during charging and reverses the process to release electricity when needed.

When paired with renewable energy sources such as solar or wind, BESS play a critical role in addressing their inherent variability. Renewable generation is often intermittent, and a BESS allows excess energy generated during peak production periods to be stored and then dispatched when generation drops or demand rises. This enables smoother integration of renewables into the grid, reduces reliance on fossil fuel backup generation, and helps stabilize voltage and frequency. In practical terms, BESS can shift solar energy into evening peak demand periods, mitigate sudden fluctuations in renewables output, and potentially provide backup power during outages.

A Lithium Iron Phosphate ($LiFePO_4$ (LFP)) battery chemistry has been selected as the basis of design for the BESS. LFP batteries have a lower energy density but offer several characteristics that are highly advantageous in a BESS context: strong thermal and chemical stability (*i.e.,* lower fire risk), long cycle life (often thousands more charge - discharge cycles), and relatively lower cost due to the absence of expensive metals like cobalt and nickel. These attributes make LFP particularly well-suited to grid-scale storage where footprint is less critical than durability, safety, and cost per cycle.

LFP-based BESS installations are widely used alongside renewable energy systems. Their long cycle life makes them ideal for daily charge - discharge patterns such as storing solar generation during the day and releasing it in the evening.

The BESS will be pre-constructed and shipped in a 20-foot shipping container. A second 20-foot container will house the inverter and switching gear. The containers will be situated on the concrete foundation remaining after the removal of the old generator shed (*Figure 22*).

This foundation will require remediation prior to installing the BESS and constructing the BESS building. The foundation currently has several trenches dug into it and these will need infilling with concrete. Any cementitious or grout wash waters produced during construction will be stored in a bunded container and neutralised to a pH of 7.0 using citric acid prior to discharge to ground at a location agreed with the environment office.

A short trench will need to be excavated to connect the necessary cabling from the BESS to the nearby site wide services ducting.

The BESS building itself will be a simple framed and clad 'shed' that spans and provides weatherproofing for the shipping containers inside.

4.4.3.5. GROUND MOUNTED PV TRIAL

The primary objective of the trial is to evaluate and compare the electrical and mechanical performance of the proposed GMPV alternatives.

Four GMPV systems will be trialled using two arrays. Each array will comprise 24 PV panels each (2 high by 12 across) – 48 panels in total. Each 24-panel array will comprise six each of four different PV panel types: bifacial PV panels, bifacial coated PV panels, monofacial PV panels and monofacial coated PV panels[6].

One array of 24 panels will be installed at a 45° angle, and the second array of 24 panels will be installed at a 60° angle, so as to allow an assessment to be made of snow build up vs energy production.

The frames will be steel and will be attached to precast concrete foundation pads. The concrete blocks will be buried into the ground up to their surface.

The panels will sit a minimum of 2m above the ground and each array will have a maximum total height of 5.5m. *Figure 23* provides an example of what the GMPV arrays will look like in reality.

The lessons learnt from the GMPV trial will inform future design optimisation in advance of a wider rollout of these technologies in the future.

[6] Solar photovoltaic (PV) panels vary by light-absorption capability and surface treatments. Monofacial panels generate power from the front side only using an opaque backsheet, whereas Monofacial-coated panels add a front-glass anti-reflective or anti-soiling chemical coating to boost front-side efficiency. Bifacial panels utilize transparent dual-glass construction to generate power from both direct front sunlight and rear-side reflected ground light (albedo). Bifacial-coated panels apply advanced chemical coatings to both glass surfaces to maximize light transmittance and optimize dual-sided energy yields, commonly used in ground-mounted or utility-scale tracking systems.



Figure 23. Example of how the GMPV trial will appear once constructed. The concrete blocks will be buried into the ground. Source: https://www.eliteprecast.co.uk/keeping-solar-panels-secure-2/#

4.4.3.6. SCHEDULING

During the 2027-28 season the roof strengthening and preparatory work will be undertaken on the Bonner Laboratory, Giants House and Gerritsz Laboratory. The GMPV system will also be established.

During the 2028-29 season the BMPV panels will be installed on all selected buildings, the BESS will be installed, and the systems will be connected, tested and commissioned.

The GMPV trial will run until the 2029-30 season. Removal of the trial panels and frames will be a reverse of the construction process *i.e.,* removal of the panels and frames, excavation of the concrete blocks and reinstatement of the ground.

Whilst detailed planning is still being undertaken, an approximate schedule of works for the two seasons of the RENEW project is shown in *Figure 24*.

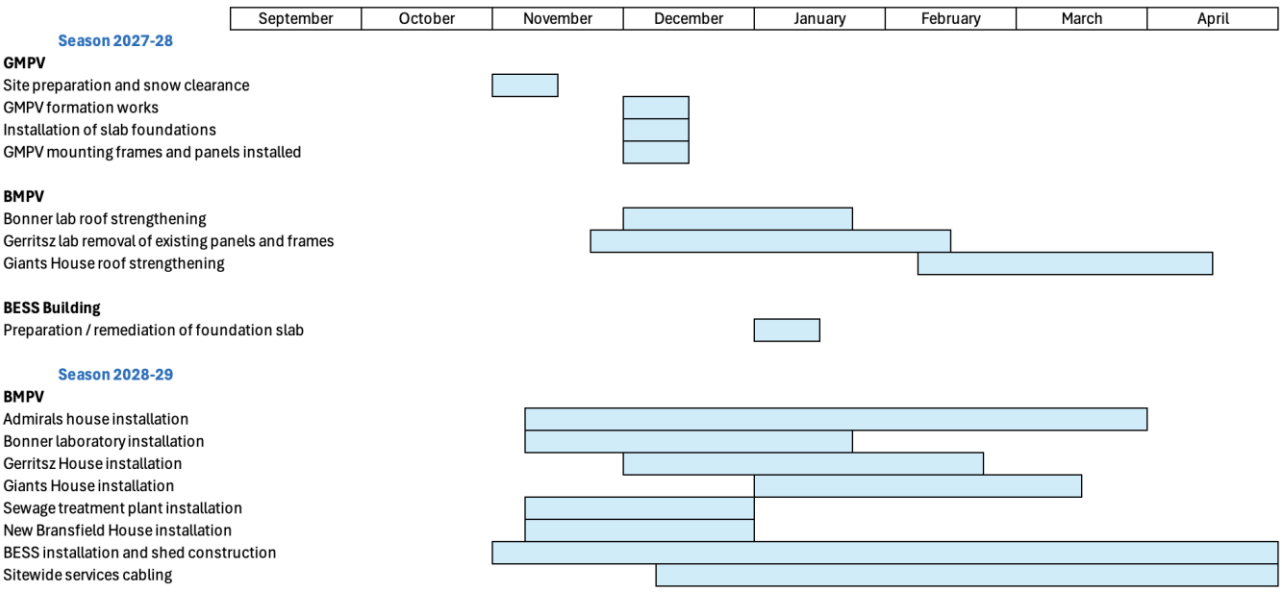


Figure 24. Approximate schedule of works for the two seasons of RENEW activities.

4.4.3.7. PERSONNEL AND EQUIPMENT

This work will be undertaken by BAM. Sixteen personnel are anticipated to be required for the RENEW project including plant operators, scaffolders, roof cladders, joiners and general construction staff.

4.4.3.8. ANTICIPATED FUEL USE

The estimated volumes of fuel required for the RENEW project each season are shown in *Table 2*. The total fuel use across the two seasons is estimated to be 13,028 litres.

Table 2. Estimated fuel volumes per season for the RENEW project.

Vehicle or plant	Duration (days)	Running time (%)	Estimated fuel consumption rate (l/hr)	Total consumption (l)
Ship offload				
Crawler crane	12	80	10.1	970
GMPV				
Excavator (36T)	21	80	12.9	2,160
Loading shovel	15	80	12.1	1,452
Dump truck	32	80	8.5	2,176
BMPV				
Telehandler	121	15	4.0	726
BESS Shed				
Excavator (36T)	15	20	12.9	386
Dump truck	15	20	8.5	255
Site wide services (cabling)				
Excavator	18	80	12.9	1,852
Dump truck	18	80	8.5	1,224
			TOTAL	**6,514**

4.4.4. Environmental aspects

The aspects that will or could arise from the installation of the building mounted and ground mounted PV systems and associated infrastructure that will or may interact with the environment are identified as (see also *Figure 25*):

Normal operations

- Importation of materials (*i.e.,* roof strengthening materials, PV panels, BESS building materials, cables) carries the risk of **introducing non-native species** to Rothera Point;
- **Emissions of dust**, arising from the digging of the GMPV foundations and excavation of the trench to connect the cabling into the site wide services ducting;
- **Emissions of exhaust gases and heat**, arising from burning fossil fuels in excavation vehicles and rock crushing equipment;
- **Emissions of noise**, arising from the use of power tools and vehicles (*i.e.,* excavators and telehandler for lifting panels);
- **Ground borne vibrations,** arising from the excavation of the GMPV foundations and BESS cabling trench;
- For the GMPV trial, **encroachment onto and mechanical action on ice-free ground** that has sustained less impact than the rest of the station with a minor extension of the station footprint;
- **Light emissions,** if artificial lighting rigs are required;
- **Generation of construction wastes** including from packaging for imported items, offcuts, removed roofing sheets and fixings, cementitious waste;
- **Establishment of new infrastructure** at Rothera point with potential to further detract from aesthetic or wilderness values.

Unplanned or Emergency situation

- The risk of **fuel spills to the terrestrial environment** because of an emergency event on a vehicle (*e.g.,* hydraulic hose failure) or during the refuelling of vehicles.

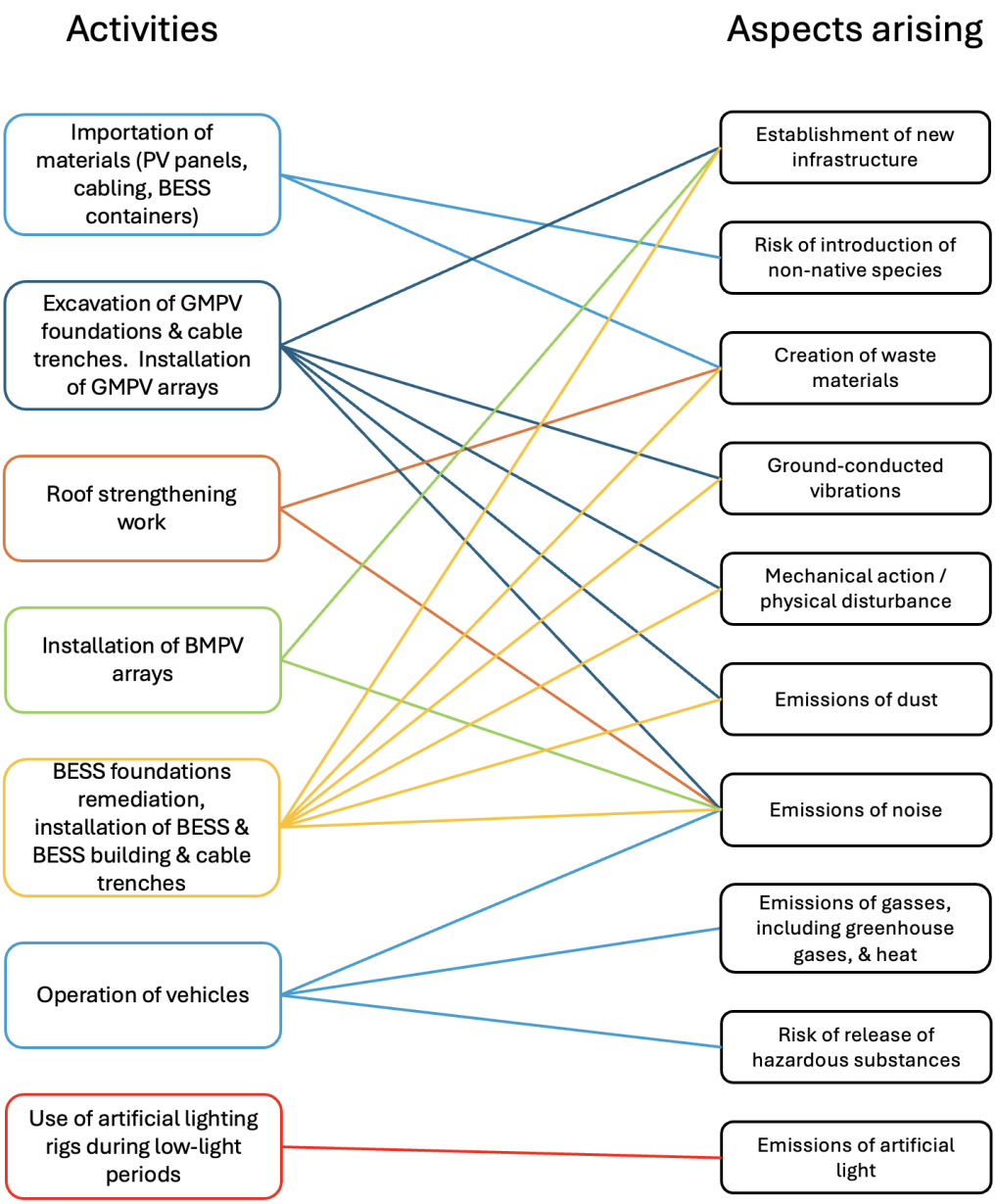


Figure 25. Overview of the aspects arising from the BMPV / GMPV and BESS installations.

4.4.5. Decommissioning and removal

Following the completed works it is considered that the PV installations will remain operational until they are no longer fit for purpose, or if there is a change in BAS operations at Rothera. In the event of changed operations, the PV panels could be removed from the buildings with little or no impacts to the local environment.

4.5. HANGAR REDEVELOPMENT

4.5.1. BACKGROUND

The existing Hangar is located on the western side of the station at the opposite side of the runway to the main station area. The Hangar is a 1,293m^2 steel portal frame building with a pitched roof. The walls and roof are clad in steel cladding panels. The substructure consists of an *in-situ* reinforced concrete floor slab.

The Hangar is over 30 years old, and previous survey findings have recommended several actions and repairs to the structure to ensure it remains usable.

As part of the AIMP, the Hangar Redevelopment Project intends to address the aging fabric of the building and extend it so that it can accommodate a new airbridge aircraft and improve its functionality.

A range of small-scale enabling activities are planned for season 2026-27 and 2027-28. These activities are to be commenced ahead of the main works to deconflict construction and air operations. The main works will commence in 2028-29 and conclude in 2029-30.

4.5.2. ALTERNATIVES CONSIDERED

4.5.2.1. DO NOTHING

Not undertaking the planned works would eliminate the impacts identified in this EIA. However, the underlying improvement needs would remain and would need to be addressed at some point in the near future in order to continue to support inter- and intra-continental flight operations.

Logistically, it is more efficient to include this work within the overall package of the AIMP whilst skilled staff and assets are available on site.

For these reasons the 'do nothing' alternative was rejected in favour of undertaking the redevelopment work.

4.5.2.2. DESIGN OPTIONS

Redevelopment - Full Design

This option extends the existing main hangar footprint to the west by 7 meters to accommodate a new airbridge aircraft plus 3 of the existing Twin Otter Fleet. To the north an extension infills behind the door pocket to accommodate the offices, workshops and storage spaces required by the air operation. To the south an extension goes beyond the door pocket providing space for air cargo handling and gateway biosecurity inspections, as well as parking for vehicles.

This design will leave the existing concrete floor slabs and foundations in place and utilise them where possible.

At the end of Royal Institute of British Architects (RIBA) Work Stage 3 the Full Design was approved to be progressed.



Figure 26. The full design option. Source: BAS / Ramboll.

Redevelopment - Reduced Design

A reduced version of the Full Design was considered during RIBA Work Stages 2 and 3. This option would have seen the southern extension removed from the design. This option would have reduced some of the impacts caused by the increase in building footprint, however it was ultimately dismissed as it did not meet the agreed User Requirements.

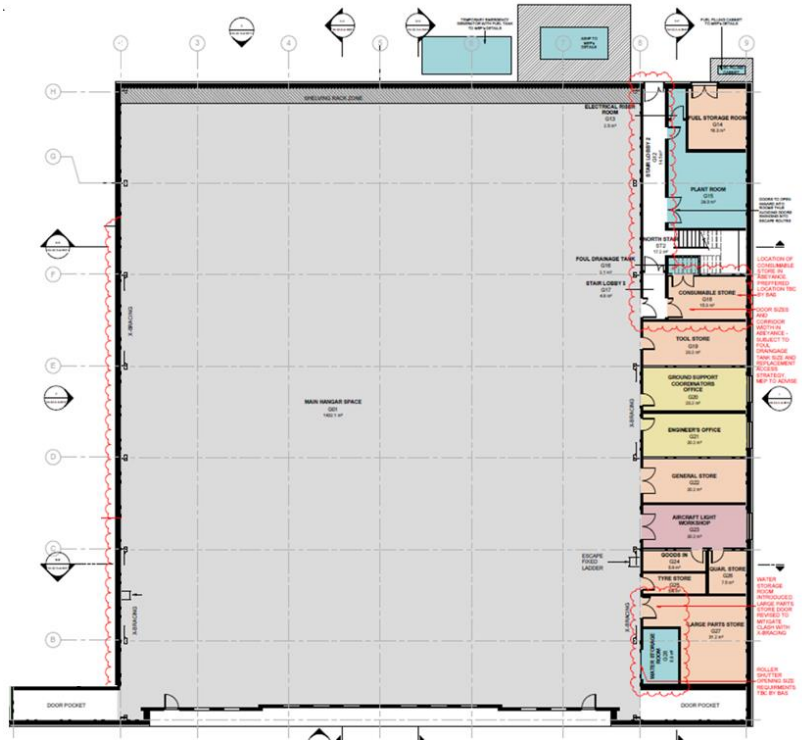


Figure 27. The Reduced Design option. Source: BAS / Ramboll.

Where alternatives were considered for some of the specific activities, these are recorded below.

4.5.3. Planned work – the preferred approach

A number of preparatory or related projects need to be undertaken in advance of, or in association with the redevelopment of the hangar. These will all be undertaken by BAM.

4.5.3.1. Laydown area and site offices

During the 2026-27 season a laydown area will be established to the south of the current hangar (*Figure 31*). This area will be used initially to stockpile processed rock material for the project, then to manage materials, plant and equipment during construction.

Following completion of the hangar project the laydown area will be retained and used by Air Operations for managing air cargo and parking airside vehicles.

The aggregate required for this area will be prepared in the rock processing area adjacent to the wharf. The work will involve the use of an excavator, dump truck, dozer, and vibrating roller.

The project will also utilise the existing AIMP laydown area north of the Gerritsz Laboratory for storage of containers and break bulk during construction. A crane will operate from this area throughout the project, loading tractors and trailers with materials for transport across the runway to the main work area as they are required.

The site office and storage area will comprise 7 x 20-foot containers – providing a boot room, toilet, briefing room, office, meeting room and storage. A temporary generator will be used to power the facility. The waste from the toilet will be macerated, pumped into an IBC tank and transported to the Rothera wastewater treatment plant.

4.5.3.2. Site investigation and ground investigation works

The purpose of these works is to better understand the condition of the existing hangar facility. Most of the planned work will be undertaken internal to the current facility. The internal work will involve material testing including:

- Ground Penetrating Radar of the floor slab
- Concrete core sampling of existing floor slab and penetration test of formation layer
- In situ metallography and microscopy
- Measurement of residual metal thickness
- Corrosion testing

The external work will involve excavation of 1m x 2m x 1m trench on the west side of the existing hangar foundation to expose a section of the concrete floor slab and foundations for the following purposes:

- Measurements and visual inspection of concrete floor slab and foundations
- Concrete core sample of foundation to confirm concrete cover and rebar design

- Carbonation testing on exposed concrete

These works will largely involve the use of hand-operated survey equipment. An excavator will be required to dig the trench adjacent to the hangar foundations and to reinstate the hole on completion of the survey. A vibrating compactor will be used to reinstate the ground following backfilling.

In addition, four trial pits will be dug to establish the height of the competent bedrock to inform the ground anchor and foundation design of the new hangar. These will be located to the north (TP118), west (TP119) and south (TP120) of the existing hangar (*Figure 28*). A fourth trial pit (TP121) is proposed in the apron to the east of the hangar to inform the design of the proposed temporary hangar.

All trial pits will follow the same methodology, which is as follows:

- Ensure that trial pit locations are free of buried services and obstructions by reference to available data and CAT scanning
- Excavate trial pit until excavator refuses on competent bedrock
- Excavated materials should be stockpiled at an agreed location a safe distance to the side of the trial pit. Where possible, excavated materials from each stratum and depth will be stockpiled individually to assist with later backfilling in the order in which they were excavated
- Photographic and written records to be taken at 1m intervals
- Upon completion, the excavation will be backfilled as soon as possible following excavation with the excavated material in such a way as to ensure that it matches the existing strata (*i.e.*, backfill in the reverse order from which it was excavated). The pit will be tamped down approximately every 0.5m depth and at the surface using the bucket to compact the soils to reduce later settlement at ground surface. Upon completion of backfilling the surfacing will be stable, relatively flat and free from hazardous materials

All of the above work is anticipated to be completed within 12 days. It is anticipated to be undertaken during the 2026-27 season. No particular alternatives to this work were considered as the information that will be obtained is critical to informing the hangar redevelopment work. Failure to collect this information would require the ground anchors and foundations to be overdesigned to mitigate the risk created by the unknown ground conditions.



Figure 28. Proposed trial pit locations. Source: BAS / BAM.

4.5.3.3. RELOCATION OF THE RUNWAY LIGHTING KIOSK

This package of work is required to relocate the existing Runway Lighting Kiosk. The kiosk is a 20ft ISO shipping container which is currently positioned within the footprint of the proposed hangar redevelopment.

This work involves relocating the container to a temporary location outside of the main area of construction for the new hangar (*Figure 33*).

This will involve disconnecting the kiosk, relocating it and reconnecting and testing it in its new location.

Ultimately the runway lighting system will be moved into the new hangar once completed.

The work will require trenching and the installation of ducting to the site wide services chamber within the access road. For this reason, it will be undertaken after the flying season and at the same time as the establishment of the access road (Section 4.5.3.5.). Any trenching will result in excess material which will be processed and added to existing stockpiles.

It is required to complete this work in March 2027 ahead of the main hangar works and outside of the flying season to minimise the impact on science and air operations. The work is expected to take 19 days. The work will involve the use of an excavator, dump truck and vibrating roller.

4.5.3.4. RETRENCHING THE NON-DIRECTIONAL BEACON CABLE

A blue shipping container is situated at the rear of the current hangar which contains the electrical equipment associated with the non-directional beacon aerial array to the west of the hangar (*Figure 29*). This is used for air traffic control and will remain in situ. To enable construction of the new access road and drainage ditch diversion (Section 4.5.3.7. below), a section of buried cable will need to be excavated, the housing container moved, the drainage ditch diverted and the cable retrenched underneath the new access road.

It is required to complete this work in March 2027 ahead of the main hangar works and outside of the flying season to minimise the impact on science and air operations.

The final location of the container (labelled 'MEP EQUIPMENT' in *Figure 31*) will be similar to its current position along the Hangar's western elevation with a similar buried cable route to the aerial array to the west of the hangar.

There will be no need to move the aerial array itself, which will remain in its current position.



Figure 29. The aerial array to the west of the hangar is the non-directional beacon used by air traffic control. The cable that runs from the array is connected into the blue shipping container at the rear of the hangar which houses the electrical equipment. The cable will need to be unearthed whilst the access road and ditch diversion are undertaken. It will then be reburied under the new access road similar to its current position. Source: BAS.

4.5.3.5. ACCESS ROAD AND FUEL LINE CROSSING

This package of work is required to reduce construction traffic from the apron during the Hangar Redevelopment Project as well as to support safe access to the Hangar on completion of the redevelopment. Construction has been planned to minimise impact on science and air operations and reduce potential breaches of the runway protection area during the flying season.

When completed the access road will remove a significant number of non-essential vehicle and personnel movements from the apron each flying season, providing effective separation of people, vehicles and aircraft.

It is being undertaken also to facilitate access to the site of the GMPV trial (Section 4.4.3.5.).

The work involves the construction of an access road utilising an existing, but unprepared route from the runway crossing to the hangar, running to the south of the apron and north of the fuel farm (*Figure 31*).

The road will be 7m wide with a 0.5m to 1m verge on either side. It will consist of graded and compacted aggregate with an unbound gravel surface as per all other roads on Station. The aggregate will be prepared in the rock processing area as described in Section 4.11.

As an alternative, consideration had been given to using geogrid[7] to establish the road and minimise the volume of graded material required. However, this option was dismissed due to concerns over the introduction of plastic into the environment and its end-of-life removal.

The access road will require the construction of a fuel line crossing point (*i.e.,* a small bridge; *Figure 30*). The bridge will be constructed using design principles from Phase 1 site-wide services crossings *i.e.,* precast concrete upstands, steel cross members and timber road surface. The bridge will be wide enough to span the existing fuel lines, whilst also providing capacity for their replacement in future seasons as part of the planned upgrade to the Fuel Farm.

As an alternative, consideration was given to removing the existing fuel lines and replacing them with buried fuel lines. This option was dismissed due to programme uncertainties with the future fuel farm project and for the reason that bridging the fuel lines is preferred for maintenance purposes.

Once across the fuel line the road will follow the outer edge of the laydown area around to the north. Upon arrival at the hangar the road will fork east to the apron and west to the main vehicle and pedestrian doors at the rear of the hangar.

The road to the rear will narrow to 3.5m wide, this is to minimise the extension to the station “high impact” zone, and to avoid interference with the Non-Direction Beacon to the west.

To minimise interference with aircraft operations, work on the access road is planned to be undertaken in stages. The road from the runway crossing to the laydown area (including the fuel pipeline crossing) will be constructed towards the end of the 2026-27 season and after the departure of the aircraft; usually early March.

The roadway from the laydown area to the rear of the hangar will be constructed at the end of the 2027-28 season and after the diversion of the drainage ditch and retrenching of the Non-Direction Beacon cable (see Section 4.5.3.4.). The work will involve the use of an excavator, dump truck, dozer, crane and vibrating roller.

[7] Geogrid is a geosynthetic reinforcement material — usually a polymer grid or mesh — placed within or beneath aggregate layers to improve the strength and stability of the ground.

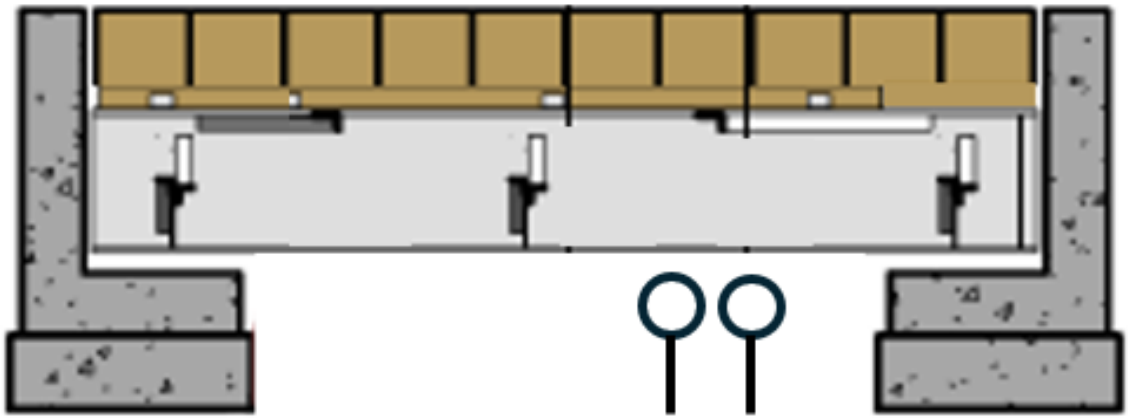


Figure 30. Cross section showing the 'bridge' design to allow the road to transit over existing fuel lines.

4.5.3.6. TEMPORARY HANGAR DUCTS

This package of work involves the installation of temporary ducting to allow power and data cables to be routed to the site of the proposed temporary hangar and temporary office facilities (*Figure 33*).

The work involves digging a short trench from the current ductwork (that runs to the current hangar) to the site of the proposed temporary hangar and laying new ductwork that interfaces with the current service run. Any trenching will result in excess material which will be processed and added to existing stockpiles.

This work will be borne as part of the access road works (Section 4.5.3.5.). Trenching to a chamber within the access road is required, and it is far more efficient to undertake this work in combination with the road construction.

Once the ducting has been laid the trench will be backfilled and compacted.

The work is expected to take three days within the 23 days of construction of the access road at the end of the 2026-27 season. The work will involve the use of an excavator and vibrating roller.

Six 50m coils of 110mm diameter twin wall ducting will be imported for the temporary hangar ducts and relocation of runway kiosk (Section 4.5.3.3.).

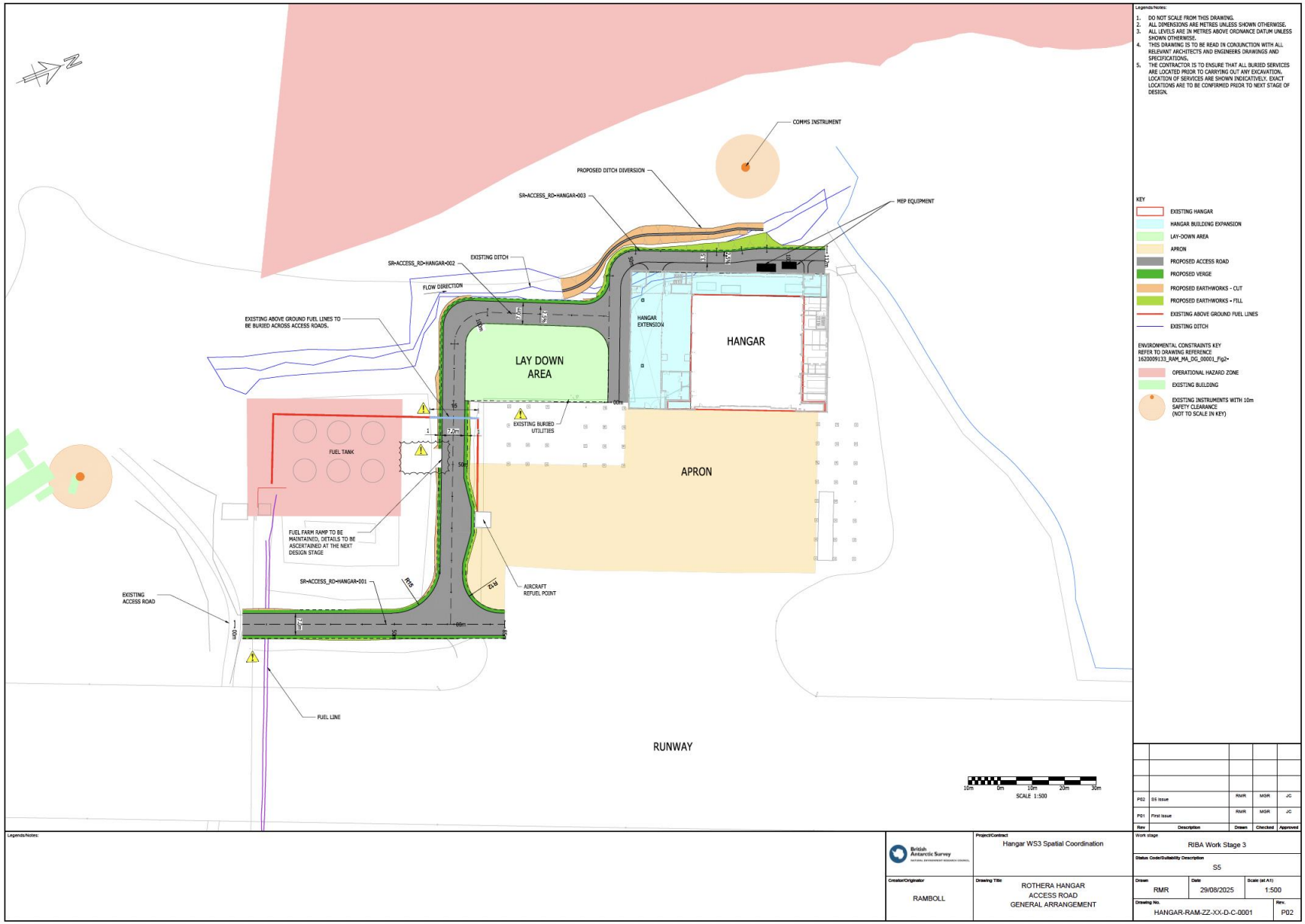


Figure 31. Extent of the hangar construction work showing the extension to the hangar, the access road and fuel line crossing, laydown area and diverted drainage ditch. Source: BAS / RAMBOLL

4.5.3.7. DRAINAGE DITCH DIVERSION

At the time of the construction of the original hangar and apron (between December 1989 and March 1991) a drainage ditch was established at the base of the ice ramp and to the west of the hangar, with the aim of diverting meltwater from the glacier away from the hangar and apron area (*Figure 33*).

The southern part of this drainage ditch (not the entire length) will need to be relocated to allow for the extended footprint of the hangar and the roadway to the rear of the hangar (*Figure 31*).

An excavator will be used to dig the new course for the drainage ditch. Compacted aggregate will be used to infill the old part of the ditch and bring the ground up to required level prior to the access road and hangar construction.

The work is expected to take one week and will be completed in the 2027-28 season and will involve the use of an excavator, dump truck, dozer, and vibrating roller. The aggregate will be prepared in the rock processing area adjacent to the wharf.

It is noted that the diversion of this drainage ditch will slightly extend the 'high impact' zone of Rothera Station out to the west. All activities will be planned to ensure plant and equipment remain within the 'high impact' zone of the boundary during construction; in addition, the boundary will be marked with flags. See also Sections 5.6. and 5.10. that report on the findings of a pre-work biological survey of this area of Rothera Point. The grass identified in Section 5.6 will be protected using pedestrian barriers and flags throughout the construction seasons.

4.5.3.8. INSTALLATION OF TEMPORARY AIRCRAFT TIE-DOWNS

A total of 48 aircraft tie downs (used to secure a parked aircraft to the ground during strong winds) are currently located to the north and southwest of the apron. During construction only 15 will remain available to support air operations, with the remainder either covered by the temporary hangar or within the designated construction site (*Figure 33*). To allow science and air operations to continue temporary tie downs will be installed.

The work involves establishing up to 27 tie downs. Each one consists of a precast 1m x 1m x 0.5m concrete block with a metal 'eye'. Installation consists of excavating a hole placing the precast block, backfilling and compacting. The final number will be no more than 27, but the required number is under discussion with the BAS Air Unit at the time of preparation of this EIA.

Alternatives that have been or are being considered include:

- ground screws. This option would reduce the extent of ground disturbance and has a lower embodied carbon than using concrete. However, this option was rejected given the unknown bedrock depth and lack of required equipment on site.
- buried steel plates with eyelets above ground level and weighted by backfill. This has the advantage of lower embodied carbon than using concrete and this option is still being explored.

The work will be undertaken during the 2027-28 season and is expected to take five days.

The work will require the use of an excavator and vibrating roller.

On completion of the main hangar redevelopment the temporary tie-downs will be removed by reversing the construction process.

4.5.3.9. INSTALLATION OF A TEMPORARY HANGAR

A temporary hangar will be established on the southwest corner of the apron, from which BAS will operate whilst the main hangar is being redeveloped (*Figure 33*). The temporary hangar will be designed to house one Twin Otter aircraft. The temporary hangar will be established during the 2027-28 season and will be occupied by BAS during the main construction seasons (2028-29 and 2029-30) when BAM will have full possession of the existing hangar site.

The temporary hangar will be a prefabricated design measuring approximately 30m x 30m and will utilise existing 20ft ISO containers to provide office, workshop and storage space (*Figure 32*). These will be covered by prefabricated steel trusses and enclosed with either a steel or fabric skin.

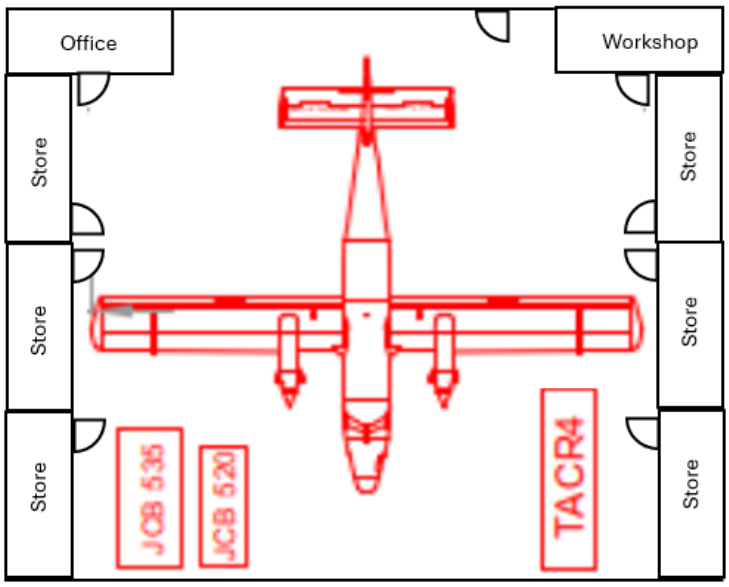


Figure 32. Temporary hangar outline design. Source: BAS.

The temporary hangar will require up to 12 precast concrete foundation pads. Installation of these will require excavation of the area to sub-formation level, placing of the pads onto compacted aggregate, then back filled with aggregate and compacted.

The actual design had not been finalised at the time of preparation of this EIA.

The temporary hangar is anticipated to take 18 days to construct and will involve the use of the crane, excavator, roller and mobile elevated platforms.

On completion of the main hangar redevelopment the temporary hangar will be removed by reversing the construction process.

Alternatives that were considered included:

- Off the shelf fabric hangars including inflatables. Although these were considered to be quicker to install, their durability in the conditions at Rothera could not be proven. This was a particular concern

over the austral winter when airside equipment will need to be stored within the building, this led to these options being dismissed.

- Field Servicing. This option would have required movement of aircraft spares, equipment and maintenance personnel into the field or to hangars elsewhere on the Antarctic continent. This option would have presented a significant logistical challenge to the operation and was ultimately discounted due to the impact on air and scientific operations.

4.5.3.10. CRANE PAD

The work involves the establishment of a flat, stable area at the north-west corner of the existing apron to support future lifting operations during the construction of the new hangar facility (*Figure 33*).

This will require the movement, levelling and compacting of approximately 74m^3 of graded fill material from existing stockpiles.

To minimise interference with aircraft operations the work is planned to be undertaken towards the end of the 2027-28 season and after the departure of the aircraft; usually early March. The work is expected to take 3 days. The work will involve the use of an excavator, dump truck and vibrating roller.



Figure 33. Overview of the works to be undertaken in and around the hangar. Source: BAS.

4.5.3.11. CONSTRUCTION OF THE NEW HANGAR

All of the works described in Sections 4.5.3.1. to 4.5.3.10. are required to prepare the site prior to the construction of the new hangar.

As well as providing sufficient space for storage of all BAS aircraft, a key element in the design of the new hangar has been to internalise storage, workshops and office spaces within the building in order to overcome the inefficiencies of having separate, external containerised storage.

In planning for the hangar redevelopment, an alternative that was considered was to reuse the internal structural steel to the maximum extent possible. Consideration was given to shot or sand blasting the existing structural steel and recoating it for reuse. However, this option was rejected given the challenges involved in retaining and removing the dust and debris from the shot blasting and the need for a heated tent arrangement that would be required for curing the steel coating.

Instead, the entire hangar will be taken back to foundations and new steel installed.

Installation of Ground Anchors and Foundation Pads

A total of 30 x 8m steel ground anchors with precast concrete pad foundations will be installed to the north, west and south of the existing hangar to support the new steel. Installation will take place in the 27-28 season prior to the deconstruction of the existing hangar and will require the use of a drill rig, grout mixing equipment, an excavator, vibrating roller and crane. This installation will follow the process outlined below:

- Preparation of level drilling platform with excavator;
- Drill holes to required depth (approximately 8 m) with drill rig;
- Install the prefabricated steel ground anchor with crane;
- Backfill hole around anchor with grout (approximately 10 litres per hole);
- Placement and compaction of general fill material around the ground anchor with excavator and vibrating roller;
- Placement of geotextile (see Section 4.5.3.12.) to contain 100mm of compacted fines followed by 30mm of kiln dried imported sand with excavator and vibrating roller;
- Placement of precast pad foundation over ground anchor with crane;
- Once the grout is cured the assembly is subject to a pull-out test using a hydraulic jack.

Grout materials will be mixed in the BAM Fitters Workshop and the wash water, once neutralised, will be discharged away from sensitive receptors to the west of the BAM Fitters Workshop.

Ground anchors are preferred as their use reduces the size of the concrete foundation required to resist the uplift created by the strong winds at the site. Alternatives considered included casting larger in-situ concrete foundations, this was rejected due to the increased embodied carbon and water usage, as well as the increased environmental risks associated with casting concrete on the site, such as biosecurity of imported aggregates and alkaline wastewater runoff.

Deconstruction of Existing Hangar

Following the BAS decamp into the temporary hangar, the existing hangar will be deconstructed to ground floor slab level in a controlled process by specialist contractors. Although the substructure will largely remain in-situ to be reused, the existing hangar door rail and foundation will be removed to allow for its replacement. All waste materials will be segregated and containerised for removal from the Station at the end of the 29-30 season.

This activity is planned to take place in the 28-29 season, it is anticipated to take 45 days and will require the use of cranes, excavators, telehandlers and MEWPs.

At the conclusion of this process only the concrete foundations and floor slab will remain.

As an alternative, consideration had been given to retaining and reusing six of the existing steel portal frames. To facilitate this the following activities would have been required;

- Front frame modifications for aircraft tail slot
- Strengthening of connections
- Welding of cleats for secondary steel
- Shot blasting all steel back to bare metal
- Inspection and welding repairs where necessary
- Recoating

This was dismissed when the full programme and environmental impact of these remediation activities were understood.

Installation of ground floor slabs, Hangar door foundations and perimeter concrete wall

Following deconstruction of the existing hangar, the new precast concrete floor slabs, precast concrete hangar door foundations and precast concrete perimeter wall will be installed in the 28-29 season. These ground bearing elements will all follow the process below:

- Placement and compaction of general fill material
- Placement of geotextile (see Section 4.5.3.12.) to contain 100mm of compacted site won fines followed by 30mm of kiln dried imported sand
- A Damp Proof Membrane (DPM) will be placed on top of this fill layer
- Non-compressible insulation will be placed on top of the DPM where it is required and covered by another layer of DPM
- Placement of precast floor slab

This activity is anticipated to take 67 days will require the use of an excavator, dump truck, vibrating roller and Crane

In the southern extension the precast floor slabs will be the finished floor level. In the western extension to the main hangar a screed with a power float finish will be required to match the existing hangar floor. In the northern extension a screed will also be required to aid the installation of prefabricated internal elements.

All floor screeds will be installed in 28 days following completion of the building envelope, and will require a screed mixer, pump and power float.

Following installation of the precast Hangar Door Foundations the door rails will be grouted in place. This activity is anticipated to take 5 days and will require a telehandler and grout mixer.

Grout and screed materials will be mixed in the BAM Fitters Workshop and the wash water, once neutralised, will be discharged away from sensitive receptors to the west of the BAM Fitters Workshop.

Installation of steel

The new steel frame will be installed in the 2028-29 season using a crane positioned on the crane pad at the northwest corner of the apron and a crane working from the lay down area. The team will fix the steel from the west to the east using MEWPs working from the new floor slab.

As well as fixing to the precast foundations installed in the 2027-28 season, the steel frame design will utilise the existing in-situ concrete foundations which will have been preserved during deconstruction.

Steel elements will be prefinished in the UK with intumescent paint.

Once the primary steel installation is sufficiently advance, installation of the secondary steel will be commenced.

Installation of Building Envelope

A composite panel cladding system will be used across the roof and facades of the building. This type of system consists of factory manufactured panels made up of a PIR insulation core sandwiched between the steel internal and external wall surfaces. This approach was used on the Discovery Building and significantly increases quality while reducing installation time and waste on-site.

Where possible external windows, doors and louvres will be installed in the factory to improve quality and further reduce installation time and waste on-site.

Following completion of the cladding system the main hangar doors will be installed, creating a wind and weather tight building envelope.

This activity is anticipated to take 26 days and will be completed by the end of the 2028-29 Season.

Internal fitout and Handover

The internal fitout will utilise prefabricated timber floor cassettes and a prefinished wall panel system to create the floors and internal walls required. Where feasible plant rooms will also be prefabricated on skids. Prefabrication is the preferred option for the internal fit out because it will reduce the number of skilled resources required to be deployed to the Station. Factory production also provides the benefit of reducing on-site waste and increasing quality.

This activity will be commenced following completion of the building envelope in the 2028-29 season and be progressed by a small wintering team during the 29 Winter.

Final commissioning and handover will take place in January 2030.

Deconstruction of temporary infrastructure

Following handover of the new hangar in the first part of the 2029-30 season the temporary hangar will be deconstructed, and the foundation pads and temporary tie downs will be removed from the apron.

4.5.3.12. NOTE ON THE USE OF GEOTEXTILES

It is noted that the use of geotextiles was rejected as an option in the resurfacing of the wharf, but the material will be used in the hangar redevelopment. The Hangar is targeting a design life of 60 years. The use of geotextiles is necessary to deliver this design life, especially the foundations. Without the physical barriers in place, there is a risk of migration of fines, and ultimately a faster degradation of the foundations that reduces the operational lifespan of the building and which would be costly to remediate.

Geotextiles also reduce the risk of water ingress and airtightness of the structure which could otherwise lead to foundation degradation and ultimately subsidence. A Rothera-wide climate risk assessment conducted in December 2025 concluded that overall temperatures, days above freezing and near surface temperatures are all predicted to increase up to the study's 2100 temporal boundary. Additionally, total precipitation, the number of days with precipitation above 10mm, and the percentage of precipitation falling as rain are all projected to increase at the station over the operational life of the Hangar. Combined, these factors increase the risk of filtration into the foundations, reducing soil density and bearing capacity, and ultimately decreasing structural stability. Containing the foundations within a geotextile layer adds an impermeable barrier to the foundations to reduce these risks.

The geotextile will only be deployed underneath the precast foundation pads, where necessary for the above reasons, as opposed to underneath the entire Hangar structure. This has been done to limit the amount of geotextile required and the subsequent environmental risk of introducing foreign materials to Antarctica. Only the required quantity of geotextile membrane will be used beneath the building footprint. This will reduce the risk of accidental disturbance during any future non-hangar-related works in the area.

The same risks of fines migration and subsidence are also present within the wharf, where the use of geotextiles has been discounted in favour of using a 'soil plug' (see Section 4.2.3.). However, unlike the hangar, the wharf is an exposed surface which allows for visual inspections, and even intrusive investigations to monitor and maintain any degradation of the substructure due to settlement migration. This is not possible in the proposed hangar design without intrusive works that could further compromise the foundations. In addition to cost, rectifying any subsidence in the Hangar foundations would be extremely difficult from a constructability perspective, carbon intensive, and impactful to BAS air operations, likely requiring another temporary Hangar in the interim.

The inaccessibility of the hangar foundations also limits the potential migration of plastics from the geotextiles compared to geotextiles on a more exposed surface, such as the wharf.

Alternatives

Biodegradable materials

Less environmentally impactful alternatives to synthetic geotextiles do exist in the form of biodegradables. These include polylactic acid - a thermoplastic polymer derived from renewable resources like cornstarch or sugarcane. The design life of these biodegradable textiles varies between 20-30 years. It is assumed that an allowable level of compaction within the sand layer would produce a dense, almost solid layer of sand

preventing migration of fine particles after the geotextile has biodegraded (around 20 to 30 years). This will be investigated further in the next design stage of the Hangar.

Soil plugs

The wharf resurfacing design includes a soil plug instead of geotextiles. This has been discounted for the hangar as it would require much more aggregate in the foundations while still being a permeable surface that would allow fines to migrate. A key environmental driver for AIMP is to prevent the need for further blasting on station for aggregate, supported by AIMPs annual stockpile surveys to track aggregate use, and plan future project needs for aggregate. Therefore, a soil plug has been discounted.

The choice of geotextile will be investigated further during the next work stage with a view to both the environmental and technical performance. Should a less environmentally impactful alternative be demonstrated to meet the design life requirements in this next work stage, the use of geotextiles in the foundations will be revisited.

End of Life

Traditional synthetic geotextiles come in woven, non-woven and knitted varieties with varying tensile strengths. The highest suitable tensile strength material will be chosen to reduce the likelihood of disintegration during its operational life, and to enable easy removal at end of life.

The deconstruction of the Hangar will be subject to a separate EIA at the time, however, the disintegration of the geotextiles can be mitigated through careful excavation of foundations: the locations where the geotextile membrane has been installed will be documented and archived on as-built drawings, which will be reviewed prior to any future removal. During removal in these areas, excavation of the backfill material will be undertaken carefully to expose the geotextile membrane while avoiding damage or disturbance. Once exposed, the membrane will be lifted and removed in a controlled manner to reduce the risk of break up and dispersal of the material to the ground and wider environment. The geotextiles will then be containerised immediately and shipped back to the UK for proper disposal.

4.5.3.13. APRON RESURFACING

Following completion of the new hangar and removal of the temporary hangar and tie downs, the apron will be resurfaced to bring it in line with the main runway resurfacing which was approved under the 2022 Runway Resurfacing and Lighting IEE.

The work will involve spreading and compacting graded aggregate material across the apron area. Compaction testing and plate bearing testing will be undertaken at required intervals to ensure that the resurfacing meets the required specification.

The work will require the use of a bulldozer, excavator and vibrating roller.

4.5.3.14. VESSEL SUPPORT

It is anticipated that the SDA will mobilise all plant and materials required for the 2026-27 and 2027-28 seasons. Following this a commercial vessel will be required to mobilise the remaining plant and materials required for the main works in the 2028-29 and 2029-30 seasons. It is anticipated that this vessel will dock at Rothera in November 2028 and require 5 days to unload.

Following completion of the project it is anticipated that a second (possibly different) commercial vessel will call in March 2030 to demobilise all waste and plant no longer required on the Station.

For efficiency, the vessels may also be used to import materials for and remove waste from other projects and activities at Rothera.

The type of commercial vessels that will be used is unknown at the time of preparing this EIA, but they will be of an adequate ice class and Polar Code compliant.

4.5.4. SCHEDULE

The project will be delivered over 4 summer and 1 winter seasons, as outlined below (see also *Figure 34*):

- 2026-27 season: enabling works and civils
- 2027-28 season: civils and foundations
- 2028-29 season: superstructure, envelope and internal fitout
- 2029 winter season: internal fitout
- 2029-30 season: internal fitout, commissioning and handover, and demobilisation.

Where possible activities have been planned to deconflict construction and aircraft operations which will continue to support science elsewhere on the continent from the apron and runway adjacent to the construction site.

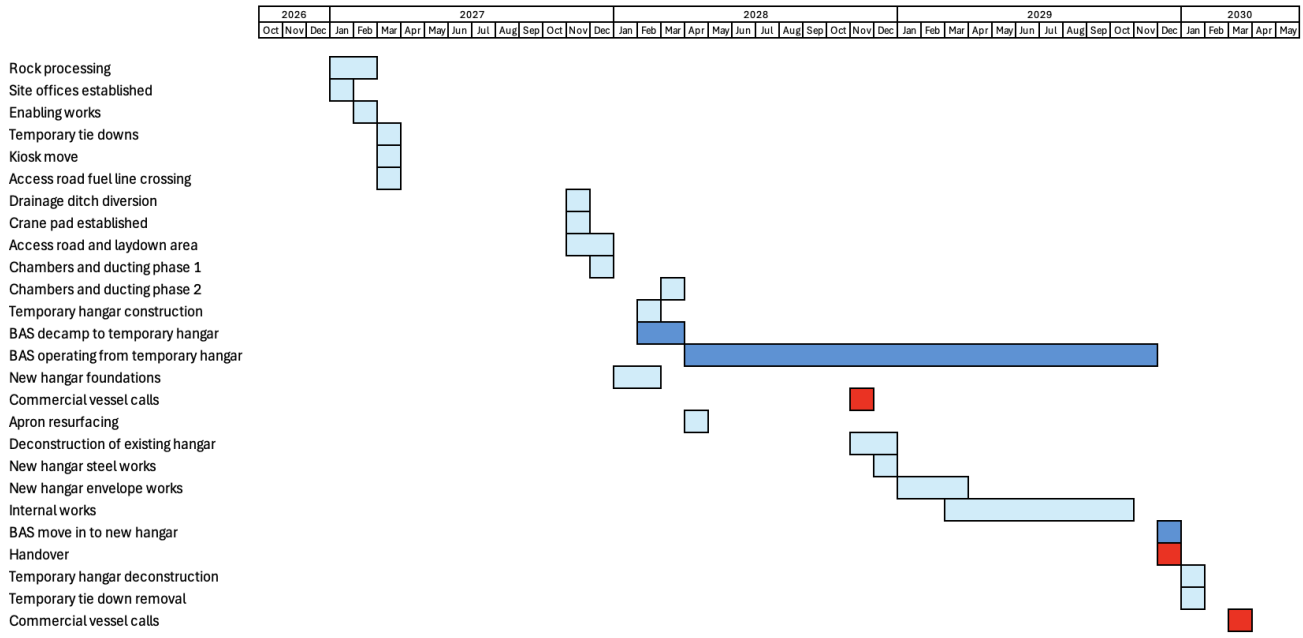


Figure 34. Outline of the planned schedule of work for the hangar redevelopment.

4.5.5. Environmental aspects

The aspects from the hangar redevelopment and associated works that will or may interact with the environment are identified as (see also *Figure 35*):

Normal operations

- **Mechanical action** and physical disturbance to ice-free areas, including the relocation of the drainage channel;
- **Emissions of noise** from the use of power tools and vehicles, including the excavator used for digging the trenches and backfilling and compaction of the fill material as well as marine noise from the operation of commercial vessels;
- **Emissions of dust** from the mobilisation of graded fill material;
- **Emission of fines** to the marine environment (*e.g.,* from the diversion of the new ditch);
- **Emissions of artificial light** if lighting rigs are used;
- **Ground borne vibrations,** arising from excavation, backfilling and compaction of fill material;
- **Emissions of exhaust gases and heat** from burning fossil fuels in vehicles and commercial vessels;
- **Light emissions,** if artificial lighting rigs are required;
- **Production of waste** (significant amounts) from the importation of materials, the dismantling of existing infrastructure, removal of temporary hangar, and cementitious waste;
- **Introduction of synthetic materials** into the Antarctic environment (e.g., use of geotextile material in the hangar foundation).

Unplanned or emergency situations

- The risk of **introducing non-native species** from the importation of building materials and plant and use of commercial vessels;
- The risk of **fuel spills** because of an emergency event on a vehicle (*e.g.* hydraulic hose failure) or during the refuelling of vehicles or from striking unknown ground services
- The risk of a **marine spill** from a commercial vessel or SDA when in support of AIMP.

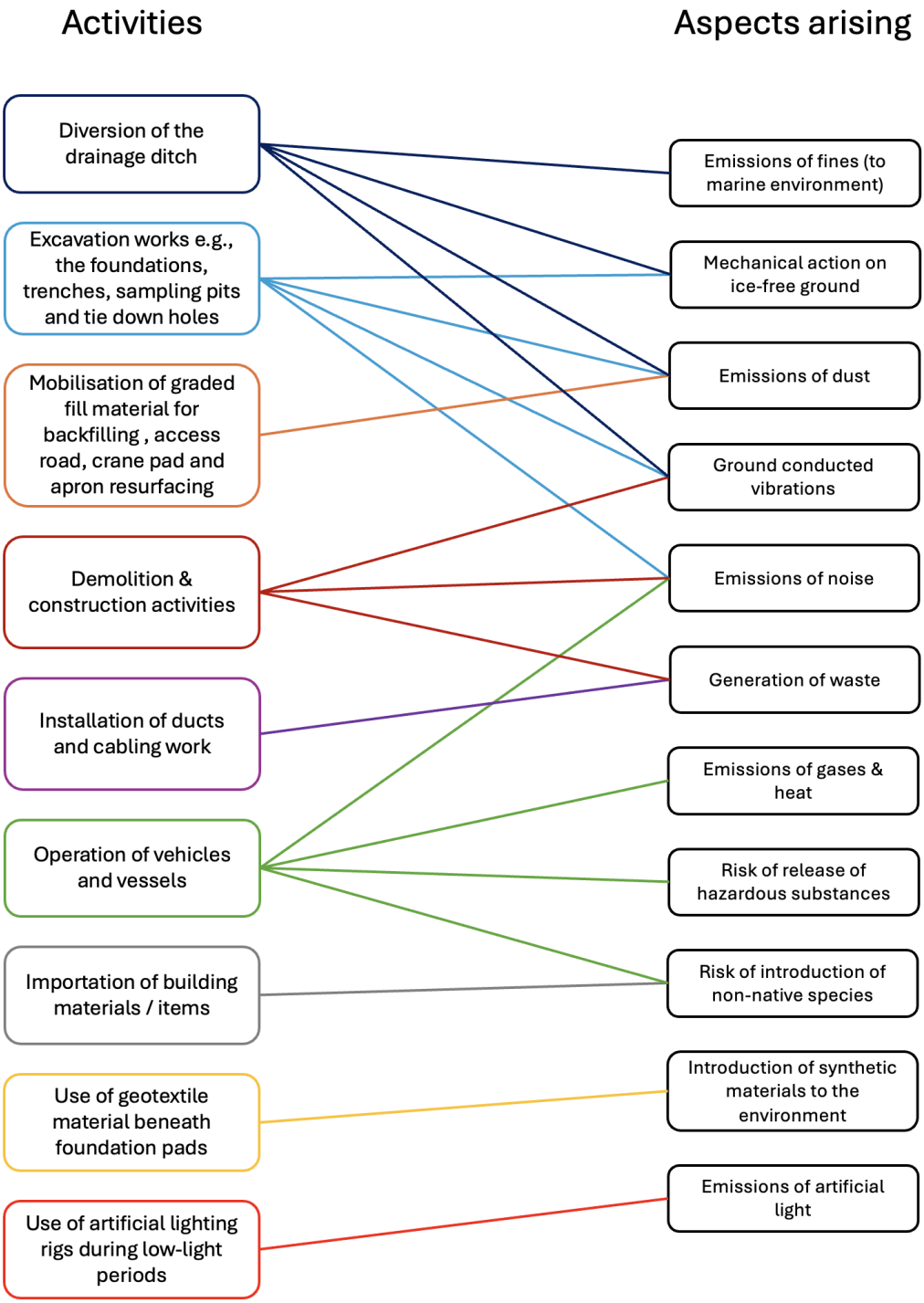


Figure 35. Overview of the aspects arising from the hangar redevelopment preparatory works.

4.5.6. Decommissioning and removal

Following the completed works it is anticipated that the hangar will have a useful life of approximately 60 years. If required, the hangar and associated infrastructure could be removed in their entirety following a reverse of the installation procedure, with materials managed so as to maximise reuse or recycling. The impacts would need to be assessed by means of a separate EIA at the time.

4.6. BOLLARD REMOVAL

4.6.1. BACKGROUND

Having contractors on site provides an opportunity also to undertake restorative or general improvement work at Rothera. During the 2026-27 season, it is planned to remove a now disused concrete mooring bollard (*Figure 36*). Not only is it no longer used, but its location close to the runway presents a degree of risk to aircraft operations, which the BAS Air Unit would prefer to see removed.

4.6.2. ALTERNATIVES CONSIDERED

There are few alternatives to be considered. Now that the mooring bollard is no longer required for ship operations, it could either be left in place, even though it has no useful purpose, or removed. It was decided that it is preferable to remove the bollard and reduce the associated risk to aircraft operations.

4.6.3. PLANNED WORK

During the 2026-27 season the mooring bollard will be removed. Given its size, and the fact that it appears to have been cast *in situ*, it is unlikely that the bollard can be removed intact. It is estimated that it sits at least 1m below ground level.

The work will be undertaken by BAS Estates. It will involve breaking the block up using a 'pecker' attachment to an excavator. The concrete block will be broken up to at least 300mm below ground level. The resulting broken concrete waste (and metal chain) will be collected and transported away and stored prior to removal from Rothera along with other waste materials. The hole will then be backfilled with graded (locally sourced) rock material and compacted to remediate the topography back to the surrounding levels.

