Australian Government

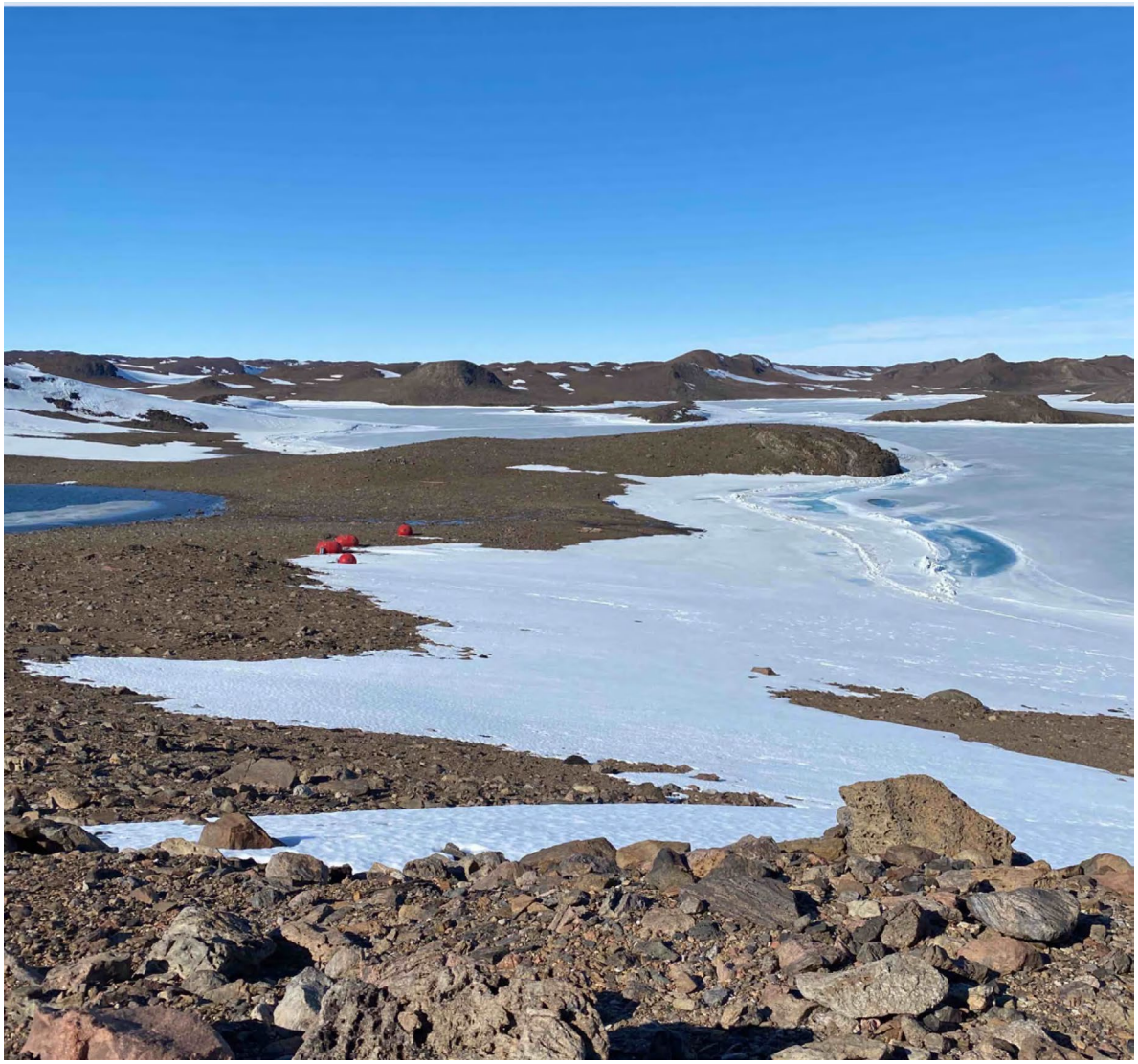
Department of Climate Change, Energy, the Environment and Water

Australian Antarctic Division

AUSTRALIAN ANTARCTIC PROGRAM

INITIAL ENVIRONMENTAL EVALUATION
Denman Terrestrial Campaign – Operational Support

September 2022



Contents

THIS PAGE IS INTENTIONALLY BLANK

NON-TECHNICAL SUMMARY

i. Introduction

The Australian Antarctic Division (AAD) has prepared this Initial Environmental Evaluation (IEE) to assess the potential environmental impacts associated with operational support activities proposed during the first year of the Denman Terrestrial Campaign (DTC), a 3-year scientific research campaign located in the Denman Glacier region of the Bunger Hills. The DTC requires the establishment of a temporary camp at Edgeworth David Base (EDB), approximately 440 km west of Casey and 60 km inland from the Shackleton Ice Shelf.

DTC operational support activities include the establishment of suitable field infrastructure, pre-placement of cargo, as well as undertaking practical site investigations for the successful operation of the EDB camp in future seasons. The broader objectives of the DTC support the achievement of the Australian Government's *Australian Antarctic Strategy and 20 Year Action Plan (2022 update)* (the Strategy) and goals of:

- conducting world-class scientific research consistent with national priorities
- conducting field programs, including operation of supporting logistics
- renovating existing field huts, and
- establishing new air-deployable field bases to facilitate research in remote and inland areas of the Australian Antarctic Territory.

ii. Description of the Proposed Activity

The DTC scientific studies will target key parameters needed to understand the sensitivity of the Denman Glacier/Shackleton Ice Shelf system, which is necessary to predict future change. The scientific research campaigns are scheduled for the 2023-24 and 2024-25 seasons and will require the utilisation of EDB huts which are in poor and aging condition. The DTC operational support component of the project (and thus the scope of this IEE) relates to work planned for the 2022-23 season only, when 5 people will be stationed at Australia's EDB to conduct the following activities:

- replacement of existing apple and melon huts
- site preparation, including preparations for new tent sites, improvements to existing tent sites, helipad clearing, formation of temporary laydown areas for cargo, marking and possible clearing of paths, and possible drainage diversion
- cargo positioning and storage
- placement of temporary infrastructure for communications and water storage, and
- collection of water samples from various waterbodies in the vicinity of EDB to assess quality for consumption during the DTC 2023-24 and 2024-25 seasons.

This IEE assesses the environmental impacts of all proposed DTC operational support activities. It identifies potential environmental risks and appropriate management measures to ensure improved environmental outcomes for the Antarctic environment and the Australian Antarctic Program (AAP).

iii. Alternatives to the Proposed Activity

The possible alternatives to the DTC operational support activities have been considered and include:

1. Not carrying out site preparations, cargo pre-placement, hut replacement and reconnaissance activities in preparation for the scientific field campaigns in the 2023-24 and 2024-25 seasons.
2. Siting the DTC field camp in a different location.
3. Not conducting the DTC.

Each alternative has different consequences for the Antarctic environment and AAD's ability to meet the objectives within the Strategy. All alternatives would impact on the AAP and the ability to conduct world-class scientific research as well as Australia's ability to facilitate research in remote and inland areas of East Antarctica.

iv. Impact Assessment

An assessment of the potential environmental impacts of DTC operational support activities is included in this IEE. The majority of impacts are mitigated through a high level of experience and understanding of the impacts of these activities on the environment, including extensive knowledge of anthropogenic impacts to Antarctic ice-free areas. Much of this knowledge has been gained through previous work in Bunger Hills and in the Vestfold Hills under the Davis Aerodrome Project.

The most significant potential impacts predicted for the DTC operational support project include:

- Biological change, including:
  - the introduction of non-native species, parasites and diseases from the loading of cargo, equipment, stores and personnel, which could establish in terrestrial and/or lacustrine environments of the Bunger Hills,
  - the translocation of Antarctic species between: 1. different waterbodies from the extraction of water from the tarn located near EDB and other lakes in the Bunger Hills for drinking, cleaning and sampling purposes, and 2. different terrestrial areas from personnel walking or moving soil/rock on ice-free areas.
  - through the accidental release of wastewater to ice-free, snow covered or marine areas.
- Habitat and landscape change, including the temporary modification of the landscape in preparation for DTC activities, and personnel walking on ice-free areas around EDB and surrounds.
- Noise pollution through the use of powered and non-powered carpentry tools, generators, equipment and general camp usage and field activities.
- Disturbance of fauna through the generation of noise, movement of soil and rock on ice-free areas, and operation of remotely piloted aircraft and aircraft operations. Wildlife may also be disturbed from daily camp activities, including movement, noise and light, and the potential exposure to waste and waste products released or accidentally released into the environment.

- Pollution of sea water, sediments, snow and ice through the accidental release of fuel, chemical preservatives and waste products.
- Pollution of air through emissions from the combustion of fuel for equipment and vehicle use.
- Potential degradation of cultural and heritage values through disturbance of unidentified heritage items.
- Degradation of landscape and wilderness values from human presence.

v. Mitigation Measures

The following example of mitigation measures to address the abovementioned potential environmental impacts. These include:

- Biological change:
  - All equipment and supplementary materials will be subjected to existing AAD cargo biosecurity screening and treatment procedures co-ordinated by the AAD Supply Services Team prior to departure.
  - All expeditions will partake in eLearning and attend an Environmental Management pre-departure briefings.
  - AAD policies and procedures will be followed to ensure that all equipment is thoroughly cleaned of organic matter prior to arriving in Antarctica.
  - The field team will follow biosecurity and waste management procedures within the *2022 AAD Field Manual (23rd ed.)* and *Station and Field Waste Management Guide*.
  - The field team will employ water sampling/extraction methods designed to minimise impacts to waterbodies, e.g. use of sampling pole from lake edge, cleaning equipment between each site to prevent cross contamination.
  - Under no circumstances will wastewater be deposited on ice-free land or in tarns/lakes. All solid and liquid human waste, wastewater and packaging generated at the field camp will be packaged in appropriate receptacles and returned to Casey station.
- Habitat and landscape change:
  - Work areas will be kept to the minimum necessary to accommodate the expected number of personnel and to ensure safety at the camp.
  - Existing disturbed areas will be used preferentially for tent sites and paths.
  - Where possible, wooden hut and tent platforms will be used to position accommodation off the substrate.
  - Camp design will employ principles of human-centred design when locating paths for foot traffic, e.g. co-locating areas frequently visited by personnel and creating straight paths between these areas where possible (while following the natural contours of the landscape and avoiding soft vegetation).

- All groundworks will be completed carefully, by hand, to minimise ground disturbance and limit generation of dust – heavy machinery will not be used.
- Groundworks will be undertaken during low wind conditions.
- Rocks that are moved during groundworks will be placed in a similar orientation (i.e., same side down) to minimise disturbance to endolithic communities.
- Pre-disturbance photographs will be taken to facilitate remediation in the 2024-25 season.

- Disturbance of fauna:
  - An initial evaluation will be conducted upon arrival to identify areas with the greatest likelihood of encountering wildlife, including potential nesting areas. Movements in and around these areas will be avoided or minimised throughout the field season.
  - Checks for seabird nests (including evidence of previous nests) will be completed prior to any movement of rock or soil.
  - All personnel will be made aware of wildlife separation distances in AAD mandatory pre-departure training.
  - The field team will follow all AAD Standard Operating Procedures (SOPs) and wildlife approach distance guidelines.
  - The field team will remain alert to changes in wildlife behaviour – especially changes in posture or vocalisations. Activities will be paused if disturbance is detected, and personnel will move away slowly and quietly.
  - If a seabird nest is located it will not be disturbed – an exclusion zone equivalent to the relevant separation distance will be placed around the nest.
  - Within EDB, foot traffic will be primarily along defined paths.
  - The field team will avoid or minimise the use of lighting during hours of darkness.
  - Pilots will follow *AAD Standard Operating Procedure Operations Manual Volume 5*, and *Environmental Policy on Unmanned Aerial Systems (Drones)*, which set out the AAD's procedures to ensure the safe and environmentally sensitive operation of unmanned aerial systems in Antarctica.
  - Aviation operations will comply with the existing guidelines and separation distances to reduce impacts on wildlife, identified in the IEE *Environmental Impact Assessment – Australian Antarctic Program Aviation Operations 2020-2025*.
  - Where possible, power tools will not be operated within 50 m of individuals or 200 m of concentrations of wildlife.
  - All items, including food scraps, will be secured to avoid interference by wildlife and to avoid degradation by weather and dispersion by wind. Dedicated storage containers will be included in the field equipment.
  - Waste will be managed in accordance with the *2022 AAD Field Manual (23rd ed.)* and the *Station and Field Waste Management Guide*. All solid waste, including solid human

waste, will be returned to Casey station for incineration or to Australia for recycling or landfill.

- Water extraction methods will be designed to minimise disturbance of microbiota in the tarn or around the tarn edge, e.g. use of a flexible pipe from outlet stream or use of submersible pump in the tarn, both of which can be left in place to avoid repeated travel along the tarn margins.

- Noise pollution:
  - To minimise noise, wooden tent platforms will be constructed off-site (either Hobart or Casey station).
  - Petrol-powered tools, which are typically noisier than battery powered tools, will not be brought to site.
  - Minimising the use of generators and vehicles where possible.
- Pollution of water, sediments, snow and ice:
  - All field personnel will be trained in spill procedures and response.
  - Fuel will be appropriately stored in sealed drums/tanks until use and managed to limit the possibilities of contamination to the environment.
  - Refuelling will be conducted in accordance with the *AAD Standard Operation Procedure Operations Manual* and all fuels and lubricants will be handled in accordance with the *Hazardous Chemicals Management Policy* and procedures.
  - Fuel spill kits and absorbent pads will be available in the event of a spill.
  - All materials and equipment will be secured and stored in a manner that prevents windblown debris.
  - Waste to be managed in accordance with the *2022 AAD Field Manual (23rd ed.)* and the *Station and Field Waste Management Guide* (with the exception of human waste and grey waste, as per below):
    - All solid waste, including solid human waste, will be double-bagged and returned to Casey station for incineration or to Australia for recycling or landfill.
    - All liquid waste, including liquid human waste, will be stored in sealed containers and returned to Casey station for treatment and disposal.
  - To avoid accidental release of chemical preservatives into waterbodies, preservatives will be added to water samples at a distance of at least 10 m from a waterbody.
  - Existing AAD emergency response and fuel spill response plans will be used in the event of an incident. For any emergencies or unexpected impacts on the environment, response plans will be developed in consultation with the Project Manager and AAD Environmental Manager.
- Pollution of air:
  - All machinery (generators, walking tractors, quad bikes, camp stoves) will be maintained and serviced prior to departure to ensure maximum efficiency.