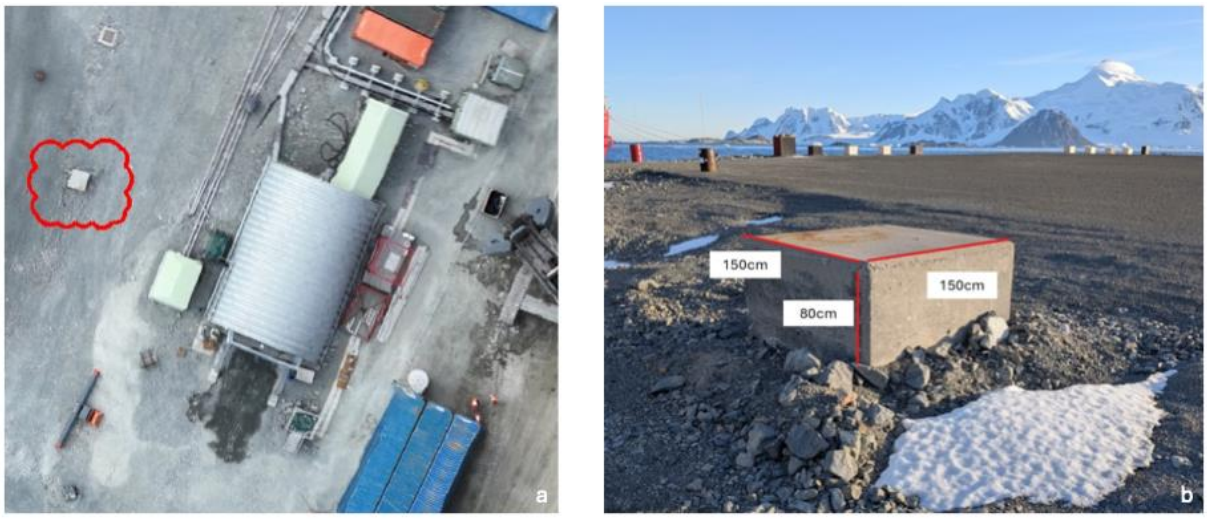


Figure 36. Location of the disused mooring bollard adjacent to the southern end of the runway (a) and its dimensions above ground (b). Source: BAS / Tim Ferns.

For completeness, it is noted that the bollard supports a fixed datum point (*Figure 37*). The BAS Mapping and Geographic Information Centre (MAGIC) have been consulted, and they have confirmed that the datum point is no longer required. Removal of the datum itself will not have any environmental implications above and beyond the removal of the concrete bollard.



Figure 37. Datum point on the disused mooring bollard. Source: Tim Ferns / BAS.

4.6.4. Environmental Aspects

The aspects from the removal of the concrete bollard that will or may interact with the environment are identified as (see also *Figure 38*):

Normal operations

- **Emissions of dust**, arising from the concrete breaking and backfilling of graded material;
- **Noise emissions** from the breaking up of the concrete block, backfilling and compaction;
- **Ground borne vibrations,** arising from the breaking of the concrete bollard, backfilling and compaction of the fill material;
- **Mechanical action on and physical disturbance to** ice-free ground from excavating around the bollard;
- **Creation of waste materials**, notably broken concrete, that will need to be removed from site and the release of alkaline fines;
- **Emissions of exhaust gases and heat** from burning fossil fuels in vehicles;
- **Light emissions,** if artificial lighting rigs are required;
- Removal of the bollard with implications for **aesthetic and wilderness values.**

Unplanned or emergency situations

- The risk of **fuel spills to the terrestrial environment** because of an emergency event on a vehicle (*e.g.,* hydraulic hose failure) or during the refuelling of vehicles.

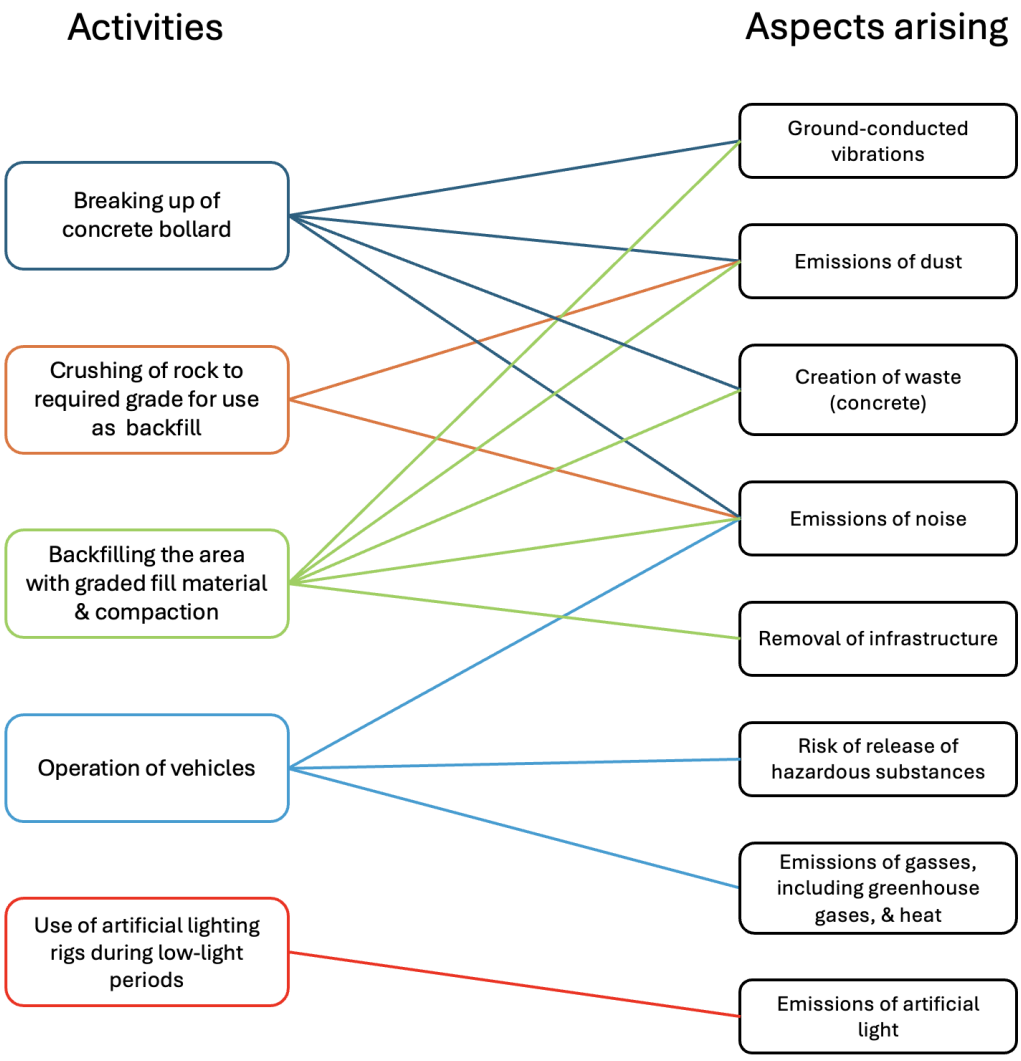


Figure 38. Diagrammatic overview of the aspects arising from the bollard removal work.

4.7. REMOVAL OF THE OLD REFUELLING HUT

The refuelling hut that had been used during refuelling operations, is no longer required. The opportunity will be taken to remove the contents of the hut, dismantle it and (on current plans) repurpose it elsewhere on the Station; though in what capacity has yet to be determined.

The hut is situated on the western side of the boatshed (*Figure 39*). The hut itself is comprised of glass reinforced plastic (GRP or fibreglass) panels. The hut sits on concrete 'dwarf walls' which are sitting on a solid concrete slab. The concrete dwarf walls will be broken up to 300mm below ground level and removed. The concrete slab will be left *in situ* and backfilled and compacted to bring the topography back to surrounding ground level.

Existing below-ground fuel lines will be carefully exposed and removed back to the fuel farm connection flanges. Lines will be drained in a controlled manner prior to cutting where required. Removed pipe sections will be cut into manageable lengths, capped and containerised for removal in accordance with station procedures.

The work will be undertaken in November 2026 (see *Figure 17*).



Figure 39. Location of the old refuelling shed. Source: Tim Ferns / BAS.

4.7.1. ALTERNATIVES

The alternative to removal is to 'do nothing' and leave the hut in its current location. This would eliminate any impacts identified in this EIA that will or may arise from its removal.

However, removing the hut provides the opportunity to fully remove the remaining pipes and any residual fuel that they may contain.

Once the new pipelines and the fuel reel bunker station are installed and commissioned, the old hut will serve little useful purpose in its current location and is likely to be more useful elsewhere.

For this reason, doing nothing was rejected in favour of removing and potentially relocating the hut.

4.7.2. Environmental aspects

The aspects from the removal of the refuelling hut and remaining subsurface pipelines that will or may interact with the environment are identified as (see also *Figure 40*):

Normal operations

- **Emissions of dust**, arising from the breaking up of the old fuel hut foundations and the backfilling of the graded rock material;
- **Emissions of exhaust gases and heat**, arising from burning fossil fuels in excavation vehicles and rock crushing equipment;
- **Noise emissions**, arising from the breaking up of the concrete dwarf walls of the old fuel hut and the use of power tools;
- **Ground borne vibrations,** arising from the breaking up of the concrete dwarf walls of the old fuel hut and compaction of fill material;
- **Light emissions,** if artificial lighting rigs are required;
- **Creation of waste materials,** from concrete breaking, as well as removal of the old fuel pipes. and the release of alkaline fines;
- Removal of the hut with implications for **aesthetic and wilderness values.**

Unplanned or emergency event

- The risk of **fuel spills to the terrestrial environment** because of an emergency event on a vehicle (e.g. hydraulic hose failure) or when excavating and removing old fuel pipelines or during the refuelling of vehicles.

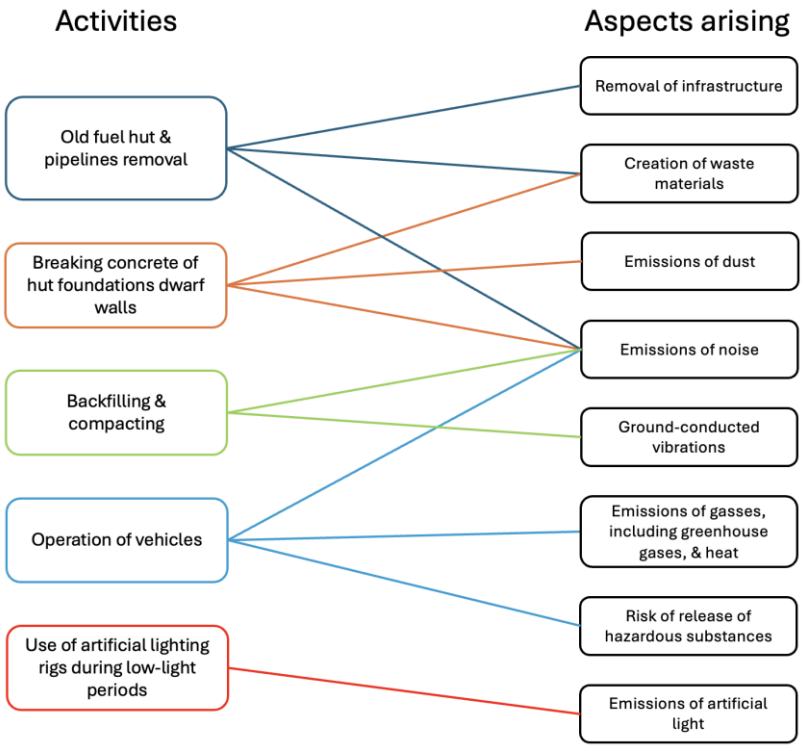


Figure 40. Diagrammatic overview of the aspects arising from the removal of the old fuel hut and disused pipelines.

4.8. RUNWAY MAINTENANCE

4.8.1. Background

The runway was fully resurfaced and a new lighting system installed during the 2022-23 and 2023-24 seasons. Ongoing maintenance of the runway requires regularly laying, compacting, and trimming the gravel surface to remove inconsistencies and maintain a smooth, compacted, and safe surface. Camber management (the curve of the runway surface) is also required to enhance drainage, and to prevent meltwater from damaging the runway during the thawing season.

For these reasons a stockpile of graded, locally sourced gravel material is maintained. The runway stockpile is located to the west of the runway and south of the fuel farm (*Figure 41*; see also *Figure 43*).



Figure 41. Location of the graded material that is used solely for runway maintenance. Source: BAS.

The precision approach runway lighting was upgraded during the 2022-23 and 2023-24 seasons. Four electrical cabinets are installed along the runway margin in connection with the lighting system (*Figure 42*). The stainless-steel cabinet covers are corroded and need to be replaced to maintain their weather tightness.

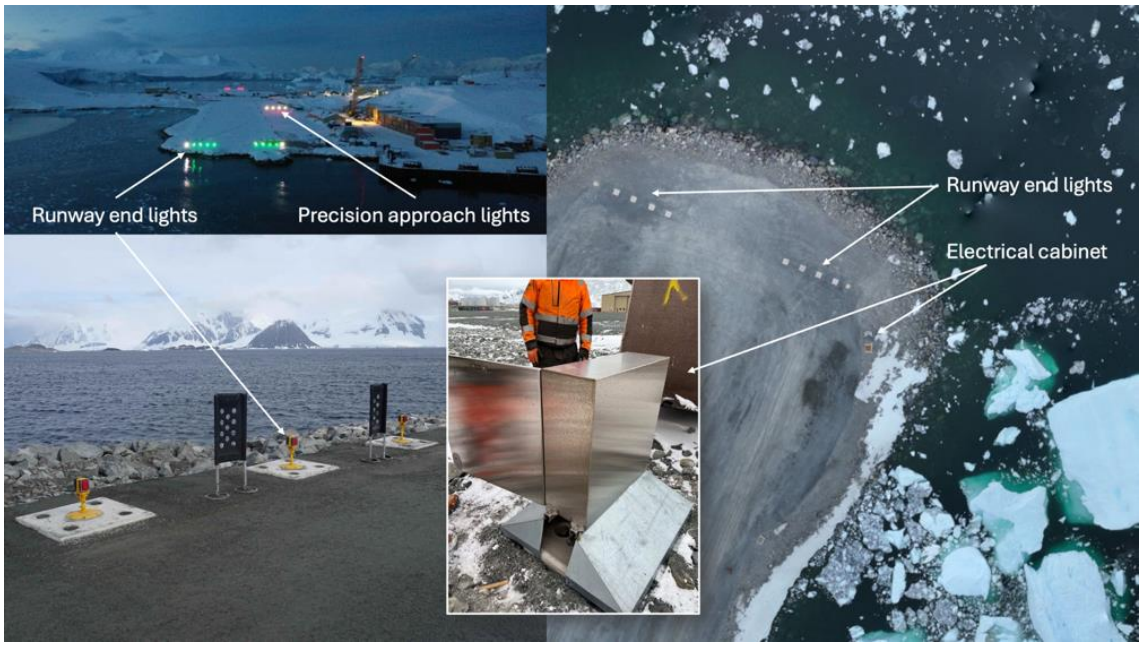


Figure 42. Images of the Rothera runway lighting system and an example location of an electrical cabinet. Source: BAS.

4.8.2. Alternatives considered

There are few alternatives, as the proposed work needs to be undertaken to maintain the safety of air operations at Rothera. Not proceeding with the planned work would remove the actual or potential impacts, but graded material will always be required for this design of runway to maintain the reliability of the runway surface.

The replacement covers for the electrical cabinets are essential for maintaining the integrity of the lighting system.

4.8.3. Planned work – the preferred approach

4.8.3.1. Stockpiling runway surface material

The runway surface aggregate stockpile will be replenished with approximately 2,100m^3 of additional material. The required grade (up to 16mm in size) will be processed from existing stockpiles. Rock processing will take place in the designated area near to the wharf (*Figure 7*, *Figure 49*, *Figure 43*) using the jaw crusher and screener.

An articulated dumper truck or hauler will transport the graded material from the rock processing area to the runway stockpile via Admirals Road and the runway crossing point. A wheeled loader will be required for the loading of the dumper truck, and an excavator will be required for unloading at the stockpile.

4.8.3.2. ELECTRICAL CABINET COVER REPLACEMENTS

Replacement stainless steel covers will be imported and installed on the North, South, precision approach and abbreviated precision approach electrical cabinets (locations marked in *Figure 43*). No excavation is involved; this is a like-for-like replacement.

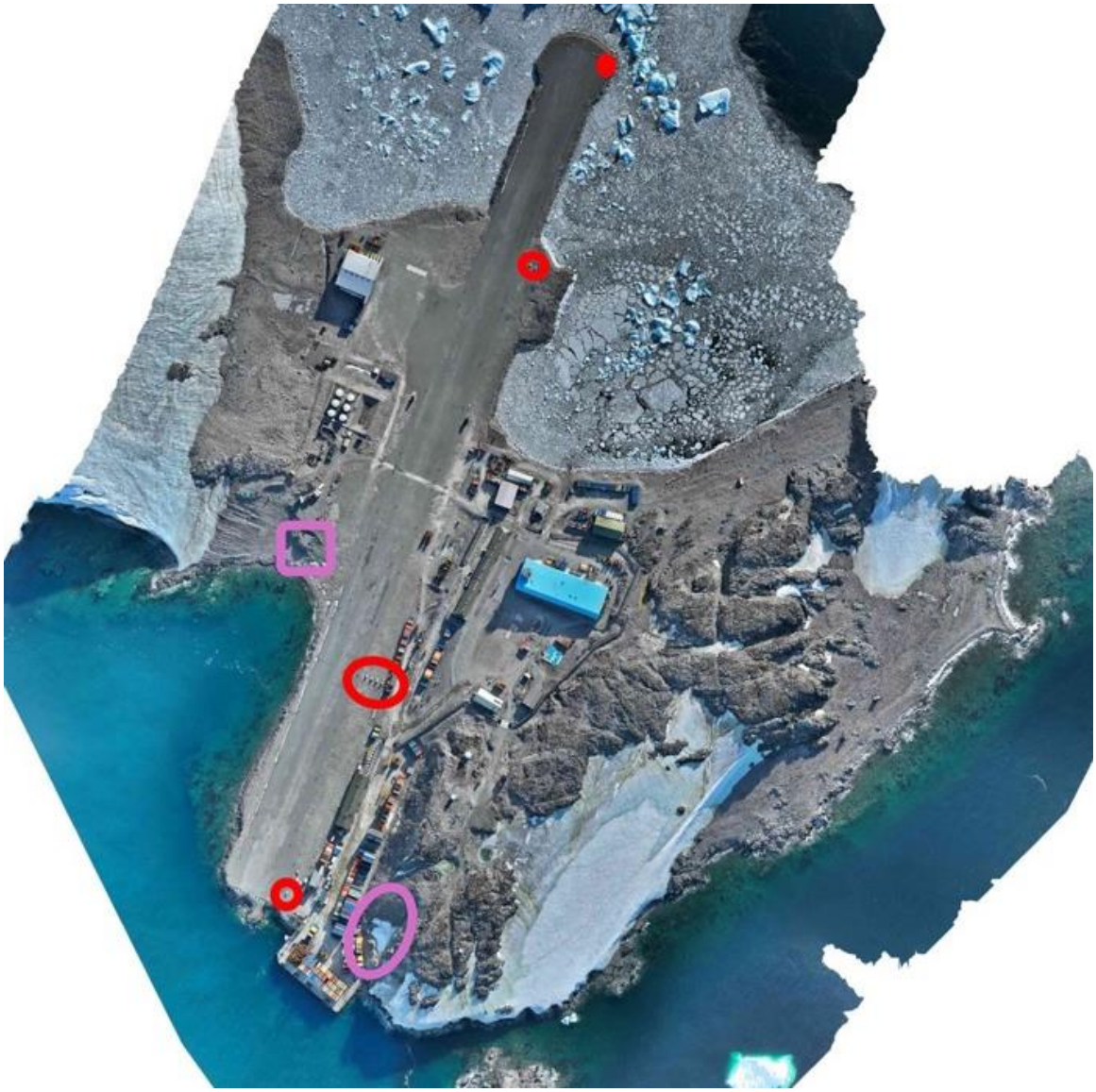


Figure 43. Locations of the runway lighting electrical cabinets (red circles). Purple oval marks the rock crushing and grading area. Purple square marks the area of the runway stockpile. Source: BAS.

4.8.3.3. SCHEDULE

As noted above, rock crushing (for all activities requiring graded material including the runway stockpile) will take place between early December 2026 and mid to late January 2027. Screening (to obtain the required

grades) for all projects will take place from early December 2026 through to early March 2027 (see Section 4.11.).

The lighting cabinet replacements are scheduled for no-fly periods and likely will be undertaken towards the end of the season once the aircraft have departed Antarctica from mid-March onwards.

4.8.3.4. PERSONNEL AND EQUIPMENT

This project will be undertaken by BAM. Resourcing for the rock crushing and stockpiling are provided in Section 4.11.

Only one or two BAM personnel will be needed to replace the lighting cabinets, which is anticipated to take no more than a few hours.

4.8.4. ENVIRONMENTAL ASPECTS

The aspects arising from the runway associated works that will or may interact with the environment are identified as (see also *Figure 44*):

Normal operations

- Importation of materials (replacement electrical cabinet covers) carries the **risk of introducing non-native species**;
- **Emissions of dust**, arising from the crushing of rock and fill material to the required grade, the filling of the dumper trucks, and the unloading and stockpiling of the graded rock material at the runway stockpile;
- **Emissions of noise** from the rock crushing and the use of vehicles as well as the use of power tools for the electrical cabinet replacements;
- **Emissions of exhaust gases and heat** from burning fossil fuels in vehicles and rock crushing equipment;
- **Generation of waste** through the removal of the existing corroded cabinet casings;
- **Light emissions,** if artificial lighting rigs are required;
- Increasing the stockpile may have **implications for aesthetic and wilderness values**.

Unplanned or emergency situations

- The risk of **fuel spills** as a result of an emergency event on a vehicle (*e.g.,* hydraulic hose failure) or during the refuelling of vehicles.

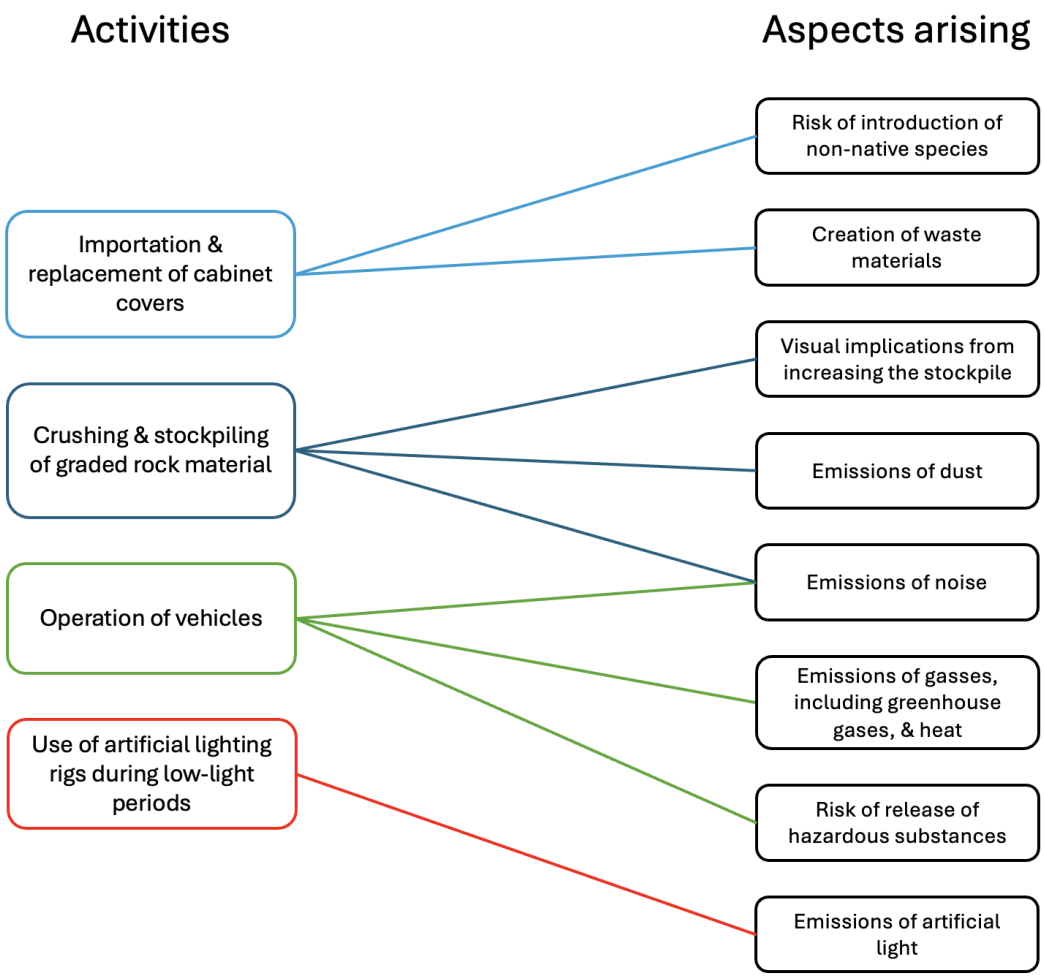


Figure 44. Diagrammatic overview of the aspects arising from the runway maintenance works.

4.8.5. Decommissioning and removal

Removal of the graded rock stockpile and runway infrastructure would only be undertaken at some point in the future if air operations at Rothera were to cease or the Station were to be closed. Removing the runway lighting and associated infrastructure would be a relatively straightforward exercise.

Considerations as to the management of the stockpile of graded material along with the runway itself would need to be part of a broader consideration of remediating the Rothera site.

4.9. ESTABLISHMENT OF A SLIPWAY

4.9.1. BACKGROUND

Small boat operations at Rothera provide the primary platforms for supporting nearshore marine biological research, transferring personnel to nearby islands for terrestrial studies, as well as providing mandatory search and rescue safety cover during aircraft operations.

Small boat launching is centred around the modernized wharf, which features a dedicated hydraulic crane to safely lower boats into the water.

However, ice and sea state conditions may restrict boat launching at the wharf and there is operational convenience and safety benefits in having alternative launching points.

Historically, a rock slipway was used to launch boats in North Cove (*Figure 45b*), but the site was overtaken by other activities during the AIMP, including the storage of scrap metal. Partly due to the wharf resurfacing project, which will disable boat launches at the wharf for a period of time, as well as to improve search and rescue response time, BAS would like to re-establish the capability to launch boats from the North Cove by reinstating a rock slipway.

It is emphasised that, because of scrap steel being stored in this area, this project is subject to the results of laboratory analysis of soil samples that were taken during the 2025-26 season. The results are expected in June 2026, and the BAS Environment Office will need to assess the results prior to the project progressing. This location will not be used as a boat launching slipway if it will lead to contaminated soil going into the sea. Only if contaminant levels are deemed environmentally safe will the project go ahead.

4.9.2. ALTERNATIVES CONSIDERED

4.9.2.1. DO NOTHING

Doing nothing and not installing a new slipway would eliminate the actual or potential impacts that will or may arise from the works involved. However, the operational and safety benefits of being able to launch small boats directly into North Cove would also be lost.

Planes currently land at Rothera on approach from the south to the north. There is therefore a need to have the capability to respond to an emergency event should a plane go off the north end of the runway. The 'do nothing' option would reduce this response capability. Having to launch the fast rescue boat from the wharf greatly increases the response time if it has to travel around Rothera Point to reach North Cove.

For this reason, the 'do nothing' option was rejected in favour of proceeding with the construction of the slipway.

4.9.2.2. ALTERNATIVE SLIPWAY LOCATIONS

Three other locations were investigated for establishing a slipway including:

- South Cove;
- further along the North Cove shoreline and closer to the runway;
- Hangar Cove.

A trial launch was undertaken in South Cove during the 2025-26 season. This did not work due to the steepness and unevenness of the rocks which resulted in damage to the boat launching trailer. This site would not improve response times to an emergency event at the northern end of the runway.

An area approximately 50m north of the proposed slipway site was investigated, but this would involve heavy civil works to remove the rock armour adjacent to the runway and to regrade what is a steep slope.

Hangar Cove is often full of brash ice making launching more difficult and potentially untenable in an emergency.

For these reasons the alternative sites were rejected in favour of the preferred location in North Cove.

4.9.3. Planned work – the preferred approach

The beach in North Cove naturally slopes from the land into the sea (*Figure 45*). It is intended to use this natural slope to profile a slipway. The area will be reprofiled using the existing beach material, no additional material is expected to be required. The area that is subject to reprofiling will be around 20m x 14m.

4.9.4. Schedule

It is anticipated that the work will occur over one or two days only during the 2026-27 season. This will be undertaken as plant and personnel availability allows during the season, but most likely will be after the flying season (after 12 March).

4.9.5. Personnel and equipment

The work will be undertaken by the BAS Estates Team. It will require an excavator and a bulldozer.

4.9.6. Anticipated fuel use

The anticipated fuel volumes to be used for the establishment of the slipway are shown in *Table 3*.

Table 3. Anticipated fuel volumes for the establishment of the slipway.

Vehicle or plant	Duration (hours)	Estimated fuel consumption rate (l/hr)	Total consumption (l)
Excavator (36T)	5	23.1	115.5
Bulldozer	2	12.8	25.6
		TOTAL	**141.1**

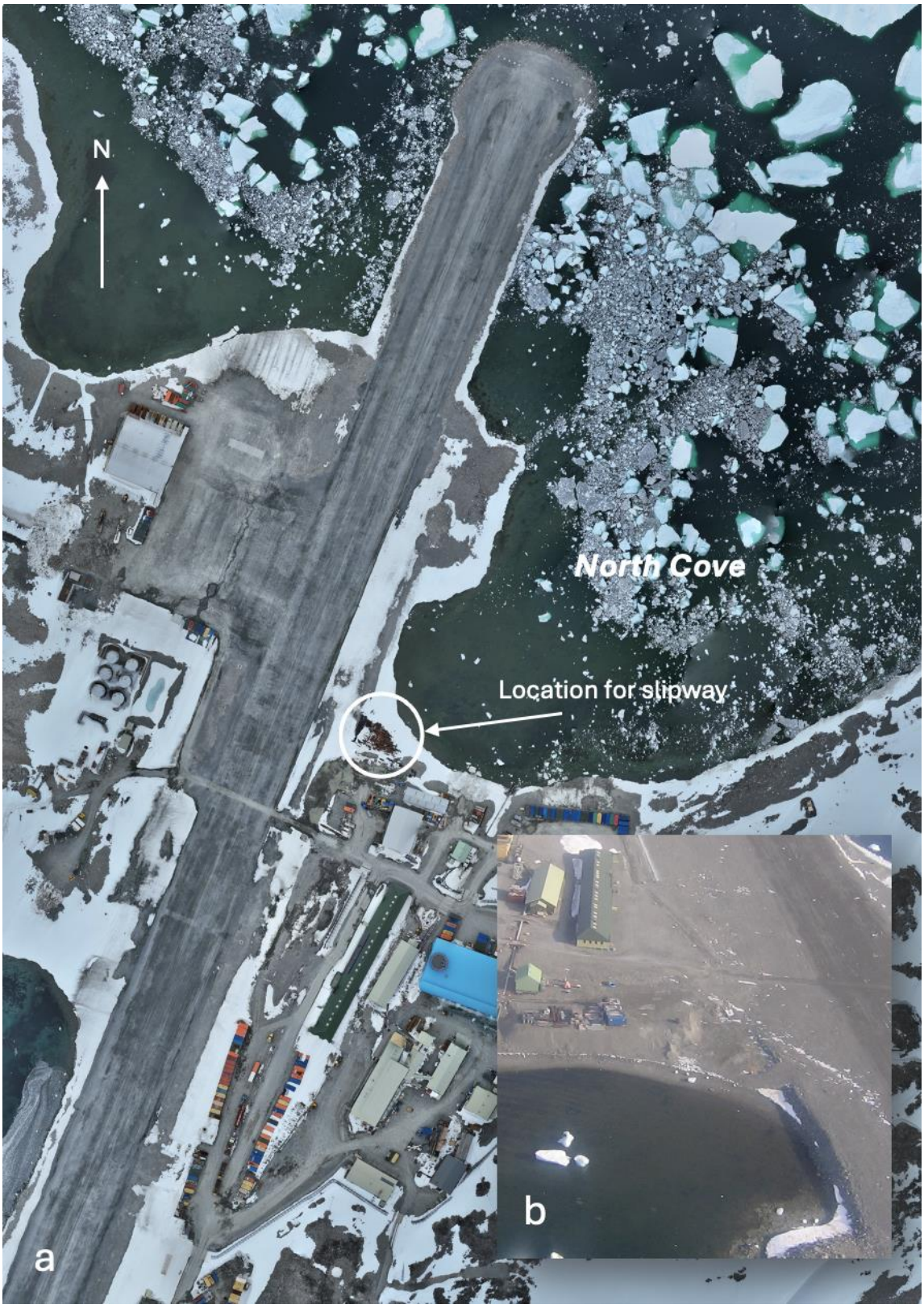


Figure 45. (a) Aerial view of Rothera showing the location of the planned slipway in North Cove. (b) Inset shows the location of the old slipway in North Cove. Source: BAS.

4.9.7. ENVIRONMENTAL ASPECTS

The aspects from the slipway construction that will or may interact with the environment are identified as (see also *Figure 46*):

Normal operations

- **Mechanical action** and physical disturbance to the shoreline;
- **Emissions of dust**, arising from the reprofiling at the slipway site;
- **Emissions of noise and the potential propagation of noise to the local marine environment** from the reprofiling work;
- **Ground borne vibrations and the potential propagation of vibrations to the local marine environment,** arising from the excavation and reprofiling;
- **The release of fines to the local marine environment** during the excavation and reprofiling;
- **The risk of releasing contaminated fines to the nearshore marine environment** – noting that the area has been used for storing scrap metal during the AIMP;
- **Highly localised water turbulence**;
- **Emissions of exhaust gases and heat** from burning fossil fuels in vehicles;
- **Light emissions,** if artificial lighting rigs are required;
- **Visual alteration to the shoreline**.

Unplanned or emergency situations

- The risk of **fuel spills** because of an emergency event on a vehicle (*e.g.,* hydraulic hose failure) or during the refuelling of vehicles with the potential to release hazardous substances to the shore / nearshore area.

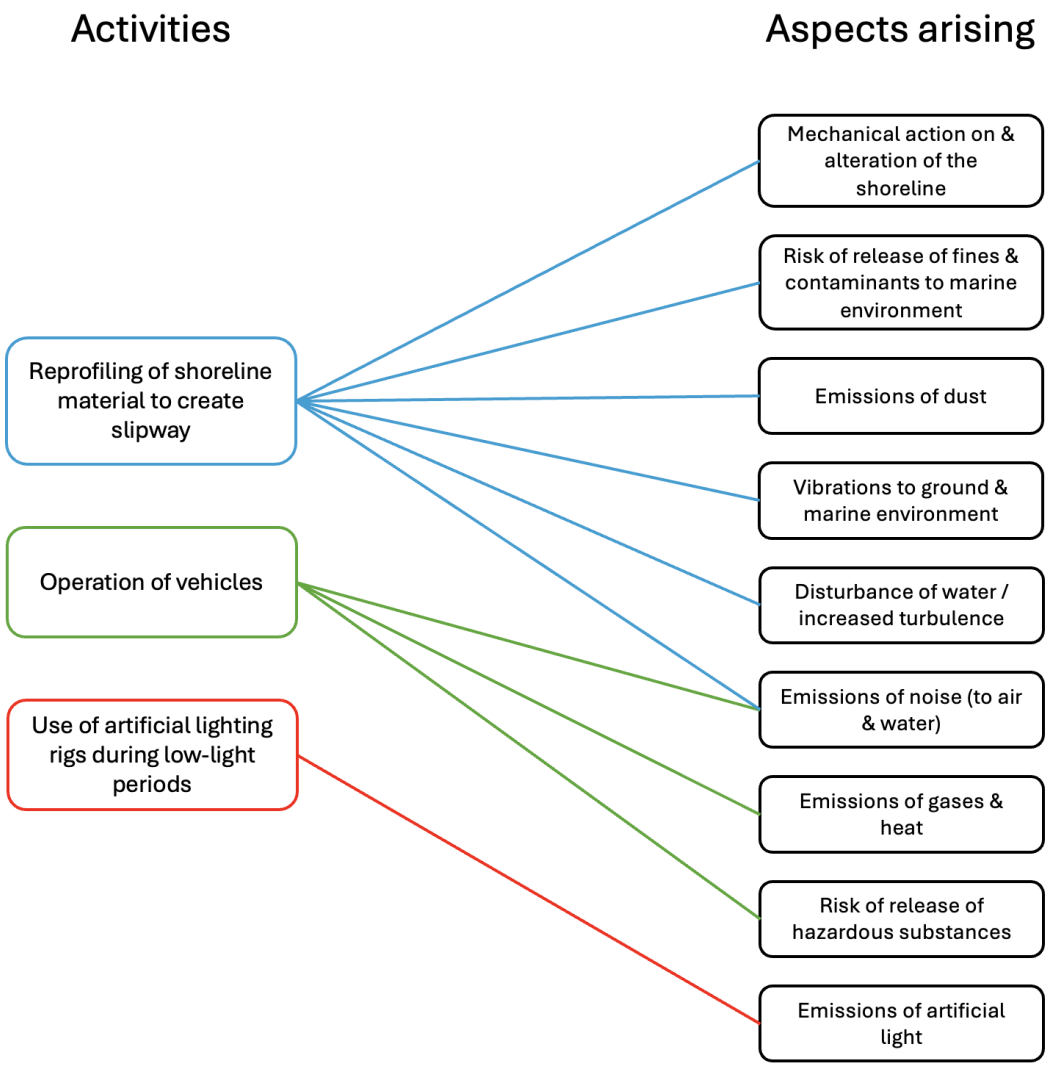


Figure 46. Diagrammatic overview of the aspects arising from the creation of the slipway.

4.9.8. Decommissioning and removal

The use of natural, locally sourced materials for the creation of the slipway, would allow for a degree of remediation should it no longer be required. The area could be reprofiled to more naturally align with the surrounding shoreline. Ice and sea action would potentially remediate the site to a more natural state over time.

4.10. GROUND CONTAMINATION ASSESSMENT

4.10.1. BACKGROUND

It is intended to undertake an evaluation of selected sites within the current station boundaries to assess the extent of ground contamination. The information gained will inform future planned work and identify opportunities for remediation.

Works on the western side of the runway includes redevelopment and extension of the aircraft hangar (see Section 4.5.), and future replacement of the fuel farm.

Further, the removal of buildings to the south of the new Discovery Building has revealed areas of ground that may also be contaminated and potentially require remediation.

4.10.2. ALTERNATIVES CONSIDERED

Few alternatives are available. Taking no action would avoid any impacts associated with the sampling. However, it would leave the nature and extent of contamination unknown and could allow future impacts to occur if remediation is not identified and undertaken.

For these reasons, the 'do nothing' option was rejected in favour of sampling to inform remediation options.

4.10.3. PLANNED WORK – THE PREFERRED APPROACH

A ground contamination assessment (GCA) will be undertaken at Rothera to identify potential sources, receptors, and risks of contamination. The GCA will only focus on key sites where historic contamination may or is known to have occurred.

The aim at these selected sites will be to understand the type and extent of contamination, the risks that are posed by any contamination that is identified and what remediation options are available. This information will be used to inform future work.

A desk-based study is being prepared which will identify the precise locations for the sampling pits and other ground investigations to be undertaken to assess contaminant presence, ground water presence and potential paths for migration. The likely locations are to the south of the new Discovery Building, and in the vicinity of the current aircraft hangar and fuel farm to the west of the runway. The report will also present remediation options if these are needed and feasible.

Between five and ten pits will be dug using an excavator (each pit about 2m x 2m x 1.5m deep). Samples will be taken for analysis and the ground reinstated by backfilling and compaction.

In addition, soil samples have been taken during the 2025-26 season from the area adjacent to North Cove, that was used for storing scrap metal (see reference also in Section 4.9.1.) as well as an area of potentially contaminated ground where Old Bransfield House used to be (to the south of the new Discovery Building and east of Admirals House). The result of the testing will be known prior to the 2026-27 season and will be used to inform a remediation strategy if needed. That remediation work may be undertaken over the next two austral summer seasons and within the timeframe of this EIA. The precise details of any remediation work are not known at this stage (see Chapter 8 – Gaps in Knowledge and Uncertainties).

4.10.4. SCHEDULE

The works will require access to the ground surface so will be undertaken once snow has been cleared. It is likely that this will be undertaken during the 2026-27 season.

The work is likely to take no more than a few days.

4.10.5. PERSONNEL AND EQUIPMENT

The work will be undertaken by BAM and will require an excavator, one excavator operative, one banksman and one inspection engineer.

4.10.6. ENVIRONMENTAL ASPECTS

The aspects from the ground contamination sampling that will or may interact with the environment are identified as (see also *Figure 47*):

Normal operations

- **Mechanical action** and physical disturbance to an ice-free site;
- **Emissions of noise** from the use of vehicles, including the excavator used for digging the pits and backfilling and compaction of the fill material;
- **Emissions of dust** during digging and reinstatement of the pits;
- **Ground borne vibrations,** arising from the excavation, backfilling and compaction of the fill material;
- **Emissions of exhaust gases and heat** from burning fossil fuels in vehicles;
- **Light emissions,** if artificial lighting rigs are required.

Unplanned or emergency situations

- The risk of **fuel spills** because of an emergency event on a vehicle (e.g. hydraulic hose failure) or during the refuelling of vehicles.

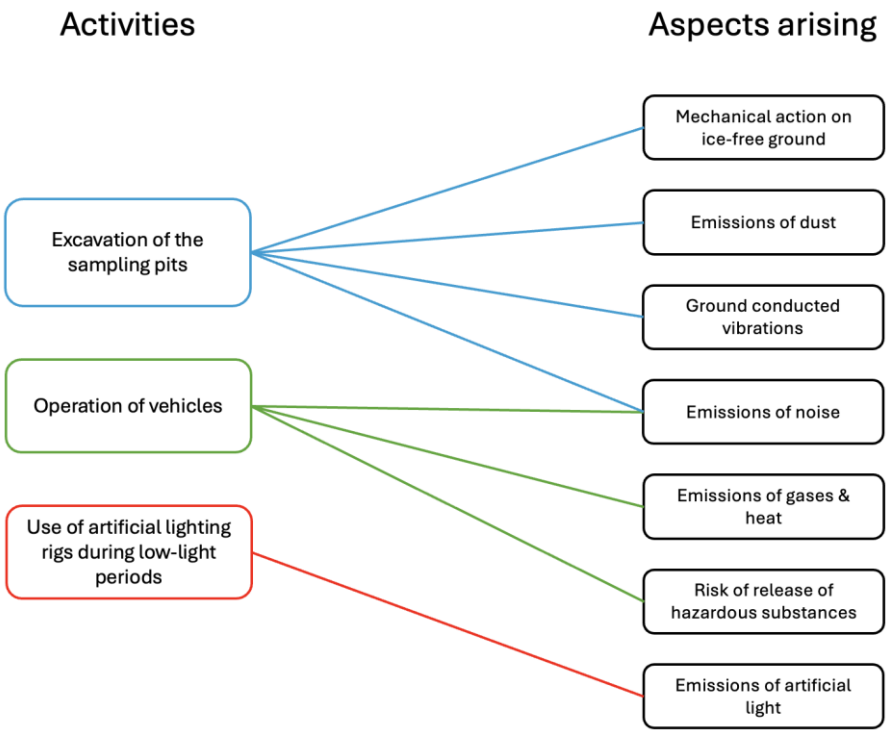


Figure 47. Diagrammatic overview of the aspects arising from the ground contamination assessment.

4.10.7. DECOMMISSIONING AND REMOVAL

This is not an applicable consideration as far as the sampling is concerned. It is possible that the same locations may need to be revisited and re-excavated if remediation options are pursued.

4.11. ROCK PROCESSING AND STOCKPILING

As described above, most of the projects in the 2026-27 season require the use of graded fill material, including for the wharf resurfacing, bedding and backfill for the pipelines trenches, groundworks around the hangar and for stockpiling for runway maintenance work.

In most cases, the graded material that is required will be generated from the excavated material. Where this needs to be supplemented, previously locally sourced material (that is stockpiled close to the wharf) will be crushed and graded.

A summary of the requirements is provided in *Table 4*.

Table 4. Summary of the aggregate required for the various projects in the 2026-27 season.

Project	Activity	Volume of material required (m^3)	Notes
Wharf resurfacing	Resurfacing Wharf	4,058	937m^3 of which is new material needing to be crushed and processed. Remaining 3,121m^3 will be scraped from the top layer of the wharf, processed, and returned
Fixed Fuel Lines	Trenching & Backfilling	250	No new material is needed. Material will be excavated, processed, and returned
Runway maintenance	Stockpiling for future maintenance of runway	2,100	Will be added to existing maintenance stockpile west of the runway
Renewable energy project	Ground preparation for GMPV trial	250	New material that needs to be processed from wharf stockpile
Hanager redevelopment preparatory works	Crane Pad Temporary laydown Permanent works Access road	74 1,002 298 1,920	New material that needs to be processed from wharf stockpile.
Sitewide services remediation	Temp Laydown	50	New material that needs to be processed from wharf stockpile
	Total	**10,062m^3**	
	Total new	**6,631m^3**	Obtained from previously locally sourced stockpile

All aggregate processing will be managed by BAM and will take place in the rock crushing area adjacent to the wharf using the Terex Powerscreen 330 jaw crusher (*Figure 49*) and a Sandvik QH332 Hydrocone Crusher. The crushed material will be screened to obtain the required grade using a Sandvik QA331 screener (*Figure 50*).

In addition to the crusher and screener, a wheeled loader, 49T excavator and 28T articulated dump truck are required for managing the material at the rock crushing area.

Other than the material needed for the wharf resurfacing, which will stay locally, the processed aggregate will be moved by dump truck to the two designated stockpile locations within the Station boundaries (*Figure 51*). An excavator is required to support the unloading and stockpiling of the aggregate once delivered.

The initial processing with the jaw crusher will take place during the early part of the season (early-December to mid-January). Screening and stockpiling will continue for most of the season (early-December to early-March) (*Figure 48*).

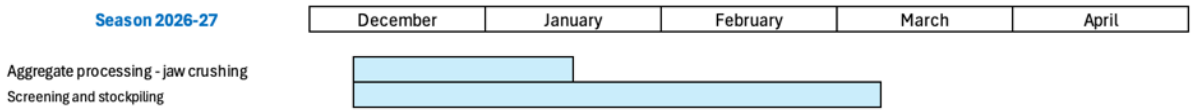


Figure 48. Approximate schedule for the aggregate processing during the 2026-27 season.



Figure 49. Jaw crusher used at Rothera prior to shipping. Source: BAS.



Figure 50. Screener in use at Rothera during the construction of the wharf. Source: Sandvik



Figure 51. Designated stockpile locations shaded in red. Source: BAS.

4.12. SUPPORT ACTIVITIES

4.12.1. BACKGROUND

The planned work described above will be undertaken on site by BAM Nuttall (BAM), the Construction Partner, and/or by the BAS Estates Team.

The work will require specialist and general construction personnel to be transported to and spend time at Rothera. Whilst at the Station, construction personnel will consume resources (energy, water, food) and produce waste (general, food and human waste) which will need to be managed. Construction workers will also occupy space on the station. The environmental consequences of these support activities also need to be accounted for in the EIA.

Alternatives are not considered in this section. The use of resources and the production of waste will occur and will be an unavoidable consequence of having construction workers travel to and be stationed at Rothera.

However, it is noted that a core element of the AIMP is to increase the efficiency of operation of the Station and to reduce environmental impacts in particular resource use and the reliance on fossil fuels. It is anticipated that, despite the impacts of the construction process itself, there will be a net environmental benefit for the general operation of the Station on completion of the AIMP.

There is a cap of 45 construction personnel on station for the 2026-27 season, which includes five BAS site supervisors. These numbers are expected to be mirrored for the 2027-28 season.

4.12.2. TRANSPORT OF PERSONNEL TO AND FROM ROTHERA

Personnel will be transported to and from Rothera either by sea or by air, depending on operational requirements and seasonal constraints. Personnel travelling by air will depart from the UK using established scheduled commercial flights to a recognised South Atlantic gateway. From there, most personnel will continue onward to Rothera aboard BAS-operated aircraft, primarily the Dash 7.

For the 2026-27 season, the Dash 7 will remain the principal means of transferring personnel between the South Atlantic gateway and Rothera, supporting the majority of staff movements.

Sea-based transport via the SDA will provide a robust and sustainable alternative, particularly for larger groups of personnel and in conjunction with cargo movements.

4.12.3. TRANSPORT OF CARGO TO AND WASTE FROM ROTHERA

The primary method for transporting cargo to Rothera is by sea, using the SDA. The vessel provides the principal logistical link between the United Kingdom and Rothera via South Atlantic gateway ports, enabling the bulk movement of equipment, fuel, construction materials, scientific apparatus, and general supplies. The SDA vessel is specifically equipped to operate in polar conditions and can deliver large volumes of cargo efficiently during the austral summer season when sea ice conditions permit access.

In addition to the SDA commercial cargo vessels are also likely to be required, not least to support the hangar redevelopment (Section 4.5.3.14.). The commercial vessels that are selected to transport personnel, cargo and plant to Rothera will be of an appropriate ice-class and Polar Code compliant.

Cargo operations at Rothera are carefully managed to minimise environmental impact, with established procedures for offloading, storage, and handling designed to reduce the risk of spills, contamination, or disturbance to the surrounding environment. Delivery schedules are planned to optimise shipping efficiency and to align with station resupply requirements and operational priorities. Ship-based delivery also supports the transfer of oversized or heavy items that cannot be accommodated through air transport.

In addition to sea transport, smaller, high-priority, or time-sensitive items may be transported by air freight. These items are typically routed via commercial flights to a South Atlantic gateway, before being transferred onto BAS-operated aircraft, such as the Dash 7, for onward movement to Rothera. Air freight provides a flexible and responsive supplementary logistics capability, particularly for essential spare parts, medical supplies, or urgent scientific equipment, although it is constrained by aircraft payload limits and weather-dependent flight operations.

4.12.4. Occupation of space at Rothera Station

There is a limit to the number of personnel that can be supported at Rothera Station.

All personnel will continue to be housed in either the existing permanent accommodation at Rothera (Admirals House or Giants House) or within Vikings House.

The presence of construction personnel has the potential to displace researchers from being able to access or spend time at Rothera. Additionally, flying hours or space on the SDA may also take up resource that could have been used to meet research objectives. Consequently, the construction programme has the potential to result in a reduction in science capability and output.

Construction personnel will have some opportunities to undertake recreational activities whilst at Rothera, although this is likely to be constrained to Rothera Point but may include running or cycling (usually confined to the runway when permitted) or walks around Rothera Point via East Beach.

4.12.5. Use of resources at Rothera Station

4.12.5.1. Station energy

It is feasible that there will be higher than usual energy use at Rothera due to additional construction personnel being on site during the planned construction work covered by this EIA.

Energy use by BAM construction personnel has been monitored since the 2018-19 season. The data shows significant variation from season to season (from a low of 16.7 kWh / person / day in the 2023-24 season to a high of 33.6 kWh / person / day in the 2020-21 season).

Power usage will be minimised wherever possible and any equipment to be installed at Rothera that requires electrical power must be approved through the planning process prior to installation.

All staff will be briefed on the importance of reducing energy consumption at Rothera.

4.12.5.2. Station potable water

There will be higher than usual potable water requirements due to additional construction personnel at Rothera during the planned construction work covered by this EIA.

Water usage associated with the presence of BAM construction personnel at Rothera was monitored for the 2022-23 season, when a total of 687.1m^3 or 90 litres / person / day was used. In that monitoring season, water use varied from building to building, but across all buildings, construction personnel used more water than BAS staff (on average 86 litres / person / day), potentially due to the need for more frequent washing including washing of work clothes.

A target of 80 litres / person / day will be set for the 2026-27 and 2027-28 seasons. All staff will be briefed on the importance of reducing water consumption at Rothera. Activities will be borne in a way that minimises water consumption as far as reasonably practicable to ensure water and energy associated with its creation is used efficiently.

Wherever possible, sea water will be used for construction activities such as dust suppression.

Water usage will be reported at the end of each season and as per project-specific Site Management Plans. If any potable water is used for construction purposes, this will be recorded and reported to BAS.

4.12.5.3. STATION FUEL

The data available for fuel use by occupancy at Rothera varies slightly depending upon where the construction staff will be accommodated. Calculations based on data collected for the 2024-25 season attribute fuel use for heating as follows:

- Vikings House: 9.8 litres per person per bed night
- Giants House: 7.2 litres per person per bed night
- Admirals House: 6.0 litres per person per bed night
- New Bransfield House 7.1 litres per person per bed night

This suggests that for a full season (200 days from 1 November to (approximately) 20 May) a construction worker may use between 1,200 litres and 1,960 litres of fuel. A team of 45 construction-associated staff each season will collectively use between 54,000 litres and 88,200 litres of base fuel.

However, not all construction staff will necessarily be present for the full season, and these figures are likely to be 'worst case'.

4.12.5.4. STATION FOOD

Catering will be provided by BAS who will also manage waste food through the normal Rothera processes. Waste food is normally incinerated locally rather than transporting it north.

4.12.6. PRODUCTION AND MANAGEMENT OF WASTE

4.12.6.1. HUMAN WASTE

Rothera has a sewage treatment plant (STP), which captures human waste and uses microbes to treat the sewage, the remaining liquids are then discharged to sea, and the resulting sewage sludge is incinerated.

Sewage and grey water production will inevitably increase because of the additional construction personnel on Station. This will in turn put the treatment plant under increased pressure and result in a greater volume of wastewater discharged into the marine environment, which could contribute to local marine pollution.

4.12.6.2. GENERAL WASTE

The planned construction activities and additional construction personnel on site will increase the general waste produced by the station including food waste, as well as general construction waste such as wood, packaging materials, and vehicle-related wastes including oil, fuel, tyres, filters, and brakes. The waste associated with the activities covered by this EIA is not considered to significantly differ to previous AIMP construction seasons and may well be less.

Responsibility for handling waste will be divided between BAS and BAM depending upon the project lead and in accordance with project specific waste management plans as follows:

- Fuel pipelines installation - BAS waste
- Renewable energy project - AIMP waste
- Hangar redevelopment - AIMP waste
- Bollard removal - BAS waste
- Removal of old refuelling hut – BAS waste
- Runway activities - AIMP waste

BAS waste is directed to the Interim waste handling facility which is managed by BAS. Waste is classified, segregated and stored appropriately, either in the facility, or in IBCs / palletised and stored in shipping containers, to await removal from Rothera (usually by the SDA).

AIMP/BAM waste is managed by BAM, directed to the wharf area where they have containers designated for different categories of waste. It is segregated and stored until shipped out.

If unused timber arises (potentially from the roof strengthening work) it will first be offered to BAS Estates for use on other projects or, as a last resort, will be used as fuel for the incinerator. A full record will be kept, and internal waste transfer notes produced if required. Waste sent for incineration is carefully managed and agreed with BAS personnel who operate the incinerator.

All domestic waste generated during the construction period will be managed by BAS as per the standard Rothera waste management procedures.

All staff will comply with the Station waste storage and segregation requirements.

4.12.6.3. HAZARDOUS WASTE

As in previous seasons, some grouting may be required with respect to repairing foundations, including the new Discovery Building or the upgrading of the old generator shed foundation in anticipation of installing the BESS.

Any cementitious or grout wash waters produced during construction will be neutralised to a pH of 7.0 using citric acid prior to discharge to ground.

Cementitious and grout materials are mixed in the BAM Fitters Workshop and the wash water, once neutralised, will be discharged away from sensitive receptors to the west of the BAM Fitters Workshop.

The dismantling of the old fuel hut and the excavation of the trenches for the new fuel pipelines may reveal disused fuel pipelines which may contain fuel residues. Waste fuel will be contained and managed in accordance with project-level waste management plans and Rothera procedures.

4.12.7. CONSTRUCTION FUEL MANAGEMENT

Fuel will be stored by BAM at key locations across the site including:

- One fuel cube ($1m^3$) situated at the wharf;
- One fuel cube in the fitter's workshop;
- A container in the area immediately west of the workshop will house engine and lubricating oils;
- A container storing recycled MGO/AVTUR from legacy fuel lines.

Numerous items of mechanical plant will be required. Plant will be refuelled using a towable 5,000 litre bunded steel bowser pulled by a tractor or similar item of plant. Oil spill equipment will be located adjacent to the fuel tank and will accompany the fuel bowser at all times. All mechanical plant will carry spill kits.

BAM staff will respond to Tier 1 spills and follow the direction of Rothera Station Leader for all (larger) Tier 2 and Tier 3 spills.

The refuelling procedure for plant and equipment is documented. Only trained personnel will undertake refuelling.

4.12.8. TRANSPORT ACROSS ROTHERA

As in previous seasons, a traffic management plan (*Figure 52*) will be prepared and agreed with the Rothera Station Manager, with construction traffic constrained to these routes. Routine daily planning and coordination with Rothera Station leaders will be implemented, including for planned vehicle movements and activities.

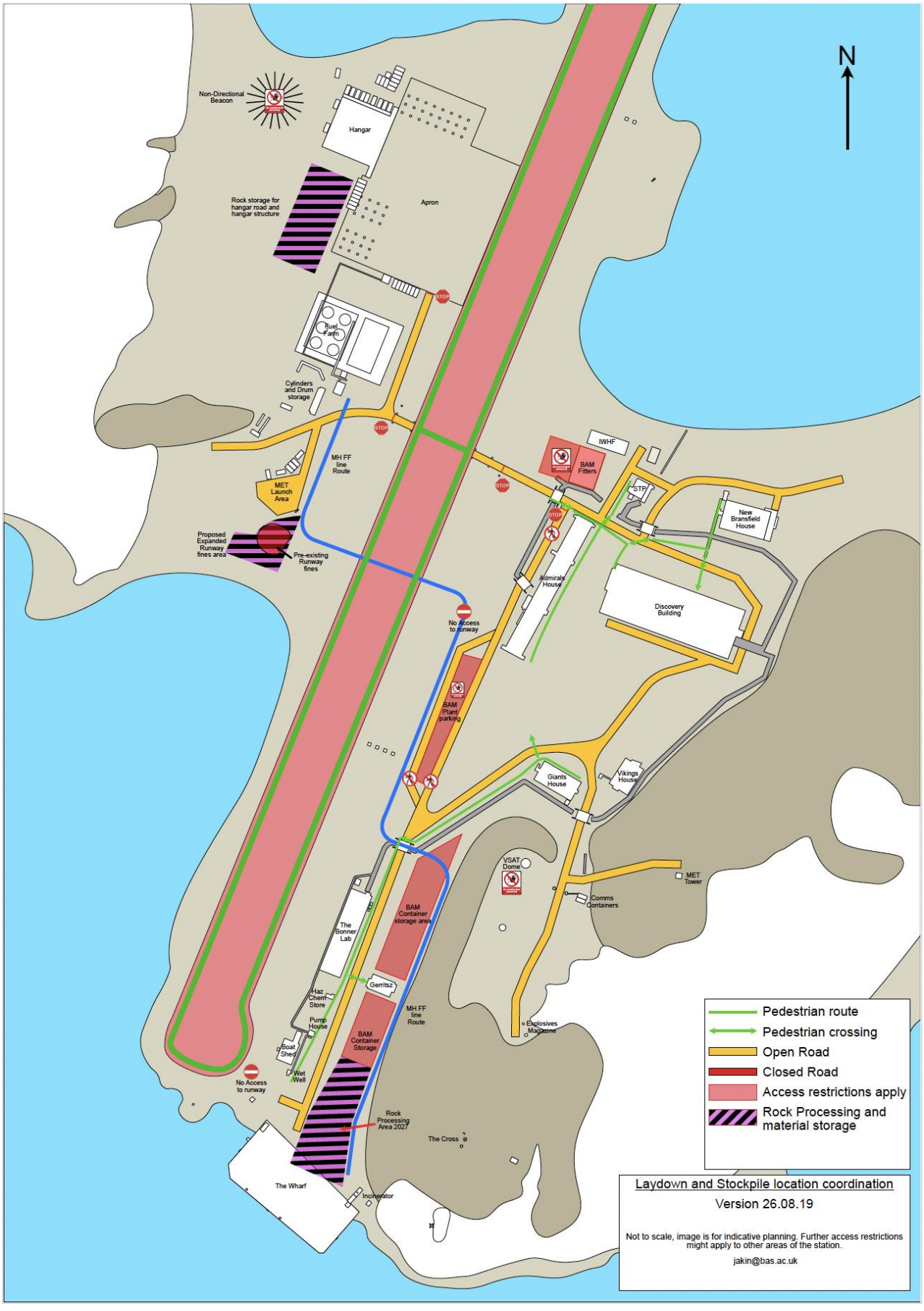


Figure 52. Rothera traffic management plan for the 2026-27 season. Source: BAS.

4.12.9. ENVIRONMENTAL ASPECTS

The aspects that will or could arise from the support activities that will or may interact with the environment or with key values are identified as (see also *Figure 53*):

Normal operations

- **Emissions of gases and heat**, arising from the burning of fossil fuels in vessels and aircraft to transport cargo and personnel to Rothera;
- **Increased carbon budget for Rothera and emission of gases and heat** as a result of increased energy use at the Station (for lighting, heating, water production etc) due to additional construction workers on site;
- **Increased wastewater discharges** from the Station due to additional construction workers on site;
- **Increased waste production** at the Station due to additional construction workers on site;
- **Additional light emissions**, if a building is used that would not otherwise be used;
- **Displacement of researchers or research support capacity** because of space and resources being utilised by construction personnel or construction activities;
- **Increased presence of personnel at Rothera Point**, including a potential increase in recreational activities with potential indirect impacts.

Unplanned or emergency situations

- **Risk of importing non-native species** to Rothera Point through personal clothing, baggage or equipment.

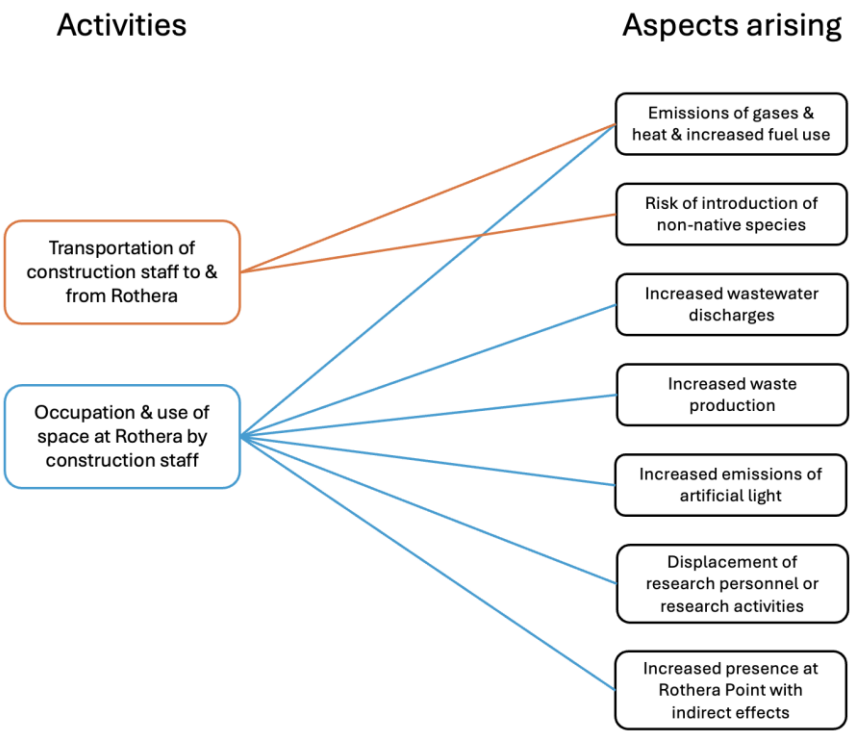


Figure 53. Overview of the aspects arising from the transport to and increased occupation of Rothera by construction personnel.

4.13. CARBON EMISSIONS ESTIMATE

4.13.1. CARBON ASSESSMENT

The carbon emissions for the activities under consideration in this EIA have been estimated using a combination of approaches, depending on the data available.

The Hangar redevelopment and Renewable Energy projects have been subject to a high level of assessment based on the Publicly Available Specification (PAS) 2080[8] Standard.

The remaining projects under consideration in this EIA (as described in this Chapter; see also *Table 5*) have not been assessed to the same degree and use broad estimates. Accordingly, the information presented here provides an indicative figure of carbon emissions that may arise from the planned activities, which may differ from actual emissions. Data will be collected on a season-by-season basis by BAM to provide more accurate post-season reporting on carbon emissions in the Post Season Environmental Reports (PSER).

The BAS Net Zero Carbon team also annually publishes the BAS Energy and Carbon Dashboard and a review of the progress towards reaching BAS' Net Zero objectives.

There are additional emission sources that have been excluded from this analysis, which are detailed below (*Table 7*), but the emissions included within the assessment are anticipated to account for most of the carbon emissions associated with the construction phase of the projects.

4.13.2. CARBON SUMMARY

Table 5 shows the estimated emissions (in tonnes of carbon dioxide equivalent (tCO2e)) arising from the activities included in this EIA.

The indicative figures in *Table 5* suggest that the emissions associated with the construction phase of these various projects over the next four seasons will be in the region of 12,766 tCO2e.

The majority of the carbon emissions are likely to arise from transport of cargo and personnel to and from Rothera by BAS Aircraft and the SDA. The multiplier used for person bed nights at Rothera accounts for personnel transport to and from the Station.

Fuel use in vehicles is the next most significant contributor to overall emissions. The multiplier used accounts for the delivery of fuel to Rothera as well as the emissions from using the fuel at the Station.

Unsurprisingly, the larger scale, longer term projects (Hanger redevelopment, renewable energy installations and fixed fuel pipelines installation) account for more than 90% of the estimated emissions over the next four seasons.

[8] PAS 2080 is an internationally recognized standard and specification for managing whole-life carbon across buildings and infrastructure. Developed by the British Standards Institution (BSI) and updated in 2023, it provides a practical framework for the entire value chain to reduce carbon emissions and costs through collaborative, intelligent design and construction.

Table 5. Estimated emissions by project. Note that the Hangar and Renewable energy projects have been subject to far greater rigour in their carbon assessments than the remaining projects.

Project / Activity	tCO2e
Hangar redevelopment *(including associated works as described in this EIA)*	**Whole of life estimate = 23,073**[9] **Construction phase (A4, A5) estimate = 6,936**
Renewable energy installations	**Whole of life estimate = 59,142** **Construction phase (A4, A5) estimate = 3,427**
Wharf Resurfacing *(Fuel use; pax numbers)*	Fuel use = 62.6 Pax = 52.9 **Total = 115.5**
Fixed fuel lines installation *(Fuel use; transport of materials; pax numbers)*	Fuel use = 33.4 Pax = 294.8 Transport of cargo to Rothera by SDA = 990 **Total = 1,318.2**
Runway maintenance *(Fuel use; transport of materials; pax numbers)*	Transport of cargo to Rothera by SDA = 7.5 **Total = 7.5**
Rock processing – all projects *(Fuel use; transport of jaw crusher; pax numbers)*	Fuel use = 90.9 Transport of jaw crusher to Rothera by SDA = 521.3 Pax = 88.2 **Total = 700.4**
Contaminated ground assessment *(Fuel use by vehicles only)*	Fuel use = 0.3 **Total = 0.3**
Slipway establishment *(Fuel use by vehicles only)*	Fuel use = 0.5 **Total = 0.5**
Bollard removal *(Fuel use; waste transport)*	Fuel use = 0.6 Transport of waste concrete to UK by SDA = 12.8 **Total = 13.4**
Removal of old refuelling hut *(Fuel use; waste transport)*	Fuel use = 0.3 Transport of waste to UK by SDA = 247.5 **Total = 247.8**

4.13.3. ASSUMPTIONS

In making the above estimates it has been assumed that:

- all vehicles and plant at Rothera will use MGO;
- all materials from the old fuel hut will be removed as waste or for recycling; although consideration is being given to reusing the hut elsewhere at Rothera, which will reduce the volume of material to be removed;
- to avoid double counting, construction workers from the main projects will be used to complete some of the minor ancillary projects;
- working hours are 10 hours a day for six days a week.

[9] It is noted that this figure assumes that the existing structural steel in the hangar will be reused. That is no longer the case and new primary steel will be used to replace the existing steel. The carbon estimate has not been updated for this change prior to submission of this EIA.

It is also noted that:

- there remains a risk of some double counting in the figures provided. For example, for operational efficiency aggregate production will be undertaken in a consolidated manner so as to provide aggregate for all projects. However, the 'whole-of-life' carbon estimates for the hangar and renewable energy projects already include estimates for aggregate production for those projects.
- some of the multipliers used for the Hangar and renewable energy project calculations may have been updated since they were prepared.

The metrics used in the above calculations are shown in *Table 6*.

Table 6. Metrics used for the carbon emissions calculations. UOM = unit of measure

Metric Used	Unit of Measure (UOM)	Metric (tCO2e per UOM)	Metric Version
Rothera Accommodation	# bed nights	0.18	BAS V2
MGO fuel burn by Rothera vehicles	# litres	0.00339804	Taken from Hangar PAS2080 calculations
Cargo delivered from UK to Rothera by SDA or cargo / waste removed from Rothera to UK by SDA	# cubic metres	3.75	BAS V2

4.13.4. Exclusions From Carbon Calculation

Some activities have been excluded from the carbon calculation for this project for the reasons shown in *Table 7*.

Table 7. Activities excluded from the calculations

Activity	Reason for Exclusion
Use of Engine Grease	De minimis
Use of Antifreeze in Rothera vehicles	De minimis
Use of Oil in Rothera vehicles	De minimis
Internal storage of items at Rothera	De minimis
Embedded carbon in some imported materials e.g. fuel lines, fuel-reel bunker station, runway lighting cabinets	No data available
Waste disposal in UK	No data available
Welding activity	No data available

5. Description of the Existing Environmental State

5.1. INTRODUCTION

This chapter describes the state of the current environment to the extent that it is known. A thorough understanding of the pre-activity state of the environment is an essential basis for predicting and evaluating impacts, and for identifying relevant and effective mitigation measures.

Consideration of the environment requires the characterisation of all relevant physical, biological, chemical and anthropic values or resources in a given area *i.e.,* those elements of the environment that the proposed activity might influence or which might influence the activity (EIA Guidelines, 2026).

This Chapter describes the current environmental state of Rothera Point including the ice ramp and the surrounding nearshore marine environment (*Figure 54*) and draws on an environmental baseline summary for Rothera Point prepared by the BAS Environment Office (Hughes, 2022) as well as previous AIMP EIAs.

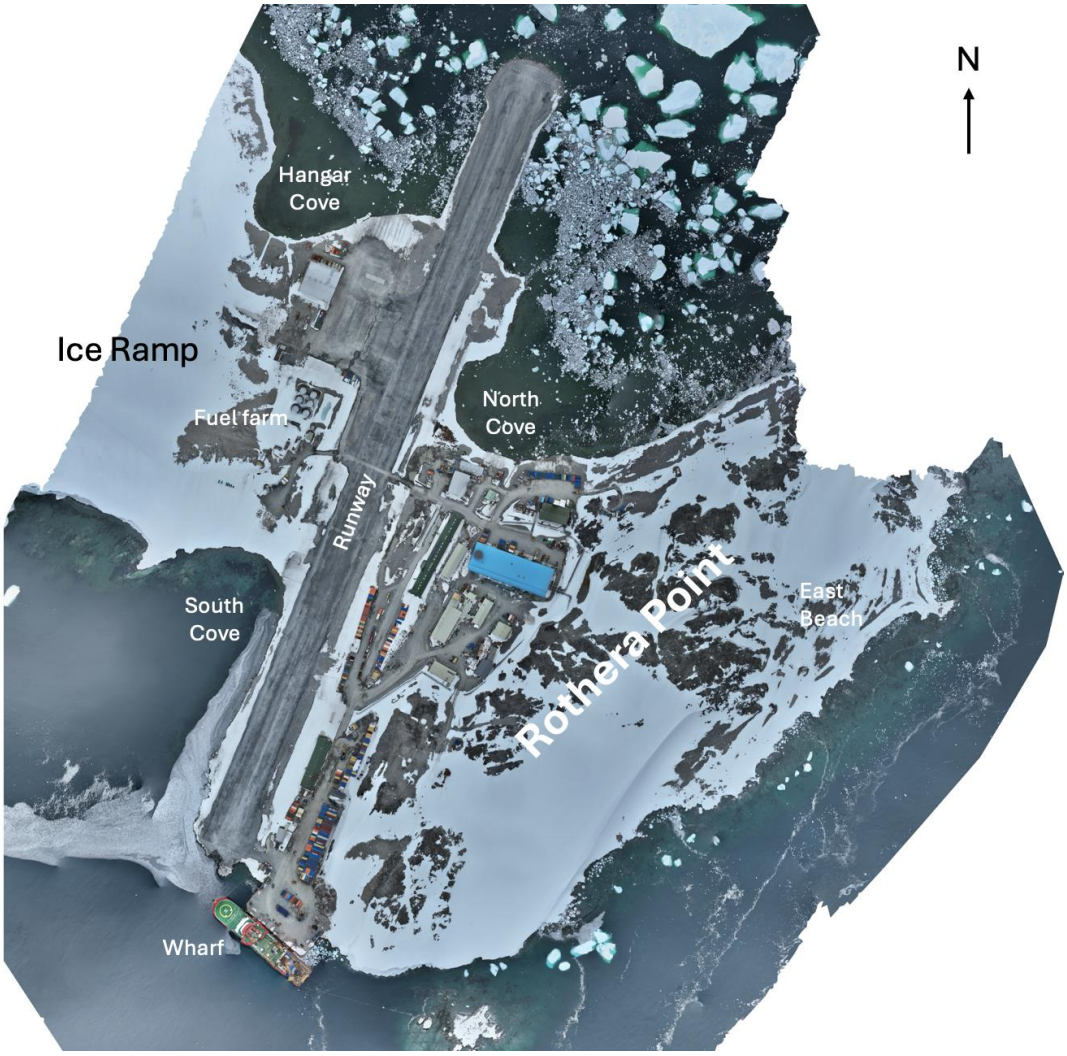


Figure 54. Rothera Point and local place names.

5.2. WEATHER

A programme of surface synoptic meteorological measurements commenced at Rothera in 1977. The climate is cold and dry and represents a transition from the more 'maritime' Antarctic to the north and the more extreme climate of 'continental' Antarctica to the south. Mean monthly air temperatures range between approximately -10.5°C and +1.4°C (*Figure 55*), with the prevailing wind from the north-north-east and averaging at 12.1ms^{-1} (*Figure 56*).

A heated snow gauge was installed at Rothera in 2008 and continues to be in operation at the present time. Its measurements have been used to estimate annual snowfall at Rothera, and this was found to be, on average, about 550mm of water equivalent (Strangeways and Colwell, 2020). The wettest months are typically in the austral autumn and winter. Precipitation is almost always in the form of snow, although rain can fall during the summer months due to warmer air temperatures.

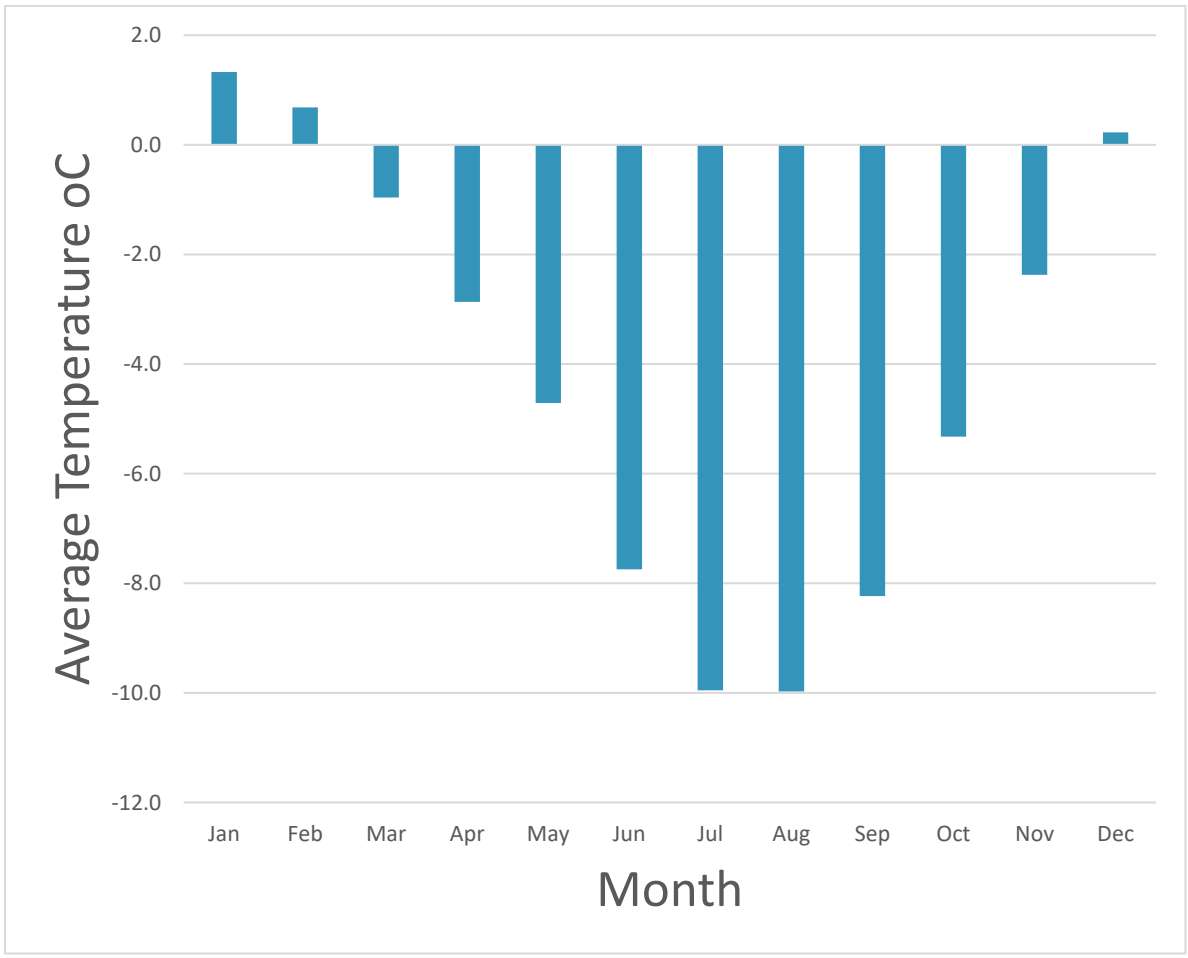


Figure 55. Mean monthly air temperatures at Rothera Station between 1976 and 2026. Source: SCAR Met-Reader database

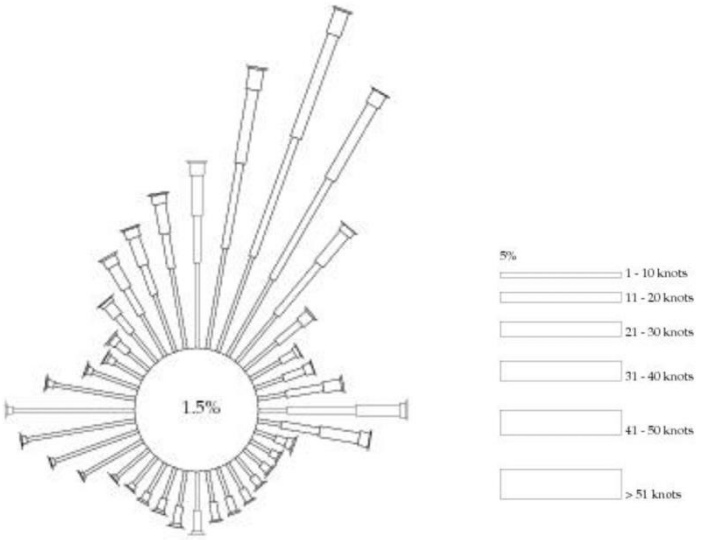


Figure 56. Wind rose for Rothera Point. Source: BAS

5.3. AIR QUALITY

No air quality data have been identified for Rothera, however significant volumes of hydrocarbons are combusted in the vicinity of Rothera by generators and the engines of vehicles, ships, small boats, and aircraft. Rothera also has an incinerator which emits combustion gasses.

Monitoring of heavy metals in lichens across Rothera Point, undertaken between 1976 and 1989 showed elevated contamination levels close to the Station (Bonner et al., 1989). Beyond this area contaminant concentrations progressively declined with increasing distance from Rothera.

Substantial levels of building activity in recent years have generated dust, but the levels have been minimised through the use of dust suppression techniques. The frequently high to moderate wind speeds in the area are likely to rapidly disperse any airborne particles and pollutants, minimising any impacts beyond the immediate area of deposition.

Dust monitoring has occurred during recent AIMP construction seasons (see Chapter 7).

5.4. CLIMATE

In the context of changing climate conditions, broadly there are two elements that Antarctic EIAs need to address. Firstly, the implications of climate change for the project and the extent to which forecast changes may need to be accommodated within the design or construction or conduct of the activity in question. Secondly, an EIA needs to consider if impacts arising from the activity in question could exaggerate or be exaggerated by the forecast impacts of climate change on environmental or other values in the area (EIA Guidelines, 2026). The first of these considerations is discussed here. The second is discussed in Section 6.7.2.3.

At a continental scale, Antarctica is experiencing rapid changes as a result of changing climate conditions (Chown et al., 2022; Turner, et al., 2014). Antarctic sea-ice extent is fluctuating far below its natural variability

of past centuries and a marked slowdown in Southern Ocean circulation systems is forecast (Krumhardt et al., 2026; Gilbert and Holmes, 2024). Ice loss from the West Antarctic Ice Sheet is increasing and potentially is close to reaching or has already reached a tipping point (Naughten et al., 2023; Lau et al., 2023). Regime shifts have been observed in Antarctic and Southern Ocean biological systems through habitat transformation or exceedance of physiological thresholds, with concerns over ongoing breeding failures leading to increased extinction risk (Abram et al., 2025).

At a regional level the Antarctic Peninsula has been one of the fastest warming regions on Earth (Ding et al. 2011; Bromwich et al. 2013; Nicolas and Bromwich, 2014; Cape et al. 2015; Turner et al. 2016) with more frequent extreme temperature and precipitation events, reduced sea ice, glacier retreat, ice shelf collapse, and ecological shifts (Davies et al., 2026). Forecasts under medium to high emissions scenarios are for more days above 0°C, increased liquid precipitation, ocean warming, and more intense extreme weather events (Davies et al., 2026).

Under the highest emission scenario, collapse of the Larsen C and Wilkins ice shelves is likely by 2100, and loss of sea ice and ice shelves around the Peninsula are forecast to exacerbate the current trends of land-ice mass loss (Davies et al., 2026). In a 30-year period up to the early 2000s, ice shelves in the region decreased in area by more than 13,500km^2 (Scambos et al. 2004; Rignot et al. 2004).

The long-term warming trend has resulted in abrupt changes in the Peninsula's biota including expansions in the range and local population numbers of certain flora, as a result of increased temperature and water availability (Convey, 2006).

However, as a demonstration of the complexity and natural variability of the climate system, over the last three decades some parts of the Peninsula have shown a cooling trend (Turner et al., 2016b, 2020; Bozkurt et al., 2020).

Evtushevsky et al. (2020) noted that, following a long period of consistent warming across the entire Antarctic Peninsula, the Northern and Southern regions of the Peninsula have shown differing trends in the last two decades with a cooling trend being observed for the Southern Antarctic Peninsula, which they attribute to changes in wind patterns.

This more recent cooling trend over the Antarctic Peninsula was confirmed by Nielsen et al., 2025 for the period 2003–2021(*Figure 57*).

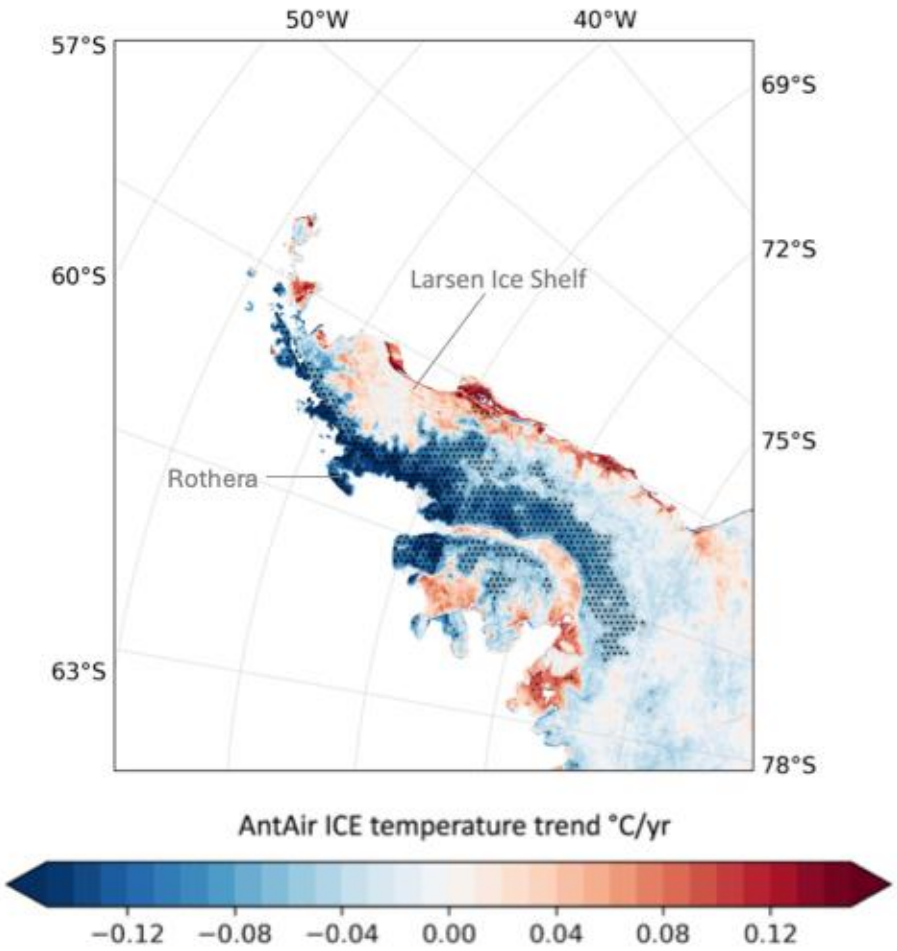


Figure 57. Annual mean air temperature trend for (a) Antarctic Peninsula, (b) Ross Sea Region, and (c) East Antarctica for AntAir ICE 2003 to 2021. Dots mark a significant trend with a p-value <0.05. Source: Nielsen et al., 2025.

5.4.1. Local Climate Studies

At the more local level some studies assist in understanding the potential implications of climate change specific to Adelaide Island or Rothera Point.

Sea level rise is not expected to be a significant threat to Rothera over the coming decades. Recent reports suggest that any rise in sea level that may occur will be largely compensated for by on-going isostatic rebound in the region (SCAR, 2024; *Figure 58*).

A survey programme was initiated in February 1989 to monitor the mass balance of the ice ramp, behind the Rothera hangar (*Figure 54*). The monitoring programme has shown that the lower section of the ice ramp at Rothera has been receding, at least since 1989 and this is attributed to increasing air temperatures in the region causing increased rates of ablation possibly exaggerated by increased dust accumulation from the construction and operation of the nearby runway (Smith et al., 1998)

Studies suggest that the ramp has been subject to episodes of advance and retreat over longer timescales (Guglielmin et al., 2016).

In the context of longer-term warming of the Peninsula, simulations with the latest generation numerical climate models reveal that Rothera can expect more frequent and more intense rainfall events towards the end of the century (Vignon et al., 2021), as well as an increased risk of permafrost thawing and increases in active layer thicknesses with implications for infrastructure (Bockheim et al., 2013).

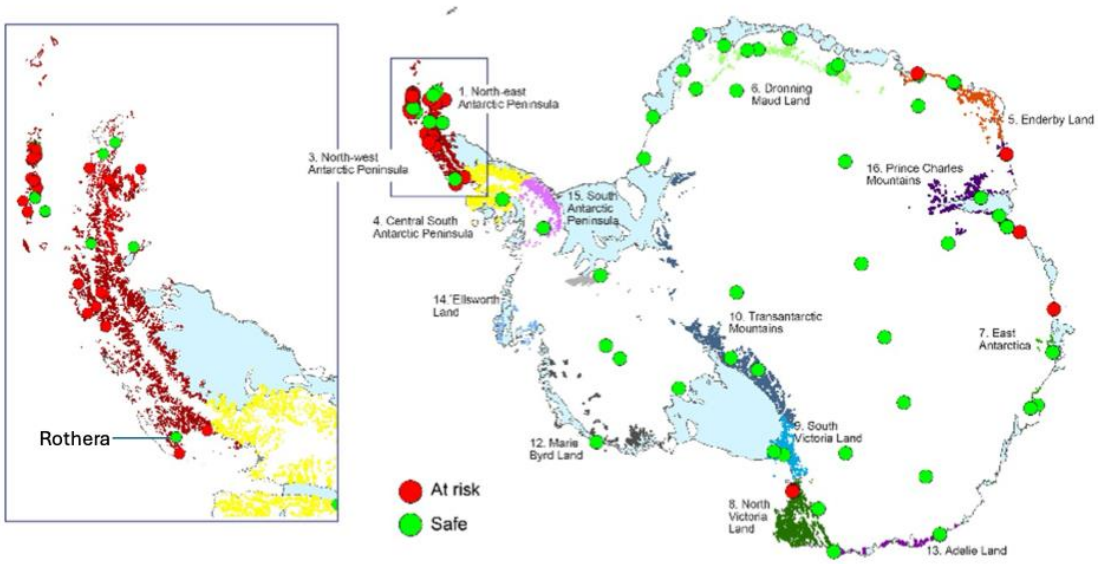


Figure 58. Antarctic facilities forecast to be at risk (red dots) or safe (green dots) from sea level rise. Source: SCAR, 2024.

To ensure that new infrastructure constructed at Rothera is resilient for the future climate, AIMP projects have been subject to a Climate Risk Assessment (CRA). Regionally specific climate projections for the Antarctic Peninsula relevant to Rothera up until 2100 have been developed through collaboration between BAS Innovation, AIMP and the BAS Atmosphere, Ice and Climate team.

The CRA has identified several climate change impacts to the Rothera Point area including:

- Melting and steepening of the ice ramp that joins Rothera to the rest of Adelaide Island;
- Increase in ice-free ground associated with the melting and shrinking of areas of permanent ice;
- Changes in bird population numbers linked to climate change effects on food sources and weather conditions during the breeding season;
- Seasonal changes in water availability for terrestrial communities leading to alterations in community structure and species distribution across Rothera Point;
- Changes in permafrost depth and active layer depth;
- Further changes in the intensity of iceberg scour of marine environments around Rothera, linked to changes in sea ice conditions that are, in turn, associated with changes in winds over the Peninsula;
- Changes in the presence of sea ice-dependant species around Rothera, as sea-ice become less reliable; and

- Increased likelihood of establishment of any non-native species introduced to Rothera.

These findings have been used to inform the planning and implementation of the AIMP.

5.5. GEOLOGY AND GEOMORPHOLOGY

Rothera Point is a small peninsula situated on the southeast of Adelaide Island. Rothera Point is a low rocky headland of about 0.4km^2 comprising a north-east to south-west trending, dissecting ridge rising to 39m altitude, an area of raised beach composed of rounded boulders on the southeastern side and similar but more extensive terrain (though composed of smaller stones and pebbles) on the north-west side. The latter forms an isthmus between North and South Cove and connects Rothera Point itself to Adelaide Island. The isthmus was extensively altered and widened during the construction of the gravel runway in the early 1990s.

The sloping ice-ramp with a gradient of about 1:5 leads from the isthmus to the Wormald Ice Piedmont. The rocks of Rothera Point have been subject to extensive frost shatter although some areas have been smoothed by the action of ice that has since retreated. A large ice-dammed melt pool that used to exist where Rothera Station now stands had disappeared by the early 1970s; its former shorelines were distinguished by more than 20 narrow terraces, but these are now largely indistinguishable due to station construction activities. Several poor-quality raised terraces are present on East Beach, representing previous higher sea level episodes, and the process of isostatic rebound is thought to be on-going in the area.

The geology of Adelaide Island is reasonably well understood. The rocks which are most abundantly exposed are of two ages: stratified volcanic and sedimentary rocks which are probably of Upper Jurassic age, and rocks of Andean plutons which intruded the stratified rocks between Middle Cretaceous and Lower Tertiary times. Minor exposures are of hypabyssal rocks of pre- and post-Andean ages (Dewar, 1970; Riley et al., 2011; *Figure 59*).

The geology around Rothera Point is dominated by granodiorite, with minor amounts of quartz diorite and diorite and is thought to be approximately 48Mya (Eocene age). The mineralogy of the Rothera Point granodiorite consists of plagioclase, quartz, amphibole, biotite and variable amounts of chlorite and epidote, which has formed along cracks and joints in the rock, as a result of hydrothermal alteration. Malachite (copper) mineralisation is also a characteristic of the granodiorites of the Wright Peninsula and at Rothera Point.

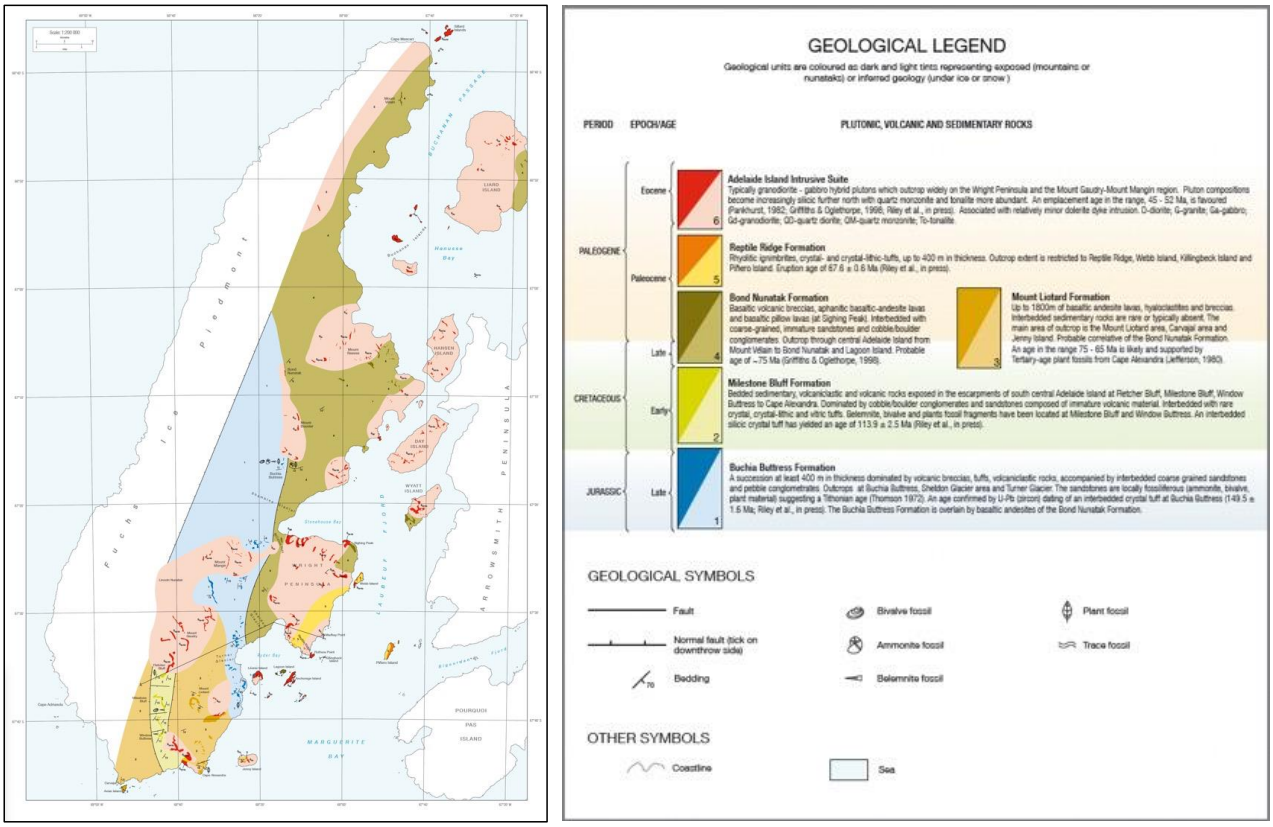


Figure 59. Geological map of Adelaide Island. BAS GEOMAP 2 Series, Sheet 2, Edition 1. Riley et al., 2011

5.6. TERRESTRIAL FLORA

Cannone et al. (2018) found 66 species of flora across Rothera Point including: one vascular plant (*Deschampsia antarctica*), 10 mosses, 55 lichens (four not determined), one green alga (*Prasiola crispa*), as well as the general category of cyanobacterial crust.

Mosses had a very low coverage across the entire area, as would be expected with the prevailing rocky substrata, and were observed predominantly outside of the Antarctic Specially Protected Area (ASPA; refer Section 5.16) associated with the occurrence of loose sediments, with the dominant species being *Sanionia uncinata*.

Vegetation mapping indicated that most of Rothera Point is vegetated, with a total coverage exceeding 50% (*Figure 60*). The most significant cover was observed on the top of rock bluffs where there was an abundant growth of lichens.

The prevailing vegetation sub-formations were a) the crustose and foliose lichen formation and b) the fruticose and foliose lichen formation (*Figure 61*).

Rothera Point is representative of some of the floristic diversity typical of vegetation communities of the north-western Antarctic Peninsula. Furthermore, Rothera Point along with Leonie Island are the two sites with the largest floristic richness and more complex vegetation within the wider geographical context of Marguerite Bay and Adelaide Island (Cannone et al., 2018). As such the vegetation on Rothera Point is of outstanding value.

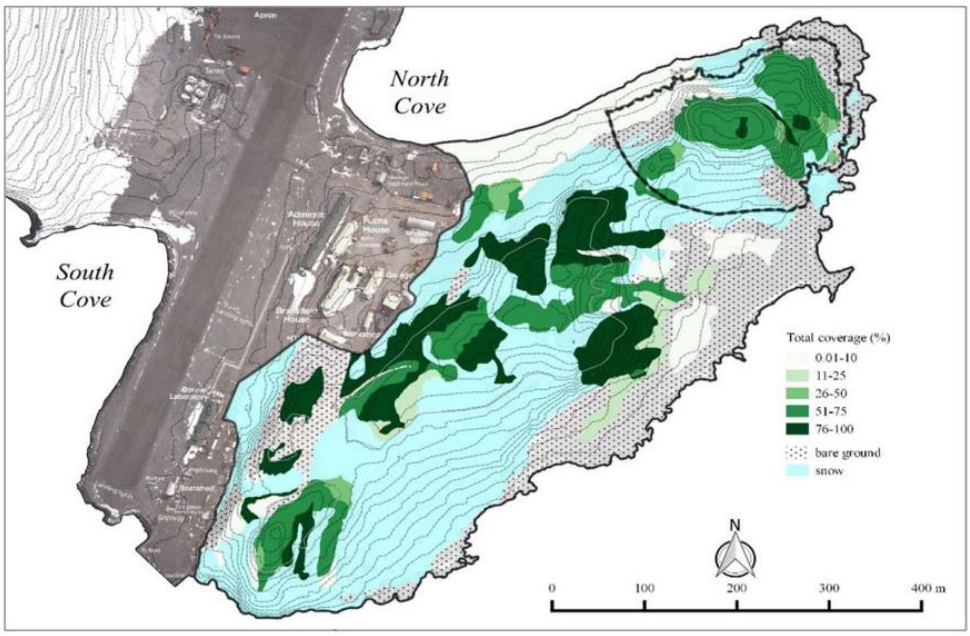


Figure 60. Vegetation cover (%) at Rothera Point. Source: Canone et al., 2018

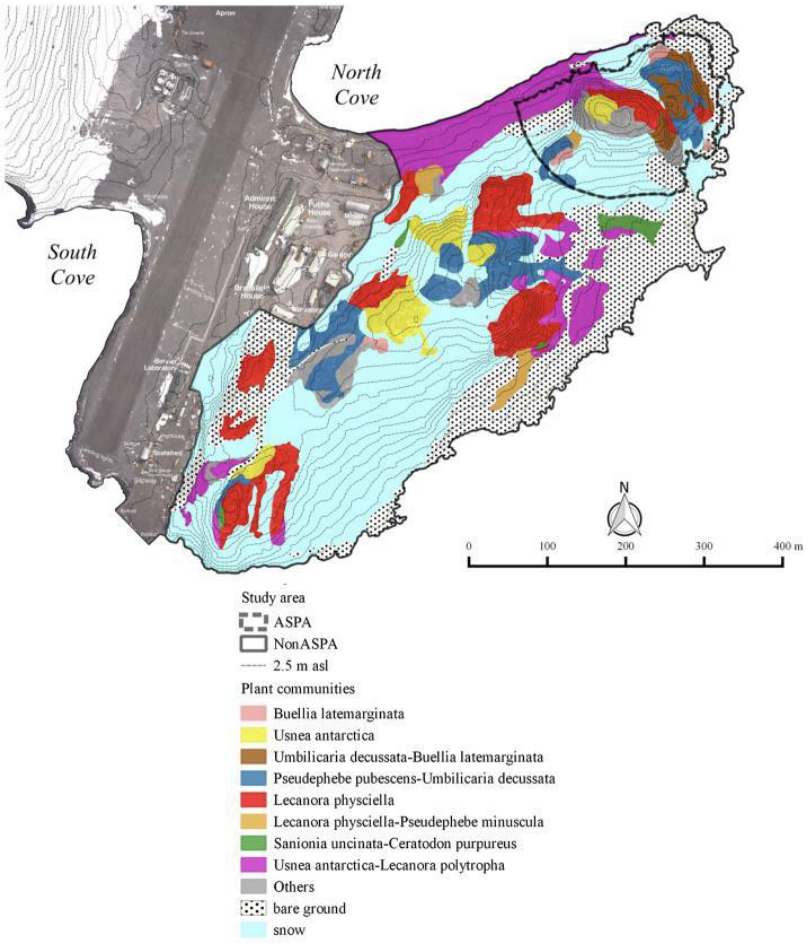


Figure 61. Phytosociological map of the vegetation across Rothera Point. Source: Canone et al., 2018

The retreating of the ice ramp on the eastern side of Rothera (to the west of the hangar and fuel farm; *Figure 54*) has re-exposed buried mosses exhibiting cryptobiosis[10] following exhumation after six centuries of glacier entombment (Cannone et al., 2017); although a more recent examination suggests that there do not appear to be any mosses remaining on these earlier exposed parts (P. Convey pers. com.).

A re-survey of the area below the ice ramp during the 2025-26 season recorded a healthy *Deschampsia antarctica* plant (Antarctic hair grass) close to the north-west corner of the Hangar (*Figure 62*) as well as evidence of lichen and moss species on newly exposed rocky knolls as the ice ramp retreats; though further laboratory testing is required to assess viability (P. Convey pers. com.).



Figure 62. Location of the Deschampsia plant to the northwest of the current hangar. Source: P. Convey / BAS

5.7. TERRESTRIAL FAUNA

Fourteen species of microarthropod have been recorded in samples collected across Rothera Point revealing similar diversity, though smaller mean population density, to samples collected from the nearby islands in Ryder Bay (Convey and Lewis-Smith, 1997).

5.8. NON-NATIVE SPECIES

No non-native plants or invertebrates are currently recorded at Rothera or the adjacent islands in Ryder Bay.

A report, dating from the mid-1990s, did record the presence of the non-native collembolan *Hypogastrura viatica* at Leonie Island, Marguerite Bay (see map in *Figure 66*; Hughes et al., 2015 and 2017). This is the most southerly record of the presence of a non-native species in the natural environment on the Antarctic Peninsula. A monitoring project was initiated in January 2015 to establish the presence and distribution of *Hypogastrura viatica* on the islands in Marguerite Bay and on Rothera. No evidence for the presence of *Hypogastrura viatica* or any other nonnative invertebrate was found in the 36,796 specimens collected. From

[10] A reversible, extreme state of suspended metabolism used by organisms to survive harsh environmental conditions such as desiccation, freezing, or oxygen deficiency.

these data it cannot categorically be stated that *Hypogastrura viatica* is absent from the area, but given the number and distribution of samples collected, it is likely that it is present in only very low numbers, and it is possible that it has become locally extinct.

5.9. AVIFAUNA

5.9.1. BREEDING SPECIES

A total of 23 bird species has been recorded in the Rothera area (Milius, 2000), of which eight are known to breed locally; mostly on the islands in Marguerite Bay. Recorded species includes Snow Petrel (*Pagodroma nivea*), Wilson's Storm Petrel (*Oceanites oceanicus*), Antarctic Shag or Cormorant (*Leucocarbo bransfieldensis*), South Polar Skua (*Catharacta maccormicki*), Kelp Gull (*Larus dominicanus*), Antarctic Tern (*Sterna vittatta*), Adelie penguin (*Pygoscelis adeliae*) and Southern Giant Petrel (*Macronectes giganteus*).

Skua, Wilson's Storm Petrel and Kelp Gull are recorded breeding on Rothera Point. Snow Petrel have also been recorded as breeding on Rothera Point though not routinely (Milius, 2000; Fretwell et al., 2015).

South Polar Skuas breed at Rothera Point, and the population has been monitored annually since the 1988-89 season. The locations of recorded nest sites are shown in *Figure 63* (Phillips et al., 2019).

Adult Skua arrive back at Rothera Point in October / November. Egg laying occurs in November / early December with incubation lasting around 26 to 34 days. Hatching occurs in December / early January with chicks fledging in February / early March.

Nest sites across Rothera Point are often reused but may be inactive for several consecutive years. Rock removal undertaken during the 2018-19 season means that the most southerly nesting sites may no longer remain viable.

Long-term data collection shows that the Skua population at Rothera Point varies considerably between years but demonstrates an increasing trend of 1.9% per annum from 11 breeding pairs in 1975-76 to 24 breeding pairs in 2017-18 (*Figure 64*, Phillips et al., 2019).

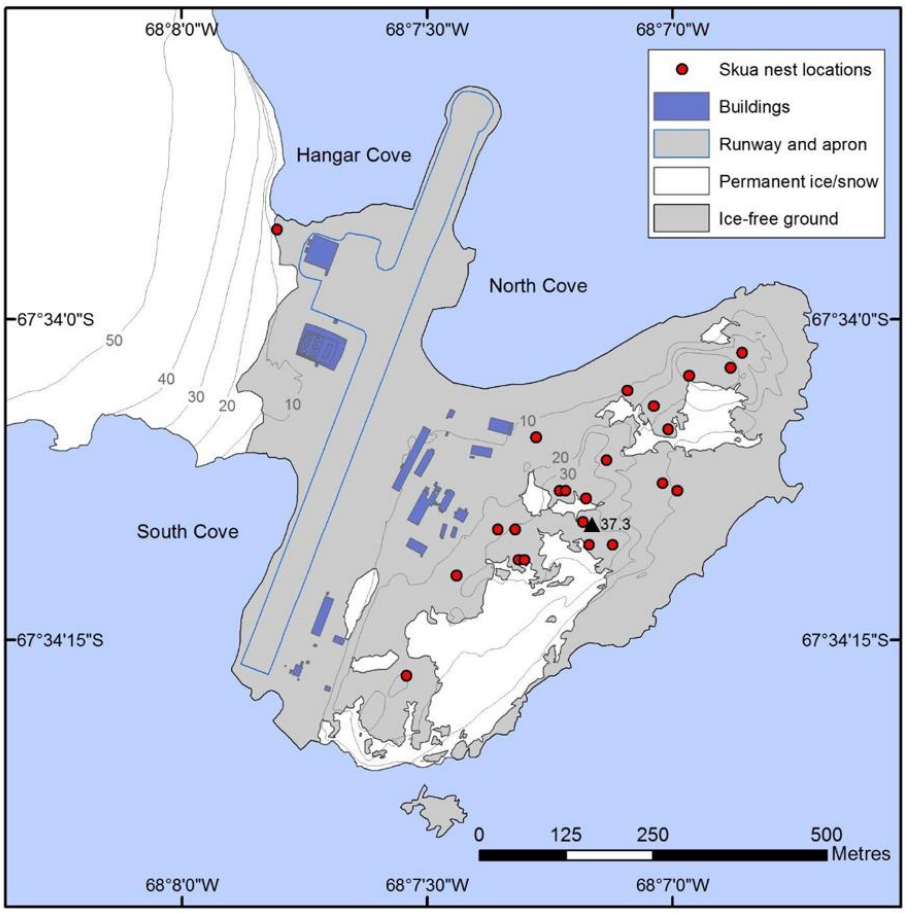


Figure 63. Distribution of skua nesting sites on Rothera Point, 2005 to 2016. Source: BAS

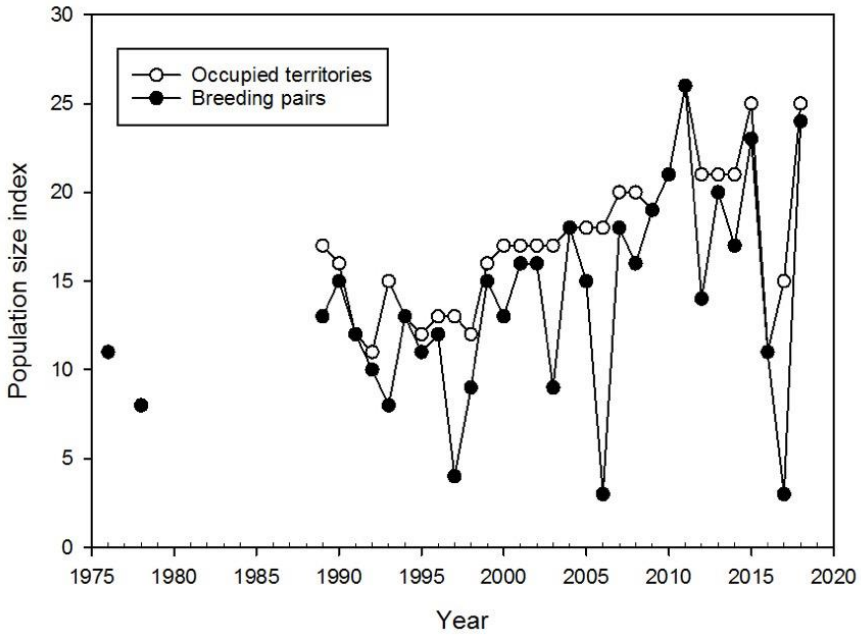


Figure 64. Changes in population sizes of south polar skuas at Rothera Point, Ryder Bay (Antarctic Peninsula) from 1976 to 2018. Years refer to the time of chick fledging (i.e. 1976 represents the 1975/76 austral summer). Source: Phillips et al., 2019.

5.9.2. Common non-breeding species

Emperor penguins (*Aptenodytes forsteri*) are almost annually observed at Rothera Point, though seldom more than a single bird is observed at any one time. On one occasion a group of 19 was recorded on 7 November 1977 (Fletcher, 1978). Nearly all records fall between August and November.

Adélie penguins (*Pygoscelis adeliae*) are observed almost daily during the summer months (late October to March) and less frequently, but still regularly, throughout the remainder of the year. In summer, counts vary greatly. Up to approximately 120 birds have been observed on East Beach.

During February and March, many of the Adélie penguins come ashore to moult. From late February to April, a small number of first-year birds are regularly recorded. Fragments of bone and eggshell in soil suggest breeding colonies of penguin (probably Adélies) have existed on Rothera Point in the past.

Chinstrap penguins (*Pygoscelis antarctica*) are a rare summer visitor to Rothera Point with records usually involving single birds between January and March.

5.9.3. Important Bird Areas

In 2015 the Antarctic Treaty Consultative Meeting (ATCM) recognised a series of 204 Important Bird Areas (IBAs) across Antarctica, through the application of criteria established by Birdlife International (ATCM Resolution 5 (2015))

There are thee identified IBAs near the planned areas of activity of this project (*Figure 65*). The closest IBAs are numbered IBA 95 (Avian Island – designated for its populations of Adélie Penguin, Imperial Shag and South Polar Skua) approximately 40 km from Rothera Point, IBA 96 (Ginger Islands - designated for its population of Imperial Shag) approximately 30 km from Rothera Point and IBA 97 (Emperor Island, Dion Islands – designated for its population of Imperial Shag) approximately 45 km from Rothera Point (Harris et al, 2015).

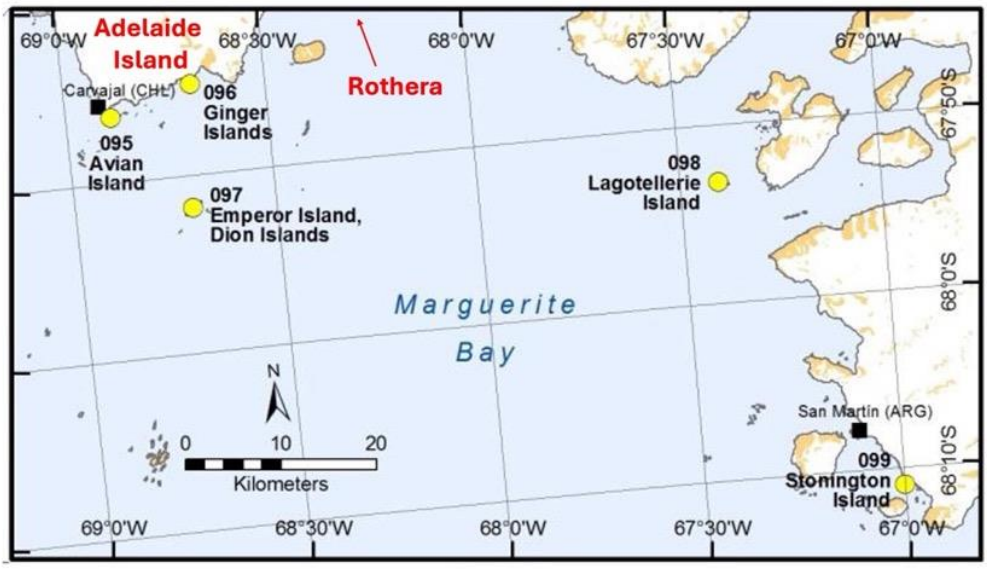


Figure 65. Important Bird Areas (IBAs) identified in Southern Margeurite Bay in the vicinity of Rothera Research Station. Source: Harris et al, 2015.

Although not formally recognised under the Antarctic Treaty System, BirdLife designated the areas around Ryder Bay as an Important Bird and Biodiversity Area (IBBA) in 2018 (AQ 205; Phillips et al., 2019). The IBBA includes part of Rothera Point (notably East Beach). The IBBA extends to the islands in Ryder Bay, many parts of which are protected under the Antarctic Treaty System through designation of ASPA 177 (see Section 5.16; *Figure 66*).

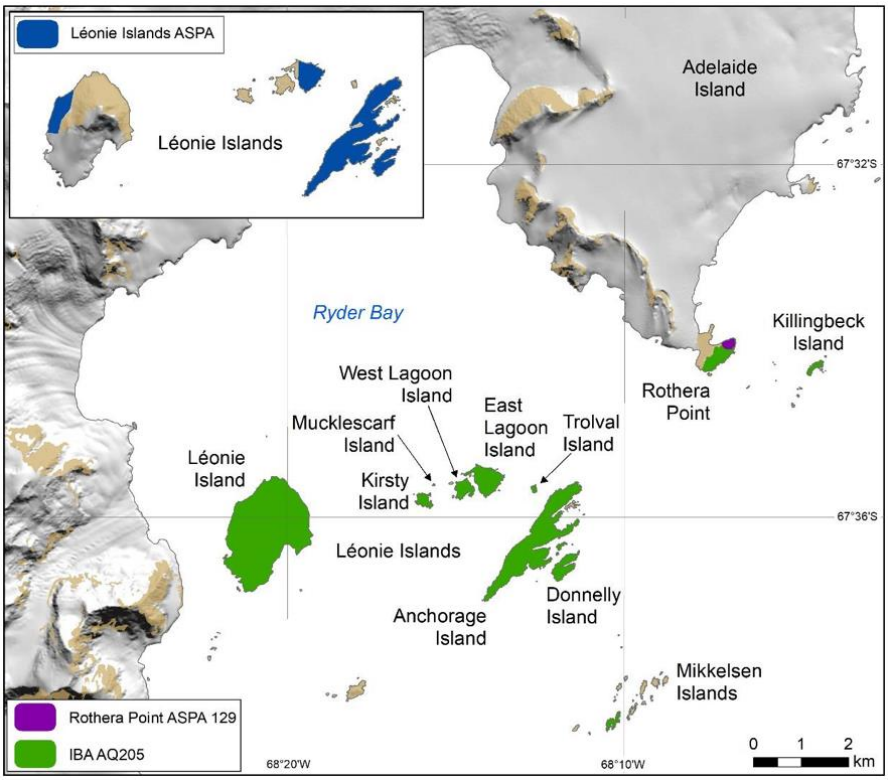


Figure 66. Map of the Ryder Bay area showing the extent of ASPA 129 Rothera Point (purple), ASPA 177 Leonie Islands and South-East Adelaide Island (blue) and Important Bird and Biodiversity Area (IBBA) AA205 (green).

5.10. FRESHWATER SYSTEMS

Historically, ten small freshwater pools (some ephemeral) have been reported across Rothera Point (Priddle and Belcher, 1981; Dartnell, 1980). However, construction activity at Rothera, including the runway development in 1989-90, appears to have removed many of these ponds.

Previous AIMP EIAs have reported a 50m long transient pool located at the west fringe of the large area of permanent ice to the south of Rothera. Seasonal meltwater from the permanent ice feeds into this water body, which consequently fluctuates in level. During winter, and sometimes extending into the summer months, the surface of the water is not visible due to ice and snow cover. The pool was partially infilled during the 2018-19 season.

A biological survey of the ice-free area at the base of the ice ramp (west of the runway and hangar) was undertaken in the 2025-26 season which revealed a series of meltwater pools. This is discussed further in Section 6.5.2.

Two human-engineered stream channels divert water away from established infrastructure below the ice ramp and behind the hangar. These were established when the runway was originally constructed between December 1989 and March 1991 with the aim of diverting meltwater from the glacier away from the hangar and apron area. The channel nearer to the hangar is the dominant one with lush development of algae. To enable the proposed hangar redevelopment including the rear access road, the latter stream channel will need to be moved several metres west of its current track. In that this stream is already a human-engineered feature, there is no obvious environmental reason for such a move not to take place (Pete Convey, BAS pers. com.).

5.11. GLACIOLOGY

Adelaide Island is dominated by extensive glacial cover, most notably the Fuchs Ice Piedmont and several marine-terminating outlet glaciers such as the Shambles, Sheldon, Hurley and Turner Glaciers (*Figure 68*). Drainage of ice from the central plateau through these glaciers into adjacent bays reflects a dynamic interplay between high snow accumulation driven by prevailing winds and ablation processes intensified by regional warming as discussed in Section 5.4.1.

Over recent decades, cryospheric studies across the broader Antarctic Peninsula, including Adelaide Island, have documented pronounced glacier retreat, thinning, and acceleration of flow velocities, attributable to increased surface melt and ocean-ice interactions (Dryak and Enderlin, 2020). The largest outlet, Shambles Glacier, flows eastward from the Fuchs Ice Piedmont and exhibits heavily crevassed surfaces indicative of dynamic stress regimes (Riley et al, 2012). Supported by radar surveys and remote sensing, investigations around Rothera Point have highlighted earlier onset of summer crevasses and increased ice velocities tied to atmospheric warming trends (Rivera et al., 2005).

Studies in nearby Marguerite Bay suggest episodic rapid thinning of the ice sheet since the end of the last glaciation (~9,600 BP), likely driven by oceanic changes, a process consistent with modern patterns of grounding-line retreat due to ocean warming (Bentley et al., 2011).

5.11.1. ROTHERA ICE RAMP

Access from Rothera Point to Adelaide Island is via an ice ramp that forms the southern limit of the Wormald Ice Piedmont (*Figure 54*). The surface elevation of the ramp rises from 10 to 110m asl, over a horizontal distance of around 600m. Following the establishment of Rothera Station in 1975, the ramp saw considerable year-round vehicle traffic, largely in support of aircraft operations from a skiway on the Wormald Ice Piedmont.

In early 1990, construction of a gravel runway between the station and ramp began and by 1992 all aircraft operations had been transferred to this runway. Subsequent traffic on the ramp has been light.

A survey programme was initiated in February 1989 to monitor the ice ramp's mass balance and to detect any changes (*Figure 67*). The uppermost part of the ramp shows no clear decline in mass balance; however, lower sections of the ramp surface have lowered, in common with other sites on the Antarctic Peninsula (Smith et al., 1998; Smith 2021). The deposition of dust on the ramp originating from the runway may be contributing to surface lowering, and mitigation measures are employed to reduce dust dispersal from the runway and station activities. Studies suggest that the ramp has been subject to episodes of advance and retreat over longer timescales.

More recently the ramp has become temporarily (possibly permanently) impassable due to the opening of crevasses, and the ice ramp adjacent to the station becoming too steep and icy for vehicles to use safely for large parts of the year (Siegert, et al., 2026).

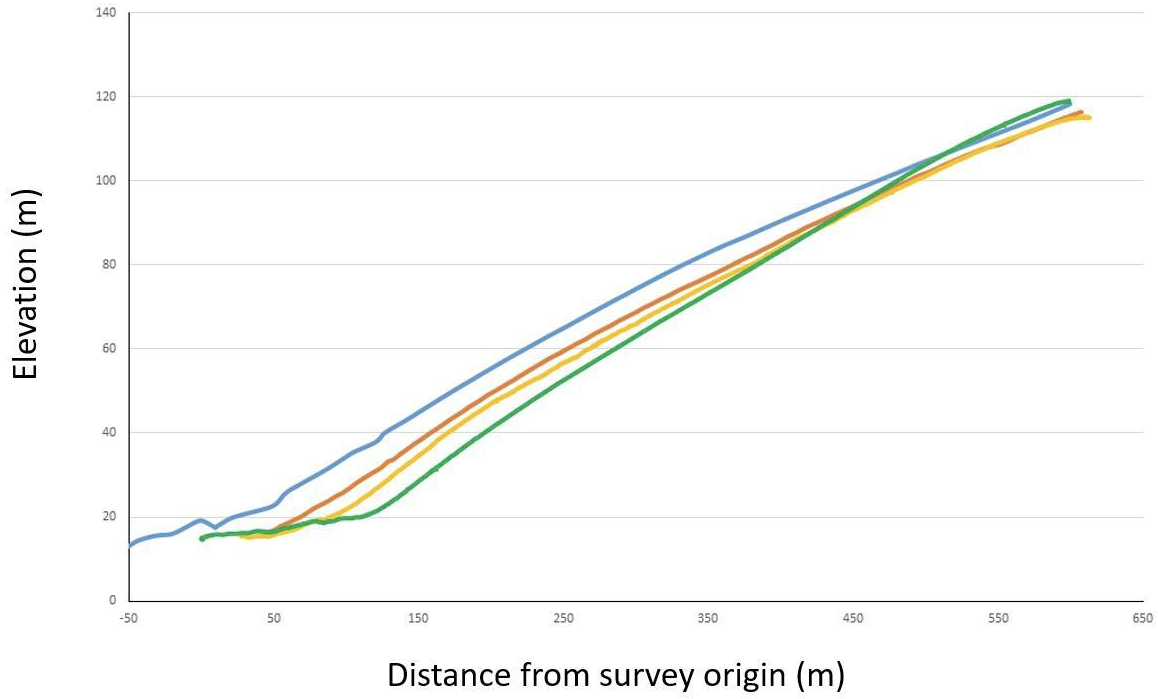


Figure 67. Elevation of the Rothera ice ramp between 1989 and 2021. Line colours correspond to ramp profiles surveyed during different years: blue (1989), orange (1998), yellow (2008), green (2021). The base of the ice ramp has receded by >100 metres in the past 30 years. Source: Hughes, 2022; Smith et al., 1998.