  - The use of quad bikes, walking tractors, generators and stoves will be minimised where possible.

- Potential degradation of cultural and heritage values:
  - If potential heritage sites are identified, photographs will be taken and the location recorded to enable heritage assessment.
  - If heritage sites are identified within a working area, markers will be installed to prevent access to the site, and management strategies will be advised by the Project Manager and Manager of the Antarctic and Environmental Regulation (AER) section.
- Degradation of landscape and wilderness values:
  - Remediation techniques are proposed to be adopted for the 2024-25 season to visually reinstate areas to resemble pre-work conditions where track use and groundworks have been undertaken.

vi. Environmental Monitoring and Management

Key environmental indicators, activities and incidents will be monitored to ensure unforeseen impacts are both monitored and managed appropriately, and in accordance with relevant SOPs. The key environmental indicators for the DTC operational support activities have been identified in this IEE using an environmental risk assessment framework and include disturbance to wildlife, ground disturbance, pollution of water, sediments, snow and/or ice, and biosecurity management.

Monitoring these activities, through inspections, visual observation and incident reporting will ensure the DTC operational support activities remain compliant with international standards, the *Antarctic Treaty (Environment Protection) Act* 1980, the AAD's Environmental Policy and commitment to continuous environmental improvement. A draft environmental monitoring plan has been developed for the DTC operational support activities and is provided in **Appendix 5**.

The environmental monitoring and reporting for the DTC operational support activities will be undertaken to:

- ensure ongoing compliance with the *Antarctic Treaty (Environment Protection) Act* 1980
- ensure impacts are avoided or limited, and are consistent with the environmental principles of the Madrid Protocol
- evaluate the IEE's conclusion that the impacts of the DTC operational support activities are likely to remain minor or transitory
- inform any changes required to practices or methodologies to comply with any impact thresholds described in the IEE
- ensure that environmental impacts are not in conflict with the community's expectations in relation to Antarctica's protection, and
- that any unforeseen and potentially significant impacts associated with the DTC operational support activities, as described in this IEE, are captured and utilised for the future management of field campaign activities, or similar activities within AAD.

Baseline date will be collected on the following key environmental indicators:

- wildlife presence

- ground disturbance
- pollution of water, sediments, snow and/or ice, and
- biosecurity management.

vii. Conclusion

This assessment concluded that the DTC's operational support activities, as described in this IEE, will result in some environmental impacts. However, provided the mitigation, monitoring and reporting measures described in this document are adhered to, these impacts will be no more than minor or transitory.

1 INTRODUCTION AND SCOPE

1.1 Introduction

Australia's Antarctic program is managed on behalf of the Australian Government by the Australian Antarctic Division (AAD), in the Department of Climate Change, Energy, the Environment and Water (DCCEEW). The AAD is tasked with advancing Australia's strategic, scientific, environmental and economic interests in the Antarctic by protecting, administering and researching the region. Consequently, Australia maintains three research stations on the coast of East Antarctica – Casey station in Wilkes Land, Davis station in Princess Elizabeth Land, and Mawson station in Mac Robertson Land.

In April 2016, the then Prime Minister launched the *Australian Antarctic Strategy and 20-year Action Plan* (the Strategy), which sets out Australia's national interests and our vision for Australia's future engagement in Antarctica. In 2022, an update to the Strategy was undertaken, which clearly defines the priorities for the next five years. The Denman Terrestrial Campaign (DTC) is an essential operational and infrastructure related component of the Strategy, incorporating the renovation of existing field huts, establishing an air-deployable field base, and conducting world-class scientific research.

1.2 Project Background

The DTC will target key parameters needed to understand the sensitivity of the Denman Glacier/Shackleton Ice Shelf system, which is necessary to predict future change. Terrestrial field studies of the DTC are scheduled for the 2023-24 and 2024-25 seasons and will require the utilisation of Edgeworth David Base huts in the Bunger Hills. The replacement of the field huts at EDB was first proposed in 2016, but due to changes in scope and an expansion of project activities, it did not proceed within the proposed timeframe. The DTC operational support project combines the EDB field hut replacement activities with site preparation, cargo pre-placement and reconnaissance activities in preparation for the scientific field campaign in the following season.

1.3 Statutory Requirements

To ensure the protection of the Antarctic environment, the Antarctic Treaty nations adopted the Protocol on Environmental Protection to the Antarctic Treaty, which came into force in 1998. Australia enforces the provisions of the Environmental Protocol through the *Antarctic Treaty (Environmental Protection) (ATEP) Act* 1980 and *Environmental Impact Assessment Regulations* 1993. The *Antarctic Marine Living Resources Conservation Act* 1981 implements the Convention of the Conservation of Antarctic Marine Living Resources.

The ATEP Act provides for three levels of environmental assessment – preliminary assessment (PA), initial environmental evaluation (IEE) and comprehensive environmental evaluation (CEE). The required level of assessment is related to the likely extent of the impacts of an activity. A PA for the DTC operational activities was undertaken in July 2022 and led to the requirement to prepare an IEE (this document). *Antarctic Treaty (Environment Protection) (Environmental Impact Assessment) Regulations 1993* specify the mandatory content of IEEs for the purposes of paragraph 12g (2) (a) of the ATEP Act. Compliance with the required content is provided in **Appendix 1**.

1.4 Purpose and Scope of the Document

The purpose of this IEE is to provide details on the DTC operational support activities, and the potential impact of these activities on the Antarctic environment. It includes consideration of alternatives to the proposed activity and consideration of cumulative impacts in light of existing and known planned activities.

Included in this IEE is an evaluation of the measures to be undertaken and applied in order to minimise or avoid these impacts.

This document contains the following sections:

- Section 2 describes the proposed activities
- Section 3 describes the alternates considered
- Section 4 describes the local environment
- Section 5 describes the environmental impacts and the measures proposed to minimise or avoid them
- Section 6 identifies any uncertainties and lack of knowledge relevant to preparation of the evaluation, and
- Section 7 outlines the conclusions.

A non-technical summary has been included at the beginning of the document to provide an overview of the IEE.

2 DESCRIPTION OF THE PROPOSED ACTIVITY

2.1 Location of the Proposed Activity

EDB is located on an ice-free area of the Bunger Hills, East Antarctica, approximately 440 km west of Casey station and 60 km inland from the Shackleton Ice Shelf (GPS location -66.249799°, 100.603052°, Figure 1).

Transkripsii Inlet is located adjacent to EDB.

Activities to be conducted for the DTC operational support project[1] (and for the primary field camp in the 2023-24 and 2024-25 seasons) will occur primarily within an area of approximately 0.38 km^2 (Figure 2). The ice-free area to be utilised for the DTC equates to less than 0.04% of the total ice-free area of the Bunger Hills. Of this area, approximately 342 m^2 will be taken up by the direct footprint of the camp accommodation. Details of the camp footprint are provided in Section 2.4.2, with marked up photographs of the site provided in Appendix 2.

[1] With the exception of water sampling activities, see Section 2.4.3.

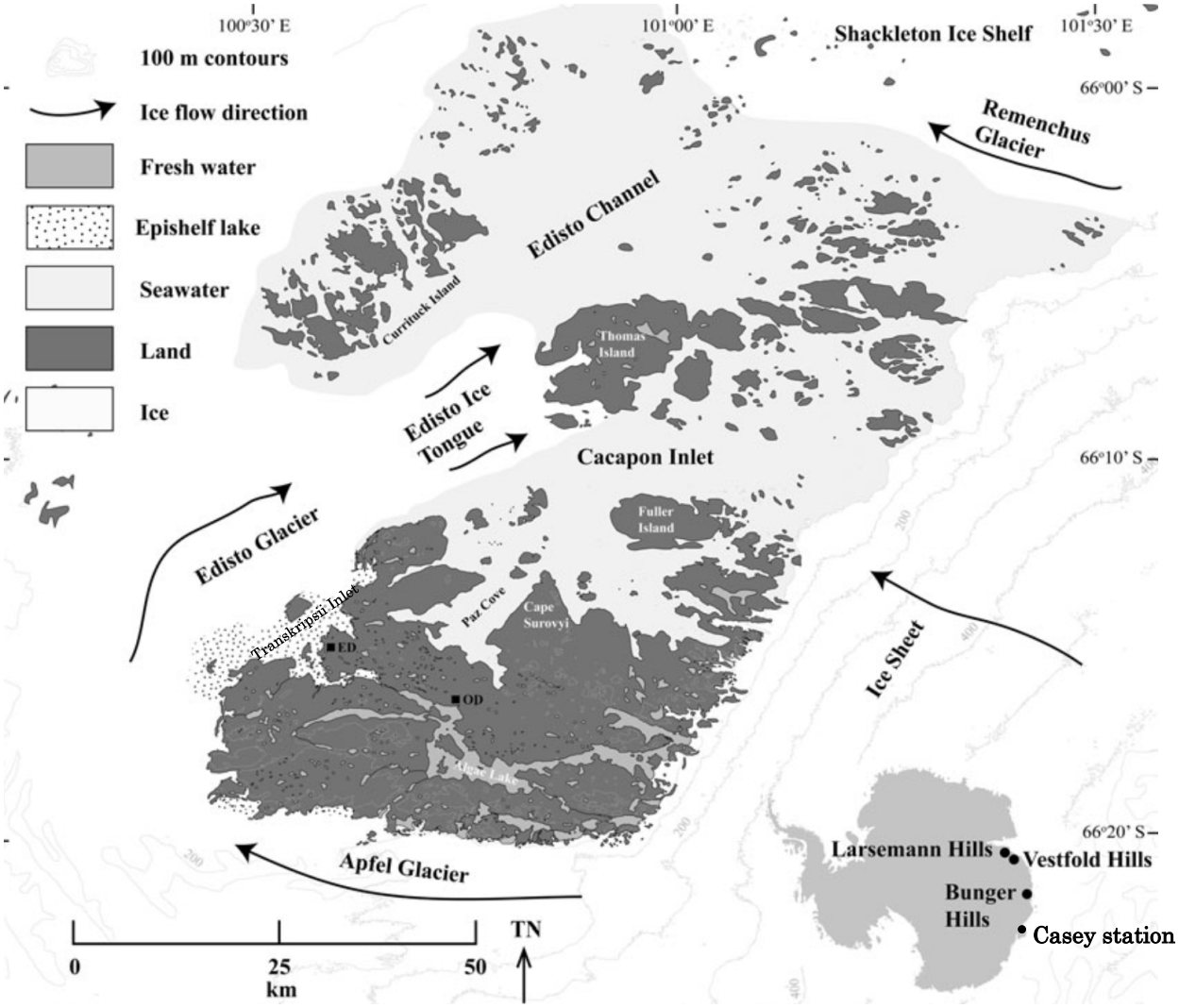


Figure 1 Location of the Bunger Hills, showing regional setting (ED = Edgeworth David Base, OD = Oasis/ Dobrowlski Stations) (modified from Leishman et al. 2020).

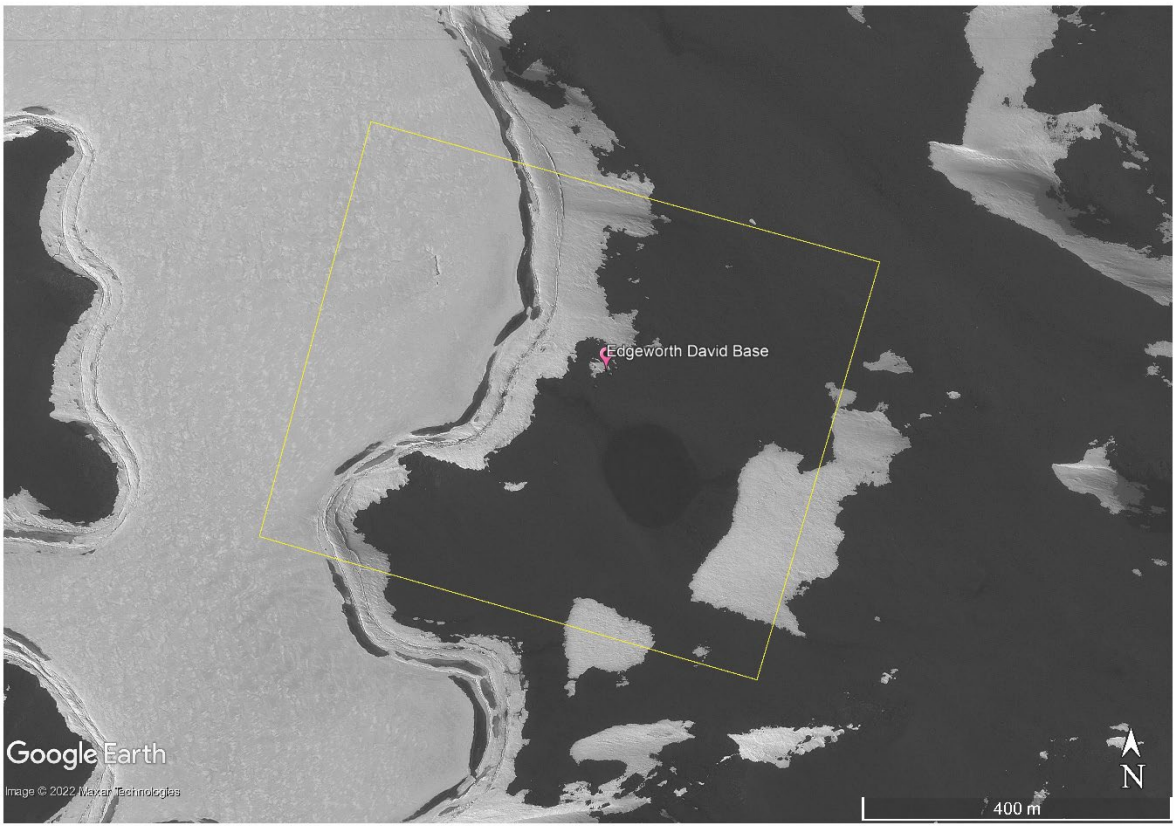


Figure 2 Geographical extent of primary activities for the Denman Terrestrial Campaign operational support project.