5.11.2. PERMAFROST

Guglielmin et al. (2014) reported on the findings of a 30m permafrost borehole installed at Rothera Point. The borehole was situated at 31m above sea level on a granodiorite knob with scattered lichen cover. Ground surface temperatures showed a high degree of variability ranging between −3.7°C and −1.5°C due to spatial and temporal variability in snow cover.

The active layer thickness ranged between 0.76m and 1.40m. Active layer thickness showed higher temporal variability than that reported at other sites at similar latitudes in the Northern Hemisphere, or with the similar mean annual air temperature in Maritime Antarctica, due in large part to the absence of vegetation and a soil organic horizon at the Rothera study site.

Zero annual amplitude in temperature was observed at about 16m depth, where the mean annual temperature was −3°C. Permafrost thickness was calculated to range between 112m and 157m, depending on the heat flow values adopted.

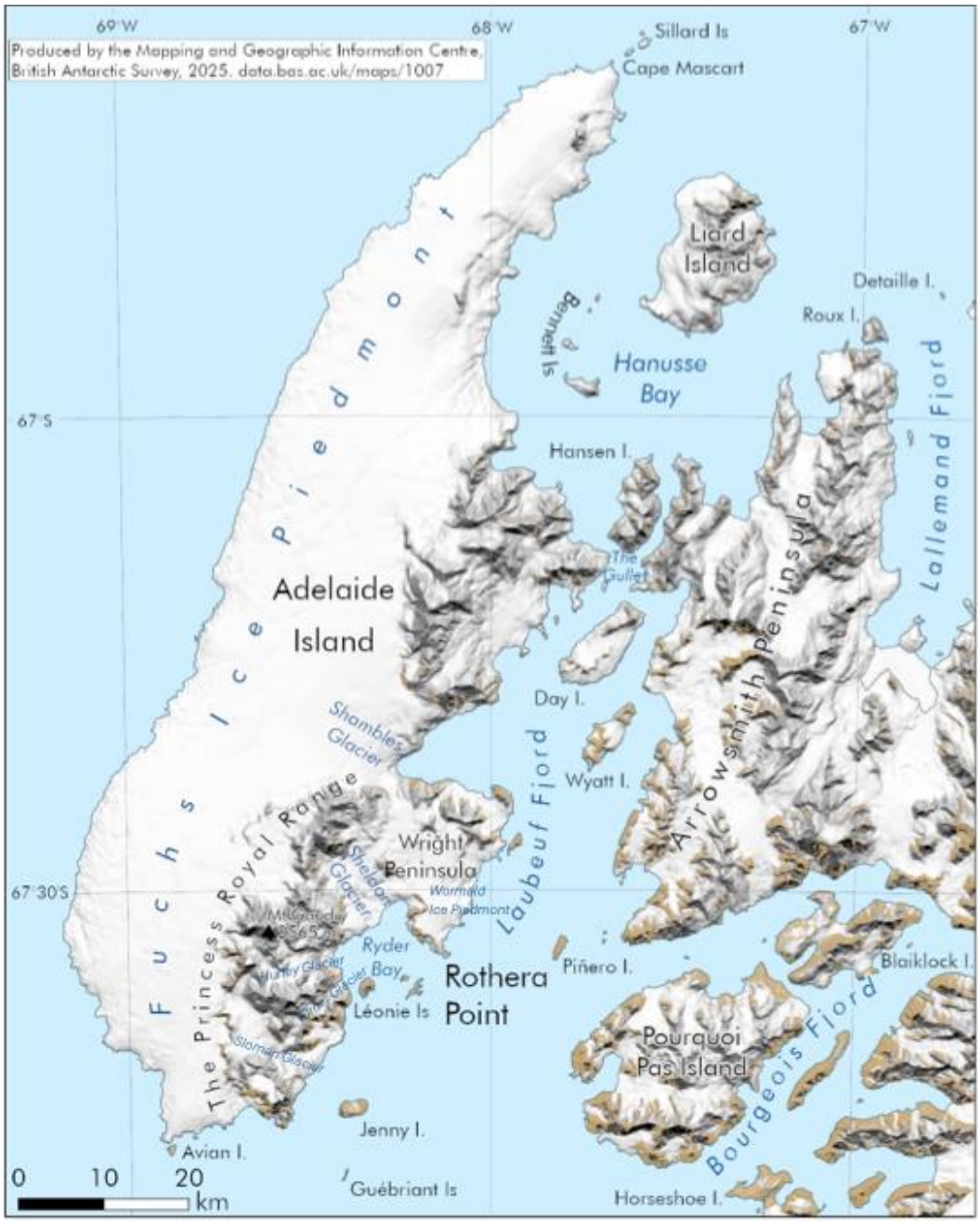


Figure 68. Glaciers on Adelaide Island. Source: BAS Mapping and Geographic Information Centre.

5.12. OCEANOGRAPHY

Marguerite Bay exhibits a strongly seasonal and cryosphere-influenced oceanographic regime characterised by a stratified upper ocean and significant freshwater inputs from multiple glacial sources. Hydrographic studies indicate that the near-surface mixed layer is substantially modified by meteoric water, primarily derived from glacial and ice-shelf melt, which can contribute up to ~5% of the upper ocean volume during austral summer, exceeding the contribution from sea-ice melt (Meredith et al., 2008). This freshwater input enhances stratification, particularly in summer, influencing vertical mixing and biological productivity.

Marguerite Bay is also influenced by shelf water masses such as relatively warm Circumpolar Deep-Water intrusions and colder winter water, with variability in these water masses linked to atmospheric forcing (e.g., ENSO-driven wind anomalies) and regional circulation patterns that affect heat and salt budgets (Meredith et al., 2004).

5.12.1. SEA ICE

Sea-ice conditions in Marguerite Bay are similarly dynamic and exhibit marked interannual and seasonal variability. The region typically experiences extensive winter sea-ice cover lasting up to approximately seven months, with near-complete coverage during austral winter–spring, although the timing of ice formation and breakup can vary by several months between years (Hyatt et al., 2011).

The sea ice is relatively thin compared to other Antarctic regions, with mean thicknesses in the order of ~0.6–1m, and is strongly influenced by snow loading, which often leads to negative freeboard, surface flooding, and the formation of snow–ice layers; processes that characterise Marguerite Bay as a "warm end-member" of Antarctic sea-ice systems (Perovich et al., 2004).

Ice dynamics are sensitive to atmospheric forcing and temperature variability, with differences in ice formation timing producing substantial contrasts in pack-ice structure (Fritsen et al., 2008). Collectively, these conditions result in a highly variable sea-ice environment that plays a central role in regulating ocean–atmosphere exchange, ecosystem structure, and regional climate feedback in Marguerite Bay.

5.13. MARINE ECOSYSTEM

5.13.1. NEARSHORE SHALLOW WATER ENVIRONMENT

The shallow areas in and around Rothera Point are reasonably well understood as a result of extensive research by BAS scientists over several decades. In addition, in support of the Rothera wharf redevelopment (BAS, 2018), BAS undertook a series of surveys in January 2016 in order to establish the baseline state of marine benthic communities.

The sea floor slopes away quickly from the wharf area and consists of a mixture of bed rock and loose cobbles with occasional pockets of mixed cobbles and sediment. The southern end of the runway has the highest proportion of bedrock with the steepest underwater gradient. The gradient is shallowest in South Cove where the substratum has the highest number of pockets of mixed cobbles and sediment.

The brown macro alga *Desmorestia antarctica* is present in small clumps and an algal mat covers some of the seabed.

Community analysis from the surveyed areas revealed a high degree of variation in density between species but all three of the surveyed sites had similar diversity and densities of species. At all three sites, the most abundant species was the Antarctic limpet, *Nacella concinna*, with up to 112 individual's per m^2, and the most speciose class was the Asteroidea with either 4 or 5 species. Fish numbers were very low, with only 5 individuals counted during the three surveys.

The spatial variability in community structure along the wharf makes it challenging to provide a concise description of the communities at each depth; however, *Table 8* provides a brief overview of abundant species identified during the 2016 surveys (BAS, 2018).

Table 8. Abundant benthic species found at different depths in the vicinity of the wharf. Source: BAS 2018.

Depth	Typical species or groups
10m	Pink encrusting algae *Nacella concinna* *Sterechinus agassizi*
20m	Pink encrusting algae *Cnemidocarpa verrucosa* *Odontaster validus*
30m	*Cnemidocarpa verrucosa* *Isotaelia antarctica* *Heterocucumis steineni*
40m	*Primonella sp.* *Promachocrinus kerguelensis* *Haliclona tenella or Calyx arcurius*
50m	*Primonella sp.* *Promachocrinus kerguelensis* *Haliclona tenella or Calyx arcurius* *Cnemidocarpa verrucosa*

Surveys were also undertaken in 2022 following completion of the wharf reconstruction. The post-construction survey revealed that differences between pre- and post-construction assemblages were minor and were not reflected in the overall number of taxa, or diversity, but there were subtle shifts in species composition. The largest differences in the macro-epifauna were a reduction in the number of the common urchin, *Sterechinus neumayeri*, and seastar, *Odontaster validus*, although these were within expected variability. The small changes detected in the macroepifauna indicate that it was minimally impacted and/or recovered in a short period of time (Robinson et al., 2024)

Sedimentation rates were also measured before and during construction. A single pulse of higher than normal sedimentation was recorded which coincided with the backfilling of the wharf pilings with crushed rocks. However, this single event does not appear to have had lasting consequences for the local benthic epifauna (Robinson et al., 2024).

Scouring from iceberg movements has an ongoing disturbance to benthic communities and is a major structuring force of shallow water polar communities, particularly those living on rocky reefs. The very high disturbance levels in the shallows result in a fauna that is dominated by mobile species that are able to rapidly recolonize areas after an iceberg impact (Deregibus et al., 2017).

The shallow waters off the Western Antarctic Peninsula have experienced rapid warming over the last 50 years, which has led to reductions in sea ice, melting of glaciers and higher levels of iceberg disturbance. These changes are causing regional benthic biomass to increase or decrease, depending on the additional influences of ice scour, turbidity and freshening. Additionally, the dominance of previously cold-restricted or light-restricted taxa is increasing, and several ecological tipping points have already been breached, leading to ecological phase shifts in some habitats (Griffiths et al., 2024).

5.13.2. MAMMALS

No seals use Rothera Point as a breeding site, although some seals will haul out on the beaches around the point. Weddell seals (*Leptonychotes weddelli*) are the most obvious mammal and are present all year round in the area around Rothera Point (Hughes, 2022). In late September, pups are born on the sea ice. Crabeater seals (*Lobodon carcinophagus*) and elephant seals (*Mirounga leonina*) are also present, and Fur seals (*Arctocephalus gazelle*) arrive in varying numbers towards the end of each summer. Leopard seals (*Hydrurga leptonyx*) are present all year round in small numbers (Muir et al., 2006).

Elephant, Weddell and Fur seals haul out on the shores and raised beaches of all of the Ryder Bay Islands. Crabeater seals are known to overwinter in Margeurite Bay (Ribic et al., 2008).

Minke whales (*Balaenoptera bonaerensis*) and humpback whales (*Megaptera novaeangliae*) are seen in Ryder Bay each summer. During some years minke whales can be observed frequently and may be year-round residents, including within the ice pack if present. Tracking methodologies have shown that minke whales have a foraging hotspot on the western Antarctic Peninsula, with the Rothera Point area lying at the southern edge of this area (Ainley et al., 2012). Acoustic survey of blue whale vocalisations in the region found blue whales more likely to be located west of Adelaide Island with little evidence for substantial blue or fin whale activity in Marguerite Bay (Sirovic and Hildebrand, 2011). Killer whales (*Orcinus orca*) inhabit the larger Marguerite Bay area and are usually seen from the station several times each summer.

Niche partitioning has been observed between humpback and minke whales in this area, suggesting minke whales feed closer to the surface and humpbacks feed in deeper waters (Friedlaender et al., 2011).

The Marine Mammals Protected Areas Task Force of the International Union for the Conservation of Nature (IUCN) has designated an Important Marine Mammal Area along the entire western Antarctic Peninsula that includes all of Marguerite Bay (*Figure 69*). This has not been reinforced through any ATCM or CCAMLR decision.

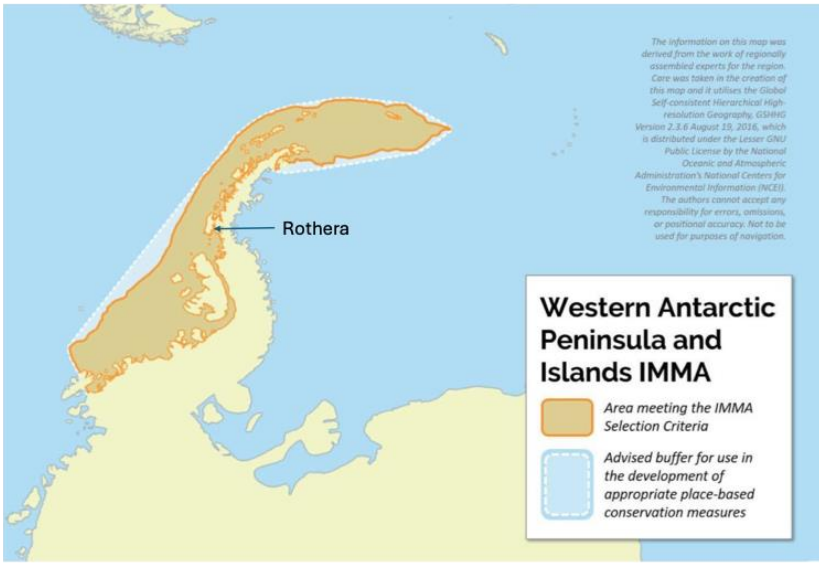


Figure 69. Area of the Western Antarctic Peninsula Important Marine Mammal Area established by IUCN. Source: https://www.marinemammalhabitat.org/factsheets/western-antarctic-peninsula-islands/

5.14. HUMAN ACTIVITY

Adelaide Island was first sighted in 1832 by a British expedition under Captain John Biscoe. Biscoe was exploring the region as part of a voyage for the Enderby Brothers, a prominent British whaling company. He named the island after Queen Adelaide, the wife of King William IV of the United Kingdom.

The first documented landing on Adelaide Island occurred in 1909 during the French Antarctic Expedition led by Jean-Baptiste Charcot. Charcot's ship, the *Pourquoi-Pas?,* explored much of the west coast of the Antarctic Peninsula.

The first station built on Adelaide Island was in 1961, when BAS established Adelaide Station (Base T). The base was built on the southern tip of Adelaide Island and occupied until 1977 when it was finally abandoned due to deteriorating skiway conditions.

Adelaide Station was left unused until it was transferred to Chile on 14 August 1984. Chile's Carvajal Base is operated only during the summer months (*Figure 70*).

The UK's Rothera Station was established in 1975 and has been occupied continuously ever since.

Other bases in the vicinity of Rothera include Argentina's San Martin base on Barry Island (established 1951) and Turkiye's research facility on Horseshoe Island (established 2019) (*Figure 70*).

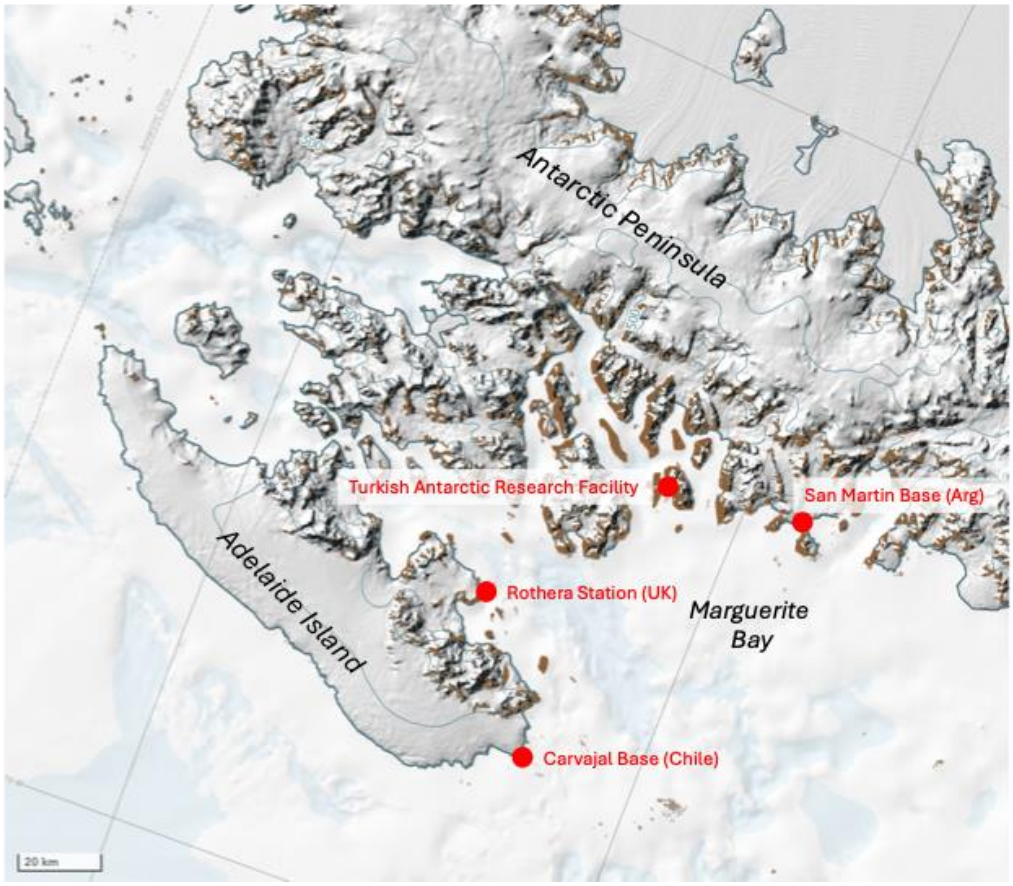


Figure 70. Bases and stations in the vicinity of Rothera. Base map SCAR ADD.

5.14.1. Development of Rothera Station

Rothera station was initially planned and constructed in phases, after which other infrastructure has been added over time as operational requirements changed (*Table 9*).

These construction activities have over time incrementally resulted in significant modifications to the landscape and appearance of Rothera Point (*Figure 71*).

The eastern side of Rothera Point is comparatively free of buildings, however, a gradual encroachment to the eastern side of the Point can be observed with several antennae having been erected and two small huts for research purposes established on East Beach in the 2021-22 and 2024-25 seasons.

Studies have demonstrated that Rothera station and associated operations have not resulted in a significant release of persistent organic pollutants (POPs) into the marine environment with detectable levels of POPs in marine fauna attributed instead to long range transport processes (Krasnobaev et al., 2020).

Discharges of sewage to the marine environment have been undertaken for several decades. In 2003 BAS established a sewage treatment plant at the Station with noticeable decreases in detectable anthropogenic microorganisms being released (Hughes, 2004).



Figure 71. Visible changes to Rothera Point due to human activity between 1957 and 2022 – noting that further infrastructure development has been undertaken since 2022. Source: BAS.

Table 9. Chronology of construction and development activity on Rothera Point.

Year / period	Activity
1 February 1976	A small accommodation hut was erected.
1976/1977	Phase II included the main accommodation block, power house and tractor shed. An old storage shed from Adelaide (Station T) was erected close to Phase I and known as the Bingham building after Surgeon Commander EW Bingham.
1978/1979	Phase III included scientific offices and a travel store and cold room. In 2001 the travel store was named Fuchs House after Sir Vivian Fuchs, Director of BAS 1958-73.
November 1985 – March 1987	Phase IV, was an extension to Phase II. In 2001 it was named Bransfield House (after BAS ship RRS Bransfield).
1991/1992	A wharf and gravel runway (with bulk fuel tanks and aircraft hangar) became operational in the 1991/92 season. Substantial rock blasting occurred, including the removal of 'Flagstaff Hill'. The wharf was named Biscoe Wharf after the BAS ship RRS John Biscoe. A new storage hut, called the Miracle Span was constructed.
1994/95 – 1996/97	Under the next phase of development, a boatshed was completed in 1994/95, a transit accommodation block in 1996/97 (named Giants House in 2001 after the Rothera sledge dog team "Giants"), and a new generator shed.
1997	The Bonner Laboratory became operational in 1997, housing biological research facilities when Signy (Station H), was reduced to summer only operations. It was named after W N Bonner, biologist 1953-86 and Deputy Director of BAS 1986-88.
1999/00 – 2000/01	A new accommodation building was erected during the 1999/00 and 2000/01 seasons. It was named Admirals House after the Rothera dog team "Admirals". Also in 1999/00 an air operations control tower was added to the north end of Bransfield House.
2002/2003	The Bonner Laboratory was destroyed by fire on 29 Sep 2001 but rebuilt in the 2002/03 season, when a sewage treatment plant was also erected.
2007/2008	A new living block, including canteen, library and recreational facilities, was completed in 2007/08 and named New Bransfield House. The upper floor of old Bransfield House then became redundant.
2013	The Dirck Gerritsz Laboratory was officially opened on Sunday 27 January by Leo le Duc on behalf of the Ministry of Education, Culture and Science of the Netherlands. The laboratory is a collaboration between BAS and the Netherlands Organisation for Scientific Research (NWO) and hosts four research projects.
2017-18	Rock blasting undertaken to produce aggregate material for the wharf and new Discovery Building
2018/19 – 2019/20	Biscoe Wharf at Rothera Station was demolished and replaced with a new, extended wharf to accommodate the RRS Sir David Attenborough.
2019/20 – 2025/26	Construction of the 4,500m², two-story Discovery Building as part of the Antarctic Infrastructure Modernisation Programme. The Miracle Span constructed in 1991/1992 was removed to accommodate the Discovery Building. The following buildings were deconstructed: Old Bransfield House, Vehicles Garage, Generator Shed, Fuchs, Chippy Shed, Binghams.

5.15. SCIENTIFIC RESEARCH

Whilst Rothera Station serves as a hub for transporting researchers and science teams into deep field locations, a significant amount of research is undertaken locally with a number of monitoring and communication installations across the Point supporting a wide range of disciplines, including space weather, terrestrial biology, marine biology, oceanography, meteorology, atmospheric chemistry, and ozone monitoring.

5.15.1. ATMOSPHERE, ICE AND CLIMATE

Meteorological data has been collected at Rothera since 1976, providing more than 50 years of continuous data. These continuous data sets have provided the backbone of the important climate statistics from the Antarctic Peninsula over the last four decades. Weather balloons are launched at over 400 locations around the world at the same time each day. These data points are used in real time by weather forecasters to get a global snapshot of the atmosphere. Climate scientists are also interested in the long-term records of temperatures at different heights in the atmosphere. At Rothera weather balloons are launched five times a week. Precipitation quantities are difficult to accurately measure in windy and snowy conditions, as are present at Rothera. An array of precipitation sensors operates side-by-side to provide the most accurate level of precipitation possible and also provides information on which types of sensors work best in differing conditions.

There is a tide gauge installed at the Wharf, which is calibrated once a week by conducting a tide dipping. This tide gauge forms part of the Global Sea Level Observing System (GSLOS).

It is vital that scientists continue to monitor the levels of ozone in the atmosphere so that they can understand the current state of the Antarctic ozone hole. At Rothera this is achieved using a Systeme d'Analyse par Observations Zénithales (SAOZ) instrument. SAOZ measures scattered sunlight in a way which allows scientists to determine how much ozone the light has passed through.

5.15.2. SPACE WEATHER AND ATMOSPHERE

Physical scientists use medium frequency radar and meteor radar to study wind and temperature in the upper atmosphere above Antarctica. A low-power magnetometer at Rothera – one of a chain of instruments that BAS has installed across Antarctica – records variations in the Earth's magnetic field.

5.15.3. BONNER LABORATORY AND BIODIVERSITY, EVOLUTION AND ADAPTATION

The Bonner Laboratory supports station-focused science projects predominantly in the areas of marine biology, oceanography, and terrestrial biology. The Biodiversity, Evolution and Adaptation team aims to understand how past, present, and future environmental change has and will affect polar biodiversity both on land and in the ocean, and how life adapts to extreme polar conditions. Their research outcomes will provide deep insight into the impact of environmental change on the natural world, make a strong contribution to future conservation measures and generate new and innovative areas of research that have potential societal benefits.

5.16. PROTECTED AND MANAGED AREAS

There are no Antarctic Specially Managed Areas (ASMAs) in the vicinity of Rothera. There are five designated Antarctic Specially Protected Areas (ASPAs) in the vicinity of Rothera (*Figure 72*).

ASPAs 107, 115 and 117 are well beyond the limits of the planned activities covered by the EIA.

ASPA 129 is just a few hundred metres away from the planned activities that are the subject of this impact assessment. ASPA 129 is designated to protect an Antarctic fellfield ecosystem and to provide a control area, against which the effects of human impact associated with the adjacent Rothera base can be monitored. The ASPA contains a rich and diverse vegetation. Rothera Point along with nearby Léonie Island (part of which is included in ASPA 177) are the two sites with the largest floristic richness and most complex vegetation within the wider geographical context of Marguerite Bay and Adelaide Island.

ASPA 177 (see also *Figure 66*) is designated to protect a combination of outstanding scientific, environmental, wilderness and aesthetic values, in particular relating to the avifauna and terrestrial biological communities within the Area; though the nearest part of this ASPA to the planned activities is approximately 4km away.

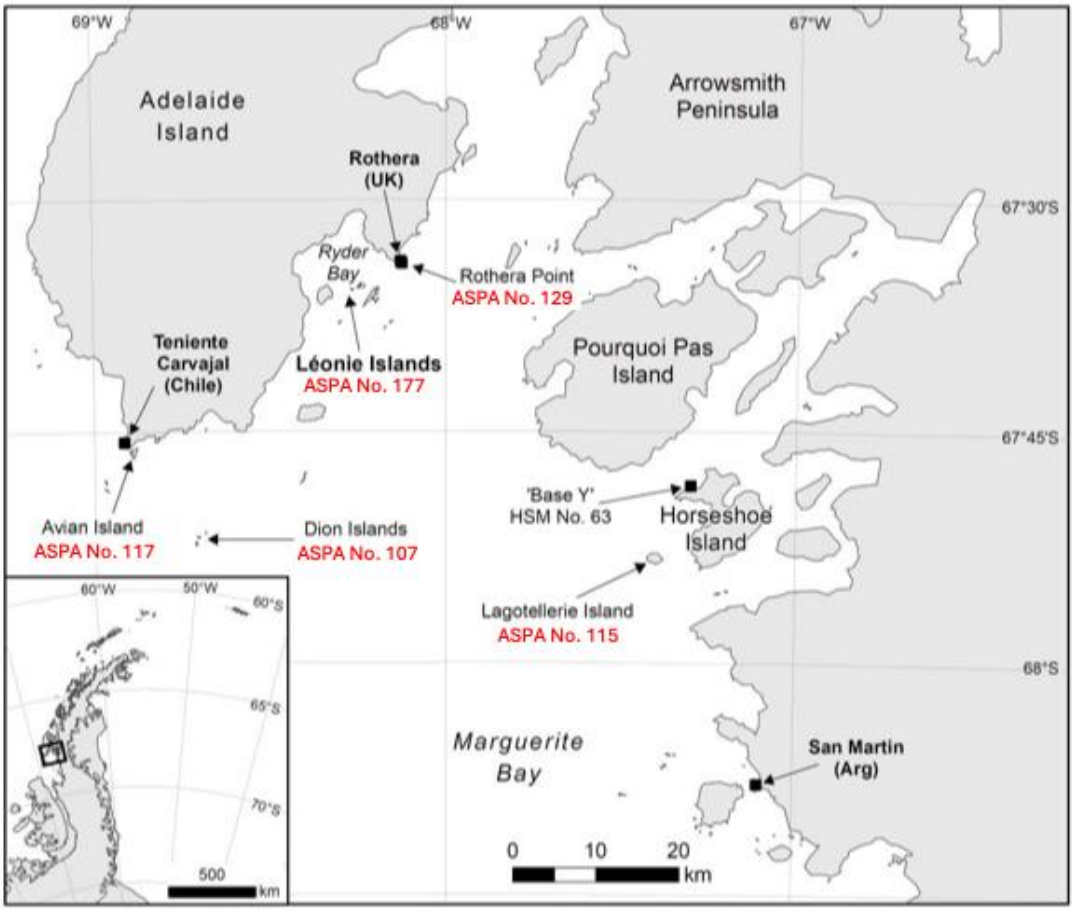


Figure 72. Designated Antarctic Specially Protected Areas in the vicinity of Rothera Base.

5.17. HERITAGE VALUES

There are no Historic Sites and Monuments (HSM) designated in the immediate area of planned activities (*Figure 73*). The nearest HSMs are numbered 26 (Ceremonial facilities of the San Martín Base), 63 (Base Y, Horseshoe Island) and 55 / 64 (East Base, Antarctica, Stonington Island and Base E, Stonington Island respectively).

The nearest HSM is HSM 63 which is approximately 50km to the east of the planned activities.

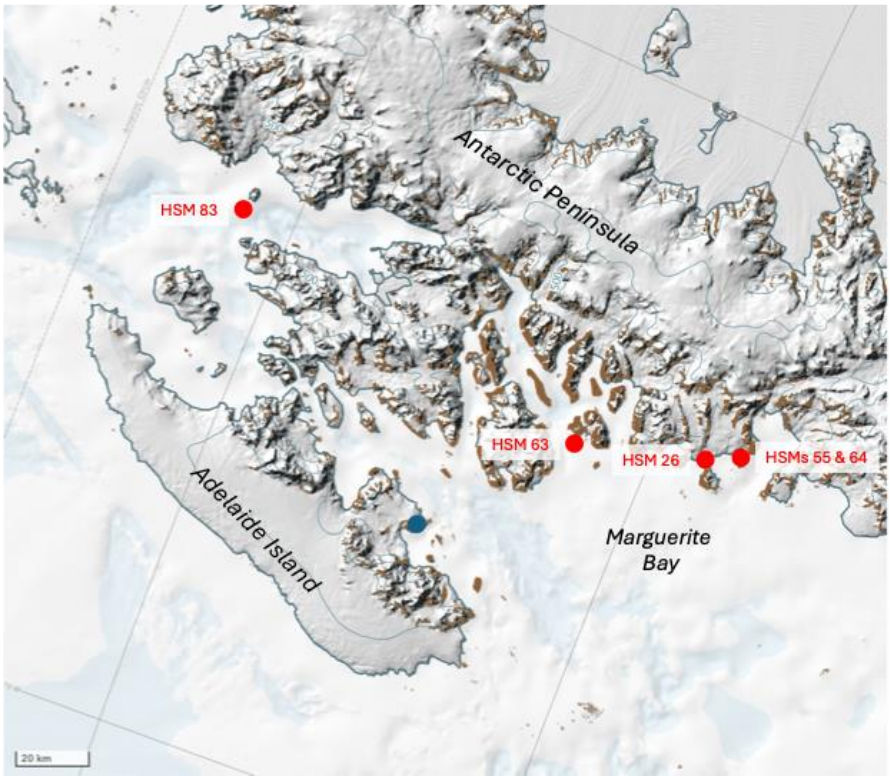


Figure 73. Map of designated Historic Sites and Monuments closest to the area of activity (blue dot). Base map SCAR ADD.

Whilst there are no formally designated Historic Sites and Monuments (HSMs) on Rothera Point, the station does have a rich cultural heritage which has developed since the Station was established in 1975. Potential impacts to Station heritage were considered in the Rothera Modernisation Phase 1 Initial Environmental Evaluation (2019).

A heritage survey was undertaken at Rothera in December 2016 in conjunction with the United Kingdom Antarctic Heritage Trust (UKAHT) to identify objects with potential heritage significance.

The survey identified several objects with potentially broad heritage significance (*i.e.,* significance to stakeholders other than station personnel, including former BAS staff, historians/heritage professionals and the public). A copy of the survey results is available as Appendix E to the Rother Modernisation Phase 1 Initial Environmental Evaluation. Instructions on how each artifact should be handled have been included in the results.

The planned activities under consideration of this EIA will not interact with these heritage values.

5.18. WILDERNESS AND AESTHETIC VALUES

Whilst there is not an internationally agreed definition of aesthetic value in Antarctica, it is generally characterised by the lack of visible evidence of human activity including permanent infrastructure. In addition, the wilderness value of a location in Antarctica is often related to a feeling of remoteness (Tin and Summerson, 2013).

For over 40 years the British Antarctic Survey has concentrated its southern Antarctic Peninsula station infrastructure largely within the confines of the 0.4 km^2 area of Rothera. This concentration of activity within a small area means that there has not been an on-going expansion of Rothera's footprint (as observed at other Antarctic stations), not least because space for construction is limited. A result of this, evidence of human presence is visible from most areas of Rothera; however, the great majority of infrastructure has been constructed on the northwest side of the central rocky north-east to southwest trending ridge that bisects Rothera Point. Consequently, it is possible to experience a greater perception of wilderness when on East Beach and on the northern fringes of ASPA 129.



Figure 74. Wilderness and aesthetic value can be appreciated within the vicinity of Rothera Point. Source: BAS.

Indeed, it is common for Rothera personnel wanting to get away from busy station life to go for a 'walk round the Point', which involves walking around the northern fringes of the ASPA to East Beach and then up to the memorial cross before returning to the station. The benefit to the mental health of Rothera personnel cannot be overstated. With most of the infrastructure confined to the Point itself, views in almost every direction away from the Point show near pristine Antarctic scenery of outstanding wilderness and aesthetic value (*Figure 74*).

5.19. FUTURE ENVIRONMENTAL REFERENCE STATE - NO ACTION SCENARIO

In the absence of the proposed activity, the future environmental reference state of the Rothera Point and the broader Ryder Bay area will continue to reflect a combination of natural environmental processes and the ongoing influence of established station infrastructure and operations, as described in this Chapter and Chapter 4.

Rothera Point is not a pristine environment; rather, it represents a managed, persistently occupied research site where a defined footprint of physical disturbance, infrastructure development, and operational activity has been ongoing since 1975. In the absence of the activities under consideration in this EIA, these existing pressures are expected to remain broadly stable in extent and intensity, and subject to routine maintenance, environmental management, and regulatory controls.

Over the next 10–20 years, the broader environmental setting is expected to be increasingly shaped by regional climatic and oceanographic change as described above. Observations and projections for the western Antarctic Peninsula indicate a continued tendency toward atmospheric and upper-ocean warming, alongside high interannual variability and an overall reduction in the duration and extent of seasonal sea ice in Ryder Bay. These changes are expected to influence the timing and magnitude of primary production, with consequent effects on pelagic ecosystems and benthic–pelagic coupling.

Benthic communities in the vicinity of Rothera Point are expected to remain largely intact outside the immediate footprint of existing infrastructure and historically disturbed areas. Community structure will continue to reflect slow growth rates, episodic recruitment, and sensitivity to natural disturbance processes such as iceberg scour and anchor ice formation, which will maintain a heterogeneous mosaic of successional stages.

Populations of seabirds and marine mammals utilising Ryder Bay and adjacent coastal habitats are expected to continue to exhibit variability driven primarily by sea-ice dynamics and prey availability. Regional trends indicate the potential for ongoing shifts in species composition and distribution, including responses by ice-dependent and open-water-associated species to changing habitat conditions.

Terrestrial environments at Rothera Point, including ice-free areas, will remain spatially limited but may experience incremental changes associated with longer snow-free periods and increased active-layer depth. These changes may influence microbial, lichen, and moss communities, particularly in areas already subject to human disturbance or nutrient enrichment.

In the absence of the proposed activities, local environmental conditions (including noise, artificial light, and contamination levels) are expected to remain within the range defined by current station operations and established environmental management practices, without substantial expansion of the disturbed area.

Overall, the future environmental reference state is characterised by a non-pristine, managed environment in which existing anthropogenic influences persist at relatively constant levels, superimposed on progressive, climate-driven environmental change operating at seasonal to decadal scales.

5.20. SUMMARY OF KEY ENVIRONMENTAL ELEMENTS

The aspects arising from the planned activities are, for the most part, only likely to have localised impacts within the area of Rothera Point and possibly the nearshore marine environment.

The evaluation in this chapter suggests that the environmental elements that require particular attention in the planning of the activity and the mitigation measures are:

- Wildlife in the area including small numbers of birds and seals that use the shoreline of Rothera point and, in particular, the Skuas that breed across the point;
- The permafrost that may be impacted as a result of the planned earthworks, although the state of knowledge of the permafrost is limited and the likely consequences may not be easy to predict or monitor;
- The areas of vegetation across Rothera Point including at the base of the ice ramp;
- The various scientific monitoring stations across Rothera Point which could be subject to damage or disturbance;
- ASPA 129, which merits attention because of the international nature of its designation;
- The nearshore marine and benthic environment, at least in the vicinity of the wharf.

6. Assessment of the Environmental Impacts

6.1. INTRODUCTION

Having established the scope of the impact assessment (Chapter 3), described the nature and scale of the proposed activities (Chapter 4) and evaluated the environments and values that may be affected by the planned activities (Chapter 5), this chapter of the EIA assesses the actual or potential impacts that will or could occur as a result of the planned activities and evaluates the significance of those impacts.

For this impact assessment the various projects have been considered separately, with the exception that the removal of the old mooring bollard has been included within the wharf resurfacing project and the removal of the old refuelling hut has been included within the fuel pipeline project.

6.2. METHODS AND DATA

The actual or potential environmental impacts of the activity are qualitatively assessed by means of a four-step analysis involving:

i. identifying the **aspects** *i.e.* the physical change imposed on, or an input released to the environment as the result of an action or activity such as emissions, dust, mechanical action on the substrate, fuel spills, noise, light, wastes, heat, introduced species, etc., arising from the proposed activities described in Chapter 4;

ii. identifying the **exposure** *i.e.* the interaction between an identified potential output and the environment including flora and fauna, freshwater, marine, terrestrial and atmospheric environments;

iii. identifying the **impacts** *i.e.* the change in environmental values or resources attributable to the activity;

iv. assessing the **significance** of the identified impacts by considering the spatial extent, duration, severity and likelihood of occurrence of the potential impacts to each environmental element – with reference to the three levels of significance identified by Article 8(1) of the Protocol (*i.e.* less than, no more than, or more than a minor or transitory impact).

6.3. ENVIRONMENTAL ASPECTS

An aspect is a physical change (*e.g.* movement of sediments by vehicle passage or noise), or an entity (*e.g.* emissions, an introduced species) imposed on or released to the environment as the result of an action or an activity (EIA Guidelines, 2026).

For the purposes of this EIA the planned work has been divided into the three main activities, namely the wharf resurfacing (to which has been included the removal of the disused mooring bollard), the fuel pipelines and fuel bunker station installation (including the removal of the old fuel hut) and the installation of the building mounted and ground mounted PV panels and associated infrastructure, as well as the support activities required in having construction personnel on the Station.

These activities have been deliberately assessed as discrete work streams as this allows any aspects or impacts that may be unique to any one work stream to be identified. The cumulative impacts arising across all work streams are considered in Section 6.7.

The aspects that will or may arise from these activities were identified in Chapter 4 and are further summarised in *Table 10* to *Table 19* below.

Table 10. Environmental aspects that will or may arise from the wharf resurfacing that will or may impact the Antarctic environment.

	ACTUAL OR POTENTIAL ENVIRONMENTAL ASPECTS										
ACTIVITY giving rise to aspect	**Gaseous emissions** *(including burning fossil fuels)*	**Noise emissions**	**Light emissions**	**Heat emissions**	**Dust or fines emissions**	**Mechanical action** *(physical disturbance to substrate & vibration)*	**Hazardous substances release** *(including fuel)*	**Wastes** *(including unrecoverable items)*	**Water turbulence**	**Introduction of non-native species or relocation of native species**	**Presence / visual disturbance**
Wharf resurfacing											
Excavation of existing surface fill material		Excavation work will emit noise including with the potential to propagate into the nearshore marine environment	Artificial lighting may be used at some times of the day		Excavation may release dust. Potential also to release fines or fill material to the nearshore marine environment	Physical disturbance to ice-free ground and potential ground vibration			*No physical disturbance to water identified*		*Activities will largely restore existing conditions. Visibly little to no change identified.*
Crushing & stockpiling of rock to the required grade		Rock crushing will emit noise	Artificial lighting may be used at some times of the day		Rock crushing and sorting of graded material may generate dust	Physical disturbance to ice-free ground					
Resurfacing of the wharf with graded fill material		Resurfacing will emit noise with the potential to propagate into the nearshore marine environment	Artificial lighting may be used at some times of the day		Resurfacing may release dust. Potential also to release fines or fill material to the nearshore marine environment	Physical disturbance to ice-free ground and potential ground vibration including propagation to the marine environment					
Use of vehicles (excavators, rock crusher, screener, vibrating roller)	Burning fossil fuels will release exhaust gases to air	Vehicle engines will emit noise		Vehicle engines will release heat		Physical disturbance to ice-free ground	Risk of unplanned releases of fuel e.g. ruptured fuel or hydraulic hose or during vehicle refuelling	Any spill event will generate hazardous waste e.g. contaminated soils			
Integrity testing of the new surface								Release of imported geological material (kiln dried sand)		Risk of importation of non-native species (in kiln dried sand)	

Table 11. Environmental aspects that will or may arise from the installation of the pipelines and the fuel reel bunker station (and removal of the old fuel hut) that will or may impact the Antarctic environment.

	ACTUAL OR POTENTIAL ENVIRONMENTAL ASPECTS										
ACTIVITY giving rise to aspect	**Gaseous emissions** *(including burning fossil fuels)*	**Noise emissions**	**Light emissions**	**Heat emissions**	**Dust or fines emissions**	**Mechanical action** *(physical disturbance to substrate & vibration)*	**Hazardous substances release** *(including fuel)*	**Wastes** *(including unrecoverable items)*	**Water turbulence**	**Introduction of non-native species or relocation of native species**	**Presence / visual disturbance**
Fuel Pipelines & Fuel Reel Bunker Station Installation											
Importation of materials including pipeline & fuel bunker station								Waste may be generated from packing / packaging materials	*No physical disturbance to water identified*	Importation of materials carries the risk of non-native species introductions	
Excavation of the pipeline trench (in stages)		Excavation work will emit noise	Artificial lighting may be used at some times of the day		Excavation may result in dust emissions	Physical disturbance to ice-free ground and potential ground borne vibration Open tranches may also pose a risk to wildlife		Old / disused fuel pipe may be uncovered & will need to be removed			
Crushing of rock to the required grade		Rock crushing will emit noise	Artificial lighting may be used at some times of the day		Rock crushing and sorting of graded material may generate dust						
Laying of the pipeline & welding	Emission of welding gases		Artificial lighting may be used at some times of the day					Pipe offcuts & other items of construction waste may be generated			
Backfilling the trench & compacting		Backfilling & compacting will emit noise	Artificial lighting may be used at some times of the day		Dust may be generated during backfilling	Physical disturbance to ice-free ground and potential ground vibration					
Installing the fuel bunker station on the wharf						Physical disturbance to ice-free ground from minor ground levelling					Additional infrastructure may have implications for visual and wilderness values
Use of vehicles (excavators, jaw crusher, screener, vibrating roller)	Burning fossil fuels will release exhaust gases to air	Vehicle engines will emit noise		Vehicle engines will release heat			Risk of unplanned releases of fuel e.g. ruptured fuel or hydraulic hose or during vehicle refuelling	Any spill event will generate hazardous waste e.g. contaminated soils			

Table 12. Environmental aspects that will or may arise from the BMPV / GMPV and BESS installations that will or may impact the Antarctic environment.

	ACTUAL OR POTENTIAL ENVIRONMENTAL ASPECTS										
ACTIVITY giving rise to aspect	**Gaseous emissions** *(including burning fossil fuels)*	**Noise emissions**	**Light emissions**	**Heat emissions**	**Dust or fines emissions**	**Mechanical action** *(physical disturbance to substrate & vibration)*	**Hazardous substances release** *(including fuel)*	**Wastes** *(including unrecoverable items)*	**Water turbulence**	**Introduction of non-native species or relocation of native species**	**Presence / visual disturbance**
RENEW - BMPV / GMPV & BESS Installations											
Importation of construction materials, PV panels, BESS building			Artificial lighting may be used at some times of the day					Waste may be generated from packing / packaging materials	*No physical disturbance to water identified*	Importation of materials carries the risk of introducing non-native species	
Roof strengthening and installation of the BMPV panels		Use of power tools will emit noise	Artificial lighting may be used at some times of the day					Roof modifications may give rise to construction waste items			PV panels will add to station infrastructure & may have implications for aesthetic or wilderness values
Construction of the BESS building		Use of power tools will emit noise	Artificial lighting may be used at some times of the day					Construction of the BESS building may give rise to waste items including cementitious waste			New building will add to station infrastructure & may have implications for aesthetic or wilderness values
GMPV trial installation		Use of power tools will emit noise			Ground levelling / excavation work may create dust emissions	Ground levelling / excavation work on relatively lightly impacted ground					GMPV panels will add infrastructure which may further detract from aesthetic or wilderness values
Operation of vehicles	Burning fossil fuels will release exhaust gases to air	Vehicle engines will emit noise		Vehicle engines will release heat			Risk of unplanned releases of fuel e.g. ruptured fuel or hydraulic hose or during vehicle refuelling	Any spill event will generate hazardous waste e.g. contaminated soils			

Table 13. Environmental aspects that will or may arise from the hangar redevelopment works that will or may impact the Antarctic environment.

	ACTUAL OR POTENTIAL ENVIRONMENTAL ASPECTS										
ACTIVITY giving rise to aspect	**Gaseous emissions** *(including burning fossil fuels)*	**Noise emissions**	**Light emissions**	**Heat emissions**	**Dust or fines emissions**	**Mechanical action** *(physical disturbance to substrate & vibration)*	**Hazardous substances release** *(including fuel)*	**Wastes** *(including unrecoverable items)*	**Water turbulence**	**Introduction of non-native species or relocation of native species**	**Presence / visual disturbance**
Hangar redevelopment and associated works											
Site investigations of existing hangar		Excavation of investigation pit will create noise	Potential for artificial light emissions if lighting rig is used		Digging of investigation pit may generate dust	Physical disturbance to ice-free areas of Rothera Point Potential for ground-borne vibrations					
Construction of access road and fuel line crossing point		Laying, profiling and compacting of aggregate will generate noise	Potential for artificial light emissions if lighting rig is used		Laying, profiling and compacting of aggregate may generate dust	Physical disturbance to ice-free areas of Rothera Point Potential for ground-borne vibrations		Possible creation of small amounts of waste items e.g. timber offcuts		Importation of materials carries risk of introducing non-native species	
Drainage ditch diversion		Digging of the new channel will generate noise	Potential for artificial light emissions if lighting rig is used		Digging of the ditch may create dust and produce fines which may be washed into Hangar Cove	Physical disturbance to ice-free areas of Rothera Point Potential for ground-borne vibrations					Relocation of the human-made ditch will slightly expand the high impact area of the Station
Installation of temporary hangar ducts		Trenching, backfilling & compacting will generate noise	Potential for artificial light emissions if lighting rig is used		Trenching, backfilling & compacting may generate dust	Physical disturbance to ice-free areas of Rothera Point Potential for ground-borne vibrations		Possible creation of small amounts of waste items e.g. duct offcuts		Importation of materials carries risk of introducing non-native species	
Preparation of crane pad		Laying, profiling and compacting of aggregate will generate noise	Potential for artificial light emissions if lighting rig is used		Laying, profiling and compacting of aggregate may generate dust	Physical disturbance to ice-free areas of Rothera Point Potential for ground-borne vibrations					
Relocation of runway lighting kiosk		Digging, backfilling and compacting connecting trench will generate noise	Potential for artificial light emissions if lighting rig is used		Digging, backfilling and compacting connecting trench may generate dust	Physical disturbance to ice-free areas of Rothera Point Potential for ground-borne vibrations		Possible creation of small amounts of waste items e.g. duct offcuts		Importation of materials carries risk of introducing non-native species	
Installation of temporary aircraft tie downs		Digging, backfilling and compacting holes will generate noise	Potential for artificial light emissions if lighting rig is used		Digging, backfilling and compacting holes may generate dust	Physical disturbance to ice-free areas of Rothera Point Potential for ground-borne vibrations				Importation of materials carries risk of introducing non-native species	
Installation of temporary hangar		Construction work will generate noise	Potential for artificial light emissions if lighting rig is used		Ground preparation works may generate dust	Ground preparation works may give rise to ground-borne vibrations		Removal of the temporary hangar will produce materials for reuse, recycling or disposal		Importation of materials carries risk of introducing non-native species	

	ACTUAL OR POTENTIAL ENVIRONMENTAL ASPECTS										
ACTIVITY giving rise to aspect	**Gaseous emissions** *(including burning fossil fuels)*	**Noise emissions**	**Light emissions**	**Heat emissions**	**Dust or fines emissions**	**Mechanical action** *(physical disturbance to substrate & vibration)*	**Hazardous substances release** *(including fuel)*	**Wastes** *(including unrecoverable items)*	**Water turbulence**	**Introduction of non-native species or relocation of native species**	**Presence / visual disturbance**
Construction of the hangar		Construction work will generate noise	Potential for artificial light emissions if lighting rig is used			Potential for ground-borne vibrations		Removal of materials from existing hangar will create waste items Use of geotextile material – introduction of synthetic materials with risk of release of microfibres		Importation of materials carries risk of introducing non-native species	The redeveloped hangar will have an expanded footprint
Apron resurfacing		Laying, profiling and compacting of aggregate will generate noise	Potential for artificial light emissions if lighting rig is used		Laying, profiling and compacting of aggregate may generate dust	Physical disturbance to ice-free areas of Rothera Point Potential for ground-borne vibrations					
Use of vehicles (excavator, dump truck & vibrating roller)	Burning fossil fuels will release exhaust gases to air	Vehicle engines will emit noise		Vehicle engines will release heat			Risk of unplanned releases of fuel e.g. ruptured fuel or hydraulic hose or during vehicle refuelling				
Use of a commercial vessel	Burning fossil fuels will release exhaust gases to air	Operation of vessels will emit noise including to the marine environment		Vessel engines will release heat			Risk of marine spill		Localised turbulence from the operation of the vessels	Risk of introduction of non-native marine species	Operation of the vessels in the remote Southern Ocean

Table 14. Environmental aspects that will or may arise from the bollard removal that will or may impact the Antarctic environment.

	ACTUAL OR POTENTIAL ENVIRONMENTAL ASPECTS										
ACTIVITY giving rise to aspect	**Gaseous emissions** *(including burning fossil fuels)*	**Noise emissions**	**Light emissions**	**Heat emissions**	**Dust or fines emissions**	**Mechanical action** *(physical disturbance to substrate & vibration)*	**Hazardous substances release** *(including fuel)*	**Wastes** *(including unrecoverable items)*	**Water turbulence**	**Introduction of non-native species or relocation of native species**	**Presence / visual disturbance**
Bollard removal											
Breaking up & removal of the disused mooring bollard		Concrete breaking will emit noise	Artificial lighting may be used at some times of the day		Dust may be generated from breaking concrete	Physical disturbance to ice-free ground and potential ground vibration		Waste concrete rubble will be created	*No physical disturbance to water identified*	*No risk of introducing non-native species or relocating native species identified*	
Backfilling & compaction of the bollard hole		Backfilling & compacting will emit noise	Artificial lighting may be used at some times of the day		Dust may be generated during backfilling	Physical disturbance to ice-free ground and potential ground vibration					Removal of the bollard may improve the aesthetics of the area
Use of vehicles (excavators, jaw crusher, screener, vibrating roller)	Burning fossil fuels will release exhaust gases to air	Vehicle engines will emit noise		Vehicle engines will release heat		Physical disturbance to ice-free	Risk of unplanned releases of fuel e.g. ruptured fuel or hydraulic hose or during vehicle refuelling	Any spill event will generate hazardous waste e.g. contaminated soils			
Crushing & stockpiling of rock to the required grade		Rock crushing will emit noise	Artificial lighting may be used at some times of the day		Rock crushing & sorting of graded material may generate dust	Physical disturbance to ice-free					

Table 15. Environmental aspects that will or may arise from the removal of the old fuel hut and disused fuel pipes that will or may impact the Antarctic environment.

	ACTUAL OR POTENTIAL ENVIRONMENTAL ASPECTS										
ACTIVITY giving rise to aspect	**Gaseous emissions** *(including burning fossil fuels)*	**Noise emissions**	**Light emissions**	**Heat emissions**	**Dust or fines emissions**	**Mechanical action** *(physical disturbance to substrate & vibration)*	**Hazardous substances release** *(including fuel)*	**Wastes** *(including unrecoverable items)*	**Water turbulence**	**Introduction of non-native species or relocation of native species**	**Presence / visual disturbance**
Removal of the Old Fuel Hut and disused fuel pipes											
Dismantling the old fuel hut, removing concrete foundations & old fuel pipes		Concrete breaking will generate noise	Artificial lighting may be used at some times of the day		Concrete breaking may result in dust emissions	Physical disturbance to ice-free ground and potential ground vibration	Risk of loss of residual fuel from old pipes	Waste concrete rubble & old / disused fuel pipe will be created	*No physical disturbance to water identified*	*No risk of introducing non-native species or relocating native species identified*	Removal of the old fuel hut may improve the aesthetics of the area
Backfilling & compacting the ground beneath the old fuel hut		Backfilling & compacting will emit noise	Artificial lighting may be used at some times of the day		Dust may be generated during backfilling	Physical disturbance to ice-free ground and potential ground vibration					
Use of vehicles (excavator, vibrating roller)	Burning fossil fuels will release exhaust gases to air	Vehicle engines will emit noise		Vehicle engines will release heat		Physical disturbance to ice-free	Risk of unplanned releases of fuel e.g. ruptured fuel or hydraulic hose or during vehicle refuelling	Any spill event will generate hazardous waste e.g. contaminated soils			

Table 16. Environmental aspects that will or may arise from the runway maintenance works that will or may impact the Antarctic environment.

	ACTUAL OR POTENTIAL ENVIRONMENTAL ASPECTS										
ACTIVITY giving rise to aspect	**Gaseous emissions** *(including burning fossil fuels)*	**Noise emissions**	**Light emissions**	**Heat emissions**	**Dust or fines emissions**	**Mechanical action** *(physical disturbance to substrate & vibration)*	**Hazardous substances release** *(including fuel)*	**Wastes** *(including unrecoverable items)*	**Water turbulence**	**Introduction of non-native species or relocation of native species**	**Presence / visual disturbance**
Runway Maintenance Works											
Crushing of rock to the required grade		Rock crushing will emit noise	Artificial lighting may be used at some times of the day		Rock crushing and sorting of graded material may generate dust	*No activities resulting in direct mechanical action identified*			*No physical disturbance to water identified*		Increasing the stockpile may have visual impact
Use of vehicles (excavators, jaw crusher, screener, dump truck)	Burning fossil fuels will release exhaust gases to air	Vehicle engines will emit noise		Vehicle engines will release heat			Risk of unplanned releases of fuel e.g. ruptured fuel or hydraulic hose or during vehicle refuelling	Any spill event will generate hazardous waste e.g. contaminated soils			
Replacement stainless steel covers on electrical cabinets			Artificial lighting may be used at some times of the day					Old stainless steel covers will need to be removed from Rothera		Importation of materials (i.e. new cabinet covers) risks introducing non-native species	

Table 17. Environmental aspects that will or may arise from the establishment of the slipway that will or may impact the Antarctic environment.

	ACTUAL OR POTENTIAL ENVIRONMENTAL ASPECTS										
ACTIVITY giving rise to aspect	**Gaseous emissions** *(including burning fossil fuels)*	**Noise emissions**	**Light emissions**	**Heat emissions**	**Dust or fines emissions**	**Mechanical action** *(physical disturbance to substrate & vibration)*	**Hazardous substances release** *(including fuel)*	**Wastes** *(including unrecoverable items)*	**Water turbulence**	**Introduction of non-native species or relocation of native species**	**Presence / visual disturbance**
Establishment of a Slipway											
Profiling of the beach to create a slipway		Scraping and profiling will generate noise including potential propagation to marine environment	Potential for artificial light emissions if lighting rig is used		Emissions of dust to air & release of fines to the marine environment could occur	Physical disturbance to shoreline environment will occur Potential for ground borne vibrations including to the marine environment	Risk of release of contaminants to the marine environment (as a result of historic stockpiling of waste metal at the site)		Potential for highly localised increased turbulence in the immediate area of works	*No risk of introducing non-native species or relocating native species identified*	The reprofiled shoreline will be visually apparent albeit in the same location as the previous slipway
Use of vehicles (excavator and dump truck)	Burning fossil fuels will release exhaust gases to air	Vehicle engines will emit noise		Vehicle engines will release heat			Risk of unplanned releases of fuel e.g. ruptured fuel or hydraulic hose or during vehicle refuelling	Any spill event will generate hazardous waste e.g. contaminated soils			

Table 18. Environmental aspects that will or may arise from the contaminated land investigations and which will or may impact the Antarctic environment.

	ACTUAL OR POTENTIAL ENVIRONMENTAL ASPECTS										
ACTIVITY giving rise to aspect	**Gaseous emissions** *(including burning fossil fuels)*	**Noise emissions**	**Light emissions**	**Heat emissions**	**Dust or fines emissions**	**Mechanical action** *(physical disturbance to substrate & vibration)*	**Hazardous substances release** *(including fuel)*	**Wastes** *(including unrecoverable items)*	**Water turbulence**	**Introduction of non-native species or relocation of native species**	**Presence / visual disturbance**
Ground Contamination Assessment											
Digging of sampling pits		Excavation of pits will create noise	Potential for artificial light emissions if lighting rig is used		Digging of sampling pits may generate dust	Physical disturbance to ice-free areas of Rothera Point Potential for ground-borne vibrations			*No physical disturbance to water identified*	*No risk of introducing non-native species or relocating native species identified*	*Activities will largely restore existing conditions. Visibly little to no change identified.*
Refilling pits and compacting		Refilling the pits and compacting will generate noise	Potential for artificial light emissions if lighting rig is used		Refilling the pits may generate dust	Physical disturbance to ice-free areas of Rothera Point Potential for ground-borne vibrations					
Use of vehicles (excavator, dump truck & vibrating roller)	Burning fossil fuels will release exhaust gases to air	Vehicle engines will emit noise		Vehicle engines will release heat			Risk of unplanned releases of fuel e.g. ruptured fuel or hydraulic hose or during vehicle refuelling	Any spill event will generate hazardous waste e.g. contaminated soils			

Table 19. Environmental aspects that will or may arise from the support activities that will or have potential to impact the Antarctic environment.

	ACTUAL OR POTENTIAL ENVIRONMENTAL ASPECTS										
ACTIVITY giving rise to aspect	**Gaseous emissions** *(including burning fossil fuels)*	**Noise emissions**	**Light emissions**	**Heat emissions**	**Dust or fines emissions**	**Mechanical action** *(physical disturbance to substrate & vibration)*	**Hazardous substances release** *(including fuel)*	**Wastes** *(including unrecoverable items)*	**Water turbulence**	**Introduction of non-native species or relocation of native species**	**Presence / visual disturbance**
Support Activities											
Transport of construction personnel & cargo to & waste from Rothera	Burning fossil fuels in aircraft & vessels will release exhaust gases to air				*No additional dust emissions identified*		*No additional hazardous substances releases identified*		*No physical disturbance to water identified*	Personal clothing, baggage and equipment risks importing non-native species	
Construction personnel spending time on Station	Increased energy use will increase fossil fuel use at the Station – and hence release of gases to air	Potential for increased noise e.g. during recreational activities	Potential for increased light emissions if additional buildings are put into use	Potential for increased heat emissions if additional buildings are put into use		Potential for increased foot traffic around Rothera Point e.g. during recreational activities		Increased waste volumes including food & general waste as well as wastewater discharges			Increased occupation and use of space (storage, facilities, bedrooms etc). Increase in recreational activities

6.4. ENVIRONMENTAL EXPOSURES

Exposure is the process of interaction between an identified environmental aspect and an environmental receptor or value (EIA Guidelines, 2026).

The environmental receptors that are potentially exposed to the aspects arising from the activities being undertaken (identified in *Table 10* to *Table 19*) are summarised in *Table 20* to *Table 29*.

Note: The exposure of an activity's aspects may vary in significance in differing environments and is not accounted for in this table. The significance of the actual or potential impacts is assessed in Section 6.6. below.

Table 20. Environmental receptors that will or may be impacted from the wharf resurfacing work.

		ENVIRONMENTAL RECEPTORS THAT WILL OR COULD BE IMPACTED								
Wharf Resurfacing	**Aspects Arising*** ** water turbulence & visual disturbance not carried over to this table*	**FAUNA AND FLORA**	**FRESHWATER** *(ponds, streams, rivers, lakes, cryoconite holes)*	**MARINE** *(including sea ice)*	**GLACIOLOGICAL** *(glaciers, ice sheet, ice shelves & permafrost)*	**TERRESTRIAL** *(ice-free ground, soil and rocks)*	**ATMOSPHERE**	**AESTHETIC & WILDERNESS VALUES**	**RESEARCH VALUES**	**VALUES UNDER SPECIAL PROTECTION**
Burning fossil fuels in vehicles used to support the resurfacing work (e.g. excavators and jaw crusher) will result in gas emissions	**Gaseous emissions** *(Burning fossil fuels)*		*No impacts have been identified to local freshwater bodies*		*No impacts have been identified to local glaciological features*		Exhaust gases including GHG released to air with implications for local air quality and climate change	*The completed work is likely to appear no different to the pre-works state and so no further impacts on aesthetic or wilderness values are identified*	*No impacts to research values identified*	*The works are not within the vicinity of the closest ASPAs and no potential consequences for ASPA 129 have been identified*
Noise emission may arise from: • Excavation of existing surface material • Crushing of rock to required grade • Resurfacing of wharf with graded material • Use of vehicles	**Noise emissions**	Potential disturbance to breeding birds on Rothera Point & marine mammals in the vicinity of the wharf								
Potential use of flood lights during: • Excavation of existing surface material • Resurfacing of wharf with graded material	**Artificial light emissions**	Artificial lighting has the potential to attract and disorient birds								
Vehicle engines will release heat	**Heat emissions**						Direct release of heat to air which will dissipate rapidly			
Dust or fines may arise from: • Excavation of existing surface material • Crushing of rock to required grade • Resurfacing of wharf with graded material	**Dust or fines emissions**	Potential smothering of terrestrial flora Release of fines or graded material to marine environment may also smother benthic fauna and flora		Release of fines or graded material to marine environment may impact water quality						
Mechanical action may arise from: • Excavation of existing surface material	**Mechanical action** *(physical disturbance to substrate & vibration)*	Ground vibrations have the potential to disturb wildlife and propagate into the marine environment disturbing marine mammals				Physical disturbance to ice-free ground albeit a highly impacted & unnatural site				
Risk of unplanned release of fuel or hydraulic fluid	**Hazardous substances release** *(Including fuel)*					Spilt liquids most likely will release to ice-free areas albeit within the confines of the Station footprint				
• Any spill event will create hazardous substances waste e.g. contaminated soils • Integrity testing will result in the release of imported geological material (sand) to the environment	**Wastes** *(Including unrecoverable items)*					Hazardous waste such as contaminated soils will be handled on ice-free areas within the Station footprint Imported geological material (sand) will be released to the environment				
Integrity testing will require the importation of geological material (kiln dried sand)	**Introduction of non-native species or relocation of native species**	If non-native species establish, they could pose a risk to native species				Any non-native establishments are most likely to occur on ice-free ground				

Table 21. Environmental receptors that will or may be impacted from the fuel pipeline installations work.

		ENVIRONMENTAL RECEPTORS THAT WILL OR COULD BE IMPACTED								
Fuel Pipelines & bunker station installation	**Aspects Arising*** ** water turbulence not carried over to this table*	**FAUNA AND FLORA**	**FRESHWATER** *(ponds, streams, rivers, lakes, cryoconite holes)*	**MARINE** *(including sea ice)*	**GLACIOLOGICAL** *(glaciers, ice sheet, ice shelves & permafrost)*	**TERRESTRIAL** *(ice-free ground, soil and rocks)*	**ATMOSPHERE**	**AESTHETIC & WILDERNESS VALUES**	**RESEARCH VALUES**	**VALUES UNDER SPECIAL PROTECTION**
Burning fossil fuels in vehicles used to support the work (e.g. excavators and jaw crusher)	**Gaseous emissions** *(Burning fossil fuels)*		*No impacts have been identified to local freshwater bodies*	*The work will be undertaken away from the shoreline, and no impacts have been identified to the local marine environment*			Exhaust gases including GHG released to air with implications for local air quality and climate change			
• Excavation of the trench(es) • Backfilling of the trench • Use of vehicles	**Noise emissions**	Potential disturbance to breeding birds on Rothera Point								
Use of flood lights during: • Excavation of the trench(es) • Pipe laying • Backfilling of the trench	**Artificial light emissions**	Artificial lighting has the potential to attract and disorient birds								
Heat loss from vehicle engines	**Heat emissions**						Direct release of heat to the air which will dissipate rapidly			
• Excavation of the trench(es) • Backfilling of the trench	**Dust or fines emissions**	Potential smothering of terrestrial flora								
• Excavation of the trench(es) • Backfilling of the trench	**Mechanical action** *(physical disturbance to substrate & vibration)*	Ground vibrations have the potential to disturb wildlife Open tranches may trap wildlife			Localised disturbance to permafrost / modification of the active layer	Physical disturbance to ice-free ground albeit a highly impacted site				
Risk of unplanned release of fuel or hydraulic fluid	**Hazardous substances release** *(Including fuel)*					Spilt liquids most likely will release to ice-free areas albeit within the confines of the Station footprint				
• Any spill event will create hazardous substances waste e.g. contaminated soils	**Wastes** *(Including unrecoverable items)*					Waste items including contaminated soils (if spills occur), will be handled on ice-free areas within the Station footprint				
Any biological contamination of imported materials e.g. new pipeline has the potential to introduce non-natives to Rothera Point	**Introduction of non-native species or relocation of native species**	If non-native species establish, they could pose a risk to native species				Any non-native establishments are most likely to occur on ice-free ground			Any non-native establishments would detract from local research values	Any non-native establishments in the ASPA would detract from the protected values
Installation of the new bunker station on the wharf	**Presence / visual disturbance**							Additional infrastructure may have implications for aesthetic or wilderness values		

Table 22. Environmental receptors that will or may be impacted from the BMPV / GMPV and BESS installation work.

		ENVIRONMENTAL RECEPTORS THAT WILL OR COULD BE IMPACTED								
BMPV / GMPV & BESS Installation	**Aspects Arising*** ** water turbulence not carried over to this table*	**FAUNA AND FLORA**	**FRESHWATER** *(ponds, streams, rivers, lakes, cryoconite holes)*	**MARINE** *(including sea ice)*	**GLACIOLOGICAL** *(glaciers, ice sheet, ice shelves & permafrost)*	**TERRESTRIAL** *(ice-free ground, soil and rocks)*	**ATMOSPHERE**	**AESTHETIC & WILDERNESS VALUES**	**RESEARCH VALUES**	**VALUES UNDER SPECIAL PROTECTION**
Burning fossil fuels in vehicles used to support the PV installations including ground levelling	**Gaseous emissions** *(Burning fossil fuels)*						Exhaust gases including GHG released to air with implications for local air quality and climate change			
• Use of power tools • Use of vehicles	**Noise emissions**	Potential disturbance to breeding birds on Rothera Point								
Use of flood lights during: • Roof strengthening work • PV panel installations • BESS building construction	**Artificial light emissions**	Artificial lighting has the potential to attract and disorient birds								
Heat loss from vehicle engines	**Heat emissions**						Direct release of heat to the air which will dissipate rapidly			
Ground levelling for the GMPV may create dust	**Dust or fines emissions**	Potential smothering of terrestrial flora	Potential for dust or fines from the levelling work to be released to the nearby ponds or meltwater stream		Potential for dust to settle on the ice ramp & contribute to ice loss					
Ground levelling for the GMPV will impact relatively unimpacted ice-free ground	**Mechanical action** *(physical disturbance to substrate & vibration)*	Ground vibrations have the potential to disturb wildlife			Localised disturbance to permafrost / modification of the active layer	Physical disturbance to relatively unimpacted ice-free ground				
Risk of unplanned release of fuel or hydraulic fluid	**Hazardous substances release** *(Including fuel)*					Spilt liquids most likely will release to ice-free areas albeit largely within the confines of the Station footprint				
• Any spill event will create hazardous substances waste e.g. contaminated soils • Potential production of construction waste from roof strengthening work or BESS building construction	**Wastes** *(Including unrecoverable items)*			Any waste items with the ability to be blown away could end up in the marine environment		Waste items including contaminated soils and construction waste will be handled on ice-free areas within the Station footprint				
Any biological contamination of imported materials e.g. construction materials, PV panels etc., has the potential to introduce non-natives to Rothera Point	**Introduction of non-native species or relocation of native species**	If non-native species establish, they could pose a risk to native species				Any non-native establishments are most likely to occur on ice-free ground			Any non-native establishments would detract from local research values	Any non-native establishments in the ASPA would detract from the protected values
Installation of new infrastructure e.g. BESS building and GMPV trial, as well as alterations to existing infrastructure e.g. BMPV	**Presence / visual disturbance**							Additional or altered infrastructure may have implications for aesthetic or wilderness values		

Table 23. Environmental receptors that will or may be impacted as a result of the hangar redevelopment and associated work.

	ENVIRONMENTAL RECEPTORS THAT WILL OR COULD BE IMPACTED									
Hangar redevelopment & associated works	**Aspects Arising**	**FAUNA AND FLORA**	**FRESHWATER** *(ponds, streams, rivers, lakes, cryoconite holes)*	**MARINE** *(including sea ice)*	**GLACIOLOGICAL** *(glaciers, ice sheet, ice shelves & permafrost)*	**TERRESTRIAL** *(ice-free ground, soil and rocks)*	**ATMOSPHERE**	**AESTHETIC & WILDERNESS VALUES**	**RESEARCH VALUES**	**VALUES UNDER SPECIAL PROTECTION**
Burning fossil fuels in vehicles used to support the range of activities and commercial vessels	**Gaseous emissions** *(Burning fossil fuels)*						Exhaust gases including GHG released to air with implications for local air quality and climate change			*No impacts to values under special protection identified*
• Excavation & trenching including diverting the drainage ditch • Rock crushing & screening • Backfilling & compacting • Demolition & construction activities • Use of vehicles • Use of vessels	**Noise emissions**	Potential disturbance to breeding birds on Rothera Point or nearby fauna								
Use of flood lights during the work if required	**Artificial light emissions**	Artificial lighting has the potential to attract and disorient birds								
Heat loss from vehicle and vessel engines	**Heat emissions**						Direct release of heat to the air which will dissipate rapidly			
Dust emissions may arise from • Excavation & trenching including diverting the drainage ditch • Backfilling & compacting • Laying & levelling aggregate	**Dust or fines emissions**	Potential smothering of terrestrial flora Algal growth in the drainage ditch may be impacted		Diverting the drainage ditch may release fines to Hangar Cove	Dust could settle on the adjacent ice ramp and contribute to accelerated surface melting					
Mechanical action on ice free areas of Rothera Point as a result of the excavation, trenching, including diverting the drainage ditch, levelling, compacting & construction activities	**Mechanical action** *(physical disturbance to substrate & vibration)*	Ground vibrations have the potential to disturb breeding birds on Rothera Point or nearby fauna Risk of physical disturbance to terrestrial vegetation	Although human-made, the drainage ditch will be altered	Potential disturbance to sea ice from operation of commercial vessels		Physical disturbance to ice-free areas of Rothera Point				
Risk of unplanned release of fuel or hydraulic fluid including from commercial vessels	**Hazardous substances release** *(Including fuel)*			Accidental releases from the commercial vessels with potential to pollute the marine environment		Spilt fuel has the potential to contaminate ice-free areas of Rothera Point				
• Production of waste items from dismantling existing hangar and temporary hangar plus general construction waste • Use of geotextiles in hangar foundations	**Wastes** *(Including unrecoverable items)*	Potential uptake of synthetic microfibres by Antarctic species		Risk of contamination from the release of synthetic microfibres from geotextile material		Waste releases to ice-free parts of Rothera Point if not managed Risk of contamination from the release of synthetic microfibres from geotextile material				
Operation of commercial vessels	**Water turbulence**			Disturbance from the operation of the vessels						
• Importation of materials *i.e.,* new tie downs, construction materials for temporary and new hangar, ducting etc • Use of commercial vessels	**Introduction of non-native species or relocation of native species**	If non-native species establish, they could pose a risk to native species		Risk of introduction of non-native marine species from hull fouling or ballast water		Any non-native establishments are most likely to occur on ice-free ground			Any non-native establishments could detract from local research values	
Diversion of the drainage ditch, new roadway, expansion of the footprint of the new hangar	**Presence / visual disturbance**							The works will slightly expand the high impact area of the Station		

Table 24. Environmental receptors that will or may be impacted from the bollard removal work.

		ENVIRONMENTAL RECEPTORS THAT WILL OR COULD BE IMPACTED								
Bollard Removal	**Aspects Arising*** ** water turbulence & non-native species not carried over to this table*	**FAUNA AND FLORA**	**FRESHWATER** *(ponds, streams, rivers, lakes, cryoconite holes)*	**MARINE** *(including sea ice)*	**GLACIOLOGICAL** *(glaciers, ice sheet, ice shelves & permafrost)*	**TERRESTRIAL** *(ice-free ground, soil and rocks)*	**ATMOSPHERE**	**AESTHETIC & WILDERNESS VALUES**	**RESEARCH VALUES**	**VALUES UNDER SPECIAL PROTECTION**
Burning fossil fuels in vehicles used to support the removal (e.g. excavators and jaw crusher) will result in gas emissions	**Gaseous emissions** *(Burning fossil fuels)*		*No impacts have been identified to local freshwater bodies*	*No impacts to the marine environment identified*	*No impacts have been identified to local glaciological features*		Exhaust gases including GHG released to air with implications for local air quality and climate change		*No impacts to research values have been identified*	*The works are not within the vicinity of the closest ASPAs and no potential consequences for ASPA 129 have been identified*
Noise emission may arise from: • Breaking up of concrete bollard and backfilling hole • Use of vehicles	**Noise emissions**	Potential disturbance to breeding birds on Rothera Point & marine mammals in the vicinity of the wharf								
Potential use of flood lights during: • Breaking up of concrete bollard and backfilling hole	**Artificial light emissions**	Artificial lighting has the potential to attract and disorient birds								
Vehicle engines will release heat	**Heat emissions**						Direct release of heat to air which will dissipate rapidly			
Dust or fines may arise from: • Crushing of rock to required grade • Breaking up of concrete bollard and backfilling hole	**Dust or fines emissions**	Potential smothering of terrestrial flora								
Mechanical action may arise from: • Breaking up and removal of concrete bollard	**Mechanical action** *(physical disturbance to substrate & vibration)*	Ground vibrations have the potential to disturb wildlife				Physical disturbance to ice-free ground albeit a highly impacted & unnatural site				
Risk of unplanned release of fuel or hydraulic fluid e.g. from a vehicle	**Hazardous substances release** *(Including fuel)*					Spilt liquids most likely will release to ice-free areas albeit within the confines of the Station footprint				
Any spill event will create hazardous substances waste e.g. contaminated soils	**Wastes** *(Including unrecoverable items)*					Hazardous waste such as contaminated soils will be handled on ice-free areas within the Station footprint				
Breaking up and removal of concrete bollard	***Presence / visual disturbance***							Removal of the bollard may improve the aesthetics of the area		

Table 25. Environmental receptors that will or may be impacted from the removal of the old fuel hut and disused pipeline.

		ENVIRONMENTAL RECEPTORS THAT WILL OR COULD BE IMPACTED								
Removal of old fuel hut & disused fuel pipes	**Aspects Arising*** ** water turbulence and non-native species not carried over to this table*	**FAUNA AND FLORA**	**FRESHWATER** *(ponds, streams, rivers, lakes, cryoconite holes)*	**MARINE** *(including sea ice)*	**GLACIOLOGICAL** *(glaciers, ice sheet, ice shelves & permafrost)*	**TERRESTRIAL** *(ice-free ground, soil and rocks)*	**ATMOSPHERE**	**AESTHETIC & WILDERNESS VALUES**	**RESEARCH VALUES**	**VALUES UNDER SPECIAL PROTECTION**
Burning fossil fuels in vehicles used to support the work (e.g. excavators and jaw crusher)	**Gaseous emissions** *(Burning fossil fuels)*		*No impacts have been identified to local freshwater bodies*	*The work will be undertaken away from the shoreline, and no impacts have been identified to the local marine environment*			Exhaust gases including GHG released to air with implications for local air quality and climate change		*No impacts identified to research values*	*No impacts identified to values under special protection*
• Breaking up fuel hut foundations • Backfilling of the area of fuel hut foundations • Compacting • Use of vehicles	**Noise emissions**	Potential disturbance to breeding birds on Rothera Point								
Use of flood lights during: • Breaking up fuel hut foundations • Backfilling of the area of fuel hut foundations	**Artificial light emissions**	Artificial lighting has the potential to attract and disorient birds								
Heat loss from vehicle engines	**Heat emissions**						Direct release of heat to the air which will dissipate rapidly			
• Breaking up fuel hut foundations • Backfilling of the area of fuel hut foundations	**Dust or fines emissions**	Potential smothering of terrestrial flora								
• Breaking up fuel hut foundations • Backfilling of the area of fuel hut foundations • Compacting	**Mechanical action** *(physical disturbance to substrate & vibration)*	Ground vibrations have the potential to disturb wildlife			Localised disturbance to permafrost / modification of the active layer	Physical disturbance to ice-free ground albeit a highly impacted site				
Risk of unplanned release of fuel or hydraulic fluid	**Hazardous substances release** *(Including fuel)*					Spilt liquids most likely will release to ice-free areas albeit within the confines of the Station footprint				
• Any spill event will create hazardous substances waste e.g. contaminated soils • It is anticipated that old and now unused fuel pipes may be recovered during excavation • Waste concrete will be generated from the fuel hut foundations	**Wastes** *(Including unrecoverable items)*					Waste items including contaminated soils (if spills occur), waste fuel pipes and waste concrete will be handled on ice-free areas within the Station footprint				
Removal of the old fuel hut	**Presence / visual disturbance**							Removal of the old fuel hut may improve the aesthetics of the area		

Table 26. Environmental receptors that will or may be impacted from runway maintenance work.

		ENVIRONMENTAL RECEPTORS THAT WILL OR COULD BE IMPACTED								
Runway maintenance works	**Aspects Arising*** ** water turbulence, mechanical action & visual disturbance not carried over to this table*	**FAUNA AND FLORA**	**FRESHWATER** *(ponds, streams, rivers, lakes, cryoconite holes)*	**MARINE** *(including sea ice)*	**GLACIOLOGICAL** *(glaciers, ice sheet, ice shelves & permafrost)*	**TERRESTRIAL** *(ice-free ground, soil and rocks)*	**ATMOSPHERE**	**AESTHETIC & WILDERNESS VALUES**	**RESEARCH VALUES**	**VALUES UNDER SPECIAL PROTECTION**
Burning fossil fuels in vehicles used to support the work including jaw crusher, dump truck and excavator	**Gaseous emissions** *(Burning fossil fuels)*		*No impacts to freshwater systems identified*	*No impacts to marine systems identified*			Exhaust gases including GHG released to air with implications for local air quality and climate change			
• Use of power tools • Use of vehicles • Rock crushing • Stockpile replenishment	**Noise emissions**	Potential disturbance to breeding birds on Rothera Point								
Potential use of flood lights during electrical cabinet replacement	**Artificial light emissions**	Artificial lighting has the potential to attract and disorient birds								
Heat loss from vehicle engines	**Heat emissions**						Direct release of heat to the air which will dissipate rapidly			
Rock crushing and mobilisation and stockpiling of aggregate	**Dust or fines emissions**	Potential smothering of terrestrial flora			Potential settlement of dust on the ice ramp during stockpile replenishment			Stockpile may detract from perceptions of aesthetic or wilderness values		
Risk of unplanned release of fuel or hydraulic fluid	**Hazardous substances release** *(Including fuel)*					Spilt liquids most likely will release to ice-free areas albeit largely within the confines of the Station footprint				
• Any spill event will create hazardous substances waste e.g. contaminated soils • Old electrical cabinets will need to be disposed of / recycled	**Wastes** *(Including unrecoverable items)*					Waste items including contaminated soils and construction waste will be handled on ice-free areas within the Station footprint				
Any biological contamination of imported materials e.g. new electrical cabinets., has the potential to introduce non-natives to Rothera Point	**Introduction of non-native species or relocation of native species**	If non-native species establish, they could pose a risk to native species				Any non-native establishments are most likely to occur on ice-free ground			Any non-native establishments would detract from local research values	Any non-native establishments in the ASPA would detract from the protected values

Table 27. Environmental receptors that will or may be impacted by the establishment of the slipway in North Cove.

	ENVIRONMENTAL RECEPTORS THAT WILL OR COULD BE IMPACTED									
Establishment of slipway in North Cove	**Aspects Arising*** ** introduction of non-native species not carried over to this table*	**FAUNA AND FLORA**	**FRESHWATER** *(ponds, streams, rivers, lakes, cryoconite holes)*	**MARINE** *(including sea ice)*	**GLACIOLOGICAL** *(glaciers, ice sheet, ice shelves & permafrost)*	**TERRESTRIAL** *(ice-free ground, soil and rocks)*	**ATMOSPHERE**	**AESTHETIC & WILDERNESS VALUES**	**RESEARCH VALUES**	**VALUES UNDER SPECIAL PROTECTION**
Burning fossil fuels in vehicles used to support slipway development	**Gaseous emissions** *(Burning fossil fuels)*		*No impacts to freshwater systems identified*		*No impacts to the glaciological environment identified*		Exhaust gases including GHG released to air with implications for local air quality and climate change		*No impacts to research values identified*	*No impacts to values under special protection identified*
Scraping and profiling will generate noise including potential propagation to marine environment	**Noise emissions**	Potential disturbance to marine mammals and birds on shoreline or in the water Potential direct impacts to small numbers of marine invertebrates in the immediate area								
Use of flood lights if required	**Artificial light emissions**	Artificial lighting has the potential to attract and disorient birds								
Heat loss from vehicle engines	**Heat emissions**						Direct release of heat to the air which will dissipate rapidly			
Ground levelling and slipway profiling may create dust and fines	**Dust or fines emissions**	Potential smothering of terrestrial flora		Potential increase in turbidity adjacent to the work site						
• Physical disturbance to the shoreline and reprofiling • Potential for ground borne vibrations	**Mechanical action** *(physical disturbance to substrate & vibration)*			Physical alteration of the shoreline profile		Physical alteration of the shoreline profile				
• Risk of unplanned release of fuel or hydraulic fluid • Risk of release of contaminants to marine environment	**Hazardous substances release** *(Including fuel)*	Risk of uptake of released contaminants by benthic marine species		Contaminants released to the nearshore marine environment		Spilt liquids most likely will release to ice-free areas				
Any spill event will create hazardous substances waste e.g. contaminated soils	**Wastes** *(Including unrecoverable items)*					Waste items including contaminated soils will be handled on ice-free areas within the Station footprint				
Reprofiling into the shallow water area	**Water turbulence**			Possible minor increase in turbulence during works albeit highly localised						
The reprofiled shoreline will be visually apparent albeit in the same location as the previous slipway	**Presence / visual disturbance**							Physical alteration of the shoreline profile may detract from aesthetic or wilderness values		

Table 28. Environmental receptors that will or may be impacted as a result of the contaminated land investigations.

	ENVIRONMENTAL RECEPTORS THAT WILL OR COULD BE IMPACTED									
Ground Contamination Assessment	**Aspects Arising*** ** water turbulence, introduction of non-native species & visual disturbance not carried over to this table*	**FAUNA AND FLORA**	**FRESHWATER** *(ponds, streams, rivers, lakes, cryoconite holes)*	**MARINE** *(including sea ice)*	**GLACIOLOGICAL** *(glaciers, ice sheet, ice shelves & permafrost)*	**TERRESTRIAL** *(ice-free ground, soil and rocks)*	**ATMOSPHERE**	**AESTHETIC & WILDERNESS VALUES**	**RESEARCH VALUES**	**VALUES UNDER SPECIAL PROTECTION**
Burning fossil fuels in vehicles used to support the assessment and sampling	**Gaseous emissions** *(Burning fossil fuels)*		*No impacts to freshwater systems identified*	*No impacts to the marine environment identified*			Exhaust gases including GHG released to air with implications for local air quality and climate change	*No impacts to aesthetic or wilderness values identified*	*No impacts to research values identified*	*No impacts to values under special protection identified*
• Digging of pits • Backfilling & compacting • Use of vehicles	**Noise emissions**	Potential disturbance to breeding birds on Rothera Point or nearby fauna								
If required use of flood lights during: • Pit digging & refilling • Sampling	**Artificial light emissions**	Artificial lighting has the potential to attract and disorient birds								
Heat loss from vehicle engines	**Heat emissions**						Direct release of heat to the air which will dissipate rapidly			
Excavation & backfilling may create dust	**Dust or fines emissions**	Potential smothering of terrestrial flora			Dust could settle on the adjacent ice ramp and contribute to accelerated surface melting					
Pit digging will occur on ice-free areas of Rothera Point	**Mechanical action** *(physical disturbance to substrate & vibration)*	Ground vibrations have the potential to disturb breeding birds on Rothera Point or nearby fauna					Physical disturbance to ice-free areas of Rothera Point			
Risk of unplanned release of fuel or hydraulic fluid	**Hazardous substances release** *(Including fuel)*					Spilt fuel has the potential to contaminate ice-free areas of Rothera Point				
• Any spill event will create hazardous substances waste e.g. contaminated soils • Potential production of construction waste from roof strengthening work or BESS building construction	**Wastes** *(Including unrecoverable items)*					Waste items including contaminated soils if a spill event occurs				

Table 29. Environmental receptors that will or may be impacted from the general support activities.

		ENVIRONMENTAL RECEPTORS THAT WILL OR COULD BE IMPACTED								
Support activities	**Aspects Arising*** ** Dust emissions, hazardous waste & water turbulence not carried over to this table*	**FAUNA AND FLORA**	**FRESHWATER** *(ponds, streams, rivers, lakes, cryoconite holes)*	**MARINE** *(including sea ice)*	**GLACIOLOGICAL** *(glaciers, ice sheet, ice shelves & permafrost)*	**TERRESTRIAL** *(ice-free ground, soil and rocks)*	**ATMOSPHERE**	**AESTHETIC & WILDERNESS VALUES**	**RESEARCH VALUES**	**VALUES UNDER SPECIAL PROTECTION**
• Burning fossil fuels in aircraft and vessels to transport construction personnel; • Increased energy and resource demand on Station through additional construction personnel	**Gaseous emissions** *(Burning fossil fuels)*		*No impacts have been identified to local freshwater bodies*		*No impacts to glacial environments have been identified*		Exhaust gases including GHG released to air with implications for local air quality and climate change	*No impacts to aesthetic or wilderness values have been identified*		
Recreational activities including walking around the point	**Noise emissions**	Potential disturbance to breeding birds on Rothera Point							Risk of disturbance to established monitoring sites / instruments	Risk of unpermitted entry into the ASPA and damage to protected values
Increased use of space and potential for additional buildings to be used	**Artificial light emissions**	Artificial lighting has the potential to attract and disorient birds								
Increased use of space and potential for additional buildings to be used	**Heat emissions**						Potential for increased heat loss from buildings if additional buildings are put into use			
Increased foot traffic around Rothera including on recreational routes	**Mechanical action** *(physical disturbance to substrate & vibration)*					Potential for increased risk of tracking or physical disturbance				
Additional construction personnel on Station	**Wastes** *(Including unrecoverable items)*	Increase in the discharge of wastewater from the Station with risk of non-native microbial introductions and risks to native marine fauna		Increase in the discharge of wastewater from the Station		Risk of waste items being released to ice-free areas across Rothera Point				
Construction personnel bringing personal clothing, baggage and equipment to Rothera	**Introduction of non-native species or relocation of native species**	If non-native species establish, they could pose a risk to native species				Any non-native establishments are most likely to occur on ice-free ground			Any non-native establishments would detract from local research values	Any non-native establishments in the ASPA would detract from the protected values
Construction personnel occupying space at Rothera and utilising aircraft hours and vessel space	**Presence / visual disturbance**								Potential displacement of research events and a reduction in research activity and outputs from Rothera	

6.5. IMPACTS AND MITIGATION MEASURES

This section considers the potential environmental impacts that will or may occur as a consequence of the identified aspects arising from the various activities identified above.

This impact assessment adopts a 'worst-case scenario' approach to assessing impacts. The actual or potential impacts are summarised in *Table 32*. *Table 32* also assesses the significance of the actual or potential impacts according to the spatial extent, duration, severity and likelihood of the impact occurring.

The following definitions are used to describe the different types of impact:

- A **direct impact** is a change in environmental values or resources that results from direct cause-effect consequences of interaction between the exposed environment and an activity or action (*e.g.,* decrease of a limpet population due to an oil spill, or a decrease of a freshwater invertebrate population due to lake water removal) (EIA Guidelines, 2026).
- An **indirect impact** is a change in environmental values or resources that results from interactions between the environment and other impacts - direct or indirect (*e.g.* alteration in seagull population due to a decrease in limpet population which, in turn, was caused by an oil spill) (EIA Guidelines, 2026). Indirect impacts may not be known until a direct impact occurs.
- A **cumulative impact** is the combined impact of past, present and reasonably foreseeable activities. Cumulative impacts may occur over time and should be assessed by looking at other human activities occurring in the proposed locations. As with indirect impacts, cumulative impacts may not be identified until a direct impact has occurred (EIA Guidelines, 2026).

In each of Sections 6.5.1. to 6.5.8. below, the impacts from the various activities identified in *Table 20* to *Table 29* are collectively discussed by the various environmental receptors or values that will or may be impacted. For example, vehicles will be used to support each of the activities under consideration in this EIA, with aspects arising in each case including the release of exhaust gases to the atmosphere. The impacts to the atmosphere arising from all projects are discussed collectively given that the consequences are likely to be the same in each case. Any variations or aspects that are unique to one of the assessed activities are highlighted.

Cumulative impacts are considered in Section 6.7. below.

6.5.1. IMPACTS TO NATIVE FAUNA OR FLORA

Impacts to native fauna and flora will or may occur in the following ways:

1. Emissions of noise causing disturbance to wildlife and particularly breeding birds across Rothera Point;
2. Ground-borne vibrations causing disturbance to wildlife and particularly breeding birds across Rothera Point;
3. Open trenches acting as a trap for penguins or seals;
4. Emissions of noise and vibrations causing disturbance to birds and marine mammals in the nearshore environment;

5. Light emissions causing disorientation in birds potentially leading to bird strike
6. Emissions of dust resulting in smothering of terrestrial flora;
7. Accidental release of graded fill material or fines causing smothering of benthic fauna and flora in the nearshore environment;
8. The risk of introduction and subsequent establishment of non-native species, including marine species;
9. Physical disturbance to native flora (notably adjacent to the proposed hangar works);
10. Uptake of synthetic microfibres released to the environment (*e.g.,* from geotextiles in the hangar foundations).

6.5.1.1. EMISSIONS OF NOISE CAUSING DISTURBANCE TO WILDLIFE / BREEDING BIRDS ON ROTHERA POINT

Noise will be generated from several sources throughout most of the projects including from excavation work, rock crushing, laying and compacting aggregate and use of vehicles, as well as (potentially) from construction personnel recreating across Rothera Point. Avian species that breed on Rothera Point (discussed in Section 5.9.) are identified as being the group most susceptible to disturbance from noise created from the projects.

In broad terms, human disturbance to wildlife is summarized in the Antarctic Environments Portal by Coetzee and Chown (2014), (www.environments.aq). They note that sustained disturbance can vary significantly, depending upon the species, the location, the time and the nature of the disturbance. Human disturbance to Antarctic wildlife can cause declines in breeding success (Tin et al., 2009; Ellenberg et al., 2007; McClung et al., 2004), and induce physiological stress (McClung et al., 2004; Regel and Putz, 1997) which can cause behavioural changes (Weimerskirch et al., 2002; Engelhard et al., 2002) and could be the cause of direct mortality (Cooper et al., 1994).

In some cases, wildlife can become accustomed to human activity and be relatively unaffected by it. Some well-studied populations show no major observable changes following disturbance (Burger and Gochfeld, 1994). In other cases, human activities have been shown to cause significant disturbance to wildlife (Cooper et al., 1994; Saraux et al., 2011; Rounsevell and Binns 1991).

Coetzee and Chown (2014) report that an individual animal's response to stress can vary widely as a function of extrinsic factors such as the type of disturbance, its form and its magnitude. Disturbance also varies with intrinsic factors such as the species, colony size and breeding stage, and different individual responses. Few studies have considered all these factors, making it difficult to draw conclusions or conduct a meta-analysis of the results across the diverse range of studies (de Villiers 2008).

Research to date likely underestimates the potential impacts of human disturbance to wildlife as behavioural responses may obscure more subtle and potentially severe physiological responses (Fowler 1999; Coetzee and Chown, 2016).

As recorded in Section 5.9., Skua, Wilson's Storm Petrel and Kelp Gull have been recorded breeding on Rothera Point. Skua nest locations can vary from season to season and cannot be predicted with certainty. Some Skua nests may be located within a few hundred metres of planned activities (*Figure 63*). The closest potential nest site is to the planned works is to the west of the hangar in Hangar Cove although the skua nest behind the hangar is a 'historic' nest. No skua has nested at this site in the past four years (potentially more)

and west of the runway does not appear to be a usual nesting site for the birds (P. Whitelaw pers. comm. - Ornithological Study, 2024).

Monitoring of the small population of south polar skuas at Rothera Point has been undertaken since the 1970s and despite significant interannual variability (which has been attributed to a range of factors such as poor body condition, late snow covering nest-sites, low marine productivity, extreme weather or unfavourable sea-ice conditions), the population has demonstrated an increasing trend between 1975-76 and 2017-18 (*Figure 64*, Phillips et al., 2019). This is notable in the context of the scale of expansion of human activities at Rothera over the last few decades (*Figure 71*); although it is not possible to determine how the population may have evolved in the complete absence of human activity at this location.

Potential impacts of noise on the Skua and other breeding birds at Rothera Point could range from minor, short-term disturbance to longer-term disturbance, including nest or chick abandonment, to chronic effects including site avoidance in future breeding seasons or auditory impairment, depending upon the source, frequency and duration of the noise.

No specific research on noise induced hearing loss or threshold shifts in Antarctic birds could be identified in the academic literature. Research on Antarctic birds has focussed on auditory capability rather than damage thresholds (for example Rößler et al., 2024).

Reviews of non-Antarctic avian hearing demonstrate that birds have species-specific frequency sensitivity, often overlapping with anthropogenic noise bands (Engel et al., 2024). Field studies near airports have demonstrated birds altering their song frequencies; a possible consequence of high-frequency hearing loss (Wolfenden et al., 2025).

The broader avian literature recognises 'acoustic masking' and auditory interference as primary implications of anthropogenic noise, where noise overlaps with hearing ranges and degrades signal detection (Engel et al., 2024).

Unlike marine mammals, quantitative injury thresholds (*i.e.,* dB levels causing temporary or permanent threshold shift) are not well established for birds and are essentially absent for Antarctic species (Roßler et al., 2024).

The transmission of anthropogenic noise to breeding birds on Rothera Point will also be influenced by weather conditions at the time. Wind strength and direction will be an influencing factor. Snow fall or precipitation may also have a masking effect.

Impact type: direct and cumulative

Noise emissions will be unavoidable and are certain to occur from multiple sources during the planned works. Any impacts to wildlife that occur will be direct and will cumulatively add to other noise sources from the operations in and around Rothera, as well as other wildlife impact sources (e.g. vibration and artificial lighting).

Noise sources are likely to vary in duration and intensity during the planned works and may include occasional bursts of intensity such as during start up and commencement of activities.

Mitigation

The equipment that will be used for activities under consideration in this EIA is similar to that used in previous seasons. No equipment will give rise to novel sources of noise, i.e. noise that has not occurred in previous seasons.

Mitigation measures that are proposed will be similar to previous AIMP seasons. These are:

- All vehicles will maintain a 10-mph speed limit on site, enforced as a standard procedure at Rothera;
- Plant items will be positioned to ensure exhaust outlets point away from sensitive receptors;
- All plant and vehicles will be regularly inspected and maintained to ensure they are working efficiently and generating as little noise as possible;
- A slow-start procedure (gradually increasing noise levels over a period of time) will be implemented for all noisy construction equipment to give wildlife on land (except nesting birds) the opportunity to move away from the noise source before it reaches its highest levels;
- Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual (Annex B), will be present at the start of works adjacent to any known nest sites to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Noisy works will not commence without express permission of the suitably trained person present;
- If agreed noise levels are exceeded, works in that area will cease until additional mitigation measures can be implemented, such as acoustic screening;
- Pre-deployment & Station in-brief training will be provided to construction staff. This will identify Station environmental controls including walking routes, wildlife viewing controls contained within the BAS wildlife Interaction Manual, and 'no go' areas.

It is also noted that the topography of Rothera Point may assist in providing a natural buffer between the location of planned construction works under consideration in this EIA, and the Skua nesting areas on the eastern side of the point (see for example *Figure 3*).

Monitoring and record keeping

As part of the AIMP, an environmental monitoring programme has been established (Annex A). This includes noise monitoring at four locations across Rothera Point as described in Chapter 7.

Skua monitoring will continue throughout the construction programme to obtain updated information on nest activity that can be used to inform any additional mitigation methods.

Records will be maintained of noise exceedance events and any notable wildlife disturbance events that are observed.

6.5.1.2. GROUND-BORNE VIBRATIONS CAUSING DISTURBANCE TO WILDLIFE / BREEDING BIRDS ACROSS ROTHERA POINT

Ground-borne vibration will be generated from several sources throughout the wharf resurfacing (and bollard removal) and pipeline laying projects; including from excavation work, rock crushing, backfilling and compaction of backfill. Whilst some disturbance to nearby individuals (*e.g.,* birds, penguins, seals) may occur, avian species that breed on Rothera Point (discussed in Section 5.9.) are considered to be the group most susceptible to disturbance from ground-borne vibrations.

A review of the academic literature suggests that very little research has been undertaken to understand the effects of anthropogenic ground-borne impacts on Antarctic wildlife. In non-Antarctic settings there is some evidence of physiological and behavioural responses in some species with a range of consequences including habitat abandonment, interference with communication signals, and decreased reproductive success (Roberts and Howard, 2022; Caorsi et al., 2019; Lucas et al., 2017; de Groot et al., 2010).

The literature provides little evidence that ground-borne vibration alone is a significant cause of disturbance to bird species, with most avian disturbance effects attributed to airborne noise (see Section 6.5.1.1. above). Research on the effects of windfarms on local bird populations have included ground vibration as a potential source of impact but only in combination with other stressors such as bird-strike, visual and audible disturbance and habitat loss during construction (Marques et al., 2021; Drewitt and Langston, 2006).

The implications of anthropogenic vibration also need to be considered in combination with naturally occurring seismic sources in Antarctica, including cryoseismic sources (such as crevasse formation, glacier calving, basal 'stick-slip' motion of glaciers, englacial fracturing and 'icequakes'; Podolskiy and Walter, 2016; Peng et al., 2014) and earthquakes (Zhang et al., 2024).

Impact type: direct and cumulative

Ground-borne vibrations are likely to occur during the planned works but are likely to be of short duration and limited intensity. Impacts may include short-term avoidance by individuals. Vibration effects may cumulatively add to natural occurring sources as well as other anthropogenic impact sources (e.g. vehicle movements around Rothera, noise and artificial lighting).

Mitigation

Mitigation measures that are proposed will be aligned with previous AIMP activities. These are:

- All staff will receive pre-deployment and on-station briefings regarding working close to wildlife, the ASPA and IBA;
- A slow-start procedure for ground-based activities (*i.e.,* gradually increasing noise and vibration levels over a period of time) will be implemented so as to give wildlife on land (except nesting birds) the opportunity to move away from the source before it reaches its highest levels;
- Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual (Annex B), will be present at the start of works adjacent to any known nests to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Activities likely to create significant vibrations will not commence without express permission of the suitably trained person present;
- All activities will only be undertaken in accordance with agreed methodologies and locations presented in this IEE. Any changes to the locations used for any activities are to be agreed with BAS Operations, the BAS Environment Office and FCDO;
- If agreed vibration levels are exceeded (see Section 7.2.), works in that area will cease until additional mitigation measures can be implemented;
- Checks of skua nests will be undertaken prior to the commencement of any works as well as ongoing skua nest monitoring (see Section 7.2.).

Monitoring and record keeping

As part of the AIMP, an environmental monitoring programme has been established (Annex A). The lack of research on the effects of vibration on Antarctic species means that no vibration limit can be set for animal

receptors. However, data are available for the effects of vibration on humans, and these limits can be applied to manage effects to wildlife. Measurements of human exposure to vibration expressed as vibration dose values (VDVs) combine the magnitude of vibration and the time for which it occurs and are measured in $ms^{-1.75}$. Guidance on how vibration is perceived by humans in residential buildings, offices, and workshops and the effects of exposure to vibration have been used to inform the acceptable limits the for the site. Vibration monitoring arrangements are set out in further detail in Chapter 7.

Records will be maintained of vibration exceedance events and any notable wildlife disturbance events that are observed.

Skua monitoring will continue throughout the construction programme to obtain updated information on nest activity that can be used to inform any additional mitigation methods.

6.5.1.3. ENTRAPMENT OF PENGUINS OR SEALS IN OPEN TRENCHES OR EXCAVATIONS

Open excavations may present a temporary entrapment hazard to penguins or seals should wildlife enter the work area, although the likelihood is considered low due to the location of the works within the station operational area and the continuous presence of personnel.

A search of the academic literature did not reveal any published instances of penguins or seals becoming trapped in construction excavations in Antarctica. However, open trenches are recognised in previous Antarctic environmental impact assessments as presenting a potential entrapment hazard to wildlife.

Impact type: direct.

Should such a situation occur it is likely to involve a very small number of individuals only. To date this does not appear to have occurred during construction work at Rothera.

Mitigation

Despite the low likelihood, mitigation measures will be implemented to minimise this risk and will include:

- Trenches will be backfilled as soon as practicable following installation of services;
- Open excavations will be inspected regularly including at the start of work each day;
- Work will be suspended if wildlife is found in an excavation. Station wildlife experts trained in accordance with the BAS Wildlife Interaction Manual (Annex B) will be used to assist in removal;
- Where trenches are left open overnight or for more than one operational period, one end of the trench will have a sufficiently gentle gradient to allow any penguin or seal that enters the excavation to exit unaided.

Monitoring and record keeping

Any wildlife incidents will be recorded and reported in Maximo.

6.5.1.4. EMISSIONS OF ARTIFICIAL LIGHT CAUSING DISORIENTATION IN BIRDS

Artificial light sources are increasingly recognised as a significant but still under-quantified disturbance factor for birds in polar regions, including Antarctica. Although direct studies on Antarctic flying birds are limited, evidence from high-latitude seabird systems demonstrates that artificial lighting can disrupt nocturnal navigation, attract birds through positive phototaxis, and cause disorientation leading to grounding or collision events, particularly in species adapted to use faint natural light cues for orientation during migration and foraging flights (Adams et al., 2021).

Attraction to light is especially common in birds, causing millions of casualties annually due to collisions with illuminated structures, including lighthouses, broadcast towers, wind turbines and buildings in towns (Rodriguea et al., 2017; Kerlinger et al., 2010; Ogden, 1996; Squires and Hanson, 1918). In Procellariiform seabirds (*i.e.,* petrels and shearwaters), artificial light has been shown to induce "fallout" events where birds become trapped in illuminated areas, resulting in exhaustion, injury, or mortality, a mechanism widely considered applicable to other Polar seabirds with similar flight morphology and behavioural reliance on low-light navigation (Sypoz et al., 2021; Telfer et al., 1987).

Broader experimental and observational studies indicate that artificial light alters flight activity, reduces nocturnal movement, and can repel or attract birds depending on intensity and spectral composition, thereby disrupting normal spatial behaviour and potentially fragmenting movement pathways in otherwise dark environments (Sypoz et al., 2021).

While Antarctic skies remain relatively dark compared with mid-latitude regions, increasing ship traffic, coastal station development, and scientific activity introduce localised light sources that may create ecological traps or disorientation risks in an environment where many birds depend on predictable low-light conditions for orientation and predator avoidance (Coleman et al., 2022; Riddle, 2009; Black, 2005).

Impact type: direct and cumulative

Such impacts are not certain to occur, but there is potentially a higher risk in the earlier and later parts of the season when flying birds are more adjusted to lower light conditions. Any such impacts are likely to affect only a small number of individuals. Any impacts that do occur at Rothera will cumulatively add to other anthropogenic impacts on flying birds in the region (*e.g.,* noise or ground-borne vibrations).

Mitigation

Mitigation measures adopted for AIMP programmes in previous seasons are considered appropriate and include:

- The proposed activities will be undertaken during daylight hours as far as reasonably practicable, and the intensity and use of lighting will be minimised during low light hours;
- In the instance when lighting rigs are to be used, they will be positioned angled towards the ground (at least 45°) and not horizontally;
- When not in use lights are to be turned off and where possible external lighting should incorporate movement sensors or similar technology to minimise the during of illumination;

- In the event of a bird strike, a suitably trained bird strike response staff member will take charge of the bird's care in accordance with the BAS Wildlife Interaction Manual (Annex B);
- Lights will be switched off immediately if more than five bird strikes occur in one period of work;
- Lighting from buildings will be managed in accordance with standard Rothera procedures i.e. window blackout blinds will be used as required by Station procedures.
- Pre-deployment & Station in-brief training will be provided to construction staff. This will identify Station environmental controls including BAS bird strike prevention and response regulations contained within the BAS wildlife Interaction Manual (Annex B).

Monitoring and record keeping

Any disoriented birds that are observed or any bird strikes that occur will be recorded in Maximo.

6.5.1.5. EMISSIONS OF NOISE AND VIBRATIONS CAUSING DISTURBANCE TO BIRDS AND MARINE MAMMALS IN THE NEARSHORE ENVIRONMENT

The resurfacing of the wharf, and potentially the development of the slipway has the potential to propagate noise and sub-audible vibrations into the nearshore marine environment. This could disturb marine fauna, penguins and other seabirds in the area.

The remaining projects, including laying of the fuel pipeline and the installation of the PV panels are not likely to generate noise or vibrations that will propagate to the marine environment.

Anthropogenic underwater noise (audible and sub-audible) is recognised as a world-wide problem, and studies have shown a broad range of negative effects in a variety of taxa (Williams et al, 2015). Underwater noise from shipping is increasingly recognised as a significant and pervasive pollutant with the potential to impact marine ecosystems on a global scale (Clark et al., 2009; Merchant et al., 2015; Williams et al., 2014).

Sub-audible vibrations (low-frequency sound, typically <100 Hz) from shipping, pile driving, and seismic surveys deeply impact marine mammals. These vibrations mask long-range communication, induce chronic stress, alter diving behaviours, and cause spatial displacement from critical feeding and breeding grounds (Erbe et al., 2018).

The impact of marine noise varies greatly depending upon the source, frequency, duration, marine conditions, location and the taxa of concern.

Anthropogenic underwater noise sources in the area around Ryder Bay are few and take the form of vessel traffic, consisting mainly of short duration visits from resupply vessels (including the SDA) and occasional tourist vessels. Such activity is sporadic and only occurs in the ice-free summer months.

Another potential source of underwater noise is naturally occurring and is formed by icebergs. Two types of sounds are generated by icebergs: one is a long-duration harmonic tremor, and the other is a broadband burst (Matsumoto et al, 2014). Harmonic tremors are generated when icebergs shoal together or collide with one another, while the more common short-duration bursts are generally associated with iceberg breakup (ice-quakes) in the open sea (Scambos et al., 2006).

As discussed in Section 5.13, the marine environment of Ryder Bay, and more broadly Marguerite Bay, harbours several wildlife populations that are potentially susceptible to noise impacts. These include cetaceans (Minke and Humpback whales, and Orca); seals (Weddell, crabeater, elephant, leopard, fur); several fish species and diving birds (Adelie, Emperor, Gentoo and Chinstrap penguins and Imperial Shag).

Noise and sub-audible vibrations propagated to the marine environment may cause disturbance to individuals or groups of marine mammals, cetaceans or foraging penguins and sea birds.

An independent marine noise assessment was undertaken in 2018 at the time of preparing the comprehensive environmental evaluation for the Rothera wharf extension. The wharf extension project involved underwater blasting and underwater rock crushing; activities with a much higher potential for causing disturbance or auditory damage to marine species than the planned wharf resurfacing work. The independent noise assessment (contained in Appendix G of the Rothera Wharf CEE) concluded that:

> *On the basis of this analysis and the approach to the works it is predicted that any arising impacts will be temporary and negligible in terms of the numbers of animals involved for marine mammals and birds. There may be some very localised mortality to fish closely associated with the wharf location due to blasting and rock breaking but again such impacts are not considered significant. The observations and measurements taking place around the activities will enable these predictions to be verified and in the unlikely event that outcomes differ from those predicted adaptive measures can be implemented if necessary.*

The Rothera wharf extension CEE recommended a series of exclusion zones for marine species (1,200m for cetaceans, 500m for seals and 300m for birds) with observations made prior to blasting. If observations identified the presence of marine species, blasting would be paused.

Any noise from the wharf resurfacing that is propagated to the marine environment is likely to be far less intense and of shorter duration than that generated from previous blasting activities and will attenuate over a much shorter distance. Noise levels and frequencies are unlikely to be sufficient to cause auditory damage in diving birds or mammals that might be in the vicinity.

It is likely that any species in the vicinity of the wharf during resurfacing activities will adopt an avoidance approach and move away from the source.

Impact type: direct and cumulative

Noise emissions to the marine environment are assessed as being likely to occur during the planned works. Any impacts that occur will be direct and will cumulatively add to other naturally occurring noise sources or anthropogenic sources from the operations in and around Rothera.

Mitigation

It is not considered necessary to establish exclusion zones around the wharf areas as was required during the wharf extension project.

However, the following mitigation measures are considered appropriate:

- Prior to work commencing each day, initial observations will be made to identify any marine species within the immediate vicinity of the wharf. Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual (Annex B), will be consulted if doubts exist about the potential disturbance of marine wildlife[11];
- A slow-start procedure (gradually increasing noise over a period of time) will be implemented for all noisy construction equipment to give marine wildlife in the water the opportunity to move away from the noise source before it reaches its highest levels;

[11] In most cases it is likely that wildlife in the water will be transiting through the area and a short pause will allow the mammals or birds to move out of the immediate vicinity.

- Commercial vessels will be operated with due care to avoid disturbance to marine mammals.

Monitoring and record keeping

Monitoring of marine noise is not considered to be required for this programme of work and is not included in the monitoring programme.

However, records will be maintained of any notable marine wildlife disturbance events that are observed.

6.5.1.6. EMISSIONS OF DUST RESULTING IN SMOTHERING OF TERRESTRIAL FLORA

Human activity in Antarctica has long been known to have direct and indirect impacts on vegetation in the immediate vicinity of research stations (Brooks et al., 2019a; Olech, 1996).

Anthropogenic dust deposition, originating from a range of sources can have physical and chemical impacts on mosses and lichens, often leading to reduced species diversity, community changes, and physiological stress. Because these organisms lack true roots and rely on atmospheric deposition for nutrients, they are susceptible to toxic accumulation and physical smothering (Sujetovienė and Galinytė, 2016; Farmer, 1993).

Whilst dust transport and deposition is a natural feature of high latitude systems (Bullard et al., 2016), excessive, localised dust deposition from human activities can have detrimental effects on vegetation beyond the immediate areas of activity, although there is currently limited research available from Antarctica adequately to quantify these effects (Brooks et al., 2019a).

Dust emissions have been identified as a concern in previous AIMP EIAs including at the time of the resurfacing of the runway.

Impact type: direct and cumulative

Dust emissions are assessed as being likely to occur during the planned works, albeit from localised activities and for a relatively short duration. Any impacts that occur will be direct and may cumulatively add to similar impacts from similar activities in previous seasons.

Mitigation

Mitigation measures adopted for AIMP programmes in previous seasons are considered appropriate and include:

- For activities likely to produce high levels of dust or when agreed dust levels are exceeded (see Section 7.2.) dust suppression equipment should be used and/or roadways sprayed down with sea water;
- Where practicable, activities which create dust will be kept downwind of sensitive receptors and proximity to known vegetation will be avoided;
- The drop height of materials during stockpiling, processing, and loading operations will be limited to the extent practicable;
- Double handling of materials will be minimised to the extent practicable to reduce the overall number of tipping actions;
- A 10-mph speed limit will be maintained, as is standard procedure for all vehicles at Rothera;
- If agreed dust levels are exceeded, works in that area will cease until additional mitigation measures can be implemented;

- The Met team will provide a weather forecast to the Site Manager every morning. This will be reviewed by the Site Manager in conjunction with the Rothera Station Leader to inform the decision on which activities can proceed that day and if any activities need to be suspended or additional mitigation measures put in place. During excessively dry, windy conditions, especially where the wind direction will blow dust towards sensitive receptors, it may be necessary to temporarily suspend operations if it is not possible to control dust by other means.

Monitoring and record keeping

Monitoring of dust levels has been included within the AIMP monitoring plan (Annex A). Four dust monitors have been established on Rothera Point, and it is recommended that this is continued. See Chapter 7 for further details.

6.5.1.7. ACCIDENTAL RELEASE OF GRADED FILL MATERIAL OR FINES CAUSING SMOTHERING OF BENTHIC FAUNA AND FLORA IN THE NEARSHORE ENVIRONMENT

The release of fines to marine environment may occur from the establishment of the slipway and, to some extent, from the diversion of the drainage ditch behind the hangar. The wharf resurfacing work poses a slight risk of small quantities of fill material accidentally being released to the nearshore marine environment. Any such releases, were they to occur, could result in disturbance to, injury to or fatality of benthic marine species in the immediate area.

Impact type: direct and cumulative

The release of fill material to the nearshore marine environment is not certain to occur but is assessed as being possible, particularly so from the establishment of the slipway. Nonetheless, any impacts to the benthic environment are likely to be highly localised and will cumulatively add to past impacts in the immediate area.

Mitigation

The following mitigation measures are considered appropriate:

- Skilled and experienced machine and plant operators will be employed;
- Plant and vehicle operators will be alerted to the risk;
- No graded material will be stockpiled close to the water's edge;
- Establishment of the slipway will be done at low tide to the extent possible.

Monitoring and record keeping

A long-term monitoring programme is being undertaken by BAS to determine the impacts on the benthic communities adjacent to the wharf (Robinson et al., 2024).

Should they occur, any accidental releases of material to the marine environment will be recorded and reported.

6.5.1.8. THE RISK OF INTRODUCTION AND ESTABLISHMENT OF NON-NATIVE SPECIES

The introduction of species beyond their natural or native range as a direct or indirect result of human action (termed non-native species here) can lead to changes in the natural ecosystems to which they are introduced (Jeschke et al., 2014). The global redistribution of species as a consequence of human activities is regarded as one of the defining ecological elements of the Anthropocene, with non-native introductions and establishments reshaping biodiversity patterns, ecosystem processes and services, and species interactions globally (Haubrock et al., 2026). The International Union for the Conservation of Nature (IUCN) report that invasive alien species have contributed to 60% of recorded global extinctions (IUCN, 2026).

Antarctic ecosystems are among the least disturbed on Earth and are increasingly vulnerable to non-native species establishments due to increasing human activity in the region and a warming climate (Hughes et al., 2020; Duffy and Lee, 2019; Hughes et al., 2015).

The risk of non-native species being introduced to the Rothera area as a result of the planned works is assessed as being possible. Events such as the delivery of biologically contaminated vehicles to the Station have occurred in the past (Hughes et al., 2010). Whilst, introduction of non-native species does not necessarily lead to establishment, examples from elsewhere in Antarctica have shown that this is possible (Hughes et al., 2015; Molina-Montenegro et al., 2014).

The works under consideration in this EIA will involve the importation of materials, including building materials, the fuel bunker station, the fuel pipeline, kiln dried sand and cladding and steel and other items for the hangar - all of which carries the risk of biological contamination from outside of Antarctica.

Non-native marine species may be introduced to Antarctica adhered to vessel hulls, sea chests and intake ports as fouling species, and within ballast water, although the risk of introductions via these pathways is not well understood (Hughes et al., 2020).

Impact type: direct, indirect and cumulative

Impacts will only occur if non-native species become established. Direct impacts may include altered community structures and a loss of native biodiversity. Indirect impacts include a loss of research value in areas where non-native species have established. Any non-native establishments will cumulatively add to non-native establishments elsewhere in Antarctica.

Mitigation

Mitigation measures to reduce the risk of importation of non-native species are well established by BAS and the construction partner and include:

- All personnel being deployed to Rothera will receive a pre-deployment briefing from a member of the BAS Environment Office which will cover biosecurity;
- All activities will be undertaken in accordance with the BAS Biosecurity Regulations (Annex C), the CEP NNS Manual and the Project-specific Biosecurity Plan;

- A trained manager will inspect all plant, equipment, and materials prior to loading onto the vessel and on disembarkation / offloading at Rothera;
- All equipment and materials required for the proposed activities will be thoroughly cleaned before dispatch to Antarctica;
- Timber (*e.g.,* for roof strengthening work) will be pre-treated to remove any biological contamination;
- Any observed biological contamination such as soil, seeds or propagules will be carefully collected and removed. Rodents and insects will be exterminated immediately.
- All construction staff will be required to check and clean all personal gear prior to travelling to Antarctica;
- Kiln dried sand (free from organic material) will be used for the integrity testing on the wharf;
- Commercial vessels will be Polar Code compliant and will maintain an effective Biofouling Management Plan and a biofouling record book;
- Vessels will operate according to the Ballast Water Convention 2004 and the IMO's 2007 Guide for Ballast water Exchange in the Antarctic Treaty Area.

Monitoring and record keeping

The Rothera Station Leader and the BAS Environment Office must be informed immediately if a biosecurity incident occurs.

Evidence of the measures undertaken will be provided in the form of completed biosecurity audit checklists.

Any biosecurity incursions will be reported immediately to the BAS Environment Office and on Maximo.

6.5.1.9. PHYSICAL DISTURBANCE TO TERRESTRIAL FLORA

The hangar works will occur adjacent to the boundaries of the Station – referred to as the high impact zone. The area at the base of the ice ramp, to the west of the hangar is less impacted and contains some native vegetation. The biological survey of this area undertaken during the 2025-26 season revealed a patch of *Deschapmsia antarctica* to the northwest of the current hangar that is potentially at risk of physical damage from the planned activities (see Section 5.6.).

Physical damage to this area outside of the high impact zone, could un-necessarily damage native vegetation, particularly native vegetation that is establishing as the ice ramp retreats.

Impact type: direct, cumulative

Impacts to native vegetation would be directed and potentially long-lasting and would cumulatively add to the impacts to native flora that have occurred across Rothera Point since the Station was established in 1975.

Mitigation

- All activities will be planned to ensure plant and equipment remain within the 'high impact' zone;
- The construction boundary will be marked with flags at all times;
- The patch of *D. antarctica* will be protected using pedestrian barriers and flags throughout the construction seasons.

Monitoring and record keeping

Any breaches of the marked boundary will be recorded and reported in the end of season environmental report.

6.5.1.10. UPTAKE OF SYNTHETIC MICROFIBRES

The laying down of a geotextile layer in the foundations of the hangar extensions introduces synthetic material into the Antarctic environment. Whilst this material remains contained within the foundations, the environmental consequences are limited. Concerns arise from the release of small quantities of the material into the terrestrial and marine environments. This could occur at the time of laying the material during the construction phase, or at the time of its removal if the hangar is dismantled; the latter may be of most concern as freeze-thaw cycling, mechanical stress, and long-term burial may cause embrittlement and fragmentation over the multi-decade life of the hangar.

Released fibres / microplastics could migrate into surrounding soils, meltwater, and the nearshore marine environment. As well as contributing to contamination of these environments, any such releases would also carry the risk of ingestion by Antarctic species and contribute to uncertain but potentially long-lived ecotoxicological consequences.

The presence of microplastics in Antarctic species is now well established in both terrestrial and marine contexts. Microplastics have been recorded in Antarctic krill and salps (Johnston et al., 2023; Zhu et al., 2023a), Antarctic fish species (Mancuso et al., 2023; Ergas et al., 2023; Zhu et al., 2023b), several penguin species (Santillán et al., 2025; Kim et al., 2023; Bessa et al., 2019) and some seal species (Santillán et al., 2025).

In a terrestrial context microplastics have been recorded in spingtails (Bergami et al., 2020) as well as in Antarctica's only endemic insect, the midge *Belgica antarctica* (Devlin et al., 2025).

Most published work to date records ingestion / presence of microplastics rather than demonstrable population-level harm; although studies on the midge *Belgica antarctica* revealed measurable physiological effects at elevated exposure (Devlin et al., 2025).

Station activities, tourism and construction are recognised potential local contamination sources alongside long-range atmospheric or oceanic transport (Bernard et al., 2024; Cunningham et al., 2022).

Impact type: direct, indirect, cumulative

The potential release of microfibres has a direct exposure pathway at first ingestion (soil fauna, or marine fauna if fibres reach meltwater/nearshore systems), with potential indirect consequences further up the food chain via trophic transfer. Any releases, were they to occur, would add cumulatively to the documented existing microplastic burden in the same environments and species.