2.2 Project Overview

The DTC is a multidisciplinary terrestrial field campaign in the Denman Glacier region of the Bunger Hills, with scientific field activities planned for the 2023-24 and 2024-25 summer seasons. The objective of the DTC is to facilitate the conduct of AAD-sponsored scientific research to deliver on Australia's national scientific priorities and objectives. To facilitate the efficient delivery of the program, preparations for a temporary camp to accommodate up to 40 personnel will be made at EDB (approx. 440 km west of Casey and 60 km inland from the Shackleton Ice Shelf) in the 2022-23 season. The operational support field program will occur over a 6-week period, with additional shorter visits to the site potentially occurring throughout the season. The DTC field camp will be dismantled and remediated in the 2024-25 field season.

This IEE relates to work planned for the 2022-23 season only, when 5 people will be stationed at Australia's EDB to conduct the following activities:

- replacement of existing apple and melon huts
- site preparation, including preparations for new tent sites, improvements to existing tent sites, helipad clearing, formation of temporary laydown areas for cargo, marking and possible clearing of paths, and possible drainage diversion
- cargo positioning and storage

- placement of temporary infrastructure for communications and water storage, and
- collection of water samples from various waterbodies in the vicinity of EDB to assess quality for consumption during the DTC 2023-24 and 2024-25 seasons.

Details of these activities and the management of the field camp in 2022-23 are detailed below. Photographs of the site, taken in January 2022, are provided in **Appendix 2**.

2.3 Timing

The sequence of DTC project activities is summarised in Table 1. Proposed project tasks are scheduled to occur during the Australian summer field season, with exact dates dependant on season/operational planning decisions and weather.

The 2022-23 field season will commence in late November 2022 when the field team arrives at Casey station. Weather permitting, the team are expected to be deployed to EDB within a week of arrival and remain on site for up to 6 weeks. Additional shorter visits may be made to EDB after the primary field program, depending on the progress of site preparations, weather and logistics. A C-17 air drop is scheduled to occur in the second week of December 2022.

Table 1: Summary of DTC project timing, activities and personnel numbers.

Field Season	2022-23	2023-24	2024-25
Campaign element	**Operational support**	**Primary field campaign**	**Secondary field campaign and remediation**
Activities	Field hut replacement Site preparation Fuel caching Cargo and infrastructure placement Water sampling	Scientific field campaign	Scientific field campaign Remediation of field camp
Fixed-wing aviation support	Basler Twin Otter C-17 (airdrop of dry cargo)	Basler / Twin Otter	Basler / Twin Otter
Helicopter support	No	2 x Eurocopter AS350 B3	2 x Eurocopter AS350 B3 or Kawasaki BK117 (to be confirmed)
PAX in Bunger Hills	5	Up to 40	Approx. 16
Days in Bunger Hills	Approx. 42	Approx. 62 (42 days for scientific field campaign + 10 days either side for mobilisation and demobilisation)	Approx. 62 (42 days for scientific field campaign + 10 days either side for mobilisation and demobilisation)

Shaded cells indicate scope covered under this IEE

2.4 Edgeworth David Base Activities

2.4.1 Field Hut Replacement

EDB was established in 1986 and consists of 2 apple huts and 2 small melon huts. The condition of all the huts is fair, except for the toilet apple hut which is in poor condition and receives more snow loading and ice/water ingress from blizz tails.

Four new field huts (2 apple huts and 2 melon huts) will be erected in the 2022-23 season. The new huts will either replace the existing huts or be sited nearby in new locations so that the existing huts can be utilised during the DTC 2023-24 and 2024-25 seasons. Any huts dismantled in 2022-23 will be returned to Australia at the end of the 2022-23 field season. If any existing huts are temporarily retained for the DTC, they will be dismantled and removed in the 2024-25 season.

The new field huts consist of multiple fibreglass panels, which are bolted together on site. The huts are mounted on wooden base platforms, some of which may need to be constructed depending on the usability of the existing platforms and whether the 4 existing huts are retained. New wooden platforms will be constructed offsite (either Casey station or Hobart) and will be flown to site to minimise noise disturbance to wildlife through the use of battery-powered carpentry and construction tools. The huts will be held down by ground anchors, some of which may be bolted to rocks.

2.4.2 Site Preparation

Groundworks

Groundworks will be required to prepare the site for the DTC, including preparations for new tent (and possibly melon hut) sites, improvements to existing tent sites, helipad clearing, formation of temporary laydown areas for cargo, marking and possible clearing of paths, and possible drainage diversion. Groundworks will be completed by hand and will involve redistribution of surficial sediment and rock.

Groundworks for the tent sites, helipads and cargo laydown areas are necessary to create safe and functional environments for field personnel and aircraft operators, and to protect field equipment and cargo. Likewise, approximately 300 m of paths may be needed to be marked out to ensure safe, unobstructed access to infrastructure, to limit foot traffic to defined areas, and to reduce potential environmental impacts to geology and vegetation. In addition, minor drainage diversion may be required if tents are deemed susceptible to ingress from tarn outflows.

Groundworks will be minimised by:

- preferentially siting tents and paths in areas of existing disturbance, i.e., locations where rocks have already been moved to create tent sites and paths have been formed and marked by rocks – see **Appendix 2**.
- utilising wooden tent platforms which are only in contact with the ground at the four corners of the platform. The platforms sit over the rocky substrate, avoiding the need to clear most rocks
- employing concepts of human-centred design when locating paths for foot traffic to avoid creation of ‘desire paths’ (a trail created owing to erosion over time by people finding their own best suitable path). This will include minimising the need for additional walking by co-locating areas frequently visited by personnel and creating straight paths between these locations where possible, and
- considering whether sleeping tents can be located on the adjacent ice or snow-covered areas.

To facilitate remediation of the groundworks in 2024-25, a remotely piloted aircraft will be used to capture pre-disturbance images of the site at the start of the 2022-23 season. The objective of

remediation efforts will be to return the site to pre-disturbance conditions, including removing star pickets, replacing rocks to their original locations and filling in any channels created for drainage purposes.

The following sections provide more information on the potential groundworks required for each element of the program.

Accommodation sites

The DTC operational support project will prepare tent sites for use in the 2023-24 and 2024-25 field seasons, with the following purposes:

- Sleeping tents – 20 x 2-person tents measuring 3 x 2.5m, with no heating, some on wooden tent platforms (total area approx. 150 m^2)
- Kitchen tent – 1 x Rak tent measuring 7 x 4.8 m, with power and heating, on wooden platform (total area approx. 33.6 m^2)
- Mess tent – 1 x Polar Haven tent measuring 7 x 4.8 m, with power and heating, on wooden platform (total area approx. 33.6 m^2), and
- Ancillary tents (e.g. Helicopter workshop) – 2 x Weather Haven Endurance tents measuring 6.5 x 2.4 m, each with power and heating, use of wooden platforms to be determined based on site conditions (total area approx. 31.2 m^2).

In addition, 4 sites may need to be prepared for the new field huts: the melon huts measure 6 x 3.6 m each (total area of both huts including hut platforms approx. 53.3 m^2), apple huts measure approximately 4 m^2 each (total area of both huts including hut platforms approx. 40.5 m^2). Depending on the condition of the existing field huts, the field team may erect (and peg down) some sleeping tents for accommodation purposes in 2022-23. All other tents will be erected in the 2023-24 season, though clearing of some tent sites will occur in 2022-23.

The field team will investigate the potential for at least part of the 2023-24 field camp to be situated on the ice adjacent to EDB or on snow covered areas if the snow is deemed thick enough. This may be possible for some of the sleeping tents; however, there may be issues with situating the larger heated tents on the ice, such as melting at the ice/equipment interface. The team will also consider any safety issues related to personnel regularly crossing the tide crack.

Helipad

The helipad site is proposed to be positioned on top of a small ridge, approximately 10 m above the existing apple huts to the south of the site. The helipad site will require rock repositioning and installation of ground anchors for helicopter tie downs (**Appendix 2**).

Paths

Paths will be marked with removable star pickets with the paths following the natural contours of the landscape wherever possible (i.e., around large obstructions / flow paths). Some rocks may need to be moved to the side of the path if deemed to be an obvious trip hazard.

Temporary bridging (using timber/cane) may be erected over the tide crack to facilitate the safe transfer of people and cargo from the ice to the camp.

Drainage diversion

A tarn is located south of the camp, draining to Transkripsii Inlet in the north. The area around and downstream of the lake outlet is the flattest area of the camp making it a suitable location to site the DTC tents (**Appendix 2**). Management of drainage from the tarn may be required to ensure that tent sites are not flooded during the warmer summer periods when flows from the tarn outlet are at their peak. If necessary, drainage would be managed through movement of rocks and possibly forming shallow channels to divert water away from the tent sites.

Cargo positioning and storage

Cargo to support the above activities will be stored on pallets on ice-free and snow-covered areas on site. Most cargo will be temporarily stored for the 2022-23 season only, with up to 13 tonnes remaining over the 2023 winter to support the DTC in 2023-24. Likely cargo storage areas are shown in **Appendix 2**.

Field supplies, including fuel and lubricants for quad bikes, helicopters and generators will be delivered from Casey station by Basler or Twin Otter ski-equipped aircraft and pre-placed on the adjacent ice in Transkripsii Inlet. Up to 20 cargo flights will be required, along with an air drop of dry cargo from Hobart via C-17. Approximately 8 drums of unleaded petrol (ULP)/diesel fuel, and up to 350 drums of aviation turbine kerosene (ATK) are expected to be stored, along with up to 13 tonnes of field supplies. ATK will be stored at the existing fuel cache on the ice. All other supplies will be transported from the ice to the edge of the tide crack by quad bikes. Once over the tide crack, cargo will be manually transferred to the field camp using walking tractors.

Air drops and the caching of aviation fuel are covered under the existing Notice of Determination and Authorisation (NoDA) for *Australian Antarctic Program (AAP) Aviation Operations 2020-2024* and are thus not described here. While some ATK will be utilised in the 2022-23 season, the majority will be stored for the DTC in 2023-24, with empty fuel drums being returned to Australia at the end of the 2023-24 or 2024-25 season.

Placement of temporary infrastructure

Communications and water storage infrastructure may be temporarily placed at or near EDB in preparation for the scientific field campaign. Communications infrastructure (i.e., antennae and repeater, maximum height of 3–5 m) will be installed on the ridge to the south of the field camp.

A header tank above the camp may be installed to run water to the Kitchen Mess. The header tank would be filled in the 2023-24 season.

All temporary infrastructure will be pegged down and/or bolted to rock.

2.4.3 Collection of water samples

Water samples will be collected in 2022-23 to assess the quality of the water for human consumption in the scientific field seasons. Water samples will be collected from:

1. the freshwater lens in Transkripsii Inlet adjacent to EDB – either through the tide crack or by drilling through the ice
2. the tarn at EDB
3. southern Transcripsii Inlet, approximately 1.8 km southwest of EDB in an area that has been free of ice in previous years, and
4. Lake Dolgoe, approximately 3.7 km southwest of EDB.

A map and approximate GPS locations of the water sampling sites are provided in **Appendix 3**. The precise locations will depend on the ability to safely access the sites and may depend on the availability of ice-free areas in the southern Transcripsii Inlet and Lake Dolgoe.

Up to 2 L of water will be collected from each water sampling site using either a sampling pole from the edge of each waterbody or a clean flexible hose from the tide crack/ice hole. Samples will either be returned to Casey station or Hobart for testing, depending on the analytical requirements.

2.4.4 Field Camp Management in the 2022-23 Season

Field personnel will utilise the older melon huts and/or erect tents for shelter during the 6-week field expedition. Water for drinking and washing will be sourced from the tarn.

All waste (including human and non-human waste) will be managed in accordance with the *2022 AAD Field Manual (23rd ed.)* and the *Station and Field Waste Management Guide*. The Field Trip Leader will be responsible for ensuring that field waste is handled in accordance with these guides. Personnel will undertake all reasonable measures to reduce the volume of waste at the field camp, including minimising packaging transported to EDB and prohibiting any loose packing materials that can become windblown or picked up by wildlife.

Under no circumstances will human liquid or solid waste be deposited on ice-free land or in tarns/lakes. All solid and liquid human waste, wastewater and packaging generated at the field camp will be packaged in appropriate receptacles and returned to Casey station.

2.5 Logistics and Equipment

Methods of transport for personnel, fuel and camp cargo include:

- Aiviq and/or Happy Dynamic vessels will be used to deliver cargo from Hobart to Casey station.
- Airbus A319 will be used to transport personnel from Hobart to Wilkins Aerodrome. The crew will complete training at Casey station before departing to EDB.
- Basler and Twin Otter ski-equipped aircraft will be used to deliver personnel, fuel and cargo from Casey station ski landing area (SLA) to the ice adjacent to EDB[2]. In addition, reconnaissance of the surrounding region to support aircraft operations will be conducted. Flight paths will be consistent with established and pre-existing landing areas, used annually to support Twin Otter flights between Casey and Davis stations.
- C-17 aircraft will be used to deliver dry cargo from Hobart[1] to the ice adjacent to EDB.
- Quad bikes will be used on the ice to transport cargo closer to the camp. Two walking tractors will be used to transport cargo over ice-free areas, and
- Field personnel will travel on foot over ice-free areas to undertake water sampling and overnight recreational trips within the Bunger Hills may occur. It is estimated that field

[2] Details of these activities and their related environmental approval conditions, including intra-continental aviation operations, air-drops, storage/caching of aviation fuel, and unmanned aircraft use for operational purposes are covered under the IEE *Environmental Impact Assessment – Australian Antarctic Program Aviation Operations 2020-2025* and NoDA for *Australian Antarctic Program (AAP) Aviation Operations 2020-2024*, respectively.

personnel will be contained to the local area and within a 2 km radius of the camp for 98% of the field program.

No heavy machinery will be brought to site.

The DTC Operational Project will utilise the following additional core equipment/energy sources:

- Power tools:
    - battery powered carpentry and construction tools including drills, drivers, saws, hammer drills and chainsaws
    - Electric chainsaw for cutting sea ice, if needed to access water.
- Petrol/diesel powered generators
- Solar panels and power hub batteries with 240V inverters

3 ALTERNATIVES TO THE PROPOSED ACTIVITY

The possible alternatives to the DTC operational activities, include:

1. Not conducting the DTC.
2. Not carrying out site preparations, cargo pre-placement, hut replacement and reconnaissance activities in preparation for the scientific field campaigns in the 2023-24 and 2024-25 seasons.
3. Siting the DTC in a different location.

The consequences of each of these alternatives are outlined below.

3.1 Do Nothing

Cancelling the DTC would result in a lost opportunity for the AAP to meet the objectives within the *Australian Antarctic Strategy and 20 Year Action Plan (2022 update)*, including:

1. Conducting world-class scientific research consistent with national priorities
2. Renovating existing field huts to use them as summer-only stations, featuring substantial remote monitoring equipment, and
3. Establishing new air-deployable field bases to facilitate research in remote and inland areas of the Australian Antarctic Territory.

The environmental consequences of not conducting the DTC would be reduced levels of emissions attached to AAP activities and a reduction in risks associated with flora and fauna disturbance, waste handling and disposal, and biosecurity. Conversely, without renovation or replacement efforts the existing melon and apple huts would continue to disintegrate, increasing the potential for inadvertent dispersal of debris over land and ice[3].

[3] Loss of an apple hut occurred at EDB in the past. One of the 5 original field huts erected at EDB in 1985 blew away sometime between 1988 and 1995 as evidenced by presence of wire guy ropes still in the ground and the red fibreglass

3.2 Alternative Timing and Locations

The DTC would be unable to be achieved in 2023-24 without the preparation activities listed in this IEE.

The DTC project has, in the first instance, been designed to minimise as much as possible its impacts on the Antarctic environment. With the exception of the areas around EDB and Oasis/Dobrowlski stations where traces of human presence are evident[4], much of the Bunger Hills is an inviolate area. Siting the DTC in another location of the Bunger Hills would thus create greater environmental impacts than siting the field camp within areas of existing disturbance at EDB. The opportunity to utilise AAD's existing field infrastructure (apple and melon huts) at EDB would also be lost, potentially necessitating more cargo flights to bring more field equipment and accommodation to a new location within the Bunger Hills. Siting the field camp further from the coast would also result in logistical and environmental issues with transporting equipment across ice-free areas given that cargo will be delivered via aircraft to the ice edge (particularly as helicopter support will not be available in the 2022-23 season).

As mentioned in Section 2.4.2, the 2022-23 field team will investigate the possibility for some accommodation tents to be sited on snow covered areas or on the ice adjacent to EDB.

4 DESCRIPTION OF THE ENVIRONMENT

4.1 Physical Characteristics of the Bunger Hills

With an area of 952 km^2, the Bunger Hills is the second largest ice-free oasis on the coastline of East Antarctica. The Bunger Hills are located on the eastern flank of Denman and Scott glaciers. The hills are completely surrounded by ice and consist of a series of rugged low-relief islands, nunataks and peninsulas. The area contains numerous inland lakes, including Algae Lake, one of the largest freshwater lakes in Antarctica (Gore et al. 2020) (Figure 1).

The nearshore marine areas adjacent to the Bunger Hills contain numerous epishelf lakes, including Transkriptsii Inlet, adjacent to EDB. Epishelf lakes form when meltwater flowing off a glacier or land is trapped behind a floating ice shelf, resulting in separation of the trapped freshwater from the dense saltwater below. Epishelf lakes maintain a direct hydraulic connection to the sea under the base of the ice shelf, thus the surface elevation of the lake changes tidally (Davies et al. 2017).

Photographs of the environment around EDB are provided in **Appendix 2**.

4.2 Terrestrial Fauna

Terrestrial fauna present in the Bunger Hills consists of birds, seals and invertebrates. Leishman et al. 2020 reported four species of birds from the Bunger Hills:

shards spread downwind (Gore et al. 2020).

[4] Types and distributions of anthropogenic rubbish have been documented at Bunger Hills by Gore et al. 2020 – see Section 4.9.

- Snow petrels (*Pagodroma nivea*) were the most abundant, with their nests occurring in rock crevices and overhangs in the north, centre and south of the hills, and particularly along the Apfel Glacier margin. Their population was estimated at up to 1000 individual birds.
- Wilson's storm petrels (*Oceanites oceanicus*) were considered rare and dispersed, with their cryptic nests typically constructed in sandy and gravelly sediment.
- South polar skuas (*Catharacta maccormicki*) were generally seen flying and at feeding or washing sites and less often on the nests they constructed amongst gravelly substrate. Up to 50 individuals were estimated in the Bunger Hills.
- Rarely, Adélie penguins (*Pygoscelis adeliae*) have been found in the Bunger Hills; however, there are no breeding colonies as access is limited by the Shackleton Ice Shelf.

Leishman et al. (2020) mapped 1999-2000 field season sightings of south polar skuas and nests of snow petrels within 1 km and 2 km of EDB, respectively. Based on photographs taken of the area in the vicinity of EDB (**Appendix 2**), there exists the potential for snow petrels, south polar skuas and/or Wilson's storm petrels to nest in the area (Southwell, C. *pers. comms*[5]).

Previous field expeditions in the Bunger Hills have recorded the presence of "camp skuas", which appeared to be attracted to habituated field camps such as EDB (Gibson 2000, Gibson, J. *pers. comms*.[6]).

An apparently isolated population of Weddell seals (*Leptonychotes weddellii*) occurs in the marine portion of Bunger Hills (Leishman et al. 2020).

4.3 Terrestrial Microbiota

The Bunger Hills belong to a biogeographic region of high invertebrate diversity including mites, tardigrades, nemotodes and rotifers. Terrestrial microbial communities would be expected to include cyanobacteria, bacteria, and protozoa, edaphic algae, and terrestrial algae (described below) (Gibson 2000).

A list of terrestrial microbiota species previously recorded in the Bunger Hills is provided in Gibson (2000). Note that this list is not definitive.

4.4 Terrestrial Flora

Terrestrial flora of the Bunger Hills consists of lichens, mosses, algae and fungi. Numerous species of lichens and mosses have been recorded from the area, especially along the southern ice edge alongside Apfel Glacier (Leishman et al. 2020). Distributions are in part related to sediment salinity, with vegetation typically confined to less salty areas (Leishman et al. 2020).

Epilithic algae, evident as black stains on rock faces especially in areas of summer seepage, are widespread throughout the southern Bunger Hills. Rich sublithic algal communities also exist beneath light coloured rocks (generally small quartz cobbles) (Gibson 2000).

Mosses are widely distributed throughout the southern Bunger Hills, with most lush mosses found in melt streams emanating from snowbanks or in streams between lakes. Lichens are more abundant

[5] Colin Southwell, 8 September 2022
[6] John Gibson, 5 May 2022

near meltwater and surface streams and are rarer in areas of the north and west (and near EDB), possibly because of increased soil salinity.

One species of lichen, *Bruellia frigida,* is common around EDB. Mosses are generally not found around the tarn drainage area (Gibson, J. *pers. comms*.[7]).

Terrestrial flora species previously recorded in the Bunger Hills are listed in Gibson (2000). Note that this list is not definitive.

4.5 Aquatic Flora and Fauna

The benthic flora of the lakes in the Bunger Hills is abundant. Nearly all lakes have thick microbial mats consisting of a community of species including cyanobacteria, chlorophytes, diatoms, mosses, and a suite of heterotrophs that graze upon this material (Gibson 2000). Major stream beds in the southern Bunger Hills are also colonised by thin, black cyanobacterial crusts, with occasional patches of green algae (Gibson 2000).

The lake fauna of the Bunger Hills, including those of epishelf lakes such as Transkripsii Inlet, are of considerable importance. A number of species are of biogeographical importance and have a very limited distribution (Gibson, J. *pers. comms*.[8]). In addition to copepods, rotifers and platyhelminths have also been recorded (Gibson 2000).

Aquatic flora species previously recorded in the Bunger Hills are listed in Gibson (2000). Note that this list is not definitive.

4.6 Geological Importance

The Bunger Hills region comprises primarily granulite facies rocks with igneous and sedimentary protoliths, voluminous weakly deformed gabbro–granite and mafic dykes (Tucker et al. 2020).

The Bunger Hills, islands and peninsulas immediately to the north and several nunataks within the Denman Glacier, are of fundamental importance in understanding the tectonic evolution of the Precambrian East Antarctic Craton (Tucker et al. 2020).

4.7 Cultural and Heritage Values

EDB and surrounds contain physical objects such as buildings and discarded items that form part of the legacy of human history in Antarctica. Gore et al. (2020) describe the types and distribution of anthropogenic items throughout the Bunger Hills, which have accumulated since the advent of scientific expeditions in the Bunger Hills in 1958.

The closest Historic Sites or Monuments (HSM) are HSM49, a concrete pillar erected by the First Polish Antarctic Expedition, and HSM10, a former Soviet station magnetic observatory. Both are located at Dobrolowski Station, approximately 7 km south-east from EDB.

There are no heritage items in the Bunger Hills listed in the Antarctic Heritage Register.

[7] John Gibson, 5 May 2022
[8] John Gibson, 31 August 2022

4.8 Meteorology and Climate

The climate of Bunger Hills is similar to that of other rocky coastal areas of the East Antarctic coastline. In most aspects, the climate is close to that of the Vestfold Hills, including temperature regime, pressure, precipitation and cloudiness (Gibson 2000). Weather data recorded by an automatic weather station (AWS) installed at EDB by the Australian Bureau of Meteorology (BoM) from December 2015 through to June 2022 show temperatures up to a maximum of 5.8°C in summer and minimum of -37.6°C in winter, with a mean air temperature of -7.4°C over a three-year period from 2015-2018 (BoM 2022).

Data on wind velocity and direction recorded at nearby Oasis station indicate that the modal winds are from the east, with a secondary component from the west over the complete year, but with another component from the north, in December (Gibson 2000). The Australian AWS reported stronger winds occurring from the east with speeds up to 32.9 m s^{-1} (average 7.3 m s^{-1}), while from the west the average was 2.3 m s^{-1} (BoM 2022). Precipitation is usually in the form of snow, with an average of 204 mm of precipitation recorded at Oasis between 1956 and 1958 (Gibson 2000).

4.9 Human Presence

The Bunger Hills have been visited over the last 75 years at low levels relative to other areas of East Antarctica (Gore et al. 2020). There are three scientific stations in the Bunger Hills, built between 1956 and 1987, with none being occupied on a permanent basis:

- EDB (Australian)
- Dobrowolski Station (the former Soviet station “Oasis” transferred to Poland in 1958), and
- Oasis-2 Station (Russia).

The nearest permanently inhabited Antarctic station to the Bunger Hills is the Russian base Mirny, located 340 km to the west.

EDB was established as a summer camp in 1985-86 and is located in the southern Bunger Hills, adjacent to the Transkripsii Inlet and northwest of Algae Lake. In addition to the presence of the apple and melon huts, there is evidence of human activities around EDB, including the AWS located on the ridge to the south of the huts. The AWS is operated by the Australian BoM with logistical support from the AAD.

Across the broader Bunger Hills there is substantial evidence of previous human occupation and activities. Types and distributions of anthropogenic rubbish have been documented at Bunger Hills by Gore et al. 2020, and include deliberately or negligently discarded items (gas cylinders, fuel drums, broken glass), abandoned unserviceable equipment (boats, vehicles, scientific equipment), spills (chemicals, fuel, oil), and old buildings that are slowly collapsing. In addition, tyre tracks are common throughout the Bunger Hills, particularly near the stations.

4.10 Scientific Values

Ice free areas in Antarctica are scarce. Accordingly, their scientific and research values are immense. The Bunger Hills region’s features are individually remarkable and highly significant in their aggregation as components of a habitat island and small ecosystem.

4.11 Wilderness, Aesthetic and Intrinsic Values

The Bunger Hills is an area of outstanding wilderness and aesthetic value. Beyond the vicinity of EDB and the abandoned Oasis-2 and Dobrowlski stations, the Bunger Hills has features that contribute to senses of beauty, solitude, remoteness, discovery, and scale.

5 ASSESSMENT OF ENVIRONMENTAL IMPACTS

5.1 Methodology

The assessment of environmental impacts from the DTC operational support project involved four key stages consistent with the objectives of Annex I of the Protocol on Environmental Protection to the Antarctic Treaty and AAD's Environmental Management System (EMS) approach to managing the AAD's interaction with the environment:

1. Identify the key activities of the project (Section 5.2)
2. Identify the environmental aspects, i.e., how the activities interact with the environment (Section 5.3)
3. Identify the environmental impacts, i.e., the change in environmental values or resources as a result of the activities (Section 5.4), and
4. Assess the significance of impacts, including the spatial extent, duration, and environmental consequences (Section 5.5).

The assessment of significance was based on the likelihood and consequence of a particular impact or group of impacts occurring because of an activity. The assessment incorporated past knowledge and experience in conducting activities both within the Bunger Hills and in other ice-free areas of Antarctica (e.g. Vestfold Hills) and advice from subject matter experts within the AAD operations and science areas. In order to determine the overall significance and risk, each potential impact was assessed based on the likelihood of the impact occurring to the following criteria:

(i) **Likelihood of the impact occurring**

Table 2: Likelihood descriptions.