Mitigation

- The type of geotextile material will be carefully selected to take account of construction and environmental objectives. The highest suitable tensile strength material will be chosen to reduce the likelihood of disintegration during its operational life, and to enable easy removal at end of life;
- Only the required quantity will be used beneath the building footprint – and only under the foundation pads;
- The location of the geotextiles will be accurately recorded and archived to support careful removal at end of life of the hangar;
- Onsite cutting of the material will be done in a controlled / contained location;
- All practicable steps will be taken to minimise the duration of exposure of the geotextile to the environment;
- Waste material will be contained and stored and removed at the earliest opportunity.

Monitoring and record keeping

No specific monitoring is identified, but the installation of the geotextile will be carefully overseen and any noted losses to the environment will be recorded and reported.

6.5.2. Impacts to freshwater systems

The area to the west of the runway and the base of the ice ramp (refer *Figure 54*) was biologically surveyed during the 2025-26 season.

The survey work that was undertaken has identified a potential risk to freshwater ponds and a meltwater stream at the base of the ice ramp behind the hangar; features that are rare on Rothera Point. Their extent and shape vary daily. Cyanobacterial carpets are present on the sediment and stone surfaces in these pools, along with areas of filamentous green algae. Considerable filamentous algal growth is present in the drainage stream behind the hangar, developing in places into dense continuous mats (P. Convey, BAS pers. com.).

The ground levelling work, ground contamination sampling, installation of the ground mounted PV panels and the hangar and access road construction will occur close to these features but with the potential to release fines or geological material causing smothering and the potential loss of biological material.

Whilst these freshwater features have been subject to a degree of impact from current station activities (such as when snow is being cleared in this area of the station, as well as from contamination through runoff into the catchment from the apron) they have been identified as the most significant ecosystem type within this part of the Station (P. Convey, BAS pers. com.).

Impact type: direct and cumulative

The release of fines and geological material to the freshwater features behind the hangar area is considered unlikely to occur but merits attention to avoid unnecessary impact. Should any impacts arise, they would directly affect the algal species present and cumulatively add to past and ongoing impacts in the immediate area.

Mitigation

The following mitigation measures will be applied:

- Construction staff will be made aware of the risk and alerted to the local freshwater environments;
- Skilled machine and plant operators will undertake the work;
- The 'footprint' of the ground levelling work will be minimised to no more than is required to meet construction objectives.

Monitoring and record keeping

No specific monitoring is required.

Any impacts to the freshwater environments will be recorded and reported in Maximo.

IMPACTS TO MARINE SYSTEMS

Impacts to the marine environment will or may occur in the following ways:

1. Accidental release of graded fill material or fines impacting water quality;
2. Accidental loss of waste items with the potential of them blowing into the marine environment;
3. Increased volumes of treated wastewater released to the nearshore environment from the Station as a result of construction personnel being on site;
4. Sea-ice disturbance from the operation of commercial vessels;
5. Accidental release of hazardous substances.

6.5.2.1. ACCIDENTAL RELEASE OF GRADED FILL MATERIAL OR FINES IMPACTING WATER QUALITY

The wharf resurfacing work poses a slight risk of small quantities of fill material accidentally being released to the nearshore marine environment. Any such release, were it to occur, could result in a temporary loss of water quality in the immediate area.

Impact type: direct

The release of fill material to the nearshore marine environment is not certain to occur but is assessed as being possible given that the resurfacing work will occur up to the very edge of the wharf. Any impacts to water quality are likely to be highly localised and temporary.

Mitigation

The following mitigation measures will be applied:

- Skilled and experienced machine and plant operators will be employed;
- Plant and vehicle operators will be alerted to the risk;
- No graded material will be stockpiled close to the wharf edge.

Monitoring and record keeping

Any accidental releases of material to the marine environment will be recorded and reported.

6.5.2.2. ACCIDENTAL LOSS OF WASTE ITEMS WITH THE POTENTIAL OF THEM BLOWING INTO THE MARINE ENVIRONMENT

All construction work have the potential to produce waste items that could be blown off the site and into the marine environment, including the laying of geotextile material in the hangar foundations.

Impact type: direct

Whilst it is likely that waste products will arise from the planned construction work, the release of waste items to the marine environment is not certain to occur but is assessed as being possible. The specific nature of any impacts resulting from such releases are hard to forecast, but the loss of any materials to the environment is inconsistent with the general principles of the Protocol and its Annex III.

Mitigation

Mitigation measures that are proposed will be similar to previous AIMP seasons. These are:

- Strict adherence to the relevant project-level waste management plan;
- The storage of waste streams will be segregated for recycling, re-use, or recovery at a dedicated area for the storage of waste. Segregation of waste will allow consolidation of packing, thus reducing volumes required for shipping back to the UK;
- The waste hierarchy will be applied to all waste products;
- The packaging of materials / supplies will be minimised where reasonably practicable prior to the consigning of cargo to Antarctica;
- Import of raw materials will only be undertaken where necessary, and in quantities required to avoid surplus material;
- Waste will be stored in the appropriate storage method as defined in the relevant waste management plan;
- Daily checks will be undertaken to ensure waste is contained and to avoid it being blown around site or beyond;
- One of the construction staff will be dedicated to environmental management who will ensure that all waste is managed appropriately;
- All construction waste is to be returned to the UK and disposed of by the appointed licensed contractor;
- Any waste materials deemed to be in good condition will be offered to the Station Leader for potential re-use on site (a waste transfer note will be prepared to record any such exchanges);
- Pre-deployment training on waste management will be provided to all contractors; this will include a requirement for all contractors to be briefed on the BAS Waste Management Handbook (Annex D).

Mitigation with respect to the laying of geotextile material is dealt with in Section 6.5.1.10.

Monitoring and record keeping

Any materials or items that are accidentally lost to the environment will be recorded and reported.

Waste statistics will be collated for future monitoring and assessment purposes.

Daily checks of the site will be undertaken.

6.5.2.3. INCREASED VOLUMES OF WASTEWATER DISCHARGES

Annex III of the Protocol requires that sewage and domestic liquid waste be treated at least by maceration prior to discharge to the marine environment from Antarctic Stations with an occupancy of more than 30 personnel (Article 5(1) of Annex III). Once released, sewage microorganisms can remain viable in low temperature Antarctic waters for prolonged periods (Hughes, 2004; Smith et al., 1994; Statham and McMeekin, 1994) and have the potential to infect and cause disease, or become part of the gut flora of local sea mammal and bird populations as well as fish and marine invertebrates (Hughes, 2004; Lenihan et al., 1995; Gardner et al., 1997; Edwards et al., 1998; Stark et al., 2003).

Treatment of sewage prior to discharge has been shown to effectively reduce the concentration of potentially harmful or non-native microorganisms (Clark et al., 2025; Hughes, 2004).

Impact type: indirect, cumulative

Releases of non-native microorganisms have the potential indirectly to affect the health of a range of marine species and will cumulatively add to discharges from other Stations and bases in coastal environments in Antarctica.

Mitigation

The following mitigation measures will be applied:

- All human waste will be treated and discharged via the Rothera Wastewater Treatment Plant (WWTP) - this includes UV treatment prior to discharge of wastewater;
- All toilets and washing facilities are connected to the foul drainage system and will discharge via the WWTP.

Monitoring and record keeping

None required.

6.5.2.4. DISTURBANCE TO SEA ICE FROM THE OPERATION OF COMMERCIAL VESSELS

Commercial vessels will be used during the 2029-30 season. Physical disturbance to sea ice in Marguerite Bay may occur as the vessels transit to or from Rothera.

Sea ice formation, extent and duration show significant interannual and seasonal variability, driven heavily by atmospheric forcing, surface air temperatures, and wind stress (Meredith et al., 2010). It is therefore challenging to forecast the sea ice conditions in future seasons. Typically, during the summer season sea-ice will breakout in November or December (Clarke et al., 2026), when vessel activity commences. Given the highly dynamic nature of sea ice, any impacts arising from physical contact or disturbance from vessels are likely to be negligible.

Impact type: direct

Any physical contact or disturbance is likely to be highly localised.

Mitigation

None required.

Monitoring and record keeping

None required.

6.5.2.5. ACCIDENTAL RELEASE OF HAZARDOUS SUBSTANCES

Commercial vessels will be used during the 2029-30 season. The accidental release of hazardous substances, particularly fuel, from vessels presents a risk of contamination of the Antarctic marine environment. The risk is heightened in Antarctic waters by the remoteness of many operating locations, limited spill-response infrastructure and the potential difficulty of containment and recovery under adverse weather, sea-ice and other conditions. The potential for such impacts is reduced through stringent fuel-handling and transfer procedures, vessel design and maintenance, spill-prevention measures, emergency preparedness and response arrangements, and the retention of oily residues onboard. Discharge of oil and oily mixtures from ships operating in the Antarctic area is subject to stringent controls under MARPOL Annex I, under which the Antarctic area south of 60°S is designated a Special Area, and under Article 3 of Annex IV to the Protocol on Environmental Protection to the Antarctic Treaty.

Impact type: direct, indirect and cumulative

A fuel spill in coastal waters could result in direct toxicity to marine organisms, physical contamination of the water surface and shoreline, and impacts on sensitive coastal and marine habitats and species (Ruoppolo et al., 2013), with potentially prolonged effects depending on the type and quantity of fuel released and prevailing environmental conditions (Filler et al., 2014).

Mitigation

Commercial vessels that are used will be carefully selected to ensure that:

- they are compliant with the Polar Shipping Code;
- navigational equipment is consistent with operating in ice covered waters;
- spill response procedures and equipment are consistent with the provisions of the Polar Shipping Code.

Monitoring and record keeping

No specific monitoring is required but any spill events will be recorded and reported in Maximo.

6.5.3. Impacts to the Glaciological Environment

This assessment has identified that impacts to the glaciological environment will or may occur in the following ways:

1. Impacts to the permafrost and active layer from physical disturbance to ice free areas from excavations;
2. Impacts to the ice ramp from the disturbance and settlement of dust leading to increased melting.

6.5.3.1. Impacts to the permafrost and active layer

The excavation and trenching works associated with the fuel pipelines installation, the GMPV installation and hangar works (*e.g.,* the access road and drainage ditch diversion) have the potential to impact upon permafrost and the active layer in the area of physical disturbance.

Physical disturbance to areas encompassing permafrost (ground that remains frozen for at least two consecutive years), can trigger a range of physical and thermal changes that have the potential to result in permafrost degradation and an increased active layer thickness (Williams et al., 2013; Jin et al., 2021).

Physical disturbance such as trenching can also impact the active layer (the top section of soil or ground that thaws in summer and refreezes in winter). Such impacts can include a deepening of the active layer, albedo changes by exposing darker mineral soil that reduces the surface albedo causing the ground to absorb more solar radiation and accelerate thawing, and hydrological shifts resulting in retention of water in some areas that can accelerate the transfer of heat to the underlying permafrost (UAF, 2024; Kholodov et al., 2023; Zastruzny et al., 2023; Williams et al., 2013; Brown et al., 1969).

Consequences for the area of disturbance can include subsidence and settlement as a result of a loss of structural integrity, the formation of Taliks (a layer of year-round unfrozen ground within the permafrost), or even a permanent loss of thin permafrost layers (Humlum et al., 2023; Jin et al., 2021; Williams et al., 2013, Lawson, 1986).

Significant ground disturbance has already occurred across Rothera Point with the development of the Station since 1976, including the creation of the runway and earlier installation of underground services. The extent to which the long-term development of the station has impacted the permafrost over time is unknown, although no subsidence or visible signs of ground settlement have been reported to date.

Impact type: direct and cumulative

The nature and extent of the impacts of the ground works on the active layer and permafrost are challenging to forecast, although any impacts that may occur are likely to be long-lasting. Impacts will be direct and cumulatively add to the impacts from past infrastructure development and any future developments across the Station.

Mitigation

Few mitigation options are available, although the following are considered applicable:

- All ground works will be spatially constrained to the extent required to achieve operational requirements;
- Excavated material will be used for backfilling the fuel pipeline trench;
- Sub-surface areas will be left exposed for as short a length of time as possible. The pipeline trench on the eastern side of the runway will be completed first before trenching occurs on the western side of the runway;
- Ducting already in place will be used for the runway crossing to avoid any further digging of the runway area.

Monitoring and record keeping

No specific monitoring is identified as being required.

Any unusual events such as significant ground water pooling or subsidence will be recorded and reported.

6.5.3.2. IMPACTS TO THE ICE RAMP

All excavation works identified in the EIA as well as vehicle operations have the potential to create airborne dust which could settle on the ice ramp leading to a loss of albedo and increased melting. As recorded in Section 5.11.1., the Ice Ramp has shown considerable decline in recent years. Whilst climate change pressures are likely to be the primary cause, the settlement of dust on the ice (reducing albedo and increasing insolation) arising from Station activities cannot be ruled out.

Impact type: direct and cumulative

Dust emissions are assessed as being likely to occur during the planned works, albeit from localised activities and for a relatively short periods of time. Any impacts that occur will be direct and may cumulatively add to similar impacts from similar activities in previous seasons and ongoing Station activities.

Mitigation

Mitigation measures adopted for AIMP programmes in previous seasons are considered appropriate and include:

- For activities likely to produce high levels of dust or when agreed dust levels are exceeded (see Section 7.2.) dust suppression equipment should be used and/or roadways sprayed down with sea water;
- The drop height of materials during stockpiling, processing, and loading operations will be limited to the extent practicable;
- Double handling of materials will be minimised to the extent practicable to reduce the overall number of tipping actions;
- A 10-mph speed limit will be maintained, as is standard procedure for all vehicles at Rothera;
- If agreed dust levels are exceeded, works in that area will cease until additional mitigation measures can be implemented;
- The Met team will provide a weather forecast to the Site Manager every morning. This will be reviewed by the Site Manager in conjunction with the Rothera Station Leader to inform the decision on which activities can proceed that day and if any activities need to be suspended or additional

mitigation measures put in place. During excessively dry, windy conditions, especially where the wind direction will blow dust towards sensitive receptors, it may be necessary to temporarily suspend operations if it is not possible to control dust by other means.

Monitoring and record keeping

Monitoring of dust levels has been included within the AIMP monitoring plan (Annex A). Four dust monitors have been established on Rothera Point, and it is recommended that this is continued. See Chapter 7 for further details.

6.5.4. Impacts to the Terrestrial Environment

This assessment has identified that impacts to the terrestrial (ice-free) environment will or may occur in the following ways:

1. Physical disturbance from mechanical action i.e. excavation and ground levelling during construction as well as the potential for additional foot traffic across Rothera Point from having extra personnel on Station;
2. Accidental release of hazardous substances;
3. Accidental release of waste items on to ice-free ground;
4. The risk of establishment of non-native species.

6.5.4.1. Physical disturbance from mechanical action

Physical disturbance to ice-free areas of Rothera Point will occur when digging the trench for the fuel pipeline, removing the old bollard/datum and fuel hut, and undertaking the ground levelling for the GMPV.

Such disturbance to ice-free areas in Antarctica can result in a range of impacts depending upon the geological characteristics of the site in question. Consequences of physical disturbance can include changes to soil dynamics (moisture balance, hydrology, infiltration capacity, resistance to compression, bulk density and CO_2 fluxes), loss of the protective desert pavement surface layer (potentially resulting in landscape instability, accelerated weathering, wind and water erosion, loss of geoheritage and increased ultraviolet (UV) penetration) (Brooks et al., 2019a; O'Neill et al., 2015a) and melting of permafrost (see Section 5.11.2.). Physical changes can also reduce the habitat suitability for edaphic fauna (Wall and Virginia, 1999).

Physical changes to ice-free areas can also result in visible evidence of human activities such as tracking from foot-traffic or vehicles (O'Neill et al., 2015b).

All of the planned construction works will take place within the existing station footprint, and on already disturbed ground[12]. Although, the ice-free area at the base of the ice ramp (to the west of the runway) is potentially less impacted due to its more recent accessibility as a result of glacial retreat.

[12] With the exception of diverting the meltwater stream at the base of the ice ramp as part of the hangar works

Construction workers may also recreate by walking around the eastern side of Rothera Point.

Impact type: direct and cumulative

Direct impacts will occur to ice-free ground as a result of the planned trenching and ground levelling works, although almost all of this will occur to previously, and in some areas heavily impacted ground within the current station footprint. Impacts will cumulatively add to the already heavily impacted ground from decades of infrastructure development at Rothera Point.

Additional foot traffic also carries the risk of tracking along preferred walking routes.

Mitigation

Few mitigation options are available, although the following are considered applicable:

- All earthworks will be spatially constrained to the extent possible to meet operational objectives;
- Trenching depths will be minimised to the extent possible, whilst ensuring burial to sufficient depth to minimise the risk of damage from surface activities e.g. vehicle movements;
- Following trenching and bollard/datum removal, naturally occurring backfill will be used;
- Pre-deployment and Station in-brief training will be provided to construction staff. This will identify Station environmental controls including walking routes, and 'no go' areas;
- The BAS Facilities team will maintain the demarcation of the no-go zone around the moss patch and ensure it is communicated to construction personnel at Rothera.

Monitoring and record keeping

No specific monitoring is identified as being required.

6.5.4.2. RISK OF ACCIDENTAL RELEASE OF HAZARDOUS SUBSTANCES

Fossil fuel (hydrocarbons) will be used in vehicles used to support the planned work (*e.g.,* excavators, jaw crusher and mobile elevated platforms).

Accidental releases of fuel, or other hazardous substance could occur either because of a catastrophic failure on a vehicle (*e.g.,* hydraulic hose failure) or when transferring fuel between containers (*e.g.,* during refuelling).

The fate of hazardous liquid substances accidentally released to the terrestrial environment will depend upon the type of liquid as well as the nature of the surface, the extent of any snow cover and ambient air or ground temperatures. Any liquid substances spilt on already disturbed ground in warmer conditions will disperse and penetrate the ground more readily than if a spill occurs on compacted ground in colder conditions (Raymond et al., 2017).

When spilled on Antarctic soils or disturbed ground, hydrocarbons undergo naturally occurring processes that reduce the mass of the contaminants. Physical processes can cause the contaminants to disperse and become diluted or volatilize, whereas chemical and biological processes can transform contaminants to other compounds, possibly causing them to precipitate or sorb to soil. These mechanisms typically occur at all spill sites to varying degrees, depending on the type and concentration of the fuels spilled and on ground characteristics (Aislabie et al., 2004).

Light fuels with a high vapor pressure such as jet fuel and mogas readily volatilize. However, being of low viscosity, they are also mobile and thus able to migrate down through the unfrozen active layer. In

comparison, heavier fuels such as lubricating and engine oil are less volatile and more viscous and do not appear to migrate far from the point of deposition (Aislabie et al., 2004).

Unrecoverable liquids will remain in the ground as a contaminant and will add to previous fuel spill events that have occurred across the Station area. Implications of spilt fuel include effects on ground temperature and moisture regimes, soil chemistry properties and on biota in the immediate area of the spill (Raymond et al., 2017; Aislabie et al., 2004).

Secondary or indirect impacts could include contamination or poisoning of wildlife should any spilt substance be ingested.

Any spill event is also likely to create hazardous waste items *e.g.,* contaminated spill response equipment.

Impact type: direct, indirect and cumulative

Contamination of ice-free ground as a result of a spill event will be a direct impact. Indirect impacts could include contamination of any wildlife. Any spill event will cumulatively add to previous spill events that have occurred at Rothera Point.

Mitigation

Mitigation measures that are proposed will be similar to previous AIMP seasons. These are:

- Refuelling will be undertaken in accordance with the Oil Spill Contingency Plan (OSCP; Annex E) refuelling requirements at Rothera to ensure continual inspections are made of fuelling equipment, and drip trays are placed under hose joints as a precaution - this procedure is reviewed annually;
- Spill response kits will be in all mobile vehicles and in well-defined and easily accessible locations on site;
- Plant nappies will be used for all static plant;
- A core oil spill response team of a minimum of 24 station staff will be formed and receive pre-deployment oil spill response training led by the BAS Environment Office and delivered by BAS and Oil Spill Response Ltd. This training is in addition to onsite training delivered by the Rothera Station Leader;
- The OSCP (Annex E) will be followed for Tier 1, 2 and 3 spills;
- De-winterising checks on all mobile and static plant will be undertaken in accordance with the OSCP (Annex E);
- All plant will be inspected daily for potential leaks and condition of hydraulic oil hoses - these checks will be recorded on the daily plant check sheets and the daily activity plan compliance record;
- All fuel storage tanks will be checked weekly and recorded on the Environmental Inspection Checklist;
- Cementitious or grout mixing must not be undertaken in high winds;
- Any cementitious or grout wash waters produced during construction will be neutralised to a pH of 7.0 using citric acid prior to discharge to ground;
- Cementitious and grout materials are mixed in the Fitters Workshop and the wash water, once neutralised, will be discharged away from sensitive receptors to the west of the Fitters Workshop.

Monitoring and record keeping

No specific monitoring is identified as being required.

All releases will be reported to the Rothera Station Leader and BAS Environment Office and either recorded in Maximo (for accidental releases) or on the BAM reporting schedule (for releases of cementitious wash water).

6.5.4.3. RISK OF ACCIDENTAL RELEASE OF WASTE ITEMS ON TO ICE-FREE GROUND

Planned construction work has the potential to generate waste items which, if accidentally lost to the environment could result in littering across Rothera Point (see also Section 6.5.2.2.). Waste that will or may arise includes packaging materials that may be used for imported items (*e.g.,* BESS, the fuel bunker station and the fuel pipelines) as well as fibres from the laying of geotextile material, building waste, disused fuel pipelines and waste, broken concrete.

Any release of waste to the Antarctic environment is inconsistent with the environmental principles of the Protocol and the provisions of its Annex III.

Impacts could include loss of aesthetic and wilderness value in areas where waste items are observed as well as ecological impacts (Aronson et al., 2011), including, in extreme cases, entanglement of wildlife (Woehler et al., 2013; Riddle, 2009).

Impact type: Direct, indirect and cumulative

Direct impacts could include implications for wildlife. Indirect impacts could include loss of aesthetic and wilderness values where waste items are observed. Any items lost to the environment will cumulatively add to previous losses of waste that have occurred at Rothera Point and across Antarctica more broadly.

Mitigation

Mitigation measures that are proposed will be similar to previous AIMP seasons. These are set out in Section 6.5.2.2. above and apply here also.

Mitigation with respect to the laying of geotextile material is dealt with in Section 6.5.1.10.

Monitoring and record keeping

Any materials or items that are accidentally lost to the environment will be recorded and reported.

Waste statistics will be collated for future monitoring and assessment purposes.

Daily checks of the site will be undertaken.

6.5.4.4. THE RISK OF INTRODUCTION AND ESTABLISHMENT OF NON-NATIVE SPECIES

This risk is discussed in Section 6.5.1.8.

6.5.5. Impacts to the Atmospheric Environment

The assessment identified the following aspects that will or could give rise to impacts to the atmospheric environment. These aspects include:

1. Emissions of gases to air from the burning of fossil fuels in mobile and static plant engines, and aircraft and vessels to transport personnel and cargo, as well as to provide power for accommodating construction workers at Rothera;
2. Emissions of heat from plant engines and buildings used to accommodate construction workers.

6.5.5.1. Emissions of gases to the atmosphere

Emissions to air will arise from the burning of fossil fuels in mobile and static plant. It is likely that having additional construction personnel on Station for the next four seasons will also increase the energy demand (for heating, water production, wastewater treatment, cooking etc.) and consequently the volume of fuel used.

Released gases from the burning of fossil fuels will quickly disperse depending upon the weather and particularly wind conditions at the time. The emission of gases will pass into the atmosphere and add to regional and global atmospheric pollution.

This will be an unavoidable impact.

Releases of gases from Antarctic activities make only a minor contribution to global pollution, and current technology has yet to provide sufficiently reliable alternatives to the burning of fossil fuels in the harsh Antarctic environment; although sustainable energy options continue to be explored (Dou et al., 2019; Bustos et al., 2021).

It is now well established that anthropogenic releases of greenhouses gases from the burning of fossil fuels and other sources, is the major contributor to measurable changes in the global climate (IPCC, 2014).

Impact type: Indirect and cumulative

Emissions of gases from the burning of fossil fuels will pass into the atmosphere and indirectly and cumulatively contribute to regional and global atmospheric pollution, and climate change; though the contributions from the planned works are likely to be negligible in a regional and global context.

Mitigation measures

Mitigation measures that are proposed will be similar to previous AIMP seasons. These are:

- Ensure that all operations at Rothera are as efficient as possible to reduce excess fuel use;
- Generators and plant will be selected which balance efficiency and reduced emissions, with reliability, serviceability, and available fuel at Rothera;
- Regular inspections and maintenance will be carried out to ensure all vehicles, plant and generators operate efficiently, as per the BAM plant management plan (PMP);
- Where practical, all drivers will be instructed to turn off engines during periods of waiting for 15 minutes or more;

- All staff will be briefed on energy efficiency whilst on Rothera as part of the pre-deployment training. This will include:
    - Avoiding use of heaters when windows are open;
    - Turning lights off when not in use;
    - Only use full washing machines on the economy setting where possible;
    - Using drying rooms rather than tumble driers when possible, and
    - Limiting showers to three minutes.
- Good programme resource management is being applied across all infrastructure project activities to mitigate overall duration impact – *e.g.*, efficiency of vehicle uses on construction activities;
- BAS will optimise transport routes to the extent practicable;
- Only staff essential to the proposed works will be deployed to Rothera;
- Data will be collected and the increased contribution to atmospheric pollution from the deployment of personnel and cargo will be accounted for in the BAS Energy and Carbon Dashboard.
- Considerations are being given to using alternative fuels in construction vehicles and generators in order to reduce emissions, including biodiesel or hydrotreated vegetable oil[13].

Monitoring and Record keeping

Records will be maintained of the volumes of fuel used and will be accounted for in the BAS Energy and Carbon Dashboard.

6.5.5.2. EMISSIONS OF HEAT

Impact description

Heat is routinely generated from a range of sources, including mobile and static engines, machinery and vessels. Heat may also be lost from Station buildings if additional buildings are utilised to house construction workers. Any heat generated will rapidly dissipate in the cold Antarctic atmosphere, particularly so with any wind blowing.

No discernible impacts are likely to arise from heat emissions, other than from the burning of fossil fuels to generate heat in the first place.

Impact type: N/A

Heat will be lost directly to the atmosphere, but with no discernible impacts.

Mitigation measures

None required.

Monitoring and Record keeping

None required.

[13] Final decisions will depend upon storage options, cost, availability in the Southern Hemisphere and the sustainability credentials of the potential source.

6.5.6. Impacts to Aesthetic and Wilderness Values

Impact description

The Protocol provides for the protection of the intrinsic value of Antarctica, including its wilderness and aesthetic values. Article 3(1) of the Protocol states:

> *The protection of the Antarctic environment and dependent and associated ecosystems and the intrinsic value of Antarctica, including its wilderness and aesthetic values and its value as an area for the conduct of scientific research, in particular research essential to understanding the global environment, shall be fundamental considerations in the planning and conduct of all activities in the Antarctic Treaty area.*

Aesthetic and wilderness values remain undefined by the Antarctic Treaty Parties, though these values have been considered widely within the academic literature (Leihy et al., 2020; Summerson and Tin, 2018; Summerson 2013; Hughes et al., 2011; Rupert and Riddle, 2000). Wilderness is generally understood to represent a measure of the relative absence of evidence of, or impacts from, human activity (EIA Guidelines, 2026). Leihy et al. (2020) estimated that 99.6% of the continent's area can still be considered wilderness, but pristine areas, free from human interference cover a much smaller area (less than 32% of Antarctica) and are declining as human activity escalates.

As discussed in Section 5.14., Rothera Point has been subject to growing human activity, infrastructure establishment and impacts for several decades.

The programme of planned work will add infrastructure to Rothera Station, notably the BESS building, the fuel bunker station and the PV panels on the buildings. In addition, planned earthworks including the pipeline trenching and the ground levelling for the GMPV, will make further, albeit minor, modifications to the topography and visual appearance of Rothera Point.

It is challenging to assess the impacts on aesthetics and wilderness values which are highly subjective concepts. But the planned modifications will add to past, current and future modifications to Rothera Point with the potential to further erode perceptions of wilderness or aesthetic values, at least in the immediate area.

The removal of the concrete bollard and the old fuel hut may have a positive impact on aesthetics at least for that part of the station.

Impact type: Indirect, Cumulative

The planned development work has the potential to indirectly impact upon perceptions of wilderness and aesthetic values in the area and will cumulatively add to long-term evidence of human presence and activity across Antarctica.

Mitigation measures

Consistent with the inherent need to minimise all impacts, the following mitigation measures are applicable:

- Construction activities will be confined to the agreed areas on site;

- All activity methodologies and locations are to be undertaken in line with agreed methodologies and locations presented in this IEE;
- Any changes to the locations used for any activities will be discussed and agreed in advance with the BAS Environment Office or FCDO and recorded on the project variation register.

Monitoring and Record keeping:

No specific monitoring is identified as being required, although over time a suite of photographic evidence is available to record the evolution of infrastructure and human activities and impact across Rothera Point.

6.5.7. Impacts to Research Values

The Protocol provides for the protection of the value of Antarctica as an area for the conduct of scientific research. As noted above, Article 3(1) of the Protocol states:

> *The protection of the Antarctic environment and dependent and associated ecosystems and the intrinsic value of Antarctica, including its wilderness and aesthetic values and its value as an area for the conduct of scientific research, in particular research essential to understanding the global environment, shall be fundamental considerations in the planning and conduct of all activities in the Antarctic Treaty area.*

As recorded in Section 5.15., Rothera Point supports a wide array of data collection instrumentation as well as locations that have research value in addition to their own intrinsic value (for example, the areas of vegetation cover and the Skua nesting sites, which are actively monitored).

The planned work has the potential to impact research values in two ways. By directly or indirectly interfering with or damaging data collection instruments or locations of current scientific research, or by taking up space at Rothera or utilising logistics resources that prevent or delay science events from conducting their research in Antarctica.

Aspects arising from the planned works programme, such as noise or ground-borne vibrations, mechanical action, or direct physical interference from construction staff have the potential to disrupt or interfere with data collection, damage sensitive instruments, or physically impact important research locations.

The scientific instrumentation suite at Rothera includes meteorological, geophysical, atmospheric and oceanographic sensors, each with differing sensitivities to anthropogenic noise and ground vibration. The instruments most susceptible to disturbance are those designed to detect very low-amplitude physical signals, such as seismological sensors, which are highly sensitive to ground-borne vibration from vehicles, aircraft operations and construction activities, although these are not currently in use at Rothera. Precipitation gauges and high-frequency meteorological sensors (e.g. anemometers) may be affected by vibration-induced artefacts or localised turbulence associated with station activity. Magnetometers may experience indirect effects where vibration or nearby infrastructure introduces instability or electromagnetic interference.

In contrast, atmospheric radar systems and most oceanographic measurements undertaken through the Rothera Time Series programme are comparatively resilient to airborne noise and ground vibration, with potential effects more likely to arise from electromagnetic interference or direct operational disturbance (*e.g.,* vessel movements).

Taking construction workers and construction equipment to Rothera and accommodating them there throughout the season has the potential to take up space that could otherwise have been utilised by research groups. In any Antarctic season maintenance and construction activities need to be undertaken and allocating space for such activities is a routine and ongoing requirement. However, the AIMP has required larger numbers of construction and technical personnel to be on Station with the potential to delay or displace research personnel.

Impact type: Direct, Indirect or Cumulative

The planned development work has the potential to directly impact sensitive instrumentation or data collection processes, indirectly impacting upon locations of scientific interest or displacing research events, and cumulatively adding to past and potential future interference with research activities at Rothera and across Antarctica.

Mitigation measures

Consistent with the inherent need to minimise all impacts, the following mitigation measures are applicable:

- Construction activities will be confined to the agreed areas on site;
- The infrastructure works programme is agreed by BAS and scheduled in advance of each season;
- All mitigation measures identified in this EIA will be employed to minimise impacts to Rothera Point;
- Construction workers and contractors will be fully briefed on locations of research importance and advised of the need to constrain construction activities to the extent possible and as identified in this EIA;
- Only staff essential to the proposed works will be deployed to Rothera. Numbers of construction workers will be minimised to the extent practicable without compromising personnel safety or the objectives of the planned construction work. This is also partially mitigated by using BAS staff to assist with the planned construction work where feasible;
- The BAS Project Support Coordinator will prepare a Station Integration Plan to demonstrate adequate space use on site for the proposed activities.

Monitoring or Record keeping:

No specific monitoring is identified as being required.

6.5.8. Impacts to Values under Special Protection

Under the provisions of the Protocol, special protection can be afforded to a species (Annex II to the Protocol) or to an area, in order to protect a range of values (Annex V to the Protocol). The only species that is designated as specially protected under the provisions of Annex II is the Ross Seal. Whilst sightings of the Ross Seal from or in the vicinity of Rothera are not zero[14], they are extremely rare. It is considered highly unlikely that any impacts from the currently planned activities will negatively impact one or more Ross Seal(s).

[14] https://www.photo.antarctica.ac.uk/external/guest/detail/cart/10011662/1/3

As discussed in Section 5.16., there are two areas under special protection close to Rothera: Antarctic Specially Protected Area (ASPA) 129 on Rothera Point and ASPA 177 which encompasses the islands in Ryder Bay (*Figure 72*). No activities have been identified that are likely to give rise to impacts to the values protected by ASPA 177.

The closer proximity of ASPA 129 (*Figure 66*) presents a slightly greater risk of impacts occurring to the values protected at this site. However, the planned work will occur a few hundreds of metres away from the nearest boundary of ASPA 129. The closest work that will be undertaken will be the roof strengthening work and installation of PV panels on New Bransfield House – albeit still some 200 metres away from the ASPA boundary.

No aspects arising are identified as presenting a particular concern, other than the risk of establishment of a non-native species. If one or more non-native species were to establish on Rothera Point, they could spread into the ASPA and thus impact on the fellfield ecosystem under special protection.

Construction workers could also inadvertently wander into the ASPA which could result in physical disturbance (*e.g.,* tracking) to the fellfield ecosystem.

Impact type: Direct and Cumulative

Should any impacts within the ASPA occur, they could result in the loss of values for which the Area has been designated and cumulatively add to pressures on ASPAs across Antarctica (Hughes et al., 2016; Shaw et al., 2014).

Mitigation measures

Measures to mitigate the risk of non-native species establishing on Rothera Point are identified in Section 6.5.1.8. above. Measures to mitigate the risk of construction workers entering the ASPA are:

- Construction activities will be confined to the agreed areas on site;
- Pre-deployment and Station in-brief training will be provided to construction staff. This will identify Station environmental controls including walking routes around Rothera Point, and the ASPA boundaries;
- The ASPA will be demarcated to prevent inadvertent entry.

Monitoring or Record keeping:

No specific monitoring is identified as being required. Any inadvertent entries into the ASPA will be recorded and reported to the BAS Environment Office.

6.6. SUMMARY AND EVALUATION OF IMPACT SIGNIFICANCE

Section 6.5. identifies the potential (direct, indirect and cumulative) impacts of the planned work and the various activities to be undertaken. This section evaluates the identified potential impacts by taking into account the three levels of significance identified in Article 8(1) of the Protocol.

In order to evaluate the significance of a given potential impact, the spatial extent, duration, severity (which also includes a level of reversibility), and likelihood of the identified potential impacts are considered so as to evaluate the overall significance of the potential impact of each activity.

Table 31 outlines the assessment criteria and definitions that have been used when evaluating the spatial extent, duration, intensity and likelihood of the identified potential impacts for the environmental elements (table and methodology modified from Oerter, 2000).

In each case the spatial extent, duration, severity and likelihood are subjectively evaluated and assigned a 'low', 'medium', 'high' or 'very high' score. An impact significance assessment (before and after treatment) is then determined based on the combination of scores as follows:

Impact significance level = extent score x duration score x severity score x likelihood score

The risk score determines whether the overall impact significance level is 'low', 'medium', 'high' or 'very high' as set out in *Table 30*.

Table 30. Significance assessment criteria.

Description	Impact Significance level	Ref Article 8 of the Protocol
Acceptable under most circumstances. Impact likely to be managed through normal operating procedures.	Low	Less than minor or transitory
May be acceptable under certain circumstances. Impact may require monitoring and possible further treatment.	Medium	No more than minor or transitory
Unlikely to be acceptable in most circumstances. Further treatment options must be explored.	High	More than minor or transitory
Unlikely to be acceptable in almost all circumstances. Significant further treatment must be explored. Significant project or activity review required if risk cannot be mitigated to reduce risk level.	Very High	

The findings of the assessment are reported in *Table 32*. This table records the aspects and potential impacts arising from the various activities (as described in Section 6.5), assesses the significance of the impacts without and with the mitigation measures in place and records the overall conclusion of the significance of the impacts against the provisions of Article 8(1) of the Protocol.

Table 32 has been divided into sections so as to evaluate the aspects arising from each of the various projects that are planned over the next two austral summer seasons. However, to minimise repetition, activities that are common to most or all of the projects have been evaluated just once. These activities include:

- Vehicle use
- Rock crushing and grading
- Use of lighting rigs
- Importation of new materials
- Production of general and construction waste

Table 31. Assessment criteria for evaluating the spatial extent, duration, intensity and probability of the potential environmental impacts (modified and updated from Oerter, 2000).

		Criteria for assessment			
Impact	***Environment Element***	***Low***	***Medium***	***High***	***Very High***
SPATIAL EXTENT OF IMPACT Area or volume where changes are likely to occur	***Freshwater Marine Terrestrial Glaciological Atmosphere***	*Local extent*	*Partial extent*	*Major extent*	*Entire extent*
		Confined to the site of the activity.	*Some parts of an area are partially affected.*	*A major sized area is affected.*	*Large-scale impact; causing further impact.*
	Flora and Fauna	*Confined disturbance of fauna and flora within area of activity, e.g. individuals affected.*	*Some parts of the community are disturbed.*	*Major disturbance in community, e.g. breeding success is reduced.*	*Impairment at population level.*
	Research Values	*Small area of research site or minor damage to equipment*	*Some parts of research site or moderate damage to equipment*	*Most of research site or major damage to equipment*	*Entire research site or complete loss of equipment*
	Aesthetic or Wilderness Values	*Small area impacted*	*Some parts of the area impacted*	*Most of the area impacted*	*Entire area impacted*
DURATION OF IMPACT Period of time during which changes in the environment are likely to occur	***Freshwater Marine Terrestrial Glaciological Atmosphere***	*Short term*	*Medium term*	*Long term*	*Permanent*
		Several weeks to one season; short compared to natural processes.	*Several seasons to several years; impacts are reversible.*	*Decades; impacts are reversible.*	*Environment will suffer long-term or permanent impact.*
	Flora and Fauna	*Short compared to growth period/ breeding season.*	*Medium compared to growth period/ breeding season.*	*Long compared to growth period/ breeding season.*	*Permanent*
	Research Values	*A few hours to days of equipment downtime or a few days lost for a research event*	*A few days to weeks of equipment downtime or weeks lost for a research event*	*A season of equipment downtime or one or more seasons lost for a research event*	*Permanent damage to equipment and complete cancellation of a research programme*
	Aesthetic or Wilderness Values	*Impacts will be short-term - several weeks to one season*	*Impacts will be medium-term - more than one season - but are reversible.*	*Impacts will last for many seasons to decades; impacts are potentially reversible.*	*Impacts are irreversible*
SEVERITY OF IMPACT A measure of the amount of change imposed on the environment due to the activity	***Freshwater Marine Terrestrial Glaciological Atmosphere***	*Minimal Affect*	*Affected*	*High*	*Irreversible*
		Natural functions and processes of the environment are minimally affected.	*Natural functions or processes of the environment are affected but are not subject to long-lasting changes.*	*Natural functions or processes of the environment are affected or changed over the long term.*	*Natural functions or processes of the environment are permanently disrupted.*
		Reversible.	*Reversible.*	*Reversibility uncertain.*	*Irreversible or chronic changes.*
	Flora and Fauna	*Minor disturbance.*	*Medium disturbance.*	*High levels of disturbance.*	*Very high levels of disturbance.*
		Recovery definite.	*Recovery likely.*	*Recovery slow and uncertain.*	*Recovery unlikely.*
	Research Values	*A few hours to days of lost data*	*Days to weeks of lost data*	*A full season of lost data*	*Complete loss of a dataset*
	Aesthetic or Wilderness Values	*Minor distraction from natural values*	*Partial distraction from natural values*	*Major distraction from natural values*	*Complete loss of natural values*
LIKELIHOOD *Probability of the occurrence of the impact*	***All elements***	*Should not occur under normal operation and conditions.*	*Possible but unlikely.*	*Likely to occur during span of project. Probable.*	*Certain to occur / unavoidable.*

Table 32.This page and following pages. Evaluation of the significance of the identified actual or potential environmental impacts of the planned activities on the Antarctic environment.

						Pre-treatment risk assessment						Post-treatment risk assessment					
Sr No.	**Impacted Environment(s) or Values**	**Activity**	**Environmental Aspects**	**Actual or Potential Impact(s)**	**Type of Impact (Direct, Indirect, Cumulative)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Raw Significance Level**	**Treatment (Preventative or Mitigating Measures)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Residual Significance Level**	**Ref Article 8 of the Protocol**
		Wharf Resurfacing															
1	Fauna & Flora	• Excavation of existing surface material • Resurfacing of the wharf with graded material	Emission of noise	Disturbance of wildlife including breeding birds on Rothera Point	Direct, Cumulative	Medium	Medium	Low	High	Medium	• A slow-start procedure (gradually increasing noise over a period of time) will be implemented for all noisy construction equipment to give wildlife on land (except nesting birds) the opportunity to move away from the noise source before it reaches its highest levels; • Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be present at the start of works adjacent to any known nest sites to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Noisy works will not commence without express permission of the suitably trained person present; • If agreed noise threshold levels are exceeded, works in that area will cease until additional mitigation measures can be implemented, such as acoustic screening; • Where programming and resource allows, works will be programmed to avoid noisy activities occurring concurrently across projects, to avoid intra-project cumulative noise impacts.	Medium	Low	Low	Medium	Low	Less than minor or transitory
2			Emission of ground-borne vibration	Disturbance of wildlife including breeding birds on Rothera Point	Direct, Cumulative	Low	Medium	Low	High	Medium	• A slow-start procedure (gradually increasing plant activity over a period of time) will be implemented to give wildlife on land (except nesting birds) the opportunity to move away from vibration sources before it reaches its highest levels; • Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be present at the start of works adjacent to any known nest sites to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Works likely to create significant vibration will not commence without express permission of the suitably trained person present; • If agreed vibration levels are exceeded, works in that area will cease until additional mitigation measures can be implemented; • Where programming and resource allows, works will be programmed to minimise cumulative vibration impacts; • Checks of skua nests will be undertaken prior to the start of any works as well as ongoing skua nest monitoring.	Low	Medium	Low	Low	Low	Less than minor or transitory
3			Emission of noise / vibrations to the marine environment	Disturbance of wildlife including marine mammals within the vicinity of the wharf	Direct	Medium	Medium	Low	Medium	Medium	• Prior to work commencing each day, initial observations will be made to identify any marine species within the immediate vicinity of the wharf; Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be consulted if doubts exist about the potential disturbance of marine wildlife; • A slow-start procedure (gradually increasing activity over a period of time) will be implemented for all construction equipment to give marine wildlife in the water the opportunity to move away from the noise source before it reaches its highest levels.	Low	Low	Low	Medium	Low	Less than minor or transitory

						Pre-treatment risk assessment						Post-treatment risk assessment					
Sr No.	**Impacted Environment(s) or Values**	**Activity**	**Environmental Aspects**	**Actual or Potential Impact(s)**	**Type of Impact (Direct, Indirect, Cumulative)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Raw Significance Level**	**Treatment (Preventative or Mitigating Measures)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Residual Significance Level**	**Ref Article 8 of the Protocol**
4	Fauna & Flora	• Excavation of existing surface material • Resurfacing of the wharf with graded material	Emission of dust	Potential smothering of native terrestrial flora	Direct, Cumulative	Medium	Medium	Low	Low	Medium	• For activities likely to produce high levels of dust or when agreed dust threshold levels are exceeded, dust suppression equipment will be used and/or roadways sprayed down with sea water; • Where practicable, activities which create dust will be kept downwind of sensitive receptors & areas of known vegetation will be avoided; • The drop height of materials during stockpiling, processing, and loading operations will be limited to the extent practicable; • Double handling of materials will be minimised to the extent practicable to reduce the overall number of tipping actions; • If agreed dust threshold levels are exceeded, works in that area will cease until additional mitigation measures can be implemented; • Daily weather reports will be used to inform which activities can proceed that day or if any activities need to be suspended or additional mitigation measures put in place. During excessively dry, windy conditions, especially where the wind direction will blow dust towards sensitive receptors, it may be necessary to temporarily suspend operations if it is not possible to control dust by other means.	Low	Low	Low	Medium	Low	Less than minor or transitory
5			Loss of fill material or fines to the nearshore marine environment	Potential smothering of benthic marine fauna & flora	Direct	Low	Medium	Low	Medium	Medium	• Skilled and experienced machine and plant operators will be employed; • Plant and vehicle operators will be alerted to the risk; • No graded material will be stockpiled close to the wharf edge.	Low	Low	Low	Low	Low	Less than minor or transitory
6	Nearshore marine		Loss of fill material or fines to the nearshore marine environment	Potential loss of water quality / increased turbidity	Direct	Low	Medium	Low	Medium	Medium		Low	Low	Low	Low	Low	Less than minor or transitory
7	Terrestrial		Mechanical action on ice-free ground	Physical disturbance to ice-free ground albeit already altered and impacted	Direct	Low	Medium	Low	High	Low	*The wharf area is an artificial surface with no intrinsic or environmental values. No mitigation measures are required in relation to this aspect*	Low	Medium	Low	High	Low	Less than minor or transitory
8		Integrity testing of the new wharf surface (importation and release of geological material (kiln dried sand))	Release of imported geological material to the environment	Release of imported geological material to the environment	Direct	Low	Low	Low	Medium	Low	*Testing will involve removing most of the kiln dried sand, although inevitable some very small quantities will remain in the test holes. This is not assessed as likely to have any detrimental effect on the environment*	Low	Low	Low	Low	Low	Less than minor or transitory

						Pre-treatment risk assessment						Post-treatment risk assessment					
Sr No.	**Impacted Environment(s) or Values**	**Activity**	**Environmental Aspects**	**Actual or Potential Impact(s)**	**Type of Impact (Direct, Indirect, Cumulative)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Raw Significance Level**	**Treatment (Preventative or Mitigating Measures)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Residual Significance Level**	**Ref Article 8 of the Protocol**
		Fuel Pipelines & Fuel Reel Bunker Station Installation															
9	Fauna & Flora	• Excavation of trenches • Backfilling of trenches • Concrete coring	Emission of noise to air	Disturbance of wildlife including breeding birds on Rothera Point	Direct, Cumulative	Medium	Medium	Low	Medium	Medium	• A slow-start procedure (gradually increasing noise over a period of time) will be implemented for all noisy construction equipment to give wildlife on land (except nesting birds) the opportunity to move away from the noise source before it reaches its highest levels; • Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be present at the start of works adjacent to any known nest sites to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Noisy works will not commence without express permission of the suitably trained person present; • If agreed noise threshold levels are exceeded, works in that area will cease until additional mitigation measures can be implemented, such as acoustic screening; • Where programming and resource allows, works will be programmed to avoid noisy activities occurring concurrently across projects, to avoid intra-project cumulative noise impacts.	Medium	Low	Low	Medium	Low	Less than minor or transitory
10			Emission of ground-borne vibrations	Disturbance of wildlife including breeding birds on Rothera Point	Direct, Cumulative	Low	Medium	Low	High	Medium	• A slow-start procedure (gradually increasing plant activity over a period of time) will be implemented to give wildlife on land (except nesting birds) the opportunity to move away from vibration sources before it reaches its highest levels; • Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be present at the start of works adjacent to any known nest sites to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Works likely to create significant vibration will not commence without express permission of the suitably trained person present; • If agreed vibration levels are exceeded, works in that area will cease until additional mitigation measures can be implemented; • Where programming and resource allows, works will be programmed to minimise cumulative vibration impacts; • Checks of skua nests will be undertaken prior to the start of any works as well as ongoing skua nest monitoring.	Low	Medium	Low	Low	Low	Less than minor or transitory
11			Emission of dust to air	Potential smothering of native terrestrial flora	Direct, Cumulative	Medium	Medium	Low	Medium	Medium	• For activities likely to produce high levels of dust or when agreed dust threshold levels are exceeded, dust suppression equipment will be used and/or roadways sprayed down with sea water; • Where practicable, activities which create dust will be kept downwind of sensitive receptors & areas of known vegetation will be avoided; • The drop height of materials during stockpiling, processing, and loading operations will be limited to the extent practicable; • Double handling of materials will be minimised to the extent practicable to reduce the overall number of tipping actions; • If agreed dust threshold levels are exceeded, works in that area will cease until additional mitigation measures can be implemented; • Daily weather reports will be used to inform which activities can proceed that day or if any activities need to be suspended or additional mitigation measures put in place. During excessively dry, windy conditions, especially where the wind direction will blow dust towards sensitive receptors, it may be necessary to temporarily suspend operations if it is not possible to control dust by other means.	Medium	Medium	Low	Low	Low	Less than minor or transitory

						Pre-treatment risk assessment						Post-treatment risk assessment					
Sr No.	**Impacted Environment(s) or Values**	**Activity**	**Environmental Aspects**	**Actual or Potential Impact(s)**	**Type of Impact (Direct, Indirect, Cumulative)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Raw Significance Level**	**Treatment (Preventative or Mitigating Measures)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Residual Significance Level**	**Ref Article 8 of the Protocol**
12	Fauna	Excavation of trenches	Entrapment risk	Penguins or seals become trapped in open excavations	Direct	Low	Low	Low	Low	Low	• Trenches will be backfilled as soon as practicable following installation of services; • Open excavations will be inspected regularly including at the start of work each day; • Work will be suspended if wildlife is found in an excavation. Station wildlife experts will be used to assist in removal; • Where trenches are left open overnight or for more than one operational period, to the extent practicable they will be fenced and covered to prevent wildlife falling in and one end of the trench will have a sufficiently gentle gradient to allow any penguin or seal that enters the excavation to exit unaided.	Low	Low	Low	Low	Low	Less than minor or transitory
13	Terrestrial	• Excavation of trenches • Backfilling of trenches	Mechanical action	Physical disturbance to ice free ground	Direct, Cumulative	Low	Medium	Low	Very High	Medium	• All earthworks will be spatially constrained to the extent possible to meet operational objectives; • Trenching depths will be minimised to the extent possible, whilst ensuring burial to sufficient depth to minimise the risk of damage from surface activities e.g. vehicle movements.	Low	Low	Low	Very High	Low	Less than minor or transitory
14	Glaciological	Excavation of trenches	Mechanical action	Disturbance of permafrost & modification of the active layer	Direct, Cumulative	Medium	High	Low	High	Medium	• All ground works will be spatially constrained to the extent required to achieve operational requirements; • Excavated material will be used for backfilling the fuel pipeline trench; • Sub-surface areas will be left exposed for as short a length of time as possible. The pipeline on the eastern side of the runway will be completed first before trenching occurs on the western side of the runway; • Ducting already in place will be used for the runway crossing to avoid any further digging of the runway area.	Low	High	Low	High	Medium	No more than minor or transitory
15	Aesthetic & Wilderness Values	Installation of new infrastructure e.g. the new fuel-reel bunker station on the wharf	Additional infrastructure	Potential for further diminution of aesthetic & wilderness values at this location	Direct, Indirect, Cumulative	Low	High	Medium	Medium	Medium	• Construction activities will be confined to the agreed areas on site; • All activity methodologies and locations are to be undertaken in line with agreed methodologies and locations presented in this IEE; • BAS Environment Office will be consulted prior to change of location of any new infrastructure from that identified in this EIA.	Low	High	Low	Medium	Medium	No more than minor or transitory

						Pre-treatment risk assessment						Post-treatment risk assessment					
Sr No.	**Impacted Environment(s) or Values**	**Activity**	**Environmental Aspects**	**Actual or Potential Impact(s)**	**Type of Impact (Direct, Indirect, Cumulative)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Raw Significance Level**	**Treatment (Preventative or Mitigating Measures)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Residual Significance Level**	**Ref Article 8 of the Protocol**
		BMPV / GMPV & BESS Installations															
16	Fauna & Flora	• Use of power tools • Ground levelling & excavation at the GMPV site	Emission of noise to air	Disturbance of breeding birds on Rothera Point	Direct, Cumulative	Medium	Medium	Low	Medium	Medium	• A slow-start procedure (gradually increasing noise over a period of time) will be implemented for all noisy construction equipment to give wildlife on land (except nesting birds) the opportunity to move away from the noise source before it reaches its highest levels; • Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be present at the start of works adjacent to any known nest sites to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Noisy works will not commence without express permission of the suitably trained person present; • If agreed noise threshold levels are exceeded, works in that area will cease until additional mitigation measures can be implemented, such as acoustic screening; • Where programming and resource allows, works will be programmed to avoid noisy activities occurring concurrently across projects, to avoid intra-project cumulative noise impacts.	Medium	Low	Low	Medium	Low	Less than minor or transitory
17			Emission of ground-borne vibration	Disturbance of wildlife including breeding birds on Rothera Point	Direct, Cumulative	Low	Medium	Low	High	Medium	• A slow-start procedure (gradually increasing plant activity over a period of time) will be implemented to give wildlife on land (except nesting birds) the opportunity to move away from vibration sources before it reaches its highest levels; • Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be present at the start of works adjacent to any known nest sites to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Works likely to create significant vibration will not commence without express permission of the suitably trained person present; • If agreed vibration levels are exceeded, works in that area will cease until additional mitigation measures can be implemented; • Where programming and resource allows, works will be programmed to minimise cumulative vibration impacts.	Low	Medium	Low	Low	Low	Less than minor or transitory
18		• Ground levelling & excavation at the GMPV site	Emission of dust to air	Potential smothering of native terrestrial flora	Direct, Cumulative	Medium	Low	Medium	Medium	Medium	• For activities likely to produce high levels of dust or when agreed dust threshold levels are exceeded, dust suppression equipment will be used and/or roadways sprayed down with sea water; • Where practicable, activities which create dust will be kept downwind of sensitive receptors & areas of known vegetation will be avoided; • If agreed dust threshold levels are exceeded, works in that area will cease until additional mitigation measures can be implemented; • Daily weather reports will be used to inform which activities can proceed that day or if any activities need to be suspended or additional mitigation measures put in place. During excessively dry, windy conditions, especially where the wind direction will blow dust towards sensitive receptors, it may be necessary to temporarily suspend operations if it is not possible to control dust by other means.	Low	Low	Low	Medium	Low	Less than minor or transitory
19	Glaciological		Creation of dust & fines	Potential for dust to settle on the ice ramp & contribute to ice loss	Direct, Cumulative	Low	High	Medium	Medium	Medium		Low	Medium	Low	Medium	Low	Less than minor or transitory
20	Freshwater		Creation of dust & fines	Potential for disturbed soils or fines to enter the meltwater ponds & stream behind the hangar	Direct	Low	Medium	Medium	Medium	Medium	As above, plus: • Ground works will be physically separated from the areas of sensitivity.	Low	Low	Low	Low	Low	Less than minor or transitory

						Pre-treatment risk assessment						Post-treatment risk assessment					
Sr No.	**Impacted Environment(s) or Values**	**Activity**	**Environmental Aspects**	**Actual or Potential Impact(s)**	**Type of Impact (Direct, Indirect, Cumulative)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Raw Significance Level**	**Treatment (Preventative or Mitigating Measures)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Residual Significance Level**	**Ref Article 8 of the Protocol**
21	Glaciological	Ground levelling & excavation at the GMPV site & in the vicinity of the BESS	Mechanical action	Disturbance of permafrost & modification of the active layer	Direct, Cumulative	Low	High	Low	Medium	Medium	• All ground works will be spatially constrained to the extent required to achieve operational requirements; • The excavated areas will be backfilled and compacted.	Low	Low	Low	High	Low	Less than minor or transitory
22	Terrestrial	Ground levelling & excavation at the GMPV site		Physical disturbance to ice free ground	Direct, Cumulative	Low	High	Low	High	Medium	This work will occur on an area of more recently exposed and less impacted ground due to local glacial retreat. Care will need to be taken to constrain the earthworks to the extent possible whilst meeting operational objectives.	Low	Low	Low	High	Low	Less than minor or transitory
23	Aesthetic & Wilderness Values	Installation of new infrastructure e.g. the new bunker station on the wharf & GMPV & solar panels on buildings	Additional infrastructure	Implications for perceptions of aesthetic & wilderness values at this location	Direct, Indirect, Cumulative	Low	High	Medium	Medium	Medium	• The majority of the installations will be within the Station boundary *The exception to the above will be the installation of the GMPV which will slightly exceed the current Station boundaries*	Low	High	Low	Medium	Medium	No more than minor or transitory

						Pre-treatment risk assessment						Post-treatment risk assessment					
Sr No.	**Impacted Environment(s) or Values**	**Activity**	**Environmental Aspects**	**Actual or Potential Impact(s)**	**Type of Impact (Direct, Indirect, Cumulative)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Raw Significance Level**	**Treatment (Preventative or Mitigating Measures)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Residual Significance Level**	**Ref Article 8 of the Protocol**
		Hangar Redevelopment & Associated Works															
24	Fauna (marine and terrestrial)	Installation of geotextile material	Release of synthetic fibres to the environment	Ingestion of microfibres by Antarctic wildlife with potential ecotoxicological effects	Direct, Indirect, Cumulative	Medium	High	Low	Medium	Medium	• The type of geotextile material will be carefully selected to take account of construction and environmental objectives. The highest suitable tensile strength material will be chosen to reduce the likelihood of disintegration during its operational life, and to enable easy removal at end of life; • Only the required quantity will be used beneath the building footprint – and only under the foundation pads; • The location of the geotextiles will be accurately recorded and archived to support careful removal at end of life of the hangar; • Onsite cutting of the material will be done in a controlled / contained location; • All practicable steps will be taken to minimise the duration of exposure of the geotextile to the environment; • Waste material will be contained and stored and removed at the earliest opportunity.	Medium	High	Low	Low	Low	Less than minor or transitory
25	Fauna & Flora	• Excavation & trenching, including diversion of the drainage ditch • Road establishment • Backfilling & compacting	Emission of noise	Disturbance of wildlife including breeding birds on Rothera Point	Direct, Cumulative	Medium	Medium	Low	High	Medium	• A slow-start procedure (gradually increasing noise over a period of time) will be implemented for all noisy construction equipment to give wildlife on land (except nesting birds) the opportunity to move away from the noise source before it reaches its highest levels; • Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be present at the start of works adjacent to any known nest sites to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Noisy works will not commence without express permission of the suitably trained person present; • If agreed noise threshold levels are exceeded, works in that area will cease until additional mitigation measures can be implemented, such as acoustic screening; • Where programming and resource allows, works will be programmed to avoid noisy activities occurring concurrently across projects, to avoid intra-project cumulative noise impacts. *The work will be undertaken at the end of or just after the breeding season when sensitivity is much less.*	Medium	Low	Low	Medium	Low	Less than minor or transitory
26			Emission of ground-borne vibration	Disturbance of wildlife including breeding birds on Rothera Point	Direct, Cumulative	Low	Medium	Low	High	Medium	• A slow-start procedure (gradually increasing plant activity over a period of time) will be implemented to give wildlife on land (except nesting birds) the opportunity to move away from vibration sources before it reaches its highest levels; • Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be present at the start of works adjacent to any known nest sites to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Works likely to create significant vibration will not commence without express permission of the suitably trained person present; • If agreed vibration levels are exceeded, works in that area will cease until additional mitigation measures can be implemented; • Where programming and resource allows, works will be programmed to minimise cumulative vibration impacts. *The work will be undertaken at the end of or just after the breeding season when sensitivity is much less.*	Low	Medium	Low	Low	Low	Less than minor or transitory