Likelihood Guide	
Almost Certain	Is expected to occur in most circumstances. Has occurred in the AAD or similar in the past year.
Likely	Will probably occur. Has occurred in the AAD or similar in the past two years.
Possible	Might occur (could happen) at some time in the future. Has occurred in the AAD or similar in the past five years.
Unlikely	Could occur but considered unlikely or doubtful. Has occurred in the AAD or similar in the past ten years.
Remote	May occur in exceptional circumstances. Has not occurred in the AAD or similar in the past ten years.

(ii) **Consequence of the impact occurring**

Table 3: Consequence descriptions.

Consequences Guide	
Insignificant	Minor incident of environmental damage that can be reversed.
Minor	Isolated but significant instances of environmental damage that could be reversed with intensive efforts.
Moderate	Significant instances of environmental damage that could be reversed with intensive efforts.
Major	Major loss of environmental amenity and real danger of continuing.
Catastrophic	Severe widespread loss of environmental amenity and irrecoverable environmental damage.

In determining significance, the following additional criteria were used to take into consideration the range of potential consequences resulting from an activity or impact.

- Spatial extent
- Reversibility
- Intensity/magnitude, and
- Duration.

Table 4 provides additional guidance in assigning an environmental consequence rating. Where activities could result in a combination of impacts and consequence ratings, the highest rating was used in the impact assessment.

Table 4: Environmental consequence criteria descriptions.

Additional Guidance for Environmental Consequences					
Environmental Consequences	**Insignificant**	**Minor**	**Moderate**	**Major**	**Catastrophic**
Spatial extent – over what approximate area are environmental impacts likely to occur?	<10 m^2 e.g. less than 3m x 3m or 5m x 2m	<100 m^2 e.g. less than 10m x 10m	<1,000 m^2 e.g. less than 32m x 32m or 10m x 100m	<10,000 m^2 e.g. less than 100m x 100m or 10m x 1000m	>10,000 m^2 e.g. over 100m x 100m or 10m x 1000m
Reversibility – how possible is it that the environmental ***impacts*** can be reversed?	Reversible with minor intervention	Reversible with moderate intervention	Reversible with intensive effort	Reversible with intensive long-term effort	Effectively irreversible
Intensity / magnitude – how much change to the environment is likely to occur?					
Consider change to landscape features *e.g. stone polygons, rare or unusual rock formations or mineral assemblages, ice-free areas.*	Degradation or loss of < 1% of the area of local occurrences of a landscape feature	Degradation or loss of < 5% of the area of local occurrences of a landscape feature	Degradation or loss of <20% of the area of local occurrences of a landscape feature	Degradation or loss of <50% of the area of **local** occurrences of a landscape feature *or* Degradation or loss of up to 5% of the area **of all known occurrences** of a landscape	Greater than 50% of the area of **local** examples of a landscape feature *or* Degradation or loss greater than 5% of the area **of all known occurrences** of a landscape

Additional Guidance for Environmental Consequences					
Environmental Consequences	**Insignificant**	**Minor**	**Moderate**	**Major**	**Catastrophic**
				feature (globally)	feature (globally)
Consider change to species of fauna and flora, including threatened species *e.g. moss beds, invertebrates.*	No observable change	Some individuals impacted. No population impact and no impact on threatened species	Loss of individuals. Minimal impact on population *or* Some impact on individuals of threatened species	Substantial impact on or loss of population. Potential loss of genetic diversity *or* Loss of individuals of threatened species	Local extinction of species. Loss of genetic diversity *or* Impact on one or more populations of threatened species
Consider change to environmental values of sites *e.g. biological, scientific, historic, aesthetic or wilderness value.*	No observable change	Some degradation of values	Substantial degradation or loss of values *or* Some degradation of values within nationally or internationally significant sites (ASPA, ASMA & Heritage managed areas)	Loss of values *or* Substantial degradation of a nationally or internationally significant site	Loss of values of a nationally or internationally significant site
Duration – over what period are the ***impacts*** likely to occur?	<1 month	<1 year	<5 years	<15 years	>15 Years

(iii) **Risk Rating**

The likelihood and consequence were considered for each activity against the aspects of the environment it interacts with and the potential environmental impacts. The following risk ratings were applied for activities pre- and post-mitigation.

Table 5: Environmental risk rating matrix.

Likelihood	**Consequence**				
	Insignificant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost Certain	Medium	Medium	High	Severe	Severe
Likely	Low	Medium	High	High	Severe
Possible	Low	Low	Medium	High	High
Unlikely	Low	Low	Medium	Medium	High
Will be remote	Low	Low	Low	Medium	Medium

For the purposes of this assessment the following classification was applied to this residual risk rating for the activities described in Section 5.2. These reflect the three levels of impact significance described in Article 8(1) of the Environmental Protocol.

Table 6: Relationship of risk ratings to the levels of impact significance described in Article 8(1) of the Environmental Protocol.

Risk Rating	Level of significance
Low	Less than minor or transitory
Medium	No more than minor or transitory
High	More than minor or transitory
Severe	

5.2 Proposed Activities

A detailed description of the scope and locations of the activities associated with the DTC operational support project is provided in Section 2 of this document. These activities have been summarised for the impact assessment process:

- Field hut replacement
- Site preparation, including preparations for new tent sites, improvements to existing tent sites, helipad clearing, formation of temporary laydown areas for cargo, marking and possible clearing of paths, and possible drainage diversion
- Cargo positioning and storage, including transport of cargo from the ice to laydown areas on ice-free and snow-covered areas, and storage of some cargo over winter
- Installation of temporary communications and water storage infrastructure
- Collection of water samples, and
- Operation of field camp, including fuel and waste management.

5.3 Environmental Aspects

Environmental aspects are the element of an organisation's activities, products or services that interact or can interact with the environment (ISO-14001). As described in the *Revised Guidelines for Environmental Impacts Assessment in Antarctica (2016)* (Annex I of the Protocol on Environmental Protection to the Antarctic Treaty), an environmental aspect may include emission of pollutants/noise/light, human presence, transfer of native or non-native species, direct contact with wildlife/vegetation, leak or spill of hazardous substances, etc. Environmental aspects may also involve removal from the environment of organic or inorganic material including, collection of fauna and flora and the removal of water, ice or rocks.

The AAD uses the following definitions in its EMS Environmental Aspects and Impacts Register.

- Energy Use – includes the use of electricity, non-renewable resources, refrigerants, water and release of exhaust, gaseous and radioactive emissions.

- Physical Disturbance – includes human activities, introduction of non-indigenous species, parasites and diseases, disturbance to soils, flora, fauna, communities and ecosystems, building and infrastructure maintenance and construction and station activities.
- Hazardous Chemicals – İncludes the storage, use and disposal of chemicals and hazardous materials.
- Waste Management – includes the management of combustible, hazardous, sewage and domestic liquid and solid waste products.

5.4 Potential Impacts and Mitigation Measures

This section outlines the potential environmental impacts resulting from the proposed activities described in Sections 2 and 5.2. The potential impacts, inherent and residual risk and mitigation measures are presented Section 5.5 Evaluation of Environmental Impacts.

The following categories of environmental impact have been used in this assessment:

- Biological change
- Habitat/landscape change
- Disturbance of fauna
- Noise pollution
- Pollution of water, sediments, snow and/or ice
- Pollution of the air
- Degradation of heritage or cultural values, and
- Degradation of wilderness values.

The following sections describe the potential for these environmental impacts to occur as a result of the key activities listed in Section 5.2.

5.4.1 Biological Change

The loading of cargo, equipment, stores and personnel in Hobart for transport to Antarctica has the potential to introduce non-native species, parasites and diseases to Antarctica, which could establish in terrestrial and/or lacustrine environments of the Bunger Hills.

Extraction of water from the tarn and lakes for drinking, cleaning and sampling purposes has the potential to translocate Antarctic species between different waterbodies. Personnel walking across ice-free areas of the Bunger Hills and/or moving soil and rock may also translocate species into other areas.

Biological change may also occur through the accidental release of wastewater to ice-free, snow covered or marine areas.

Mitigations include:

- All equipment and supplementary materials will be subjected to existing AAD cargo biosecurity screening and treatment procedures co-ordinated by the AAD Supply Services Team prior to departure.
- All expeditions will partake in eLearning *PDE101 Introduction to Environmental Management in Antarctic/sub-Antarctic* and attend an Environmental Management pre-departure session.

- AAD policies and procedures will be followed to ensure that all equipment is thoroughly cleaned of organic matter prior to arriving in Antarctica.
- The field team will follow biosecurity and waste management procedures within the *2022 AAD Field Manual (23rd ed.)* and *Station and Field Waste Management Guide*.
- Under no circumstances will wastewater be deposited on ice-free land or in tarns/lakes. All solid and liquid human waste, wastewater and packaging generated at the field camp will be packaged in appropriate receptacles and returned to Casey station.
- The field team will employ water sampling/extraction methods designed to minimise impacts to waterbodies, e.g. use of a sampling pole from the lake edge, cleaning equipment between each site to prevent cross contamination.

5.4.2 Habitat and Landscape Change

The landscape within the immediate vicinity of EDB will be modified temporarily to prepare the site for the DTC field campaigns, including for the preparation of new tent (and possibly melon hut) sites, improvements to existing tent sites, helipad clearing, formation of temporary laydown areas for cargo, marking and possible clearing of paths, and possible drainage diversion. Tie down points will be installed for hut and tent platforms, helicopters, communications and water infrastructure, and possibly cargo. Star pickets will be temporarily installed to mark paths throughout the site. Groundworks will be completed by hand and will involve redistribution of surficial sediment and rock.

In addition to groundworks, habitat change may result from field personnel walking on ice-free areas around EDB and surrounds, and the settling of dust generated through movement of rocks and soil. Dust generation is expected to be very minimal as no heavy machinery will be used in ice-free areas. These activities may impact a small number of individual plants, algae and microbiota.

Habitat and landscape alterations will be remediated in the 2024-25 season.

Mitigations include:

- Work areas will be kept to the minimum necessary to accommodate the expected number of personnel and to ensure safety at the camp.
- Existing disturbed areas will be used preferentially for tent sites and paths.
- Where possible, wooden hut and tent platforms will be used to position accommodation off the substrate.
- Camp design will employ principles of human-centred design when locating paths for foot traffic, e.g. co-locating areas frequently visited by personnel and creating straight paths between these areas where possible (while following the natural contours of the landscape and avoiding soft vegetation).
- All groundworks will be completed carefully, by hand, to minimise ground disturbance and limit generation of dust – heavy machinery will not be used.
- Groundworks will be undertaken during low wind conditions.
- Rocks that are moved during groundworks will be placed in their original orientation to minimise disturbance to endolithic communities.
- Pre-disturbance photographs will be taken to facilitate remediation in the 2024-25 season.

5.4.3 Disturbance of Fauna

DTC operational activities pose a variety of potential causes and sources of impacts that may result in disturbance of fauna. These include noise generated from construction works and vehicle movements; disturbance to microbiota through movement of soil and rock and walking on ice-free areas; operation of remotely piloted aircraft during collection of pre-disturbance imagery; potential exposure to chemicals from fuel spills or inadvertent release of solid or liquid wastes; potential ingestion or engagement in waste generated at the field camp, and; inadvertent disturbance during water sampling and daily camp activities due to movement, noise and light. Aircraft operations, including movement of passengers and cargo between the aircraft and EDB, also present the potential for disturbance of fauna, particularly flying seabirds.

Given the terrain, coastal location, and timing of project activities in relation to wildlife breeding periods, personnel may encounter seabirds in flight or nesting. As recent seabird surveys have not been conducted in the Bunger Hills, the probability of these encounters is unknown (Southwell, C. *pers. comms.*[9]).

The AAD has extensive experience and established procedures and guidelines for working in and around wildlife. These are regularly reviewed and updated based on new information, research, and/or investigations into past incidents.

Mitigations include:

- An initial evaluation will be conducted upon arrival to identify areas with the greatest likelihood of encountering wildlife, including potential nesting areas. Movements in and around these areas will be avoided or minimised throughout the field season.
- Checks for seabird nests (including evidence of previous nests) will be completed prior to any movement of rock or soil.
- All personnel will be made aware of wildlife separation distances in AAD mandatory Pre-departure training.
- The field team will follow all AAD Standard Operating Procedures (SOPs) and wildlife approach distance guidelines.
- The field team will be briefed in and remain alert to changes in wildlife behaviour – especially changes in posture or vocalisations. Activities will be paused if disturbance is detected, and personnel will move away slowly and quietly.
- If a seabird nest is located it will not be disturbed – an exclusion zone equivalent to the relevant separation distance will be placed around the nest.
- Within EDB, foot traffic will be primarily along defined paths.
- The field team will avoid or minimise the use of lighting during hours of darkness.
- Pilots will follow *AAD Standard Operating Procedure Operations Manual Volume 5* and *Environmental Policy on Unmanned Aerial Systems (Drones)*, which set out the AAD's procedures to ensure the safe and environmentally sensitive operation of unmanned aerial systems in Antarctica.

[9] Colin Southwell, 9 September 2022

- Aviation operations will comply with the existing guidelines and separation distances to reduce impacts on wildlife, identified in the IEE *Environmental Impact Assessment – Australian Antarctic Program Aviation Operations 2020-2025*[10].
- Where possible, power tools will not be operated within 50 m of individuals or 200 m of concentrations of wildlife.
- All items, including food scraps, will be secured to avoid interference by wildlife, degradation by weather, and dispersion by wind. Dedicated storage containers will be included in the field equipment.
- Waste will be managed in accordance with the *2022 AAD Field Manual (23rd ed.)* and the *Station and Field Waste Management Guide*.
- All solid waste, including solid human waste, will be double bagged into sealed containers for return to Casey station for treatment and/or incineration, or to Australia for recycling/landfill.
- Water extraction methods will be designed to minimise disturbance of microbiota in the tarn or around the tarn edge, e.g. use of a flexible pipe from outlet stream or use of submersible pump in the tarn, both of which can be left in place to avoid repeated travel along the tarn margins.

5.4.4 Noise Pollution

Emissions of noise will occur through use of powered and non-powered carpentry tools for construction and through operation of aircraft, walking tractors, quad bikes, and generators. Noise will also be generated during general camp usage and field activities (e.g., talking). Noise pollution impacts the wilderness values of an area (Section 5.4.8) and has the potential to impact on wildlife (Section 5.4.3).

Mitigations include:

- To minimise noise at EDB, wooden tent platforms will be constructed off-site (either Hobart or Casey station).
- Petrol-powered tools, which are typically noisier than battery powered tools, will not be brought to site.
- Minimising the use of generators and vehicles where possible.

5.4.5 Pollution of Water, Sediments, Snow and/or Ice

The proposed fieldwork operations have the potential to introduce environmental impacts associated with hydrocarbon spills (through incorrect use of machinery and equipment, tank puncture, machinery failure, fuel drum rupture or spill), waste disposal (through accidental release of solids and wastewater, and water sampling (through accidental release of chemical preservatives). If mitigation measures are not in place, there is the potential for adverse environmental impacts to visual and aesthetic values and ecological regimes.

Mitigations include:

- All field personnel will be trained in spill procedures and response.

[10] https://documents.ats.aq/EIES/EIA/02221enFinal%20IEE%202020-24_AAP%20Aviation_October%202020.pdf

- Fuel will be appropriately stored in sealed drums/tanks until use and managed to limit the possibilities of contamination to the environment.
- Refuelling will be conducted in accordance with the *AAD Standard Operation Procedure Operations Manual* and all fuels and lubricants will be handled in accordance with the *Hazardous Chemicals Management Policy* and procedures.
- Fuel spill kits and absorbent pads will be available in the event of a spill.
- All materials and equipment will be secured and stored in a manner that prevents windblown debris.
- Waste will be managed in accordance with the *2022 AAD Field Manual (23rd ed.)* and the *Station* and *Field Waste Management Guide* (with the exception of human waste and grey waste, as per below):
    - All solid waste, including solid human waste, will be double bagged into sealed containers for return to Casey station for treatment and/or incineration, or to Australia for recycling/landfill.
    - All liquid waste, including liquid human waste, will be stored in sealed containers and returned to Casey station for treatment and disposal.
- To avoid accidental release of chemical preservatives into waterbodies, preservatives will be added to water samples at a distance of at least 10 m from a waterbody.
- Existing AAD emergency response and fuel spill response plans will be used in the event of an incident. For any emergencies or unexpected impacts on the environment, response plans will be developed in consultation with the Project Manager and AAD Environmental Manager. All avenues to reduce impacts would be considered and performed with appropriate managers' approvals.

5.4.6 Pollution of Air

Pollution of the air will result from the combustion of fuel and emissions to the environment from exhaust of quad bikes, walking tractors, generators and camp stoves. Emissions will include carbon dioxide, carbon monoxide, nitrous oxides, sulphur dioxide, particulates, and trace amounts of heavy metals. Emissions are expected to be rapidly dispersed by wind, although there will be some deposition of pollutants in the local area. Whilst it is acknowledged that the emissions resulting from the logistics and other field activities all contribute to a reduction in air quality, the impacts are expected to be minor and unavoidable.

Mitigations:

- All machinery (generators, walking tractors, quad bikes, camp stoves) will be maintained and serviced prior to departure to ensure maximum efficiency.
- The use of quad bikes, walking tractors, generators, and stoves will be minimised where possible.

5.4.7 Degradation of Heritage or Cultural Values

With the exception of replacing the existing field huts at EDB, there is no intention to interfere with any cultural or heritage items in the Bunger Hills (including HSM49 and HSM10 at Dobrolowski station). Time permitting, the 2022-23 field team may assess the effort and logistics required to remove any historical rubbish around EDB to inform future clean-up and remediation efforts.

Mitigations to avoid disturbing any unidentified heritage items include:

- If potential heritage sites are identified, photographs will be taken and the location recorded to enable heritage assessment.
- If heritage sites are identified within a working area, markers will be installed to prevent access to the site, and management strategies will be advised by the Project Manager and Manager of the Antarctic and Environmental Regulation (AER) section.

5.4.8 Degradation of Wilderness Values

Human presence in Antarctic has the potential to impact on landscape and wilderness values. This is an unavoidable consequence of operating in an environment characterised by the lack of human activity. DTC operational support activities will lead to a short-term degradation of wilderness values through modification of the landscape, generation of noise, and operation of remotely piloted aircraft.

Mitigation measures to avoid or minimise these impacts have been discussed in the sections above. Remediation techniques are proposed to be adopted for the 2024-25 season to visually reinstate areas to resemble pre-work conditions where track use and groundworks have been undertaken. Based on visual photographic records reviewed from the 2022-23 field season, it is anticipated that ground disturbance may be slightly discernible at the completion of the field season, but that it will not be visible in the future due to natural weathering processes.

The AAD has a successful record of remediation of much larger scale disturbance for previous geotechnical investigations in the Vestfold Hills, and similar principles will be applied to the DTC (though on a much smaller scale as heavy machinery will not be required).

5.4.9 Impacts on Other Programs or Projects

The DTC operational support project may interface with other programs and projects in the Antarctic region through the utilisation of resources and logistical support at Casey station and through the requirement for berths and seats on transport to and from Antarctica. These programs and projects will submit environmental applications as required and have not been considered within the scope of this IEE. There are no known AAP projects to be co-located at EDB in 2022-23.

5.4.10 Cumulative Impacts

Cumulative impacts are changes to the environment caused by the combined impact of past, present and future human activities. The multiple impacts of different activities can have an additive, synergistic or antagonistic effect on one another and with natural processes. Evidence of the previous 33+ field expeditions to the Bunger Hills are obvious through the area, mostly in the form of deliberately or negligently discarded items (gas cylinders, broken glass), abandoned unserviceable equipment (boats, vehicles, scientific equipment), spills (chemicals, fuel, oil), tyre tracks, and the slow collapse of old buildings (Gore et al 2020).

Gore et al. (2020) noted that one of the most concerning human impacts in the Bunger Hills is the actual and potential loss of station buildings and field huts. When strong winds gain ingress to field huts the structures can fail with large-scale dispersal of debris from the hut and its contents (Gore et al. 2020). Such an event has previously occurred at EDB. Replacement and removal of the existing field huts at EDB during the DTC operational support project will significantly reduce the potential for this impact.

There are no other known programs (national or international) operating in the Bunger Hills in 2022-23; however, other field programs will occupy areas of the Bunger Hills in future years. In 2019, Poland announced its intention to revitalise Dobrowolski station for the purposes of conducting scientific research[11]. From January to February 2022, a group of scientists spent 6 weeks reactivating the station (including maintenance on the stations' wooden buildings) and installing year-round, autonomous geophysical equipment (seismic, magnetic), an AWS, and an antenna for ionosphere research. Oasis-2 station was also occupied during this time[12]. These activities indicate a renewed international interest in conducting science within the Bunger Hills. Likewise, the DTC will occur over a period of three years, thus cumulative impacts resulting from habitat/landscape change, foot traffic, disturbance of fauna, introduction of non-native biota, and pollution need to be considered.

In the case of the DTC, ground disturbance presents the greatest possibility for cumulative impact, with the greatest intensity of impacts expected in the 2023-24 field season (see Table 1). The intention is to remediate all signs of ground disturbance during the decommissioning period in 2024-25, with the success of remediation efforts monitored through the collection of baseline and post-remediation data (e.g. aerial imagery). Management of the camp during the scientific field seasons will take into consideration environmental impacts, logistical constraints and guidance from other field campaigns.

11 https://dobrowolski.igf.edu.pl/

12 https://titan.uio.no/blogg/2022/what-happened-between-antarctica

5.5 Evaluation of Environmental Impacts

DTC Operational Support Project 2022-23 Environmental Impact Matrix						Inherent Risk Rating				Residual Risk Rating		
Activity #	**Location**	**Activity description**	**ASPECTS**	**IMPACT(S)**	**Potential causes/sources of an impact happening**	Likelihood	Consequence	**RISK**	**Existing Reduction/Control Measures - against the Aspect.**	Likelihood	Consequence	**RISK**
1	Antarctica, Hobart	Field hut replacement and site preparation: - Transfer and storage of cargo	Physical disturbance-Introductions	Biological change, Habitat change	1. Inter and intra-continental transfer of non- native species. 2. Accidental introduction of non-native species through accidental carriage on clothing and personal items	Likely	Moderate	**High**	1. Cargo Biosecurity Standard Operating Procedure (SOP) includes procedures, staff training, emergency response and maintenance of buildings, external work areas and equipment. 2. It is mandatory for all AAP expeditioners to complete eLearning PDE101 Introduction to Environmental Management in Antarctic/sub-Antarctic and to attend an Environmental Management pre-departure session. Both presentations cover biosecurity. 3. Cargo, equipment and stores quarantined at AAD head office/CBC before being loaded onto vessel. 4. The CBC has an approved arrangement with the Australian Government to manage biosecurity risks on the Government's behalf. The AAD maintains an incident reporting system to monitor, respond and learn from biosecurity issues and threats, in a timely and effective manner. 5. AAD policies and procedures will be followed to ensure that all equipment is thoroughly cleaned of organic matter prior to arriving in Antarctica. 6. AAD Operations Manual Volume 5 - Aviation 7. Alien Species Invertebrate Kit to be taken to site and used to collect alien specimens if needed.	Possible	Minor	**Low**
2	Antarctica	Field hut replacement and site preparation: - Groundworks	Physical disturbance-Landscape	Degradation of wilderness values, Destruction of flora, Disturbance of fauna, Habitat change, Landscape change	1. Modification of the landscape through movement of rock and soil for clearing and/or levelling of tent, hut and helipad sites, laydown areas, paths, drainage diversion. 2. Covering of substrate and installation of tie downs for hut and tent platforms, helicopters, communications and water storage infrastructure, cargo. 3. Ground disturbance due to walking on ice-free areas around Edgeworth David Base and surrounds. 4. Use of star pickets to mark paths.	Almost certain	Minor	**Medium**	1. Keep work areas to a minimum necessary to accommodate number of expected personnel and to ensure safety at camp. 2. Remediate any disturbance in the 2024-25 season. Take pre-disturbance photographs to facilitate remediation efforts. 3. Use existing disturbed sites for tent sites and paths. 4. Where possible, utilise wooden tent platforms that are positioned above the rocky substrate, avoiding the need to clear most rocks. 5. Employ human-centred design when locating paths for foot traffic, e.g. co-locate areas frequently visited by personnel and create straight paths between these areas where possible (while still following the natural contours of the landscape and avoiding soft vegetation). 5. Checks for seabird nests (including evidence of previous nests) will be conducted prior to any movement of rock or soil. 6. Rocks that are moved during groundworks to be placed in their original orientation to minimise disturbance to endolithic communities. 7. Follow AAD's Wildlife Approach Distance Guidelines. Remain alert to changes in wildlife behaviour – especially changes in posture or vocalisations. Cease activities if disturbance is detected. Move away slowly and quietly. 8. If a seabird nest is located it will not be disturbed - an exclusion zone equivalent to the relevant separation distance will be placed around the nest.	Likely	Insignificant	**Low**
3	Antarctica	Field hut replacement and site preparation: - Groundworks	Physical disturbance-Dust emission	Degradation of wilderness values, Destruction of flora, Disturbance of fauna, Habitat change, Landscape change	1. Dust generation through movement of rocks and soil for clearing and/or levelling of tent, hut and helipad sites, laydown areas, paths, drainage diversion (all groundworks will be completed by hand).	Possible	Minor	**Low**	1. Dust generation is expected to be minimal as no heavy machinery will be used for clearing and levelling activities. 2. Keep work areas to a minimum necessary to accommodate number of expected personnel and to ensure safety at camp. 3. Careful placement of rocks during movement by hand to limit generation of dust. 4. Undertake work during low-wind conditions.	Unlikely	Insignificant	**Low**