						Pre-treatment risk assessment						Post-treatment risk assessment					
Sr No.	**Impacted Environment(s) or Values**	**Activity**	**Environmental Aspects**	**Actual or Potential Impact(s)**	**Type of Impact (Direct, Indirect, Cumulative)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Raw Significance Level**	**Treatment (Preventative or Mitigating Measures)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Residual Significance Level**	**Ref Article 8 of the Protocol**
27			Mechanical action on ice-free surfaces	Physical harm to native terrestrial vegetation	Direct, Cumulative	Medium	Medium	Medium	High	Medium	• All activities will be planned to ensure plant and equipment remain within the 'high impact' zone; • The construction boundary will be marked with flags at all times; • The patch of D. antarctica will be protected using pedestrian barriers and flags throughout the construction seasons.	Low	Medium	Medium	Low	Low	Less than minor or transitory
28			Emission of dust to air	Potential smothering of native terrestrial flora	Direct, Cumulative	Medium	Medium	Low	Low	Medium	• For activities likely to produce high levels of dust or when agreed dust threshold levels are exceeded, dust suppression equipment will be used and/or roadways sprayed down with sea water; • Where practicable, activities which create dust will be kept downwind of sensitive receptors & areas of known vegetation will be avoided; • The drop height of materials during stockpiling, processing, and loading operations will be limited to the extent practicable; • Double handling of materials will be minimised to the extent practicable to reduce the overall number of tipping actions; • If agreed dust threshold levels are exceeded, works in that area will cease until additional mitigation measures can be implemented; • Daily weather reports will be used to inform which activities can proceed that day or if any activities need to be suspended or additional mitigation measures put in place. During excessively dry, windy conditions, especially where the wind direction will blow dust towards sensitive receptors, it may be necessary to temporarily suspend operations if it is not possible to control dust by other means.	Low	Low	Low	Medium	Low	Less than minor or transitory
29	Glaciological			Settling of dust on the ice ramp contributing to ice loss	Direct, Cumulative	Low	High	Low	Medium	Medium		Low	Low	Low	High	Low	Less than minor or transitory
30	Terrestrial	• Excavation & trenching, including diversion of the drainage ditch • Road establishment • Backfilling & compacting	Mechanical action on ice-free ground	Physical disturbance to ice-free ground	Direct	Low	Medium	Low	Very High	Medium	• Vehicles used for excavating the drainage ditch will be kept to the eastern side of the works • The majority of the work will be within the existing Station high impact area *The exception to this will be a slight expansion in the footprint of the redeveloped hangar and the permanent diversion of the drainage ditch*	Low	Medium	Low	Very High	Medium	No more than minor or transitory
31	Marine	Digging / diversion of the drainage ditch	Release of fines into Hangar Cove	Increase in turbidity & smothering of benthic species	Direct	Low	Low	Low	High	Low	• Diverted section will be minimised to the extent required *Any impacts may not occur until the following season when meltwater starts to flow*	Low	Low	Low	High	Low	Less than minor or transitory
32	Freshwater		Modification to a freshwater environment *albeit human-made*	Modification to a freshwater environment / loss of some algal growth	Direct	Low	Medium	Low	Very High	Low	• Diverted section will be minimised to the extent required	Low	Medium	Low	Very High	Low	Less than minor or transitory
33	Aesthetic & Wilderness Values	• Diversion of the drainage ditch • Road establishment • Expanded hangar footprint	Expansion of the physical footprint of the Station	Expansion of the high impact area of the station with implications for perceptions of aesthetic & wilderness values	Direct, Indirect, Cumulative	Low	High	Low	Very High	Medium	• Expansion of the high impact area of the station will be minimised to the extent practicable	Low	High	Low	Very High	Medium	No more than minor or transitory

						Pre-treatment risk assessment						Post-treatment risk assessment					
Sr No.	**Impacted Environment(s) or Values**	**Activity**	**Environmental Aspects**	**Actual or Potential Impact(s)**	**Type of Impact (Direct, Indirect, Cumulative)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Raw Significance Level**	**Treatment (Preventative or Mitigating Measures)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Residual Significance Level**	**Ref Article 8 of the Protocol**
		Bollard Removal															
34	Fauna & Flora	• Breaking up of the concrete bollard • Backfilling bollard hole	Emission of noise	Disturbance of wildlife including breeding birds on Rothera Point	Direct, Cumulative	Medium	Medium	Low	High	Medium	• A slow-start procedure (gradually increasing noise over a period of time) will be implemented for all noisy construction equipment to give wildlife on land (except nesting birds) the opportunity to move away from the noise source before it reaches its highest levels; • Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be present at the start of works adjacent to any known nest sites to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Noisy works will not commence without express permission of the suitably trained person present; • If agreed noise threshold levels are exceeded, works in that area will cease until additional mitigation measures can be implemented, such as acoustic screening; • Where programming and resource allows, works will be programmed to avoid noisy activities occurring concurrently across projects, to avoid intra-project cumulative noise impacts.	Medium	Low	Low	Medium	Low	Less than minor or transitory
35			Emission of ground-borne vibration	Disturbance of wildlife including breeding birds on Rothera Point	Direct, Cumulative	Low	Medium	Low	High	Medium	• A slow-start procedure (gradually increasing plant activity over a period of time) will be implemented to give wildlife on land (except nesting birds) the opportunity to move away from vibration sources before it reaches its highest levels; • Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be present at the start of works adjacent to any known nest sites to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Works likely to create significant vibration will not commence without express permission of the suitably trained person present; • If agreed vibration levels are exceeded, works in that area will cease until additional mitigation measures can be implemented; • Where programming and resource allows, works will be programmed to minimise cumulative vibration impacts; • Checks of skua nests will be undertaken prior to the start of any works as well as ongoing skua nest monitoring.	Low	Medium	Low	Low	Low	Less than minor or transitory
36			Emission of dust	Potential smothering of native terrestrial flora	Direct, Cumulative	Medium	Medium	Low	Low	Medium	• For activities likely to produce high levels of dust or when agreed dust threshold levels are exceeded, dust suppression equipment will be used and/or roadways sprayed down with sea water; • Where practicable, activities which create dust will be kept downwind of sensitive receptors & areas of known vegetation will be avoided; • If agreed dust threshold levels are exceeded, works will cease until additional mitigation measures can be implemented; • Daily weather reports will be used to inform which activities can proceed that day or if any activities need to be suspended or additional mitigation measures put in place. During excessively dry, windy conditions, especially where the wind direction will blow dust towards sensitive receptors, it may be necessary to temporarily suspend operations if it is not possible to control dust by other means.	Low	Low	Low	Low	Low	Less than minor or transitory
37	Terrestrial		Mechanical action on ice-free ground	Physical disturbance to ice-free ground albeit already altered and impacted	Direct	Low	Medium	Low	High	Medium	*The bollard is located on heavily disturbed ground with no environmental or intrinsic values. Activity will not extend much beyond the area of the bollard itself. No mitigation measures are required in relation to this aspect, other than to constrain the activity to the extent practicable.*	Low	Medium	Low	High	Low	Less than minor or transitory
38	Aesthetic & Wilderness Values	Removal of infrastructure	Removal of infrastructure	Implications for aesthetic & wilderness values	Direct, Indirect, Cumulative	*No mitigation required.* *Significance is challenging to assess in the context of removing infrastructure - but removal is unlikely to have a negative impact on perceptions of wilderness or aesthetic values and could have a positive impact. Given the setting within the current Station boundaries, the overall impact is likely to be negligible i.e., less than minor or transitory*										Less than minor or transitory

						Pre-treatment risk assessment						Post-treatment risk assessment					
Sr No.	**Impacted Environment(s) or Values**	**Activity**	**Environmental Aspects**	**Actual or Potential Impact(s)**	**Type of Impact (Direct, Indirect, Cumulative)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Raw Significance Level**	**Treatment (Preventative or Mitigating Measures)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Residual Significance Level**	**Ref Article 8 of the Protocol**
		Fuel Hut & Disused Pipes Removal															
39		• Use of power tools • Breaking of concrete foundations • Compacting fill material	Emission of noise to air	Disturbance of wildlife including breeding birds on Rothera Point	Direct, Cumulative	Medium	Medium	Low	Medium	Medium	• A slow-start procedure (gradually increasing noise over a period of time) will be implemented for all noisy construction equipment to give wildlife on land (except nesting birds) the opportunity to move away from the noise source before it reaches its highest levels; • Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be present at the start of works adjacent to any known nest sites to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Noisy works will not commence without express permission of the suitably trained person present; • If agreed noise threshold levels are exceeded, works in that area will cease until additional mitigation measures can be implemented, such as acoustic screening; • Where programming and resource allows, works will be programmed to avoid noisy activities occurring concurrently across projects, to avoid intra-project cumulative noise impacts.	Medium	Low	Low	Medium	Low	Less than minor or transitory
40	Fauna & Flora	• Breaking of concrete foundations • Compacting fill material	Emission of ground-borne vibrations	Disturbance of wildlife including breeding birds on Rothera Point	Direct, Cumulative	Low	Medium	Low	High	Medium	• A slow-start procedure (gradually increasing plant activity over a period of time) will be implemented to give wildlife on land (except nesting birds) the opportunity to move away from vibration sources before it reaches its highest levels; • Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be present at the start of works adjacent to any known nest sites to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Works likely to create significant vibration will not commence without express permission of the suitably trained person present; • If agreed vibration levels are exceeded, works in that area will cease until additional mitigation measures can be implemented; • Where programming and resource allows, works will be programmed to minimise cumulative vibration impacts.	Low	Medium	Low	Low	Low	Less than minor or transitory
41		Breaking of concrete foundations	Emission of dust to air	Potential smothering of native terrestrial flora	Direct, Cumulative	Low	Medium	Low	Medium	Medium	• For activities likely to produce high levels of dust or when agreed dust threshold levels are exceeded, dust suppression equipment will be used and/or roadways sprayed down with sea water; • Where practicable, activities which create dust will be kept downwind of sensitive receptors & areas of known vegetation will be avoided; • The drop height of materials during stockpiling, processing, and loading operations will be limited to the extent practicable; • Double handling of materials will be minimised to the extent practicable to reduce the overall number of tipping actions; • If agreed dust threshold levels are exceeded, works in that area will cease until additional mitigation measures can be implemented; • Daily weather reports will be used to inform which activities can proceed that day or if any activities need to be suspended or additional mitigation measures put in place. During excessively dry, windy conditions, especially where the wind direction will blow dust towards sensitive receptors, it may be necessary to temporarily suspend operations if it is not possible to control dust by other means.	Low	Low	Low	Low	Low	Less than minor or transitory
42	Terrestrial	Excavation to remove old pipes and hut foundations	Mechanical action	Physical disturbance to ice free ground	Direct, Cumulative	Low	Medium	Low	High	Medium	*The hut is located on heavily disturbed ground with no natural environmental or intrinsic values. Activity will not extend much beyond the area of the hut itself, although some excavation may be required to removed old pipes.* *No mitigation measures are required in relation to this aspect, other than to constrain the activity to the extent practicable.*	Low	Low	Low	High	Low	Less than minor or transitory

						Pre-treatment risk assessment						Post-treatment risk assessment					
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43	Glaciological environment		Mechanical action	Localised disturbance to permafrost / modification of the active layer	Direct, Cumulative	Medium	Medium	Low	High	Medium	• All ground works will be spatially constrained to the extent required to achieve operational requirements; • The excavated areas will be backfilled and compacted.	Low	Low	Low	Medium	Low	Less than minor or transitory
44	Aesthetic & Wilderness Values	Removal of infrastructure	Removal of infrastructure	Implications for aesthetic and wilderness values at this location	Direct, Indirect, Cumulative	*No mitigation required.* *Significance is challenging to assess in the context of removing infrastructure - but removal is unlikely to have a negative impact on perceptions of wilderness or aesthetic values and could have a positive impact. Given the setting within the current Station boundaries, the overall impact is likely to be negligible i.e., less than minor or transitory*											Less than minor or transitory

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Sr No.	**Impacted Environment(s) or Values**	**Activity**	**Environmental Aspects**	**Actual or Potential Impact(s)**	**Type of Impact (Direct, Indirect, Cumulative)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Raw Significance Level**	**Treatment (Preventative or Mitigating Measures)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Residual Significance Level**	**Ref Article 8 of the Protocol**
		Runway maintenance works															
45	Fauna & Flora	• Use of power tools • Stockpile replenishment	Emission of noise to air	Disturbance of wildlife including breeding birds on Rothera Point	Direct, Cumulative	Medium	Medium	Low	Medium	Medium	• A slow-start procedure (gradually increasing noise over a period of time) will be implemented for all noisy construction equipment to give wildlife on land (except nesting birds) the opportunity to move away from the noise source before it reaches its highest levels; • Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be present at the start of works adjacent to any known nest sites to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Noisy works will not commence without express permission of the suitably trained person present; • If agreed noise threshold levels are exceeded, works in that area will cease until additional mitigation measures can be implemented, such as acoustic screening; • Where programming and resource allows, works will be programmed to avoid noisy activities occurring concurrently across projects, to avoid intra-project cumulative noise impacts.	Medium	Low	Low	Medium	Low	Less than minor or transitory
46		• Stockpile replenishment	Emission of ground-borne vibrations	Disturbance of wildlife including breeding birds on Rothera Point	Direct, Cumulative	Low	Medium	Low	High	Medium	• A slow-start procedure (gradually increasing plant activity over a period of time) will be implemented to give wildlife on land (except nesting birds) the opportunity to move away from vibration sources before it reaches its highest levels; • Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be present at the start of works adjacent to any known nest sites to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Works likely to create significant vibration will not commence without express permission of the suitably trained person present; • If agreed vibration levels are exceeded, works in that area will cease until additional mitigation measures can be implemented; • Where programming and resource allows, works will be programmed to minimise cumulative vibration impacts.	Low	Medium	Low	Low	Low	Less than minor or transitory
47		Stockpiling of the aggregate adjacent to the runway	Emission of dust to air	Potential smothering of native terrestrial flora	Direct, Cumulative	Medium	Medium	Low	Low	Medium	• For activities likely to produce high levels of dust or when agreed dust threshold levels are exceeded, dust suppression equipment will be used and/or roadways sprayed down with sea water; • Where practicable, activities which create dust will be kept downwind of sensitive receptors & areas of known vegetation will be avoided; • The drop height of materials during stockpiling, processing, and loading operations will be limited to the extent practicable; • Double handling of materials will be minimised to the extent practicable to reduce the overall number of tipping actions; • If agreed dust threshold levels are exceeded, works in that area will cease until additional mitigation measures can be implemented; • Daily weather reports will be used to inform which activities can proceed that day or if any activities need to be suspended or additional mitigation measures put in place. During excessively dry, windy conditions, especially where the wind direction will blow dust towards sensitive receptors, it may be necessary to temporarily suspend operations if it is not possible to control dust by other means.	Low	Low	Low	Medium	Low	Less than minor or transitory
48	Glaciological			Settling of dust on the ice ramp contributing to ice loss	Direct, Cumulative	Low	High	Low	Medium	Medium		Low	Low	Low	High	Low	Less than minor or transitory
49	Aesthetic & Wilderness Values	Replenishment of the runway stockpile	Visual disturbance	Implications for perceptions of aesthetic & wilderness values	Direct, Indirect, Cumulative	Low	High	Medium	Medium	Medium	• Stockpile dimensions will be constrained as far as is practicable. *Stockpile at this location is not new & is simply being replenished, but expansion could impact perceptions of aesthetic or wilderness values.*	Low	High	Low	Medium	Medium	No more than minor or transitory

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		Establishment of Slipway in North Cove															
50	Fauna & Flora	Scraping & profiling of the shoreline	Emission of noise to air & marine environment	Disturbance of wildlife including breeding birds on Rothera Point & marine wildlife	Direct, Cumulative	Medium	Medium	Low	Medium	Medium	• A slow-start procedure (gradually increasing noise over a period of time) will be implemented for all noisy construction equipment to give wildlife on land (except nesting birds) the opportunity to move away from the noise source before it reaches its highest levels; • Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be present at the start of works adjacent to any known nest sites to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Noisy works will not commence without express permission of the suitably trained person present; • If agreed noise threshold levels are exceeded, works in that area will cease until additional mitigation measures can be implemented, such as acoustic screening; • Where programming and resource allows, works will be programmed to avoid noisy activities occurring concurrently across projects, to avoid intra-project cumulative noise impacts; • Prior to work commencing each day, initial observations will be made to identify any marine species within the immediate vicinity of the slipway project. Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be consulted if doubts exist about the potential disturbance of marine wildlife; • A slow-start procedure (gradually increasing activity over a period of time) will be implemented for all construction equipment to give marine wildlife in the water the opportunity to move away from the noise source before it reaches its highest levels. *The activity is some distance from the known Skua breeding sites, although checks will be undertaken as per the above.*	Medium	Low	Low	Medium	Low	Less than minor or transitory
51			Emission of ground-borne vibrations including to the marine environment		Direct, Cumulative	Low	Medium	Low	High	Medium	• A slow-start procedure (gradually increasing plant activity over a period of time) will be implemented to give wildlife on land (except nesting birds) the opportunity to move away from vibration sources before it reaches its highest levels; • Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be present at the start of works adjacent to any known nest sites to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Works likely to create significant vibration will not commence without express permission of the suitably trained person present; • If agreed vibration levels are exceeded, works in that area will cease until additional mitigation measures can be implemented; • Where programming and resource allows, works will be programmed to minimise cumulative vibration impacts.	Low	Medium	Low	Low	Low	Less than minor or transitory

						Pre-treatment risk assessment						Post-treatment risk assessment					
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52	Fauna & Flora	Scraping & profiling of the shoreline	Emission of dust to air	Potential smothering of native terrestrial flora	Direct, Cumulative	Medium	Medium	Low	Low	Medium	• For activities likely to produce high levels of dust or when agreed dust threshold levels are exceeded, dust suppression equipment will be used and/or roadways sprayed down with sea water; • Where practicable, activities which create dust will be kept downwind of sensitive receptors & areas of known vegetation will be avoided; • If agreed dust threshold levels are exceeded, works in that area will cease until additional mitigation measures can be implemented; • Daily weather reports will be used to inform which activities can proceed that day or if any activities need to be suspended or additional mitigation measures put in place. During excessively dry, windy conditions, especially where the wind direction will blow dust towards sensitive receptors, it may be necessary to temporarily suspend operations if it is not possible to control dust by other means. *The area surrounding the planned slipway development is within the Station boundaries and is highly impacted and contains no reported sensitive vegetation.*	Low	Low	Low	Medium	Low	Less than minor or transitory
53			Hazardous substances / contaminants release from contaminated soils	Risk of uptake of released contaminants by benthic marine species	Direct, Cumulative	Low	High	High	Medium	High	• Contaminant testing is being undertaken at the time of drafting this EIA. Test results will be used to determine the risk. Only if the contaminant levels are unlikely to have any impact will the activity proceed.	Low	Low	Low	Low	Low	Less than minor or transitory
54	Marine			Risk of release of contaminants to the marine environment	Direct, Cumulative	Low	High	High	Medium	High		Low	Low	Low	Low	Low	Less than minor or transitory
55			Release of fines to the marine environment	Increase in turbidity & smothering of benthic species	Direct	Low	Medium	Low	Medium	Medium	• Profiling will be undertaken at low tide to the extent practicable *Any increase in turbidity or turbulence that may occur is likely to be highly localised to area of work only.*	Low	Low	Low	Medium	Low	Less than minor or transitory
56	Marine / Terrestrial		Mechanical action	Physical alteration of the shoreline profile	Direct	Low	High	Medium	High	Medium	• Work will be spatially constrained to the minimum area required to meet operational requirements; *Area selected is not a natural coastline and has been significantly altered in the past including through a previous slipway.*	Low	High	Low	High	Medium	No more than minor or transitory
57	Aesthetic & Wilderness Values		Visual disturbance	Implications for perceptions of aesthetic and wilderness values at this location	Direct, Indirect, Cumulative	Low	High	Medium	Medium	Medium	• Work will be spatially constrained to the minimum area required to meet operational requirements; *Area selected is not a natural coastline and has been significantly altered in the past including through a previous slipway.*	Low	High	Low	Medium	Medium	No more than minor or transitory

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		Contaminated Ground Investigations															
58	Fauna & Flora	• Excavation of test pits • Backfilling & compacting	Emission of noise	Disturbance of wildlife including breeding birds on Rothera Point	Direct, Cumulative	Medium	Medium	Low	High	Medium	• A slow-start procedure (gradually increasing noise over a period of time) will be implemented for all noisy construction equipment to give wildlife on land (except nesting birds) the opportunity to move away from the noise source before it reaches its highest levels; • Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be present at the start of works adjacent to any known nest sites to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Noisy works will not commence without express permission of the suitably trained person present; • If agreed noise threshold levels are exceeded, works in that area will cease until additional mitigation measures can be implemented, such as acoustic screening; • Where programming and resource allows, works will be programmed to avoid noisy activities occurring concurrently across projects, to avoid intra-project cumulative noise impacts. *The activity is some distance from the known Skua breeding sites, although checks will be undertaken as per the above.*	Medium	Low	Low	Medium	Low	Less than minor or transitory
59			Emission of ground-borne vibration	Disturbance of wildlife including breeding birds on Rothera Point	Direct, Cumulative	Low	Medium	Low	High	Medium	• A slow-start procedure (gradually increasing plant activity over a period of time) will be implemented to give wildlife on land (except nesting birds) the opportunity to move away from vibration sources before it reaches its highest levels; • Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be present at the start of works adjacent to any known nest sites to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Works likely to create significant vibration will not commence without express permission of the suitably trained person present; • If agreed vibration levels are exceeded, works in that area will cease until additional mitigation measures can be implemented; • Where programming and resource allows, works will be programmed to minimise cumulative vibration impacts.	Low	Medium	Low	Low	Low	Less than minor or transitory
60			Emission of dust	Potential smothering of native terrestrial flora	Direct, Cumulative	Medium	Medium	Low	Low	Medium	• For activities likely to produce high levels of dust or when agreed dust threshold levels are exceeded, dust suppression equipment will be used and/or roadways sprayed down with sea water; • Where practicable, activities which create dust will be kept downwind of sensitive receptors & areas of known vegetation will be avoided; • If agreed dust threshold levels are exceeded, works in that area will cease until additional mitigation measures can be implemented; • Daily weather reports will be used to inform which activities can proceed that day or if any activities need to be suspended or additional mitigation measures put in place. During excessively dry, windy conditions, especially where the wind direction will blow dust towards sensitive receptors, it may be necessary to temporarily suspend operations if it is not possible to control dust by other means.	Low	Low	Low	Medium	Low	Less than minor or transitory
61	Terrestrial		Mechanical action on ice-free ground	Physical disturbance to ice-free ground albeit already altered and impacted	Direct	Low	Medium	Low	Very High	Medium	*The area is within the current Station boundaries and is already highly disturbed with no remaining intrinsic value. No mitigation measures are required in relation to this aspect*	Low	Low	Low	Very High	Low	Less than minor or transitory

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		Rock crushing and grading - all activities															
62	Fauna & Flora	Crushing & screening of rock to required grade	Emission of noise	Disturbance of wildlife including breeding birds on Rothera Point	Direct, Cumulative	Medium	Medium	Low	High	Medium	• Plant items will be positioned to ensure exhaust outlets point away from sensitive receptors; • All plant and vehicles will be regularly inspected and maintained to ensure they are working efficiently and generating as little noise as possible; • A slow-start procedure (gradually increasing noise over a period of time) will be implemented for all noisy construction equipment to give wildlife on land (except nesting birds) the opportunity to move away from the noise source before it reaches its highest levels; • Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be present at the start of works adjacent to any known nest sites to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Noisy works will not commence without express permission of the suitably trained person present; • If agreed noise threshold levels are exceeded, works in that area will cease until additional mitigation measures can be implemented, such as acoustic screening; • Where programming and resource allows, works will be programmed to avoid noisy activities occurring concurrently across projects, to avoid intra-project cumulative noise impacts; • Rock crushing & screening will be undertaken for all projects in as constrained a time period as possible.	Medium	Low	Low	Medium	Low	Less than minor or transitory
63			Emission of ground-borne vibration	Disturbance of wildlife including breeding birds on Rothera Point	Direct, Cumulative	Low	Medium	Low	High	Medium	• A slow-start procedure (gradually increasing plant activity over a period of time) will be implemented to give wildlife on land (except nesting birds) the opportunity to move away from vibration sources before it reaches its highest levels; • Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be present at the start of works adjacent to any known nest sites to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Works likely to create significant vibration will not commence without express permission of the suitably trained person present; • If agreed vibration levels are exceeded, works in that area will cease until additional mitigation measures can be implemented; • Where programming and resource allows, works will be programmed to minimise cumulative vibration impacts; • Rock crushing & screening will be undertaken for all projects in as constrained a time period as possible.	Low	Medium	Low	Low	Low	Less than minor or transitory

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64	Fauna & Flora	Crushing & screening of rock to required grade	Emission of dust	Potential smothering of native terrestrial flora	Direct, Cumulative	Medium	Medium	Low	Medium	Medium	• For activities likely to produce high levels of dust or when agreed dust threshold levels are exceeded, dust suppression equipment will be used and/or roadways sprayed down with sea water; • Where practicable, activities which create dust will be kept downwind of sensitive receptors & areas of known vegetation will be avoided; • The drop height of materials during stockpiling, processing, and loading operations will be limited to the extent practicable; • Double handling of materials will be minimised to the extent practicable to reduce the overall number of tipping actions; • If agreed dust threshold levels are exceeded, works in that area will cease until additional mitigation measures can be implemented; • Daily weather reports will be used to inform which activities can proceed that day or if any activities need to be suspended or additional mitigation measures put in place. During excessively dry, windy conditions, especially where the wind direction will blow dust towards sensitive receptors, it may be necessary to temporarily suspend operations if it is not possible to control dust by other means; • Rock crushing & screening will be undertaken for all projects in as constrained a time period as possible.	Low	Low	Low	Medium	Low	Less than minor or transitory

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		Support Activities															
65	Fauna & Flora	Recreational activities including walks around Rothera Point	Presence & noise from personnel	Disturbance of breeding birds on Rothera Point	Direct, Cumulative	Medium	Medium	Medium	Medium	Medium	Pre-deployment & Station in-brief training will be provided to construction staff. This will identify Station environmental controls including walking routes, wildlife viewing controls contained within the BAS wildlife Interaction Manual, and 'no go' areas.	Low	Low	Low	Medium	Low	Less than minor or transitory
66		Use of additional buildings to house construction workers	Emissions of artificial light from the Station	Disorientation in birds leading to bird strike	Direct, Cumulative	Low	Low	Medium	Medium	Medium	• Pre-deployment & Station in-brief training will be provided to construction staff. This will identify Station environmental controls including BAS bird strike prevention and response regulations contained within the BAS wildlife Interaction Manual; • Window blackout blinds will be used as required by Station procedures.	Low	Low	Low	Low	Low	Less than minor or transitory
67		Additional personnel on Station	Increased discharge of wastewater to the marine environment	Risk of introduction of non-native microflora with risk to native fauna	Direct, Indirect, Cumulative	Medium	Medium	Medium	High	Medium	• All human waste will be treated and discharged via the Rothera Wastewater Treatment Plant (WWTP) - this includes UV treatment prior to discharge of wastewater; • All toilets and washing facilities are connected to the foul drainage system and will discharge via the WWTP.	Low	Medium	Low	Low	Low	Less than minor or transitory
68		Construction personnel bringing personal clothing, baggage and equipment to Rothera	Biological contamination risks introducing non-native species	Native species are outcompeted; community structures are altered	Direct, Cumulative	Medium	High	High	Medium	High	• Pre-deployment & Station in-brief training will be provided to construction staff. This will identify biosecurity controls as set out in the "BAS Biosecurity Regulations" and the CEP's Non-native Species Manual; • Construction staff will also be required to understand and adhere to the Project-specific Biosecurity Plan; • All construction staff will be required to check and clean all personal gear prior to travelling to Antarctica; • Should soil, seeds or propagules be imported unintentionally, they will be carefully collected and destroyed. Rodents and insects will be exterminated immediately.	Low	Medium	High	Low	Medium	No more than minor or transitory
69	Terrestrial	Construction personnel bringing personal clothing, baggage and equipment to Rothera	Biological contamination risks introducing non-native species	Any establishments are likely to occur on ice-free ground	Direct, Cumulative	Medium	High	High	Medium	High	• Pre-deployment & Station in-brief training will be provided to construction staff. This will identify biosecurity controls as set out in the BAS Biosecurity Regulations and the CEP's Non-native Species Manual; • Construction staff will also be required to understand and adhere to the Project-specific Biosecurity Plan; • All construction staff will be required to check and clean all personal gear prior to travelling to Antarctica; • Should soil, seeds or propagules be imported unintentionally, they will be carefully collected and destroyed. Rodents and insects will be exterminated immediately.	Low	Medium	High	Low	Medium	No more than minor or transitory
70	Research values	Construction personnel bringing personal clothing, baggage and equipment to Rothera	Biological contamination risks introducing non-native species	Any establishments are likely to reduce research value of impacted areas	Direct, Cumulative	Medium	High	High	Medium	High	• Pre-deployment & Station in-brief training will be provided to construction staff. This will identify biosecurity controls as set out in the BAS Biosecurity Regulations and the CEP's Non-native Species Manual; • Construction staff will also be required to understand and adhere to the Project-specific Biosecurity Plan; • All construction staff will be required to check and clean all personal gear prior to travelling to Antarctica; • Should soil, seeds or propagules be imported unintentionally, they will be carefully collected and destroyed. Rodents and insects will be exterminated immediately.	Low	Medium	High	Low	Medium	No more than minor or transitory

						Pre-treatment risk assessment						Post-treatment risk assessment					
Sr No.	**Impacted Environment(s) or Values**	**Activity**	**Environmental Aspects**	**Actual or Potential Impact(s)**	**Type of Impact (Direct, Indirect, Cumulative)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Raw Significance Level**	**Treatment (Preventative or Mitigating Measures)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Residual Significance Level**	**Ref Article 8 of the Protocol**
71	Values under special protection	Construction personnel bringing personal clothing, baggage and equipment to Rothera	Biological contamination risks introducing non-native species to the ASPA	Any establishments are likely to reduce value of the ASPA	Direct, Indirect, Cumulative	Medium	High	High	Medium	High	• Pre-deployment & Station in-brief training will be provided to construction staff. This will identify biosecurity controls as set out in the "BAS Biosecurity Regulations" and the CEP's Non-native Species Manual; • Construction staff will also be required to understand and adhere to the Project-specific Biosecurity Plan; • All construction staff will be required to check and clean all personal gear prior to travelling to Antarctica; • Should soil, seeds or propagules be imported unintentionally, they will be carefully collected and destroyed. Rodents and insects will be exterminated immediately; • The ASPA will be demarcated to prevent inadvertent entry.	Low	Medium	High	Low	Medium	No more than minor or transitory
72	Marine	Additional personnel on Station	Increased discharge of wastewater to the marine environment	Increased release of contaminants into the nearshore marine environment	Direct, Cumulative	Medium	Medium	Medium	High	Medium	• All human waste will be treated and discharged via the Rothera Wastewater Treatment Plant (WWTP) - this includes UV treatment prior to discharge of wastewater; • All toilets and washing facilities are connected to the foul drainage system and will discharge via the WWTP.	Low	Medium	Low	Low	Low	Less than minor or transitory
73	Terrestrial	Additional personnel on Station & increased recreational activity	Increased movement of personnel across ice-free areas	Increased risk of physical disturbance to ice-free areas e.g. tracking	Direct, Cumulative	Medium	High	High	High	High	• Pre-deployment & Station in-brief training will be provided to construction staff. This will identify Station environmental controls including walking routes, and 'no go' areas; • The BAS Facilities team will maintain the demarcation of the no-go zone around the moss patch and ensure it is communicated to construction personnel at Rothera	Low	Medium	Low	Low	Low	Less than minor or transitory
74		Additional personnel on Station	Increased waste production	Risk of accidental release of waste items across Rothera Point	Direct, Indirect, Cumulative	Medium	Medium	Medium	High	Medium	• Pre-deployment & Station in-brief training will be provided to construction staff. This will identify Station environmental controls including waste management procedures as set out in the BAS Waste Management Handbook; • Emphasis will be placed on the 'Reduce, Reuse, Recycle' approach; • Prohibited products will not be taken to Antarctica; • Incineration of waste will be minimised, as far as is reasonably practicable.	Low	Low	Low	Low	Low	Less than minor or transitory
75	Atmosphere	Use of aircraft & vessels to transport construction workers to / from Rothera	Emission of exhaust gases including greenhouse gases to air	Localised loss of air quality and contribution to climate change	Direct, Indirect, Cumulative	Medium	High	High	High	High	• BAS will optimise transport routes to the extent practicable; • Only staff essential to the proposed works will be deployed to Rothera; • Data will be collected and the increased contribution to atmospheric pollution from the deployment of personnel and cargo will be accounted for in the BAS Energy and Carbon Dashboard.	Low	Low	Low	High	Low	Less than minor or transitory
76		Increased energy demand on Station from additional construction personnel	Additional fuel use for Station operations resulting in increased gas emissions including greenhouse gases to air	Localised loss of air quality and contribution to climate change	Direct, Indirect, Cumulative	Medium	High	High	High	High	• Pre-deployment & Station in-brief training will be provided to construction staff. This will include briefings on energy efficiency whilst at Rothera; • Only staff essential to the proposed works will be deployed to Rothera; • Data will be collected and the increased contribution to atmospheric pollution from the deployment of personnel and cargo will be accounted for in the BAS Energy and Carbon Dashboard; • Incineration of waste is to be minimised, as far as is reasonably practicable.	Low	Low	Low	High	Low	Less than minor or transitory

						Pre-treatment risk assessment						Post-treatment risk assessment					
Sr No.	**Impacted Environment(s) or Values**	**Activity**	**Environmental Aspects**	**Actual or Potential Impact(s)**	**Type of Impact (Direct, Indirect, Cumulative)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Raw Significance Level**	**Treatment (Preventative or Mitigating Measures)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Residual Significance Level**	**Ref Article 8 of the Protocol**
77	Atmosphere	Potential for additional buildings to be utilised to house construction workers	Additional heat loss from buildings	Highly localised warming of air but with rapid dissipation	Direct	Low	Medium	Low	High	Medium	• Pre-deployment & Station in-brief training will be provided to construction staff. This will include briefings on energy efficiency whilst at Rothera; • Only staff essential to the proposed works will be deployed to Rothera.	Low	Low	Low	Low	Low	Less than minor or transitory
78	Research values	Additional personnel on Station	Additional personnel numbers across Rothera Point	Risk of interference with or damage to research sites or equipment	Direct	Medium	High	High	Medium	High	Pre-deployment & Station in-brief training will be provided to construction staff. This will identify Station environmental controls including walking routes; science equipment deployed across Rothera Point and 'no go' areas.	Low	Low	Low	Low	Low	Less than minor or transitory
79			Displacement of research personnel	Reduced research capacity at the Station and reduction in research outputs	Indirect	High	High	High	High	High	• The BAS Project Support Coordinator will prepare a Rothera Station Integration Plan (RSIP) to demonstrate adequate space use on site for the proposed activities; • Only staff essential to the proposed works will be deployed to Rothera.	Low	Medium	High	High	Medium	No more than minor or transitory
80	Values under special protection		Increased movement of personnel across ice-free areas	Risk of inadvertent entry into ASPA 129 and impact on values under protection	Direct, Indirect, Cumulative	Medium	High	High	High	High	• Construction activities will be confined to the agreed areas on site; • Pre-deployment & Station in-brief training will be provided to construction staff. This will identify Station environmental controls including walking routes, and the ASPA boundaries; • The ASPA will be demarcated to prevent inadvertent entry.	Low	Low	Medium	Low	Low	Less than minor or transitory

						Pre-treatment risk assessment						Post-treatment risk assessment					
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		Vehicle & Vessel Use - all activities															
81	Terrestrial	Use of vehicles	Accidental loss or spill of hydrocarbons to the ground e.g. hydraulic fuel leak or fuel spill	Creation of waste e.g. contaminated soils	Direct, Cumulative	Low	Medium	Low	Medium	Medium	• Strict adherence to the relevant project-level waste management plan will be maintained; • The storage of hazardous waste will be managed in accordance with the relevant project-level waste management plan; • Daily checks will be undertaken to ensure waste is contained and to avoid it being lost to the environment; • One of the construction staff will be dedicated to environmental management who will ensure that all waste is managed appropriately; • All hazardous waste will be returned to the UK and disposed of by the appointed licensed contractor; • Pre-deployment training on waste management will be provided to all contractors.	Low	Medium	Low	Medium	Low	Less than minor or transitory
82			Accidental loss or spill of hydrocarbons to the ground e.g. hydraulic fuel leak or fuel spill	Contamination of ice-free ground - albeit already heavily impacted	Cumulative	Low	Medium	Low	Medium	Medium	• Refuelling will be undertaken in accordance with the Oil Spill Contingency Plan (OSCP) refuelling requirements at Rothera e.g. continual inspections of fuelling equipment & drip trays placed under hose joints as a precaution; • Spill response kits will be in all mobile vehicles and in well-defined & easily accessible locations on site; • Plant nappies will be used for all static plant; • A core oil spill response team of a minimum of 24 station staff will be formed and receive pre-deployment oil spill response training led by the BAS Environment Office and delivered by BAS and Oil Spill Response Ltd. This training is in addition to onsite training delivered by the Rothera Station Leader; • The OSCP will be followed for Tier 1, 2 and 3 spills; • De-winterising checks on all mobile and static plant will be undertaken in accordance with the OSCP; • All plant will be inspected daily for potential leaks and condition of hydraulic oil hoses - these checks will be recorded on the daily plant check sheets and the daily activity plan compliance record.	Low	Low	Low	Low	Low	Less than minor or transitory
83	Fauna		Emissions of noise including marine noise	Disturbance to wildlife	Direct, Indirect, Cumulative	Medium	Medium	Medium	Medium	Medium	• All plant and vehicles regularly inspected & maintained to ensure they are working efficiently & generating as little noise as possible; • All vehicles will maintain a 10-mph speed limit on site, enforced as a standard procedure at Rothera; • All plant and vehicles will be regularly inspected and maintained to ensure they are working efficiently and generating as little noise as possible; • Vessels will be operated with due care and attention to minimise marine mammal disturbance.	Low	Medium	Low	Medium	Low	Less than minor or transitory
84	Flora		Emissions of dust to air from vehicle traffic	Smothering of vegetation		Medium	Medium	Medium	Medium	Medium	• All vehicles will maintain a 10-mph speed limit on site, enforced as a standard procedure at Rothera; • Roadways will be sprayed down with sea water as required.	Low	Medium	Low	Medium	Low	Less than minor or transitory
85	Glaciological			Dust settling on glacial surfaces and contributing to melt		Medium	Medium	Medium	Medium	Medium		Low	Medium	Low	Medium	Low	Less than minor or transitory

						Pre-treatment risk assessment						Post-treatment risk assessment					
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86	Atmosphere	Use of vehicles and vessels	Emission of exhaust gases including greenhouse gases to air	Localised loss of air quality and contribution to climate change	Direct, Indirect, Cumulative	Medium	Medium	Low	Very High	Medium	• All vehicles will maintain a 10-mph speed limit on site, enforced as a standard procedure at Rothera; • Generators and plant will be selected which balance efficiency and reduced emissions, with reliability, serviceability, & available fuel at Rothera; • Regular inspections & maintenance will be carried out to ensure all vehicles, plant and generators operate efficiently, as per the BAM PMP; • Where practical, all drivers will be instructed to turn off engines during periods of waiting for 15 minutes or more; • All staff will be briefed on energy efficiency whilst on Rothera as part of the pre-deployment training; • Good programme resource management is being applied across all AIMP project activities to mitigate overall duration impact – e.g. efficiency of vehicle uses on construction activities; • Considerations are being given to using alternative fuels to reduce emissions, including biodiesel or hydrotreated vegetable oil.	Low	Medium	Low	Very High	Medium	No more than minor or transitory
87			Emission of heat from vehicle & vessel engines and power systems	Highly localised warming of air but with rapid dissipation	Direct	Low	Low	Low	Very High	Low	*Whilst heat emissions will occur, impacts will be negligible. No mitigation measures are required in relation to this aspect.*	Low	Low	Low	Very High	Low	Less than minor or transitory
88	Marine	Operation of vessels	Mechanical action on sea ice	Physical disturbance to sea ice	Direct	Low	Low	Low	Medium	Low	*Physical disturbance to sea ice from vessel activity is likely to be of negligible consequence. No mitigation measures are required in relation to this aspect.*	Low	Low	Low	Medium	Low	Less than minor or transitory
89			Biofouling and ballast water	Risk of introduction of non-native marine species	Direct, Cumulative	Medium	High	High	Medium	Medium	• Vessels will operate according to the Ballast Water Convention 2004 and the IMO's 2007 Guide for Ballast water Exchange in the Antarctic Treaty Area.	Low	High	High	Low	Medium	No more than minor or transitory
90			Accidental loss or spill of hydrocarbons to the marine environment	Localised pollution event	Direct, Indirect, Cumulative	Low	Medium	Medium	Low	Medium	• Vessels that are used will be compliant with the Polar Shipping Code; • Navigational equipment will be consistent with operating in ice covered waters; • Spill response procedures and equipment will be consistent with the provisions of the Polar Shipping Code. *NB: BAS does not have the capacity to deal with oiled wildlife and so the mitigation is focussed on avoiding spills in the first place and being able to clear up a spill (to the extent practicable) should one occur*	Low	Medium	Low	Low	Low	Less than minor or transitory
91	Fauna			Contamination of marine mammals or birds	Direct	Low	Medium	Medium	Low	Medium		Low	Medium	Low	Low	Low	Less than minor or transitory

						Pre-treatment risk assessment						Post-treatment risk assessment					
Sr No.	**Impacted Environment(s) or Values**	**Activity**	**Environmental Aspects**	**Actual or Potential Impact(s)**	**Type of Impact (Direct, Indirect, Cumulative)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Raw Significance Level**	**Treatment (Preventative or Mitigating Measures)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Residual Significance Level**	**Ref Article 8 of the Protocol**
		Use of lighting rigs - all activities															
92	Fauna & Flora	Use of artificial lighting rigs if / as required	Emissions of artificial light	Disorientation in birds leading to bird strike	Direct, Cumulative	Medium	Low	Low	Medium	Medium	• The proposed activities will be undertaken during daylight hours as far as reasonably practicable, and the intensity and use of lighting will be minimised during low light hours; • In the instance when lighting rigs are used, they will be angled towards the ground (at least 45 degrees) and not horizontally; • When not in use lights will be turned off and where possible external lighting should incorporate movement sensors or similar technology; • In the event of a bird strike, a suitably trained bird strike response staff member will take charge of the bird's care in accordance with the BAS Wildlife Interaction Manual; • Lights will be switched off immediately if five bird strikes occur in one period of work.	Low	Low	Low	Low	Low	Less than minor or transitory

						Pre-treatment risk assessment						Post-treatment risk assessment					
Sr No.	**Impacted Environment(s) or Values**	**Activity**	**Environmental Aspects**	**Actual or Potential Impact(s)**	**Type of Impact (Direct, Indirect, Cumulative)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Raw Significance Level**	**Treatment (Preventative or Mitigating Measures)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Residual Significance Level**	**Ref Article 8 of the Protocol**
		Importation of materials - all activities															
93	Fauna & Flora	Importation of materials e.g. pipeline & fuel-reel bunker station container; BESS container; building materials including for temporary and new hangar, runway lighting cabinets, kiln dried sand	Biological contamination which carries the risk of introducing non-native species	Native species are outcompeted; community structures are altered	Direct, Cumulative	Low	High	High	High	High	• All personnel being deployed to Rothera will receive a pre-deployment briefing from a member of the BAS Environment Office which will cover biosecurity; • All activities will be undertaken in accordance with the BAS Biosecurity Regulations, the CEP Non-native species Manual and the project Biosecurity Plan; • A trained manager will inspect all plant, equipment, and materials prior to loading onto the vessel and on disembarkation / offloading at Rothera; • All equipment and materials required for the proposed activities will be thoroughly cleaned & inspected before dispatch to Antarctica; • Any observed biological contamination such as soil, seeds or propagules will be carefully collected and removed. Rodents and insects will be exterminated immediately; • Kiln dried sand will be used for the runway integrity tests which is free from organic material.	Low	High	High	Medium	Medium	No more than minor or transitory
94	Research Values		Biological contamination which carries the risk of introducing non-native species	Any establishments would diminish research value in altered communities and ecosystems	Direct, Cumulative	Low	High	High	High	High		Low	High	High	Medium	Medium	No more than minor or transitory
95	Values under Special Protection		Biological contamination which carries the risk of introducing non-native species	Any establishments in ASPA 129 would diminish the value of the designation	Direct, Cumulative	Low	High	High	High	High		Low	High	High	Medium	Medium	No more than minor or transitory
96	Terrestrial		Biological contamination which carries the risk of introducing non-native species	Any establishments are likely to occur on ice-free ground	Direct, Cumulative	Low	High	High	High	High		Low	High	High	Medium	Medium	No more than minor or transitory

						Pre-treatment risk assessment						Post-treatment risk assessment					
Sr No.	**Impacted Environment(s) or Values**	**Activity**	**Environmental Aspects**	**Actual or Potential Impact(s)**	**Type of Impact (Direct, Indirect, Cumulative)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Raw Significance Level**	**Treatment (Preventative or Mitigating Measures)**	**Extent of impact**	**Duration of impact**	**Severity of impact**	**Likelihood of impact**	**Residual Significance Level**	**Ref Article 8 of the Protocol**
	Production of general & construction waste - all activities																
97	Terrestrial &/or marine	Importation of cargo & materials	Packaging waste	Risk of loss of waste items to the environment	Direct, Cumulative	Low	Low	Low	High	Low	• Strict adherence to the relevant project-level waste management plan will be maintained; • Construction waste will be managed in accordance with the relevant project-level waste management plan; • Daily checks will be undertaken to ensure waste is contained and to avoid it being lost to the environment; • One of the construction staff will be dedicated to environmental management who will ensure that all waste is managed appropriately; • All construction waste will be returned to the UK and disposed of by the appointed licensed contractor; • Pre-deployment training on waste management will be provided to all contractors, this will include a requirement for all contractors to be briefed on the BAS Waste Management Handbook.	Low	Low	Low	Medium	Low	Less than minor or transitory
98	Terrestrial	Planned activities including: • Breaking up of the concrete bollard • Recovery of disused pipes & electrical cabling • Roof strengthening works • Removal of old runway lighting cabinets	Creation of waste e.g. waste items	Risk of loss of waste items to the environment	Direct, Cumulative	Low	Low	Low	High	Low		Low	Low	Low	Medium	Low	Less than minor or transitory
99		Planned activities including: • Recovery of disused fuel pipes • Cementing and grouting	Creation of hazardous wastes	Risk of loss of waste items to the environment	Direct, Cumulative	Low	Low	Low	High	Low	As above, plus: • Waste fuels will be collected and contained in accordance with the relevant waste management plan and Station procedures; • Cementitious or grout mixing must not be undertaken in high winds; • Any cementitious or grout wash waters produced during construction will be neutralised to a pH of 7.0 using citric acid prior to discharge to ground; • Cementitious and grout materials are mixed in the Fitters Workshop and the wash water, once neutralised, will be discharged away from sensitive receptors to the west of the Fitters Workshop.	Low	Low	Low	Medium	Low	Less than minor or transitory

6.7. CUMULATIVE IMPACTS

Cumulative impacts occur as a result of the combined impacts of past, present and reasonably foreseeable activities. Cumulative impacts may occur over time and should be assessed by looking at other human activities occurring in the proposed locations. As with indirect impacts, cumulative impacts may not be identified until a direct impact has occurred. Cumulative impacts may occur over time and space and can be additive or synergistic (EIA Guidelines, 2026).

To consider the cumulative impacts arising from the planned works, this section has been divided into two elements. Firstly, an assessment is made of the cumulative impacts that will or may occur across the activities and the spatial and temporal boundaries that are within scope for this EIA (see Section 6.7.1.).

Secondly, an assessment is made of the potential cumulative impacts of the activities within scope of this EIA across a broader spatial and temporal scale, and in combination with past and reasonably foreseeable activities in this region of Antarctica (see Section 6.7.2.).

In assessing potential cumulative impacts, consideration is given as to whether the combined effects are:

- **additive** impacts, *i.e.,* multiple sources contributing the same type of stressor, or
- **synergistic** impacts, *i.e.,* interaction between stressors producing disproportionately larger effects, or
- **triggered** impacts, *i.e.,* one impact setting off a chain reaction of subsequent effects.

In considering the cumulative impacts that will or may arise, three questions will be addressed:

- Do the planned activities require further modification or mitigation?
- Do the identified cumulative impacts require changes to or additional monitoring?
- Does the assessed significance of cumulative impacts influence the conclusion of the EIA regarding the overall impact of the planned activities[15]?

6.7.1. CUMULATIVE IMPACTS WITHIN THE SCOPE OF THIS EIA

Within the scope of the planned works, the following environments or values have been identified as being susceptible to several aspects arising across all planned activities and which may result in cumulative impacts:

- breeding birds on Rothera Point (in particular Skua);
- the terrestrial ice-free environment of Rothera Point;
- the atmosphere;
- research values;
- marine environment, and
- wilderness and aesthetic values.

[15] i.e., will the aspects in combination have a greater impact than each aspect alone, and will this influence the conclusion of the EIA as to whether the planned activities will have less than, no more than, or more than a minor or transitory impact?

6.7.1.1. CUMULATIVE IMPACTS TO BREEDING BIRDS

The impact assessment above identified that disturbance to birds breeding on Rothera Point, could arise from three aspects including acoustic (noise) emissions, ground-borne vibrations, or light emissions (*Figure 75*).

These aspects could be additive in several ways *e.g.*, multiple noise sources occurring at the same time, or noise emissions occurring simultaneously to ground-borne vibrations. Such disturbances might also be compounded by birds being disoriented by artificial light.

These aspects may also arise at the same time as naturally occurring noise or vibration sources (as discussed in Section 6.5.1.), as well as disturbance arising from ongoing Station activities, such as aircraft activity and other vehicle operations.

As noted above, the consequences of significant disturbance events could range from minor acute effects including short term disturbance of a few individuals, to moderate acute effects such as short-term egg or chick abandonment, to more chronic effects such as a decrease in breeding success or population numbers over time, to complete relocation of the breeding population to another site.

The earlier part of the season when adult birds are incubating eggs or feeding young hatchlings is a more sensitive time when cumulative effects may be more of a concern.

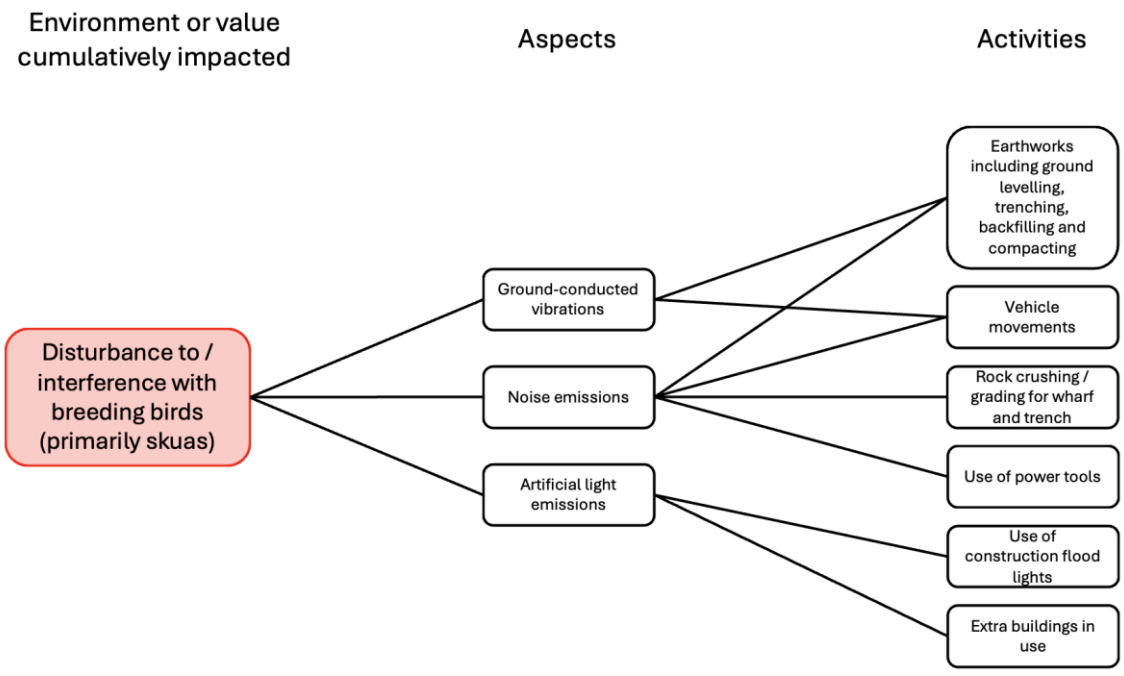

Figure 75. Flow diagram showing the activities and aspects that cumulatively contribute to impacts on breeding birds on Rothera Point.

Do the planned activities require further modification or mitigation?

Mitigation measures have been identified to reduce the potential impacts of noise emissions, ground-borne vibrations and artificial light across all planned activities (see *Table 32*).

With these measures in place the residual impact significance has been assessed as 'low' or 'less than minor or transitory' for each of the relevant aspects.

By way of further mitigation, the following will also be exercised whenever practicable to do so (see *Table 33*):

- Where programming and resource allows, works will be programmed to avoid noisy activities occurring concurrently across projects, to avoid intra-project cumulative noise impacts.

Do the identified cumulative impacts require changes to or additional monitoring?

The AIMP monitoring programme includes noise and vibration monitoring (see Chapter 7 and Annex A). If noise or vibration levels exceed agreed thresholds, work will cease and additional operational controls will be considered.

In addition, BAS undertakes regular skua counts which provides a longer-term assessment of the impacts of the Sation, and associated activities on the population.

No additional monitoring is required.

Does the assessed significance of cumulative impacts influence the conclusion of the EIA regarding the overall impact of the planned activities?

An assessment of the significance of the cumulative impacts on breeding birds is shown in *Table 33*. It is considered likely that the aspects that may contribute to disturbance of breeding birds could occur simultaneously. However, the extent, duration and severity of the cumulative impacts are assessed as being no more than minor or transitory provided that the identified mitigation measures are rigorously applied.

Table 33. Assessment of the significance of cumulative impacts to breeding birds on Rothera Point.

				Post-treatment significance assessment						
Environmental Aspects (Outputs)	**Actual or Potential Impact(s)**	**Potential Cumulative Impact**	**Treatment (Preventative or Mitigating Measures)**	**Extent of cumulative impacts**	**Duration of cumulative impacts**	**Severity of cumulative impacts**	**Likelihood of cumulative impacts**	**Residual Significance Level**	**Ref Article 8 of the Protocol**	**Are additional mitigation measures needed?**
Emission of noise from multiple sources during the season Ground borne vibrations from multiple sources during the season Artificial light emissions at various locations - primarily early and late season	Disturbance &/or disorientation of breeding birds on Rothera Point	**Additive**. Multiple stressors could occur at the same time, increasing the levels of disturbance or stress to breeding birds	Mitigation measures for 'noise', 'vibration' and 'light' emissions are recorded in Table 31 and discussed in Section 6.5.	Medium	Medium	Low	High	Medium	No more than minor or transitory	By way of further mitigation, the following will also be exercised whenever practicable to do so: • Where programming and resource allows, works will be programmed to avoid noisy activities occurring concurrently across projects, to avoid intra-project cumulative noise impacts.

6.7.1.2. CUMULATIVE IMPACTS TO THE TERRESTRIAL ICE-FREE AREA OF ROTHERA POINT

The impact assessment has identified that impacts to the ice-free area of Rothera Point, could arise from several aspects including direct physical modification, the risk of release of waste items or hazardous substances, and the risk of non-native species being introduced and establishing (*Figure 76*).

For the most part, these within-project cumulative impacts will or may occur to ice-free areas within the physical boundaries of the Station that have been previously impacted by human activities since the station was established in 1975.

Potentially, the more significant cumulative effects will be the increased recreational foot traffic around Rothera Point, and the slightly increased risk of introducing non-native species to the area.

The GMPV trial will occur on ice-free ground that has received less impact, and which has become more recently exposed as the ice ramp to the west of the hangar has receded. The GMPV trial will also result in a slight expansion of the boundaries of the Station.

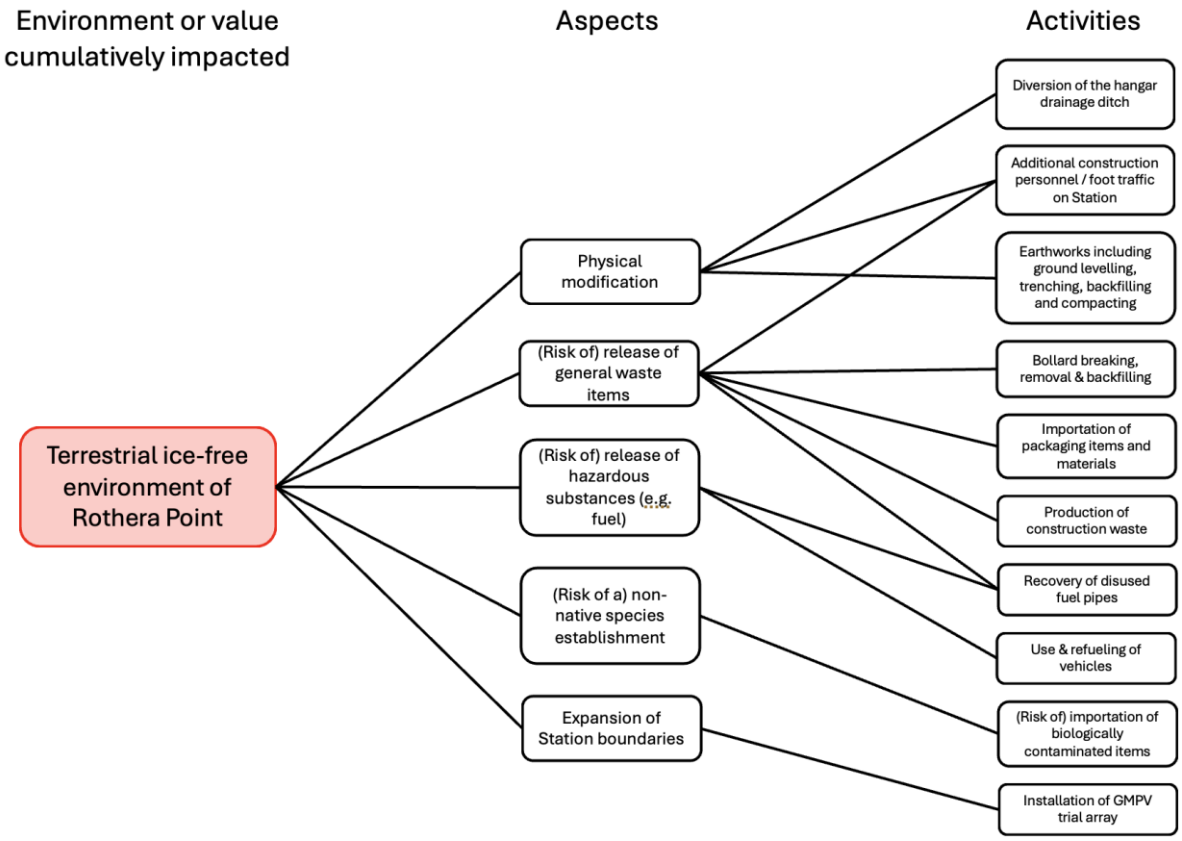

Figure 76. Flow diagram showing the activities and aspects that cumulatively contribute to impacts to the terrestrial ice-free areas of Rothera Point

Do the planned activities require further modification or mitigation?

Mitigation measures have been identified to reduce the potential impacts of the terrestrial ice-free environment across all planned activities (see *Table 32*).

With these measures in place the residual impact significance, for the most part, has been assessed as 'low' or 'less than minor or transitory' for each of the relevant aspects.

The aspect of most concern is the risk of introducing one or more non-native species, which has been assessed as being 'medium' or 'no more than minor or transitory'. With the appropriate mitigation measures in place, the likelihood of species being introduced and establishing is assessed as being 'low', but the severity of the impacts could be 'high' and with long term implications if an establishment were to occur.

BAS is acutely aware of the risks associated with non-native species and has developed and implemented its Biosecurity Regulations to reduce the risk to an acceptable level. BAM has used these Regulations as well as the CEP's non-native species manual to develop its own project-specific Biosecurity Plan.

Consequently, no further mitigation measures are considered necessary.

Do the identified cumulative impacts require changes to or additional monitoring?

Any spill events or accidental releases to the environment are recorded and reported. Any biological contamination is treated immediately with any non-native material contained and destroyed.

No additional monitoring is identified as being needed.

Does the assessed significance of cumulative impacts influence the conclusion of the EIA regarding the overall impact of the planned activities?

An assessment of the significance of the cumulative impacts on terrestrial ice-free areas of Rothera Point is shown in *Table 34*. The extent and duration of the combined effects are assessed as being of 'medium' consequence, although with 'low' severity. No significant topographic modifications are planned for the next four seasons with all earthworks being backfilled. The likelihood of cumulative impacts occurring is assessed as 'medium' (e.g., the potential for multiple small spills of fuel), but with an overall significance assessment of 'medium' or no more than minor or transitory, provided that the identified mitigation measures are rigorously applied.

Table 34. Assessment of the significance of cumulative impacts to ice-free areas of Rothera Point.

				Post-treatment significance assessment						
Environmental Aspects (Outputs)	**Actual or Potential Impact(s)**	**Potential Cumulative Impact**	**Treatment (Preventative or Mitigating Measures)**	**Extent of cumulative impacts**	**Duration of cumulative impacts**	**Severity of cumulative impacts**	**Likelihood of cumulative impacts**	**Residual Significance Level**	**Ref Article 8 of the Protocol**	**Are additional mitigation measures needed?**
Physical modification	Anthropogenic modifications to & enduring evidence of the presence of human activities across the terrestrial ice-free areas of Rothera Point	**Additive**. Multiple aspects could combine to cumulatively increase the overall impacts to ice-free areas of Rothera Point	Mitigation measures are recorded in Table 31 and discussed in Section 6.5.	Medium	Medium	Low	Medium	Medium	No more than minor or transitory	No further mitigation is identified as being required.
(Risk of) releases of general waste										
(Risk of) releases of hazardous substances (e.g. fuels)										
(Risk of) a non-native species establishment										

6.7.1.3. CUMULATIVE IMPACTS TO THE ATMOSPHERE

The impact assessment has identified that impacts to the atmosphere, including reduced local air quality and contributions to global climate change, could arise from gaseous emissions from the burning of fossil fuels as well as heat emissions arising from several activities over both seasons (*Figure 77*).

These emissions are certain to occur throughout the duration of the planned activities.

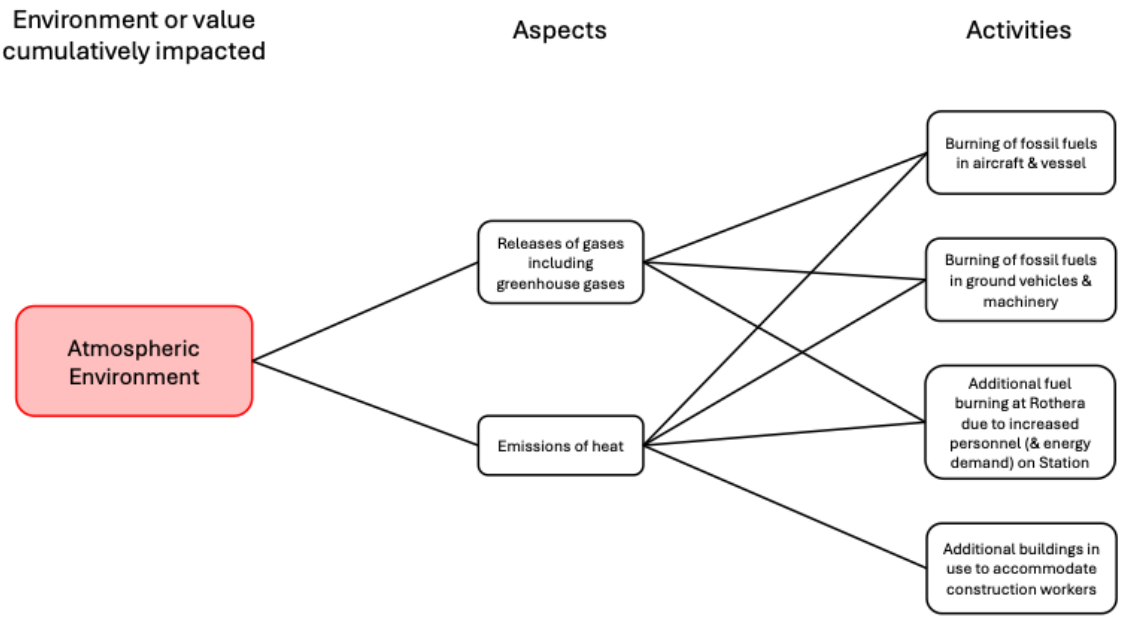

Figure 77. Flow diagram showing the activities and aspects that cumulatively contribute to impacts to the atmosphere.

Do the planned activities require further modification or mitigation?

Alone or in combination the impacts of these atmospheric discharges are not likely to be detectable within the duration of the planned activities. Of greater concern is the ongoing contribution to climate change through the release of greenhouse gases, which BAS is addressing through the AIMP and its sustainability programme.

Accordingly, the mitigation measures that have been identified (*Table 32*), primarily to minimise the burning of fossil fuels to the extent practicable, are seen as appropriate and no further mitigation is required.

Do the identified cumulative impacts require changes to or additional monitoring?

BAS monitors fuel use across all of its Antarctic activities. Fuel use records will also be maintained by BAM for the AIMP activities.

No additional monitoring is required.

Does the assessed significance of cumulative impacts influence the conclusion of the EIA regarding the overall impact of the planned activities?

An assessment of the significance of the cumulative impacts on the atmosphere is shown in *Table 35*.

Whilst releases to the atmosphere will occur ('high' likelihood), the severity of the impact in regional and global scales is considered to be 'low'. The atmospheric emissions that will be occur over the duration of the planned work, specifically as a result of the AIMP projects, will be relatively minor compared to all of BAS' activities over the same period.

Nonetheless, releases from multiple sources are considered to represent a 'medium' level of significance, and within-project cumulative impacts are assessed as being no more than minor or transitory.

Table 35. Assessment of the significance of cumulative impacts to the atmosphere.

				Post-treatment significance assessment						
Environmental Aspects (Outputs)	**Actual or Potential Impact(s)**	**Potential Cumulative Impact**	**Treatment (Preventative or Mitigating Measures)**	**Extent of cumulative impacts**	**Duration of cumulative impacts**	**Severity of cumulative impacts**	**Likelihood of cumulative impacts**	**Residual Significance Level**	**Ref Article 8 of the Protocol**	**Are additional mitigation measures needed?**
Release of greenhouse gases from multiple sources	Loss of local air quality and a contribution to global climate change	**Additive**. Ongoing releases of greenhouse gases will make a contribution (albeit negligible) to global climate change	Mitigation measures are recorded in Table 31 and discussed in Section 6.5.	Medium	Medium	Low	High	Medium	No more than minor or transitory	No further mitigation is identified as being required.
Emissions of heat from multiple sources										

6.7.1.4. CUMULATIVE IMPACTS TO RESEARCH VALUES

This impact assessment has identified several aspects that will or may give rise to impacts on research values (including monitoring equipment across Rothera Point). These include emissions of noise and ground vibrations which may affect sensitive recording instruments, physical harm or damage arising from vehicle operations or movement of people, the risk of non-native species establishing on Rothera Point and the displacement of researchers or research events as a consequence of accommodating extra construction personnel at Rothera (*Figure 78*).

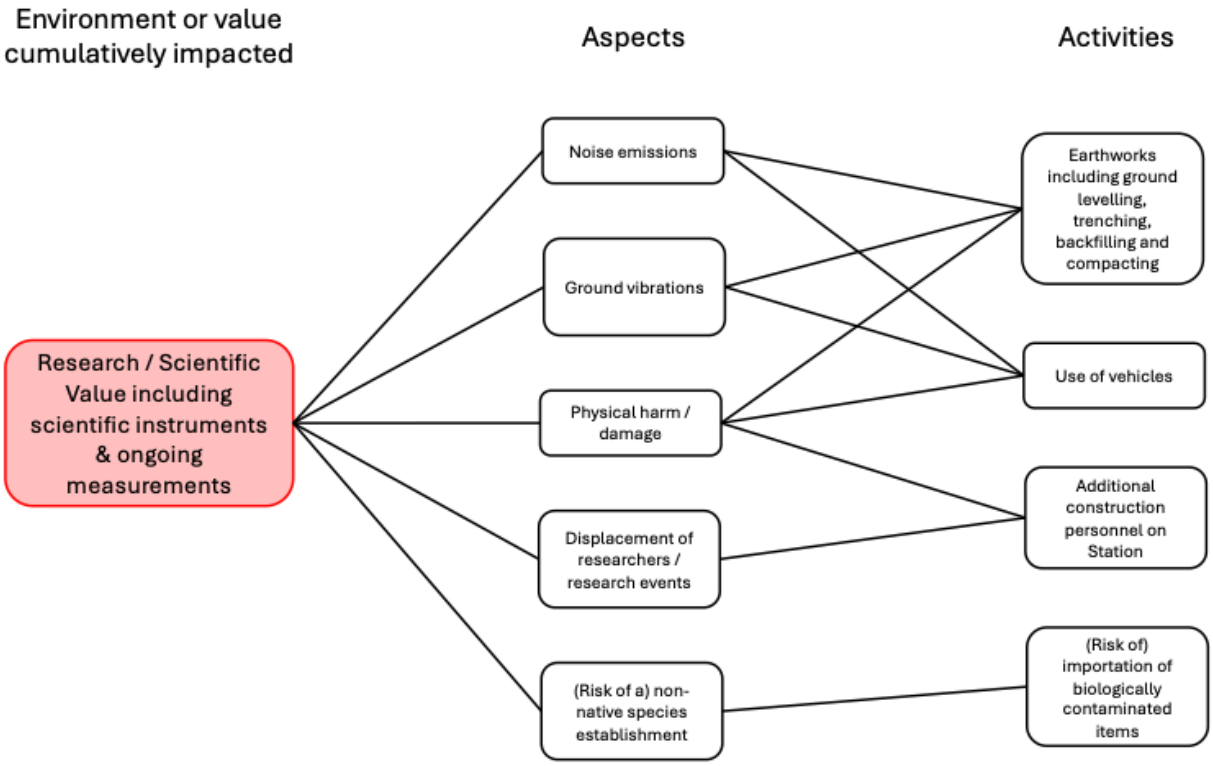

Figure 78. Flow diagram showing the activities and aspects that cumulatively contribute to impacts to research values.

Do the planned activities require further modification or mitigation?

The research equipment at Rothera does not appear to be highly sensitive to noise or ground vibrations. A sense check with the BAS Environment Office and AIMP staff for this EIA suggests that no major impacts on data collection has occurred to date as a result of construction activities.

The mitigation measures that have been identified (summarised in *Table 32*) coupled with the physical separation of the planned works from the locations of scientific interest, are assessed as being sufficient to minimise or eliminate direct and cumulative impacts.

Do the identified cumulative impacts require changes to or additional monitoring?

Noise and vibration monitoring is already established and will be continued for the duration of the planned work. Any impact events that do occur will be recorded and reported.

BAS' Biosecurity Regulations provide for early detection of any non-native species introductions and are considered sufficient.

No additional monitoring is identified as being needed.

Does the assessed significance of cumulative impacts influence the conclusion of the EIA regarding the overall impact of the planned activities?

Arguably, the most significant cumulative impact on Antarctic research as a result of the planned work, is the potential displacement of researchers or research events as a result of having more construction workers at Rothera.

It has not been possible to quantify the impact, given that the planning process for science, logistics and infrastructure development in any one season needs to consider multiple operational, financial and research factors. However, it is assessed that the impact is likely to be no more than minor or transitory and with the longer-term aim of the AIMP being to improve the efficiency and effectiveness with which science is supported in Antarctica.

Overall, the cumulative impacts on research at Rothera is assessed as being no more than minor or transitory (*Table 36*).

Table 36. Assessment of the significance of cumulative impacts to research and research values at Rothera.

				Post-treatment significance assessment						
Environmental Aspects (Outputs)	**Actual or Potential Impact(s)**	**Potential Cumulative Impact**	**Treatment (Preventative or Mitigating Measures)**	**Extent of cumulative impacts**	**Duration of cumulative impacts**	**Severity of cumulative impacts**	**Likelihood of cumulative impacts**	**Residual Significance Level**	**Ref Article 8 of the Protocol**	**Are additional mitigation measures needed?**
Emission of noise from multiple sources during the season	Loss of research values at Rothera Point; loss of data or loss of research outputs	**Additive**. Aspects could combine to increase the degree of impact. The ongoing nature of the AIMP could displace researchers or research events over several seasons	Mitigation measures are recorded in Table 31 and discussed in Section 6.5.	Medium	High	Medium	Medium	Medium	No more than minor or transitory	No further mitigation is identified as being required.
Ground borne vibrations from multiple sources during the season										
(Risk of) physical impacts to research sites or research equipment										
Displacement of researchers or research events due to the presence of construction workers										
(Risk of) a non-native species establishment on Rothera Point										

6.7.1.5. CUMULATIVE IMPACTS TO THE MARINE ENVIRONMENT

Several aspects have been identified in this EIA that will or may give rise to impacts to the marine environment, including the risk of release of graded fill material or fines and an increase in turbidity during the wharf resurfacing work and the slipway development in North Cove, the potential emission of noise to the marine environment with risk of disturbance to marine species, and an increase in discharge from the waste water treatment plant as a result of having additional construction personnel on site, with a risk of introducing non-native microbial species (*Figure 79*). The use of vessels for resupply and waste removal also adds the risk of introducing non-native marine species, marine fuel spills and noise disturbance.

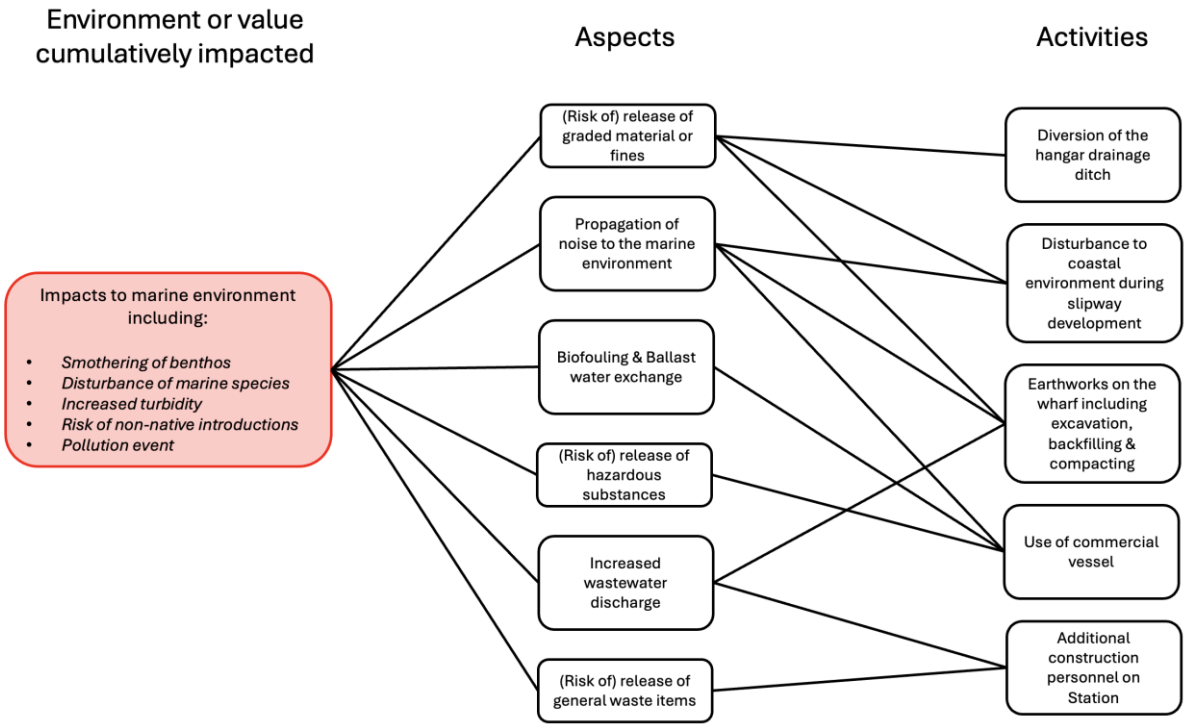

Figure 79. Flow diagram showing the activities and aspects that will or may cumulatively contribute to impacts to the marine environment.

Do the planned activities require further modification or mitigation?

Not all of the identified aspects are certain to occur. For example, care will be taken to minimise or eliminate the risk of release of any graded material or fines to the marine environment during the wharf resurfacing. Some activities will also be of very short duration such as the creation of the new slipway. Further, any impacts that may occur are likely to be extremely localised and of short duration.

Impacts to the marine environment, should they occur, will also be spatially separated and will either occur in the immediate area of the wharf to the south of Rothera Point or in North Cove with no identified risk of impacts in these locations combining to create a larger effect.

Mitigation measures have been identified to reduce the extent or likelihood of the impacts occurring and no further mitigation is assessed as being needed.

Do the identified cumulative impacts require changes to or additional monitoring?

There are no specific monitoring measures that have been identified regarding impacts to the marine environment, although records will be maintained should any incident occur.

This assessment of the potential cumulative impacts of various activities has not identified the need for any additional monitoring.

Does the assessed significance of cumulative impacts influence the conclusion of the EIA regarding the overall impact of the planned activities?

The small spatial extent of potential impacts to the marine environment, the limited duration and intensity of these impacts and the low likelihood of cumulative effects arising results in an overall assessment of 'low' significance or less than minor or transitory.

Table 37. Assessment of the significance of cumulative impacts to the marine environment.

				Post-treatment significance assessment						
Environmental Aspects	**Actual or Potential Impact(s)**	**Potential Cumulative Impact**	**Treatment (Preventative or Mitigating Measures)**	**Extent of cumulative impacts**	**Duration of cumulative impacts**	**Severity of cumulative impacts**	**Likelihood of cumulative impacts**	**Residual Significance Level**	**Ref Article 8 of the Protocol**	**Are additional mitigation measures needed?**
(Risk of) release of graded material or fines Propagation of noise to the marine environment (Risk of) release of general waste items Increased discharge of wastewater from the Station Risk of a vessel fuel spill	Impacts to marine environment including: Smothering of benthos Disturbance of marine species Increased turbidity Risk of non-native introductions Risk of pollution event	**Additive** - in some cases e.g. discharges to and increased turbidity in North Cove.	Mitigation measures are recorded in Table 15 and discussed in Section XX.	Low	Medium	Low	Medium	Low	Less than minor or transitory	No further mitigation is identified as being required.

6.7.1.6. CUMULATIVE IMPACTS TO AESTHETIC OR WILDERNESS VALUES

This impact assessment has identified two aspects that will or may give rise to impacts on aesthetic or wilderness values in the vicinity of Rothera. The addition of new infrastructure, such as the new (expanded) hangar, the BESS and the fuel-reel bunker station as well as the installation of the PV panels on buildings and on the ground adjacent to the hangar, as well as the increased scale of the runway aggregate stockpile may negatively impact on perceptions of aesthetics and wilderness.

In contrast the removal of the disused concrete mooring bollard and the old fuel hut may have a positive impact on perceptions of these values (*Figure 80*).

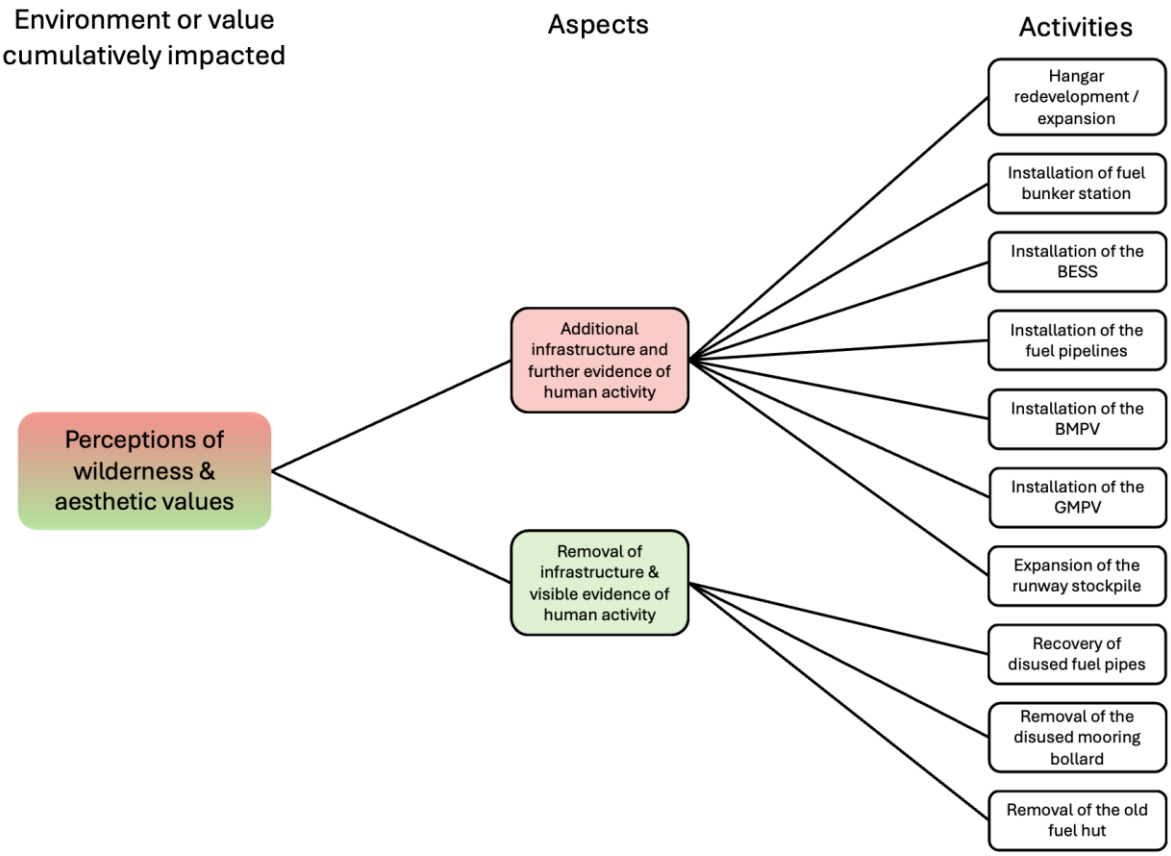

Figure 80. Flow diagram showing the activities and aspects that cumulatively contribute to impacts to aesthetic or wilderness values.

Do the planned activities require further modification or mitigation?

There are few mitigation measures that can be applied, although every attempt will be made to constrain activities to the current Station boundaries to the extent possible.

On completion the work is likely to result in relatively minor alterations to the appearance of the Station.

No further mitigation is assessed as being needed.

Do the identified cumulative impacts require changes to or additional monitoring?

Aesthetic and wilderness values are undefined concepts, highly personal in their interpretation and challenging to evaluate.

Other than the ongoing collection of images to record changes to Rothera Point over time, no additional monitoring is identified as being needed.

Does the assessed significance of cumulative impacts influence the conclusion of the EIA regarding the overall impact of the planned activities?

As noted above, aesthetic and wilderness values are challenging to define and can be highly personal. Arguably, the planned activities may have limited discernible consequences for perceptions of aesthetics or wilderness at Rothera.

Consequently, on balance, the significance of the cumulative effects is assessed as being 'low' or less than minor or transitory (*Table 38*).

Table 38. Assessment of the significance of cumulative impacts to research and research values at Rothera.

				Post-treatment significance assessment						
Environmental Aspects (Outputs)	**Actual or Potential Impact(s)**	**Potential Cumulative Impact**	**Treatment (Preventative or Mitigating Measures)**	**Extent of cumulative impacts**	**Duration of cumulative impacts**	**Severity of cumulative impacts**	**Likelihood of cumulative impacts**	**Residual Significance Level**	**Ref Article 8 of the Protocol**	**Are additional mitigation measures needed?**
Additional infrastructure installed at Rothera Some removal of infrastructure from Rothera	Perceptions of change in the aesthetic and wilderness values of Rothera Point	**Additive**. In combination, the changes to the infrastructure could alter perceptions of aesthetics and wilderness of the area (positively and negatively)	Mitigation measures are recorded in Table 31 and discussed in Section 6.5.	Low	High	Low	Medium	Low	Less than minor or transitory	No further mitigation is identified as being required.

6.7.2. CUMULATIVE IMPACTS OF THE PLANNED WORKS IN COMBINATION WITH OTHER PAST, PRESENT AND REASONABLY FORESEEABLE ACTIVITIES

Accessing information to support cumulative impact assessments in an Antarctic context can be challenging given that the international community has placed limited emphasis on monitoring and assessing incremental, but nonetheless cumulative impacts, across broader spatial and temporal scales (Tin et al., 2009).

It is therefore important to consider the contribution that the impacts arising from the planned work will make to the combined impacts of other human activities, on broader spatial and temporal scales. For this assessment, the spatial scale is extended to the Antarctic Peninsula region, and the temporal scales covers a twenty-year period from 2015 to 2035 (although it is noted that activities have occurred along the Antarctic Peninsula since the 1800s).

Within these boundaries, the qualitative method used here has attempted to identify:

- activities that have occurred and those that are planned to take place or may occur;
- the primary impacts that have occurred or are anticipated to occur from these past and planned activities;
- how the planned activities will contribute to the overall cumulative impacts.

Data sources that were searched to assess past, current and planned activities in the area covered by this EIA include:

- Google Scholar[16]
- The Environmental Impact Assessment database (EIA database) maintained by the Antarctic Treaty Secretariat[17]
- The Electronic Exchange of Information System (EIES)[18] database maintained by the Antarctic Treaty Secretariat, and
- A general web search.

In broad terms human activity in Antarctica, in all its forms, continues to expand across the continent and the Southern Ocean. New research Stations are being constructed, or existing stations are being rebuilt or expanded. National and international research programmes are expanding across the continent supported by increasingly sophisticated logistics capabilities. Tourism continues to increase with new vessels joining the fleet, and landed passenger numbers increase each season.

The work outlined in this EIA will incrementally add to infrastructure development at Rothera as well as throughout the Antarctic Peninsula. Carbon emissions from burning fossil fuels will contribute to regional emissions from other stations and bases, ships and aircraft in the region, and the combined entrenchment

[16] https://scholar.google.co.nz

[17] https://ats.aq/devAS/EP/EIAList?lang=e

[18] https://ats.aq/devAS/InformationExchange/LatestReports?lang=e

and expansion of human presence will further reduce perceptions of wilderness. These cumulative effects are discussed further below.

6.7.2.1. Further development work at Rothera Point through the AIMP

As described in Section 5.14., Rothera has undergone regular development and expansion since it was established in 1975. Most recently developments have included construction of the Discovery Building, installation of site-wide services, improvements to the runway, a new larger wharf to accommodate the SDA, and the installation of temporary accommodation.

Many of the recent works have fallen under the AIMP (which began in 2014) and have been included in past EIAs (see Section 1.4.).

The most significant development in the last ten years has been the expansion of the wharf. The Wharf works involved blasting, which significantly altered the environment and landscape around Rothera Point. The wharf work was assessed by means of a CEE with impacts assessed as being more than minor or transitory.

The activities which were identified in the Wharf CEE as having a potentially cumulative impact were:

- Dust deposition on the ice ramp;
- Loss of ice-free ground for terrestrial habitat;
- Removal of rock resulting in a change in the aesthetics of Rothera Point;
- Increase in station footprint resulting in the loss of marine benthic habitat;
- Contribution to global atmospheric pollution.

Multiple other activities at Rothera Point have been assessed at the level of a PEE, which when assessed individually are likely to have less than minor or transitory impacts, but when considered cumulatively over longer time periods, the overall impact may have been more extensive.

It is harder to assess future activities as they are not fully scoped, and timelines are unknown. However, the following activities shown continue to be discussed as being part of AIMP:

- Renewables: Potential for installation of additional ground-mounted solar PV, air source heat pumps, and wind turbines with associated infrastructure.
- Hangar: Potential for expansion of building, and diversion of the meltwater stream;
- Mooring Point: Potential for a new track to be constructed in the memorial cross area, and drilling / blasting / removal of rock, to house anchors;
- Potential Radar Hut on East Beach: Potential for a new radar hut to accommodate science equipment, on East Beach with the East Beach hut.

Elements of these works, if they proceed, are likely to expand the physical boundaries of the Station albeit modestly.

The emissions identified in this EIA, including greenhouse gases, heat, dust, noise, artificial light, ground vibrations, and hazardous substances will have occurred and will continue to occur from the planned activities and with varying degrees of cumulative impact, some of which have been or are being monitored.

The most significant cumulative impacts identified in previous EIAs, and which may arise during future works at Rothera Point are potentially:

- Increasing loss of ice-free ground for terrestrial habitat and disturbance to local wildlife;
- Dust deposition on the ice ramp, and around the station;
- Removal of rock and change of topography, resulting in change of aesthetics;
- Loss of marine habitat as footprint increases, or substances are released to the sea;
- Contribution to global atmospheric pollution and climate change.

A 2025 internal report prepared by the BAS Environment Office evaluated the potential cumulative impacts at Rothera over the 2016 to 2024 period. This report also noted that areas originally identified for temporary storage have tended to become more permanently used, which could result in impacts that are no more than minor or transitory, but that have been assessed (if assessed at all) as less than minor or transitory.

6.7.2.2. STATION BUILDING AND EXPANSION AND USE OF ICE-FREE LAND

Searches of the databases listed above did not reveal any infrastructure development plans along the Antarctic Peninsula other than Argentina's reconstruction of its Petrel Base on Dundee Island at the very northern tip of the Peninsula.

Nonetheless, the Antarctic Peninsula region has witnessed a steady growth in the number, size, and operational intensity of research stations and their associated infrastructure over the past decades. This pattern is especially pronounced in areas like the South Shetland Islands and north-western Antarctic Peninsula, where more than 30 national facilities have been established. While each development may be relatively minor on a continental scale, their cumulative footprint is concentrated within the scarce and ecologically critical resource of ice-free ground.

Ice-free areas comprise less than 1% of Antarctica's continental surface (Brooks, et al., 2019b), yet they support most of the region's terrestrial biodiversity, including mosses, lichens, microbial communities, and important breeding sites for birds and seals. Due to their ecological significance, these habitats are highly sensitive to disturbance. The expansion of stations—through new construction, upgrades to runways, storage areas, and supporting logistics infrastructure—can directly cause loss, fragmentation, or functional degradation of ice-free habitats (Brooks et al., 2024). Even when the physical footprint of infrastructure is limited, related activities such as vehicle movements, trampling, dust generation, and localised contamination can extend the affected area beyond the immediate site.

The cumulative effect of multiple national programmes operating near each other in the Antarctic Peninsula region increases the risk of gradual encroachment into remaining undisturbed ice-free areas, especially in coastal zones that are also preferred by wildlife (Brooks et al., 2019b)). This trend is further driven by climate-induced deglaciation, which is exposing new ice-free ground. However, these newly revealed areas may lack ecological resilience and are often quickly colonised and carry the risk of establishment by non-native species (Duffy and Lee, 2019).

In the context of cumulative impacts, the principal risk is not only the absolute loss of habitat area, but also the incremental reduction in the availability of undisturbed reference sites and the increasing spatial overlap between infrastructure and ecologically important areas.

In the absence of coordinated spatial planning and effective use of existing management tools, such as protected areas and site guidelines, continued infrastructure expansion could result in irreversible localised habitat loss and heightened pressure on representative terrestrial ecosystems in Antarctica (Brooks et al., 2024).

6.7.2.3. CONTRIBUTION TO CLIMATE CHANGE

Research stations and logistical bases on the Antarctic Peninsula contribute to climate change primarily through direct greenhouse gas (GHG) emissions from energy generation and indirect emissions associated with transport, construction, and supply chains. While these emissions are small in global terms, their cumulative significance is increasingly recognised because of the sensitivity of the Antarctic environment and the spatial concentration of facilities.

Most Antarctic stations rely on diesel-fuelled power generation for electricity, heating, water production, and wastewater treatment systems. Combustion of these fuels produces carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and short-lived climate forcers such as black carbon. Studies of Antarctic facilities confirm that diesel generators are a dominant source of station-level atmospheric emissions, alongside associated pollutants such as NO_2 and particulate matter (Kakareka and Salivonchyk, 2024).

Although individual stations emit relatively small quantities compared with global industrial sources, the Peninsula hosts a high density of year-round and seasonal stations, with more than 30 facilities in operation along the Peninsula. This spatial clustering leads to localised cumulative emission hotspots, particularly during winter when renewable energy inputs (*e.g.,* solar) are limited and diesel reliance increases.

The carbon footprint of Antarctic stations extends beyond on-site combustion. Significant indirect emissions arise from long-distance marine and air transport of personnel, food, fuel, cargo and equipment as well as exporting waste materials and return logistics.

The Antarctic Peninsula is a focal area for scientific activity, tourism logistics, and long-term national presence. The continued modernisation, expansion, and replacement of older stations increase both energy demand and associated emissions, even where newer facilities are more energy efficient.

There is an emerging shift towards hybrid renewable energy systems (wind, solar, and battery storage) integrated with diesel backup at several stations. Research indicates that adoption of renewables can substantially reduce fuel consumption and associated emissions, improving overall sustainability of Antarctic operations. However, uptake remains uneven across national programmes, and diesel generators continue to provide the backbone of energy security in most Peninsula facilities.

The trajectory of increasing activity means that station-based emissions form a non-trivial and growing component of the Peninsula's human environmental footprint, particularly when assessed cumulatively over multi-decadal periods.

6.7.2.4. IMPACTS ON WILDERNESS VALUES

The Antarctic Treaty Parties have not agreed a definition for the term 'wilderness', but it is generally understood to represent a measure of the relative absence of evidence of, or impacts from, human activity (EIA Guidelines, 2026).

The AIMP work at Rothera over the last ten years, coupled with the works that are likely to occur over the next ten years and in combination with the growing human activity on the Antarctic Peninsula have the potential to contribute to the incremental loss of wilderness values of the region.

The Antarctic Peninsula region is widely recognised as one of the most environmentally and aesthetically significant wilderness areas on Earth, characterised by extensive ice cover, limited ice-free terrestrial habitats, and relatively high biological productivity compared to the broader Antarctic continent. However, this perception of "wilderness" is increasingly challenged by the progressive expansion of human presence, particularly through the establishment and upgrading of research stations, field camps, tourism infrastructure, and associated logistics networks. As human footprint intensifies, there is a corresponding reduction in perceived and functional wilderness qualities, including remoteness, naturalness, and absence of human artefacts. Visual intrusion from infrastructure, aircraft activity, vessel traffic, and lighting can diminish the sense of isolation that is central to wilderness character, while the cumulative spatial spread of operational areas can lead to fragmentation of otherwise undisturbed landscapes.

Beyond physical infrastructure, increasing human activity also introduces indirect pressures that erode wilderness values through sound, emissions, waste management systems, and routine operational movements across previously undisturbed terrain. Even when individual activities are relatively small in scale, their aggregation across multiple national programmes and seasonal tourism operations contributes to a gradual normalisation of human presence in areas that were historically pristine. This can alter both objective environmental conditions and subjective perceptions of wilderness, particularly in frequently visited coastal zones of the Peninsula.

Over time, such changes risk shifting baseline expectations of what constitutes "natural" Antarctic conditions, thereby reducing the integrity of wilderness values as identified in the Protocol.

6.8. SUMMARY OF IMPACT ASSESSMENT

Even with no mitigation measures in place most activities have been assessed as being of 'Medium' or 'Low' significance (*Table 32*).

The unmitigated impacts which were assessed as being of 'High' significance include:

- The risk of importing biologically contaminated construction items leading to the establishment of non-native species at Rothera Point;
- The risk of construction workers bringing biological materials on personal gear and clothing leading to the establishment of non-native species at Rothera Point;
- The increased risk of physical disturbance to ice-free areas of Rothera Point (notably from the earthworks and increased numbers on Station);
- The risk of interference with or damage to research sites or equipment, with increased construction activity and workers on site;

- The displacement of researchers or research events due to construction work and workers taking up space at Rothera as well as on ships and aircraft;
- The risk of inadvertent entry into ASPA 129 due to extra construction workers on site.

Nevertheless, mitigation measures have been identified as being practicable in moderating anticipated impacts in all cases and are considered likely to be effective in reducing the environmental risk to medium or low *i.e.,* either no more than, or less than a minor or transitory environmental impact.

Further confidence is gained through the ongoing relationship with BAM and the experience that they have gained in operating at Rothera and with understanding the local environmental sensitivities. Further still, the mitigation measures recorded in this EIA have been tested over the last few seasons and demonstrated to be effective.

The assessment also noted several outputs that have the potential for a cumulative environmental impact either in conjunction with other AIMP activities, or in conjunction with past, planned or reasonably foreseeable activities in the Antarctic Peninsula region. Potential cumulative impacts that may occur within the scope of the planned works were:

- Disturbance to breeding birds on Rothera Point from the combined effects of noise, ground-borne vibrations and artificial light pollution;
- Impacts to the ice-free areas of Rothera Point from the combined effects of physical modification and the risks of releasing waste, hazardous substances and non-native species;
- Releases to the atmosphere including heat and greenhouses gases from the burning of fossil fuels in aircraft, ships, ground vehicles and generators, which will be exacerbated by the extra energy demand of having construction workers at Rothera;
- Consequences for scientific research including scientific equipment from the combined effects of noise, ground vibrations, the risk of physical damage to research sites or equipment and the displacement of researchers due to extra construction workers at Rothera. All of which has the potential to reduce the research outputs over the course of the next four seasons;
- Impacts to the nearshore marine environment adjacent to the wharf and in North Cove, although not all identified impacts are certain to occur;
- Consequences for wilderness and aesthetic values, albeit with the removal of some structures potentially compensating for the establishment of new infrastructure.

However, in each case the planned mitigation measures have been assessed as being sufficient to reduce the cumulative impacts to 'low' or 'medium', *i.e.,* less than or no more than minor or transitory.

Over broader spatial and temporal scales, the planned work will add to the incremental increase in human activities, infrastructure development and associated impacts that are being observed in the Antarctic Peninsula region. Concerning cumulative impacts include the increasing utilisation of ice-free areas and the gradual loss of unimpacted, ecologically important terrestrial sites, the increasing carbon emissions and contributions to climate change from stations, bases and associated logistics assets that are, to a large extent, still dependent upon fossil fuels, and the incremental loss of wilderness values due to increasing human presence in the region.

Overall, with the identified mitigation measures rigorously applied, and the implementation of the monitoring plan to assist in confirming the accuracy of predicted impacts, the activities have been assessed as being likely to have no more than a minor or transitory impact on the environment.

7. Monitoring and Record Keeping

7.1. INTRODUCTION

The Protocol provides that a key consideration in the planning and conduct of activities is the extent to which key environmental parameters can be monitored so as to identify and provide early warning of any adverse effects of the activity and to provide for such modification of operating procedures as may be necessary in the light of the results of monitoring (Article 3(2)(c)(v) of the Protocol).

For the EIA process, monitoring should be oriented towards confirming the accuracy of predictions about environmental impacts of the activity (*e.g.,* impacts arising from planned waste discharges, noise generation or atmospheric emissions), including cumulative impacts, and to detect unforeseen impacts or impacts more significant than expected. It can be useful to set environmental thresholds or standards for an activity that monitoring results are assessed against. If these thresholds are exceeded, then a review or re-analysis would be required of assumptions made regarding the environmental impacts or of management systems related to the activity (EIA Guidelines, 2026).

In 2005, the ATCM adopted Practical Guidelines for the Developing and Designing Environmental Monitoring Programs in Antarctica (Resolution 2 (2005)).

A monitoring programme has been designed in parallel to the AIMP and will continue for the duration of activities being assessed by this EIA. The monitoring programme aims to allow assessment of the impacts of ongoing activities and the verification of predicted impacts.

7.2. AIMP MONITORING

Monitoring tasks are split into three types. Firstly, short-term monitoring of activities which could result in an immediate impact on the environment, and which can be modified during the programme of works to avoid adverse effects. This includes:

- Wildlife displacement;
- Moss patch condition;
- Noise emissions;
- Ground borne vibrations, and
- Airborne dust.

For noise, vibration, and dust emissions, four monitoring stations have been established (*Figure 81*). The positioning of these monitoring stations has considered the proposed and potential projects during Phase 2 of the AIMP, reflecting on lessons learned from previous seasons, as well as the latest information regarding sensitive receptors, particularly those that are part of the natural environment at Rothera.

For these parameters, as well as for wildlife displacements, threshold levels have been set (*Table 39*) which if equalled or exceeded will require work to cease and a re-evaluation of mitigation measures to be undertaken.

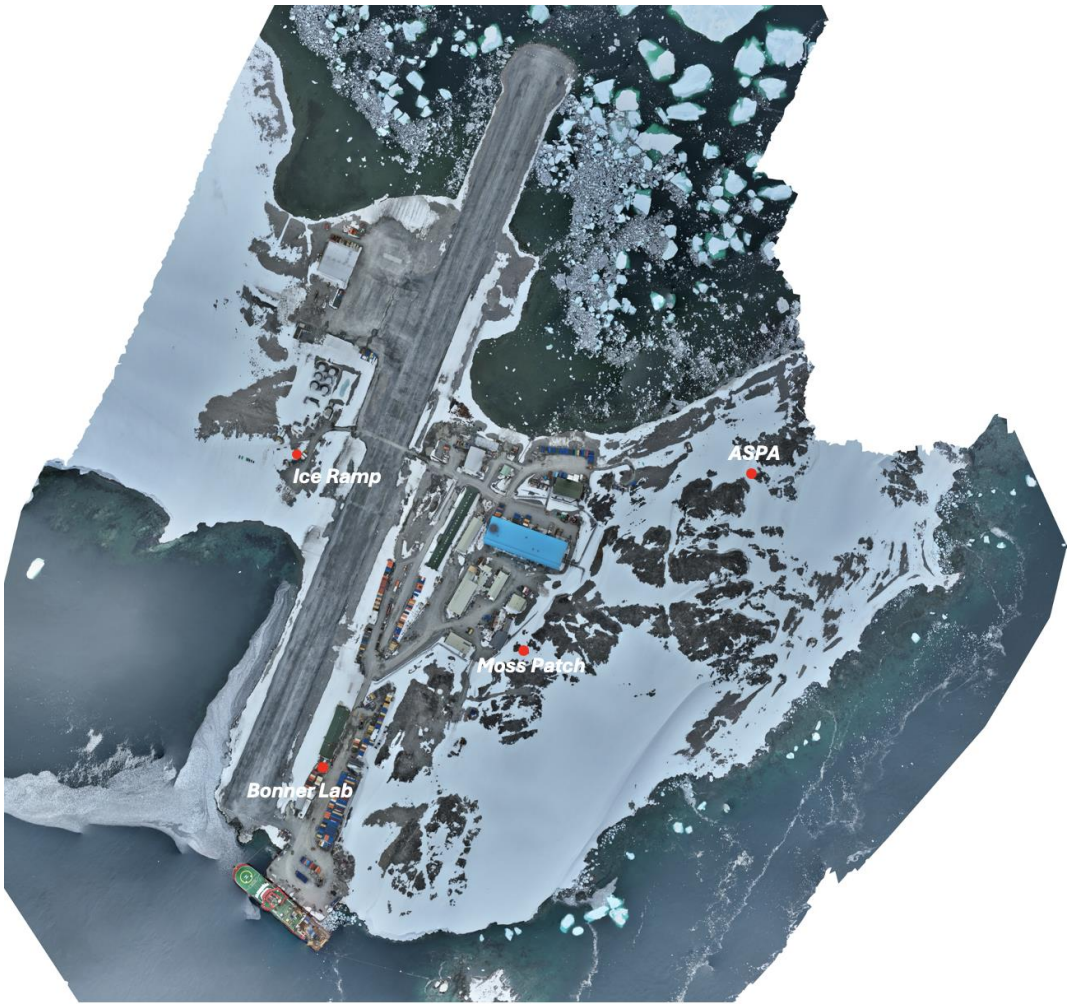

Figure 81. Location of monitoring stations. Positions are approximate.

Table 39. Monitoring parameters and thresholds for real time monitoring throughout the season.

Activity	Equipment / Technique	Location	Frequency of monitoring	Threshold	Who is responsible
Wildlife displacement	Only trained BAS & BAM staff should move wildlife	Within construction site	Daily throughout project	>5 seal displacements or >5 penguin displacements per day	BAM Environmental Engineer
Noise (terrestrial)	Sventek microphone,	1 x Moss Patch, 1 x Bonner Lab, 1 x Ice Ramp, 1 x ASPA	Constant monitoring – real time reporting or downloaded once a day during all construction activities	Laeq 12hr = < 75bB(A) BS5228 Laeq 1 hr = < 80db(A) BS5228	BAM Environmental Engineer
Vibration (terrestrial)	Sventek triaxial accellerometers,	1x Moss Patch, 1 x Bonner Lab, 1 x Ice Ramp, 1 x ASPA		VDV = 2.4mms$^{-1.75}$ BS5228 Peak Particle Velocity < values outlined in DIN 4150-3 Line 2	BAM Environmental Engineer
Airborne Dust Monitoring	Aeroqual Dust Sentry Pro Monitoring Units	1x Moss Patch, 1 x Bonner Lab, 1 x Ice Ramp, 1 x ASPA		TSP < 250µg m^{-3} 15 min^{-1} PM10 < 50µg/m3/24-hour period	BAM Environmental Engineer

Secondly, monitoring of environmental parameters which may reflect impacts that can only be measured in the long term (*i.e.,* over several Antarctic seasons) and which are unlikely to be modified beyond the original mitigation identified in the EIA. This includes monitoring of skua breeding success on Rothera Point which is undertaken by BAS.

Thirdly, operational environmental record keeping is undertaken by BAM for several aspects (*Table 40*).

Table 40. Operational monitoring parameters that will be undertaken by BAM. WMH = waste management handbook

Environmental management activity	Reference in this EIA	Reporting Output
Waste Management: segregation, packaging, storage, and disposal of waste as per the relevant project-level waste management plan and BAS WMH	Section 4.12.6	• Waste Transfer notes • Waste Quantity and Type data • Neutralising cement contaminated waters
Biosecurity: implementation of the Biosecurity Plan at all stages of cargo and personnel movement	Sections 6.5.1.8 & 6.5.5.4	• Biosecurity checklists • Biosecurity breaches reported
Fuel Management: daily refuelling as per refuelling procedure	Section 4.12.7	• Staff training records • Fuel spill reporting • Fuel consumption for carbon accounting
Oil Spill Response: BAM will provide appropriate spill response equipment	Section 4.12.7	• BAM staff will respond to Tier 1 spills and follow the direction of Rothera Station Leader for all Tier 2 and Tier 3 spills. • Fuel spill reporting • Spill kits used and disposed of appropriately
Wildlife	Section 6.5.1.4	• Any bird strikes on artificial lighting rigs

7.3. PLANNED MONITORING

Following a review, and despite some challenges that have been experienced with the noise, vibration and dust monitoring equipment, it is proposed that the monitoring programme will continue largely unchanged, at least for the 2026-27 and 2027-28 seasons.

Dust, noise and vibration monitors are hardwired to Rothera's local area network (LAN) to provide real time data and allow BAS and BAM to identify the cause of any exceedances, which can then be actioned to mitigate the potential environmental impact within a suitable time frame. A backup manual data collection process will be retained in case of issues with the communications through the LAN.

An end of season environmental monitoring report will be prepared.

7.4. PROJECT VARIATION REGISTER

The purpose of a Project Variation Register (PVR) is to capture any variation to the permitted works as described in the EIA. Before any variation occurs, the BAS Environment Office will be consulted, and, depending on the size of the variation, a PEE may be required, and / or the FCDO will be consulted. Once approved, a variation can be signed off and included into the PVR.

A reduction in PVR entries over time is seen as a performance improvement opportunity.

7.5. INCIDENT REPORTING

Any unplanned environmental incidents that occur, such as wildlife injury or fatality, fuel spills or loss of items to the environment, will be reported immediately to the BAS Environment Office and recorded in the BAS Incident Reporting System (Maximo).

7.6. AUDIT PROGRAMME

An environmental audit programme will be undertaken during the construction works by the BAS Site Supervisor to ensure that the actions and mitigation measures committed to in this document are being adhered to. This will follow a BAS Environment Office approved checklist.

The audits will be borne against the ISO14001 standard to which BAS is certified. Updated audit proformas are currently being produced. A minimum of two onsite audits will be undertaken during each season of the planned works and a further EIA review which will include a site visit to Rothera will be undertaken on completion of the works.

Any changes to activities proposed as a result of the monitoring data, will be made by the Construction Manager in conjunction with the BAS Environment Office. All monitoring data will be communicated to the BAS Environment Office and will be made available on request for auditing purposes.

8. Gaps in knowledge and Uncertainties

8.1. INTRODUCTION

No activity in Antarctica can be planned with absolute certainty, due to the extreme, changeable and unpredictable environmental conditions.

Although the objectives of AIMP are clearly described and the work plans have been identified, there remain several unknowns that will require flexibility during the programme of work. These are set out below.

8.2. WEATHER AND SNOW CONDITIONS

The weather in Antarctica can be highly variable both between and within summer seasons. Periods of poor weather may result in delays to planned schedules or deferral of work to future seasons. As far as possible, the work schedules that are presented in this EIA have taken account of potential weather delays to ensure that the schedules remain realistic.

Commencement of some of the planned work as well as the establishment of the monitoring equipment is dependent on the amount of snow found on site. If excessive snow is found on site at the start of the season, additional snow clearing will be required which may delay some of the planned activities, although this may only be a few days at most.

Monitoring equipment must be established prior to construction activities commencing, otherwise this presents a major risk to environmental monitoring at Rothera.

8.3. PROPOSED WORKS

Exact timing and duration of all elements of the planned work are not available for all activities at the time of drafting the EIA. In these cases, assumptions have been made that these activities would take place within the season identified.

As noted above (Section 7.4.) any deviations to the information presented within this EIA will be accounted for within a PVR; a live document that is actively managed and owned by BAS in close collaboration with BAM personnel at Rothera. Any variations will be reported in the PVR, along with a full complement of the monitoring data collected in support of the works in any one season.

8.3.1. GROUND CONTAMINATION AND REMEDIATION

As recorded in Section 4.10.3. soil samples were taken for contaminant testing during the 2025-26 season from the area of Old Bransfield House and the area adjacent to North Cove that was used to store scrap steel (Section 4.9.).

The results of the sample testing will be used to inform a remediation plan, which will take time to design both in terms of the approach to be taken, the resources needed and the timing.

The feasibility and extent of any remediation and the approach to be taken is therefore an unknown at the time of drafting this EIA. It is possible that remediation efforts may be undertaken within the timeframe covered by this EIA. If that seems likely, a separate EIA will be undertaken.

8.3.2. Defect management

Inevitably minor remediation works may be required to address defects or faults that are identified during the commissioning phase of the planned works. It is not possible to forecast the extent of such defects nor the work required, though it is likely to be minor in comparison to the main works programme. It is likely that such work may need to be undertaken during the 2028-29 and 2029-30 seasons.

8.3.3. Aircraft tie downs

At the time of drafting this EIA, it remains unknown what the final design of the temporary aircraft tie downs will be (see Section 4.5.3.8.). It is also possible that some of the temporary tie downs may remain after completion of the hangar and become permanent. The precise number and location of these remains unknown (although they will remain within the current apron area).

8.3.4. Use of geotextiles

The use of artificial geotextile material has been removed from the planned work to the extent practicable except for the hangar redevelopment. As recorded in Section 4.5.3.12., the current design of the hangar requires the use of geotextile material in the foundations to ensure the expected 60-year life span for the hangar.

However, the next work stage for the hangar will investigate the foundation design in greater detail. Should a less environmentally impactful alternative be demonstrated to meet the design life requirements in this next work stage, the use of geotextiles in the foundations will be revisited.

8.3.5. Scale of the RENEW project

The scope of the renewable energy works is subject to ongoing review. The available capacity of both the GMPV and BMPV may be reduced due to budget constraints and challenging constructability. The extent of this descoping exercise will be finalised over the next design phase.

Any reduction in GMPV capacity would lessen the environmental impacts associated with ground disturbance and construction activities. However, this would also reduce the overall renewable energy generation and carbon reduction figures.

The final scope of the RENEW project will be explained in future post season environmental reports.

8.4. COMMERCIAL SUPPORT VESSELS

As recorded in Section 4.5.3.14. the type of commercial vessel that will be used to support the hangar redevelopment (and potentially other projects recorded in this document) is not known at the time of preparing the EIA. Nonetheless, any vessel that is selected will be of an appropriate ice class to operate in Antarctic water and will be complaint with the IMO Polar Shipping Code.

8.5. UNKNOWN WASTE ITEMS

Most of the planned activities described in this EIA involve earthworks and excavation. Experience has shown that this can lead to the discovery of redundant services from past activities such as discussed electric cables and drainage pipes. If identified this can lead to slight adjustments being made to planned activities or to further excavation to remove old materials if practicable.

At the time of preparation of the EIA, the extent to which this will occur is unknown. Any such redundant items that are discovered will be removed if feasible to do so and managed as waste in accordance with the Rothera waste management procedures.

8.6. CARBON ESTIMATES

The carbon emission estimates presented in Section 4.13. have been prepared based on several assumptions and to varying degrees of accuracy.

As noted, the Hangar redevelopment and Renewable Energy projects have been subject to a high level of assessment based on the Publicly Available Specification (PAS) 2080[19] Standard. However, the hangar calculations assumed that the existing primary steel structure of the hangar would be reused. This is no longer the case and new steel will be imported to replace the old steel, meaning that the presented figure slightly under-estimates the overall carbon budget for the hangar project. The embedded carbon in the new steel has not been included in the calculations presented in this EIA but will be calculated during the next work stage.

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None of the identified knowledge gaps or uncertainties are of sufficient concern to influence the overall conclusion of this EIA and can be managed through established project management controls.

[19] PAS 2080 is an internationally recognized standard and specification for managing whole-life carbon across buildings and infrastructure. Developed by the British Standards Institution (BSI) and updated in 2023, it provides a practical framework for the entire value chain to reduce carbon emissions and costs through collaborative, intelligent design and construction.

9. Summary and Conclusion

This EIA has assessed the actual and potential environmental impacts arising from a coordinated package of infrastructure works proposed at Rothera Research Station over the next four austral summer seasons - 2026–27 to 2029–30.

The principal activities that are planned comprise resurfacing of the wharf, installation of permanent fuel pipelines between the wharf and the fuel farm, delivery of renewable energy infrastructure including building-mounted photovoltaic panels, a trial ground-mounted photovoltaic array and a battery energy storage system, and redevelopment of the hangar and associated works. The assessment also addresses associated works, including runway maintenance, creation of a slipway, and contaminated ground assessments (described in Chapter 4). These projects are intended to improve safety, operational efficiency, fuel handling resilience, long-term infrastructure performance and environmental sustainability at Rothera, while supporting the continued delivery of BAS science and wider decarbonisation objectives.

The assessment has been undertaken in accordance with Article 8 of and Annex I to the Protocol on Environmental Protection to the Antarctic Treaty and the applicable domestic requirements of the Antarctic Act 1994 and associated legislation.

Consistent with the adopted impact assessment methodology, the evaluation has been precautionary in nature and has considered the principal environmental aspects, the pathways by which environmental receptors may be exposed, the resulting impacts, and the significance of those impacts with reference to their spatial extent, duration, intensity and likelihood (described in Chapter 6).

The assessment identifies a number of key environmental pathways by which impacts may arise, including noise, vibration and artificial lighting affecting wildlife; dust generation and accidental releases of graded fill affecting terrestrial and marine receptors; physical disturbance of limited areas of ice-free ground; risks of fuel and hazardous substance spills; atmospheric emissions associated with plant, vehicles and energy use; increased demands on wastewater and waste management systems; and the potential introduction of non-native species (described in Chapter 6).

The assessment concludes that, in the absence of appropriate controls, several of these pathways could give rise to impacts of concern, particularly in relation to breeding birds, nearshore marine habitats, sensitive terrestrial surfaces, local air quality and scientific activities.

However, the assessment determines that these risks can be effectively reduced through the application of established mitigation measures and good operational practice. These measures include spatial and temporal controls on works, management of noise and lighting where practicable, dust suppression, secure fuel and waste handling procedures, spill prevention and emergency response arrangements, reinstatement of disturbed ground, biosecurity controls, and close coordination with station operations and scientific programmes.

These controls will be detailed in appropriate project documentation.

The cumulative effects assessment recognises that the proposed works form part of a broader and longer-term development of infrastructure at Rothera and identified potential combined effects on breeding birds, terrestrial ice-free areas, research values, wilderness and aesthetic values, the marine environment and greenhouse gas emissions.

Notwithstanding this wider context, the EIA concludes that, with the identified mitigation and monitoring in place, the proposed activities are expected to result in impacts that are no more than minor or transitory. This finding is consistent with the threshold for an Initial Environmental Evaluation under the Protocol.

Monitoring, record keeping and adaptive management will be used to verify the assessment predictions and to respond to any unforeseen effects should they arise. On this basis, the planned works are considered environmentally manageable and justified in light of the operational, safety, scientific and sustainability benefits they are expected to provide at Rothera.

Further assessment at the level of a comprehensive environmental evaluation is not considered to be required.

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Annexes

ANNEX A – MONITORING PROGRAMME

Environmental monitoring

Environmental aspect	Method of monitoring	Limits	Frequency	Responsibility (name/job title) or subcontractor	Records
Wildlife displacement	Count	5 seals or penguins in a day	Each time wildlife displaced.	Neil Goulding – BAM Environmental Lead / Trained and approved operatives	BAM Monitoring and Reporting Schedule
Noise from construction activities. LAeq, 1 & 12 hour	4 Number noise monitors	$LAeq_{12\ hour}$ < 75dBA $LAeq_{1\ hour}$ < 80dBA	Continuous monitoring, real time reporting	Neil Goulding – BAM Environmental Lead Site Environmental Engineer	BAM Monitoring and Reporting Schedule
Vibration from construction activities. PPV & VDV	4 Number triaxial accelerometers	PPV < DIN 4150-3 Line 2 VDV < 2.4 $ms^{-1.75}$	Continuous monitoring, real time reporting	Neil Goulding – BAM Environmental Lead Site Environmental Engineer	BAM Monitoring and Reporting Schedule
Dust from construction activities. TSP, PM10, PM2.5 & PM1	4 Number dust monitors	TSP < 250µg/m3/15 minutes PM10 < 50µg/m^3/24 hours	Continuous monitoring, real time reporting	Neil Goulding – BAM Environmental Lead Site Environmental Engineer	BAM Monitoring and Reporting Schedule
Skua breeding success on Rothera Point	Visual survey		Weekly	BAS Ecological Scientist	Data submitted to the BAS Data Centre
Condition of plant and equipment	Daily plant inspection. Routine maintenance		Daily by operator	BAM Plant dept. fitter BAM Plant operator/foremen	BAM Plant inspection procedure
Fuel/chemical storage area	Visual Inspection		Weekly as a minimum	Site Environmental Engineer	Recorded inspections (EC01)
Waste segregation and storage	Visual inspections on site		Weekly	Foremen / Environmental Lead / Site Environmental Engineer	Completed checklists EC01 / Site diary
Waste Transportation	Visual inspections / maintenance of records		As required	Foremen / Environmental Lead / Site Environmental Engineer	Site diary / Bill of Lading
Waste Disposal	Maintenance of records		As required	Neil Goulding – BAM Environmental Lead Site Environmental Engineer	Bills of Lading / Waste Transfer Notes
Emergency spill kits	Visual inspection		Weekly / after spill response	Foremen / Environmental Lead / Site Environmental Engineer	Recorded inspections (EC01)
Emergency arrangements – e.g. practice drills	Practice drill		8 weekly	Foremen / Environmental Lead / Site Environmental Engineer	Record of drill/site training. (SF513)

BAM Nuttall management system

ANNEX B – BAS WILDLIFE INTERACTION MANUAL

BAS Wildlife Interaction Manual

Edited by the Environment Office

Edition	Version	Date	Reason for amendment	Status/Approved by
1	1.4	14/02/25	Update of HPAI procedures (Chpt.3) Inclusion of new chapter on small boats and wildlife interactions (Chpt.10)	Kevin Hughes/Alison Massey



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ANNEX C – BAS BIOSECURITY REGULATIONS

BAS BIOSECURITY REGULATIONS

Edited by the Environment Office

Edition	Version	Date	Amendments	Approved by
2	10	05/11/25	Provision of information on availability of biosecurity equipment; removal of the use of insect sticky traps in the UK; clarification regarding the storage of foods in Cambridge/Bar Hill; prohibition of the use of corn starch-based packing chips; update on use of sprouting; information on dealing with bed bug/flea infestations; update on biofouling measures.	Kevin Hughes



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ANNEX D – BAS WASTE MANAGEMENT HANDBOOK

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BAS WASTE MANAGEMENT HANDBOOK

18th Edition, Vs. 1.0 - November 2025

Edition	Vs.	Date	Amendments	Status/Approver
18th	1.0	03.11.25	Changes throughout – full reprint required. Significant updates/new information in following chapters: - 3.1.2. – 'Reuse or Resale' – refer to BAS policy for donations or resale - 3.2.1. – 'Staff responsibilities' – new info re Station Leaders (including KEP specific) and Doctors - Table 2 – 'Waste containers', provides updated guidance on use of new 205L drums and re-use of empty AVTUR drums for liquid wastes. Also reflected in sections: 7.1, 7.5, 8.9 and 8.10. - 4.1.5. – 'UN approved packaging' – reminder to NOT paint over the UN containers (e.g. drums) original UN identification Also reflected in 8.13 - 4.2.1. – 'Case numbers' – new case number system - 4.3. – 'Shipping Documentation' – reflects changes related to new Maximo cargo system and BOLs - 6.10.1. – 'Mixed domestic plastics' – updated guidance on types of plastics accepted. - 7.12. – 'IT equipment' – NEW guidance, ALWAYS consign to IT in Cambridge as cargo, this is NOT waste - 8.5.4. – 'Controlled drugs' – no longer incinerated at Rothera and Halley, doctors must denature and consign to UK - 8.12 – 'Flares' – new guidance in line with BAS flare SOP - 11 – 'SDA operational wastes' – NEW guidance. - All waste dangerous goods queries to be directed to cargo@bas.ac.uk and annlao@bas.ac.uk	FINAL Annal Malaos Environment Office

Edited by the Environment Office





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ANNEX E – BAS OIL SPILL CONTINGENCY PLAN

Oil Spill Contingency Plan

Rothera Research Station



Document Title		Rothera Research Station Oil Spill Contingency Plan	
Author(s)		BAS Environment Office	
Version No.	**Date**	**Amendment Details**	**Approved By**
Draft V1	31/10/2023	Removal of duplication of oil storage locations from the fast facts that is already in section 2.5. Addition of Oil Spill Kit inventory as an appendix. Update to reflect increase in MGO/AVCAT mix.	Senior Environmental Manager
FINAL 9th Edition	27/10/2023		Head of Environment Office

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