DTC Operational Support Project 2022-23 Environmental Impact Matrix						Inherent Risk Rating				Residual Risk Rating		
Activity #	**Location**	**Activity description**	**ASPECTS**	**IMPACT(S)**	**Potential causes/sources of an impact happening**	Likelihood	Consequence	**RISK**	**Existing Reduction/Control Measures - against the Aspect.**	Likelihood	Consequence	**RISK**
4	Antarctica	Field hut replacement and site preparation: - Noise generation	Physical disturbance-Noise emission	Noise pollution, Disturbance of fauna, Degradation of wilderness values	1. Use of powered and non-powered carpentry and construction tools. 2. Cargo positioning using vehicles and machinery (walking tractors). 3. General camp usage (generators, talking).	Almost certain	Minor	**Medium**	1. Follow AAD's Wildlife Approach Distance Guidelines. The AAD has extensive experience and established procedures and guidelines for working in and around wildlife. These are regularly reviewed and updated based on new information, research or investigations into past incidents. 2. Remain alert to changes in wildlife behaviour – especially changes in posture or vocalisations. Cease activities if disturbance is detected. Move away slowly and quietly. 3. Where possible, do not operate power tools within 50 m of individuals or 200 m of concentrations of wildlife 4. Use only battery-powered power tools rather than petrol powered tools. 5. Minimise the use of generators and vehicles where possible. 6. Wooden tent platforms will be constructed off site (either Hobart or Casey station).	Almost certain	Insignificant	**Medium**
5	Antarctica	Field hut replacement and site preparation: - Use of remotely piloted aircraft (RPA)	Physical disturbance-Human impact	Noise pollution, Disturbance of fauna, Degradation of wilderness values	1. Use of RPA to take pre-disturbance photographs of camp site to inform remediation efforts.	Likely	Minor	**Medium**	1. Follow the AAD Operations Manual Volume 5, and Environmental Policy on Unmanned Aerial Systems (Drones), which set out the AAD's procedures to ensure the safe and environmentally sensitive operation of unmanned aerial systems in Antarctica.	Possible	Insignificant	**Low**
6	Antarctica	Field camp operation: - use of generators, camp stoves and machinery	Energy use-exhaust emission	Pollution of the air, Depletion of non-renewable resources	1. Combustion of fuel and increase in emissions to the environment from exhaust.	Almost certain	Insignificant	**Medium**	1. All machinery (generators, walking tractors, quad bikes, camp stoves) maintained and serviced prior to departure to ensure maximum efficiency. 2. Wind disperses particulates and minimises risk of emission concentrations. 3. Minimise the use of generators, stoves, walking tractors, and quad bikes.	Likely	Insignificant	**Low**
7	Antarctica	Field camp operation: - storage and usage of fuel	Energy use-Leak/spill of fuels	Degradation of wilderness values, Destruction of flora, Disturbance of fauna, Habitat change, Pollution of land, Pollution of sea water/ sediments, Pollution of inland waters/sediments	1. Incorrect use of machinery and equipment. 2. Vehicle related incident. 3. Tank puncture. 4. Machinery failure. 5. Fuel drum spill or rupture.	Possible	Moderate	**Medium**	1. Visual inspections conducted daily. 2. Training of personnel and application of best practice fuel management to reduce the likelihood of fuel spills caused by human error. 3. AAD Operations Manual: - Volume 1 : Station and Field - Volume 2: Emergency Response 4. 2022 AAD Field Manual (23rd ed.) 5. Hazardous Chemicals Management policy and procedures. 6. AAD Incident Reporting system.	Unlikely	Minor	**Low**
8	Antarctica	Field camp operation:- solid waste management	Waste Management-Landfill, Waste Management-Combustible solids	Degradation of wilderness values, Disturbance of fauna, Pollution of inland waters/ sediments, Pollution of land, Pollution of sea water/sediments	1. Accidental release of solids to ice-free or snow covered areas.2. Degradation of materials due to poor storage.3. Ingestion or entanglement of solid wastes (including packaging) with wildlife.	Possible	Moderate	**Medium**	1. All solid waste (including solid human waste) to be returned to Casey station for incineration or returned to Australia for recycling or landfill. 2. Waste to be managed in accordance with the 2022 AAD Field Manual (23rd ed.) and the AAD Station and Field Waste Management Guide. 3. Ensure all items are secured to avoid wind dispersion. Dedicated storage containers included in field equipment. 4. Ensure all food scraps are secured.	will be Remote	Insignificant	**Low**

DTC Operational Support Project 2022-23 Environmental Impact Matrix						Inherent Risk Rating				Residual Risk Rating		
Activity #	**Location**	**Activity description**	**ASPECTS**	**IMPACT(S)**	**Potential causes/sources of an impact happening**	Likelihood	Consequence	**RISK**	**Existing Reduction/Control Measures - against the Aspect.**	Likelihood	Consequence	**RISK**
9	Antarctica	Field camp operation: - wastewater management	Waste Management-Sewage/ greywater	Destruction of flora, Disturbance of fauna, Pollution of inland waters/ sediments, Pollution of land, Pollution of sea water/sediments	1. Accidental release of wastewater to ice-free, snow covered or marine areas.	Likely	Minor	**Medium**	1. Wastewater to be managed in accordance with the 2022 AAD Field Manual (23rd ed.) and the AAD Station and Field Waste Management Guide. 2. All wastewater to be returned to Casey station.	Possible	Minor	**Low**
10	Antarctica	Field camp operation - daily camp activities	Physical disturbance-Human impact	Degradation of wilderness values, Disturbance of fauna	1. Noise, movement and light generated from general camp usage and from field expeditions for recreational purposes and/or water sample collection.	Almost certain	Minor	**Medium**	1. Initial survey upon arrival to determine areas with greater likelihood of encountering wildlife, including potential nesting areas. Avoid, or minimise movements in those areas throughout the field season. 2. Limit movements to within the immediate vicinity of Edgeworth David Base to avoid disturbing areas with higher concentrations of wildlife. 3. Within Edgeworth David Base, minimise foot traffic to defined paths. 4. Avoid or minimise use of lighting during hours of darkness. 5. Follow AAD's wildlife approach distance guidelines. Remain alert to changes in wildlife behaviour – especially changes in posture or vocalisations. Cease activities if disturbance is detected. Move away slowly and quietly. 6. If a seabird nest is located it will not be disturbed - an exclusion zone equivalent to the relative separation distance will be placed around the nest.	Possible	Minor	**Low**
11	Antarctica	Field camp operation: - water extraction	Energy use-water/ equivalent	Destruction of flora, Disturbance of fauna, Pollution of inland waters/ sediments, Depletion of water/equivalent, Biological change	1. Removal of water from the tarn for drinking and/or cleaning purposes. 2. Disturbance of microflora and fauna in the tarn or around tarn edge when collecting water. 3. Introduction of non-native species into the tarn.	Almost certain	Minor	**Medium**	1. Employ water extraction methods designed to minimise impacts to waterbodies, e.g. use of a flexible pipe from outlet stream or use of submersible pump in the tarn, both of which can be left in place to avoid repeated travel along the tarn margins. 2. Minimum amount of water necessary to be removed from tarn. 3. Biosecurity and waste management procedures within the 2022 AAD Field Manual (23rd ed.) to be followed.	Possible	Minor	**Low**
12	Antarctica	Field camp operation: - water sampling	Physical disturbance-Taking samples	Destruction of flora, Disturbance of fauna, Pollution of inland waters/ sediments, Depletion of water/equivalent, Biological change	1. Removal of water from waterbodies for water sampling purposes. 2. Disturbance of microflora and fauna in waterbodies when collecting water samples. 3. Translocation of species between different waterbodies. 4. Accidental release of chemicals used to preserve water samples.	Possible	Major	**High**	1. Employ water sampling/extraction methods designed to minimise impacts to waterbodies, e.g. use of sampling pole from lake edge, cleaning equipment between each site to prevent cross contamination. 2. Preservatives added to samples at a distance of at least 10m from waterbody. 3. Minimum amount of water necessary to be removed from waterbodies. 4. Biosecurity and waste management procedures within the 2022 AAD Field Manual (23rd ed.) to be followed. 5. Hazardous Chemicals Management policy and procedures.	Unlikely	Minor	**Low**

This Impact matrix refers to a number of documents and procedures, which are the responsibility of the AAD. See **Appendix 4** for a complete list of documents mentioned in the IEE.

5.6 Environmental Monitoring and Management

Australia is strongly committed to the comprehensive protection of the Antarctic environment. The AAD is responsible for fulfilling that commitment, as well as mitigating and managing the environmental impacts of Australia's activities in the Southern Ocean and sub-Antarctic.

The AAD's Environmental Policy outlines a commitment to continual improvement in environmental management performance and forms the foundation of the AAD's EMS. The EMS is a systematic framework for managing the AAD's interaction with the environment. The system considers the environmental aspects, impacts, risks and opportunities associated with activities and strategic planning.

The overall objective of the EMS is to protect the unique environmental values of Antarctica and the Southern Ocean, and to ensure environmental monitoring and management are foremost in planning and operations within the organisation.

The objective of the environmental monitoring for the DTC operational support project will be to:

- ensure ongoing compliance with the *Antarctic Treaty (Environment Protection) Act* 1980
- ensure impacts are avoided or limited consistent with the environmental principles of the Madrid Protocol
- establish the accuracy of the IEE's conclusion that the impacts of aviation are likely to remain minor and transitory
- inform any changes needed to practices to comply with impact thresholds set by regulators
- ensure impacts are not in conflict with the broader community's expectations in relation to Antarctica's protection, and
- inform the mitigation of any unforeseen but potentially significant impacts associated with operations and activities described in this IEE.

Ongoing monitoring and measurement of the main impacts and key environmental indicators identified in the IEE include but are not limited to:

- wildlife presence
- ground disturbance,
- pollution of water, sediments, snow and/or ice, and
- biosecurity management.

A draft Environmental Monitoring Plan is provided in **Appendix 5**.

5.6.1 Incident and Hazards Reporting

The AAD's environmental incident and hazard reporting system is a key component of the AAD's EMS and provides the capacity to monitor and track activities or incidents which either directly or indirectly have the potential (near misses and improvements) to impact the environment. This reporting system forms part of a monitoring framework that identifies, prioritises and responds to environmental impacts or risks in real-time. The integration of this reporting system into AAD quarterly and annual reporting provides analysis of incidents and trends to identify and monitor

environmental impacts and response actions. AAD's environmental incident reporting system provides an evidence-based approach for the development and delivery of continual improvements to the AAD's EMS and Antarctic operations.

6 UNCERTAINTIES

Across the project team there is a high level of experience and understanding of the impacts of the proposed DTC operational support activities on the environment. Within the AAD, extensive knowledge of anthropogenic impacts to Antarctic ice-free areas has been gained through previous work in Bunger Hills and in the Vestfold Hills for the Davis Aerodrome Project. The activities described in this application are anticipated to have low or negligible environmental impact.

The following uncertainties/knowledge gaps are pertinent to the preparation of this assessment:

- There is limited recent information on wildlife concentrations and seabird breeding locations in the vicinity of EDB in the Bunger Hills – potential impacts on wildlife and vegetation were determined based on surveys completed between 1995 and 2000. The project team proposes to conduct a pre-disturbance survey of potential seabird nesting habitats and record wildlife observations throughout the 2022-23 field season (**Appendix 5**).
- Precise locations for groundworks and areas for surficial clearing are unknown at this stage and will be refined based on an assessment of site conditions in the 2022-23 season.

7 SUMMARY AND CONCLUSION

The activities described in this IEE are required to support the DTC scientific field campaigns in the 2023-24 and 2024-25 seasons. The field campaigns will target key parameters needed to understand the sensitivity of the Denman Glacier/Shackleton Ice Shelf system, which is necessary to predict future change. These field studies will require the utilisation of EDB huts which are in poor and aging condition. The DTC operational support component of the project proposes to combine EDB field hut replacement activities with site preparation and cargo pre-placement activities, in preparation for scientific field campaigns in the following seasons.

The DTC is an essential operational and infrastructure related component of the *Australian Antarctic Strategy and 20-year Action Plan*, which sets out Australia's national interests and our vision for Australia's future engagement in Antarctica. The Strategy's priorities for the next five years incorporate the renovation of existing field huts, establishing an air-deployable field base, and conducting world-class scientific research.

The assessment of impacts included in Chapter 5 of this IEE has identified that the majority of potential impacts can and will be mitigated through methods and technologies already tested on similar field camp activities and by using existing AAD procedures. The DTC operational support activities have been planned and designed to have minimum impact on the environment while enabling the successful establishment of camp facilities and storage of supporting equipment and materials. There is a high level of certainty in understanding the impacts of the proposed 2022-23

field activities on the environment, as they have all been undertaken in a form under various AAD projects over previous field seasons. This understanding extends to the environment in which the DTC operational support activities will be undertaken, gained from previous activities in similar environments, particularly for the Davis Aerodrome Project in the Vestfold Hills. Mitigation measures undertaken on similar projects provide assurance that potential impacts and mitigation measure associated with these activities have been identified.

Key environmental indicators, activities and incidents will be monitored to ensure unforeseen impacts are both monitored and managed appropriately, and in accordance with relevant SOPs. Monitoring these activities, through inspections, visual observations and incident reporting will ensure the DTC operational support activities remain compliant with international standards, the *Antarctic Treaty (Environment Protection) Act* 1980, the AAD's Environmental Policy, and the AAD's commitment to continuous environmental improvement.

This IEE concludes that, provided the activities and the mitigations are undertaken in the manner described, the DTC operational support activities will have no more than a minor or transitory impact.

8 AUTHORS

This IEE was prepared by Melissa Wrohan, Environmental Project Officer, Australian Antarctic Division 203 Channel Highway, Kingston Tasmania, with technical input from the Environmental Management Unit and advice from the AAD Science Branch and subject matter experts across the AAD.

Mailing Address:

Australian Antarctic Division
GPO Box 858
Canberra City, ACT 2601
Australia

9 ACKNOWLEDGEMENTS

Expert contributions on DTC operational support components included AAD personnel Donald Hudspeth and Martin Passingham. Dr John Gibson provided advice on the environmental values of the Bunger Hills. Dr Colin Southwell provided expert opinion on the possibility of encountering seabirds in the Bunger Hills.

Contributors to baseline environmental and impact assessment chapters, and the development of the environmental monitoring plan include: Andrew Sharman, Kirsten Leggett, Helen Achurch and Jacqueline Fisher.

10 ACRONYMS AND ABBREVIATIONS

AAD	Australian Antarctic Division
AAP	Australian Antarctic Program
AER	Antarctic and Environmental Regulation
ASMA	Antarctic Specially Managed Area
ASPA	Antarctic Specially Protected Area
ATEP	Antarctic Treaty (Environment Protection)
AWS	Automatic Weather Station
CEE	Comprehensive Environmental Evaluation
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DTC	Denman Terrestrial Campaign
EDB	Edgeworth David Base
EMS	Environmental Management System
GPS	Global Positioning System
IEE	Initial Environment Evaluation
ISO	International Standards Organisation
PA	Preliminary Assessment
SLA	Ski Landing Area
SOP	Standard Operating Procedure

11 REFERENCES

AAD [Australian Antarctic Division]. 2022. Australian Antarctic Strategy and 20 Year Action Plan – Update 2022. Commonwealth of Australia.

ATCPs [Antarctic Treaty Consultative Parties]. 1991. Protocol on Environmental Protection to the Antarctic Treaty (plus annexes). 11th. Antarctic Treaty Special Consultative Meeting. Madrid, 22-30 April, 17-23 June 1991.

BoM [Bureau of Meteorology]. 2022. Raw data downloaded from the Edgeworth Davis Base remote AWS located at Bunger Hills.

Davies BJ, Hambrey MJ, Glasser NF, Holt T, Rodés A, Smellie JL, Carrivick JL & Blockley SPE, 2017. Ice-dammed lateral lake and epishelf lake insights into Holocene dynamics of Marguerite Trough Ice Stream and George VI Ice Shelf, Alexander Island, Antarctic Peninsula. Quaternary Science Reviews 177, 189-219.

Gibson J. 2000. The environment of the Bunger Hills. Report for the Australian Antarctic Division, September 2020.

Gore D, Gibson J & Leishman M. 2020. Human occupation, impacts and environmental management of Bunger Hills. Antarctic Science 32(2), 72-84.

Leishman M, Gibson J & Gore D. 2020. Spatial distribution of birds and terrestrial plans in Bunger Hills. Antarctic Science 32(2), 153-166.

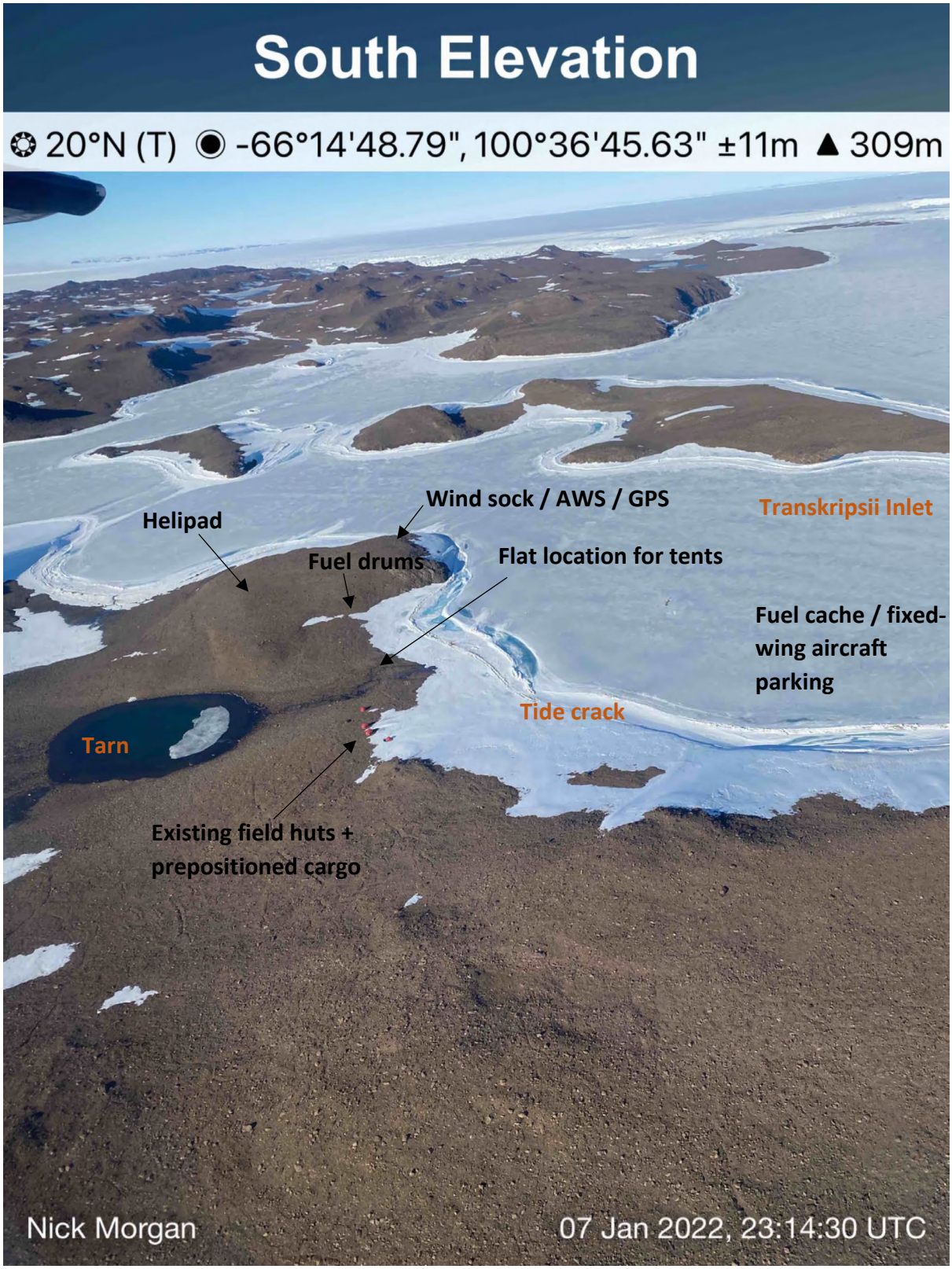
Tucker N, Hand M & Clark C. 2020. The Bunger Hills: 60 years of geological and geophysical research. Antarctic Science 32(2), 85-106.

12 APPENDIX 1 – COMPLIANCE WITH LEGISLATIVE REQUIREMENTS

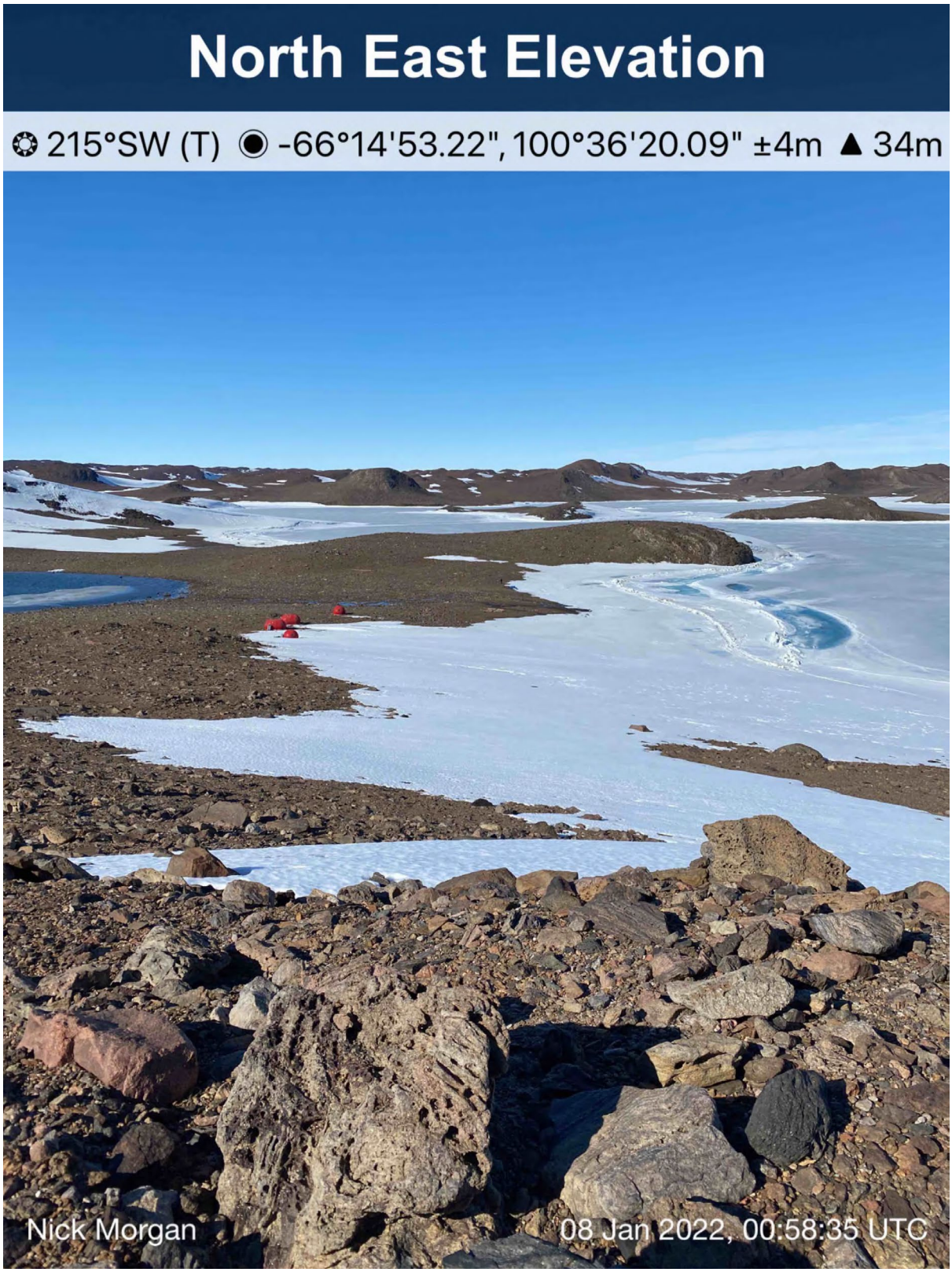
Required Content	Section
(a) a description of the activity, including a statement of: (i) the purpose; and (ii) the location; and (iii) the duration; and (iv) the intensity of the activity	2
(b) a description of possible alternatives to the activity, including the alternative of not carrying on the activity	3
(c) a description of the consequences of each possible alternative to the activity	3
(d) a description of the environmental reference state with which predicted changes are to be compared	4
(e) a prediction of the future environmental reference state if the activity does not take place	3
(f) an estimation of the nature, extent, duration and intensity of the likely direct impacts of the activity	5
(g) consideration of possible indirect impacts of the activity	5.4
(h) consideration of the cumulative impacts of the activity in the context of other activities in the same area that are planned, in progress, or reasonably foreseeable when the evaluation is being prepared	5.4.10
(i) consideration of the effects of the activity on scientific research and other uses and values, including historic values, of the areas that will be affected by the activity	5.4.7 – 5.4.9
(j) identification of unavoidable impacts of the activity	5.4
(k) a description of the methods and data used to forecast the impacts of the activity	5.1, 5.5
(l) identification of uncertainties and lack of knowledge relevant to preparation of the evaluation	6
(m) identification of measures, including monitoring programs, that are proposed to be taken to: (i) minimise or mitigate impacts of the activity; and (ii) detect impacts of the activity that were not predicted in the evaluation; and (iii) provide early warning of adverse effects of the activity; and (iv) deal promptly and effectively with accidents	5.4, 5.5, 5.6 Appendix 5
(n) a description of: (i) consultation of persons and organisations, other than the proponent of the activity, during preparation of the evaluation; and (ii) the comments received from persons consulted; and (iii) how the matters raised during consultation have been addressed	8 9
(o) a summary, in language that is not technical, of the information described in paragraphs (a) to (n) inclusive	I
(p) a statement of the arrangements that will be made to report to the Minister the results of the monitoring	Appendix 5
(q) the name and address of the person who prepared the evaluation	8

13 APPENDIX 2 – PHOTOGRAPHS OF EDGEWORTH DAVID BASE, JANUARY 2022

Photograph 1: Potential layout of field camp



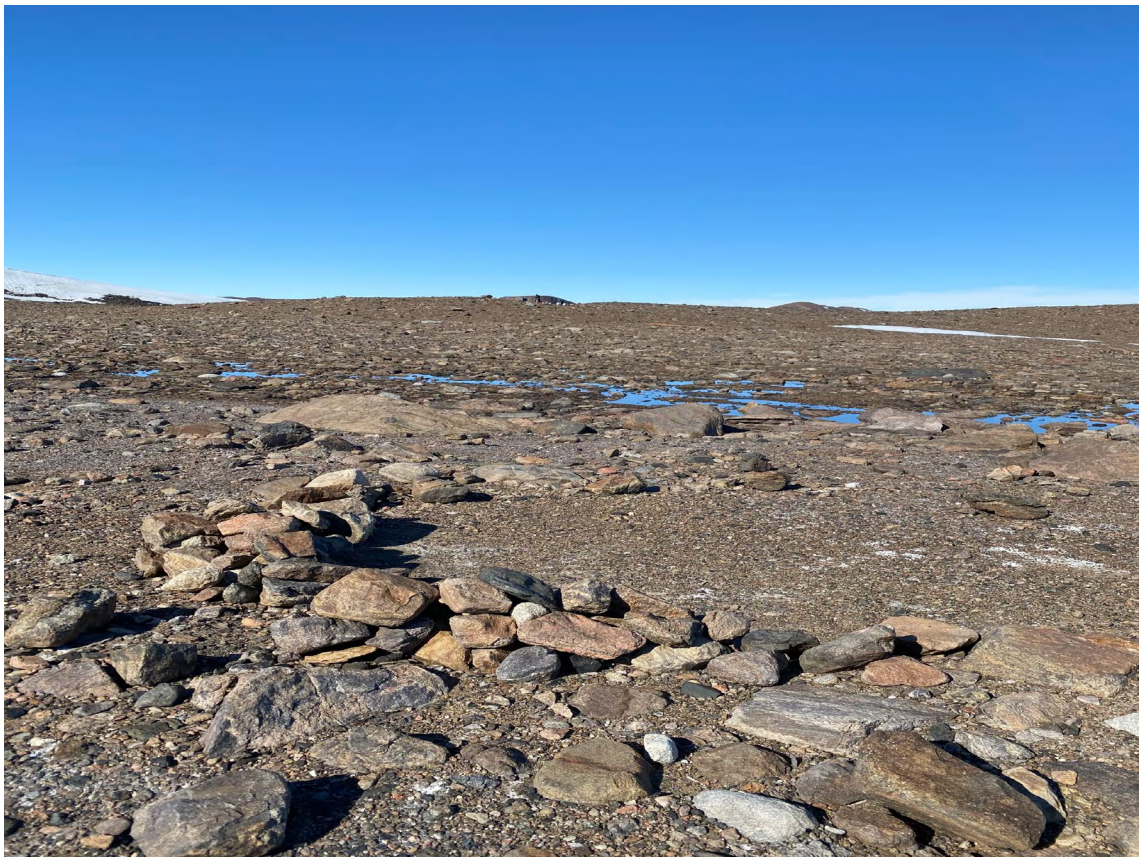
Photograph 2: Existing field huts, showing larger rocks/boulders on the knoll to the north of Edgeworth David Base (foreground) and the southern ridge (background).



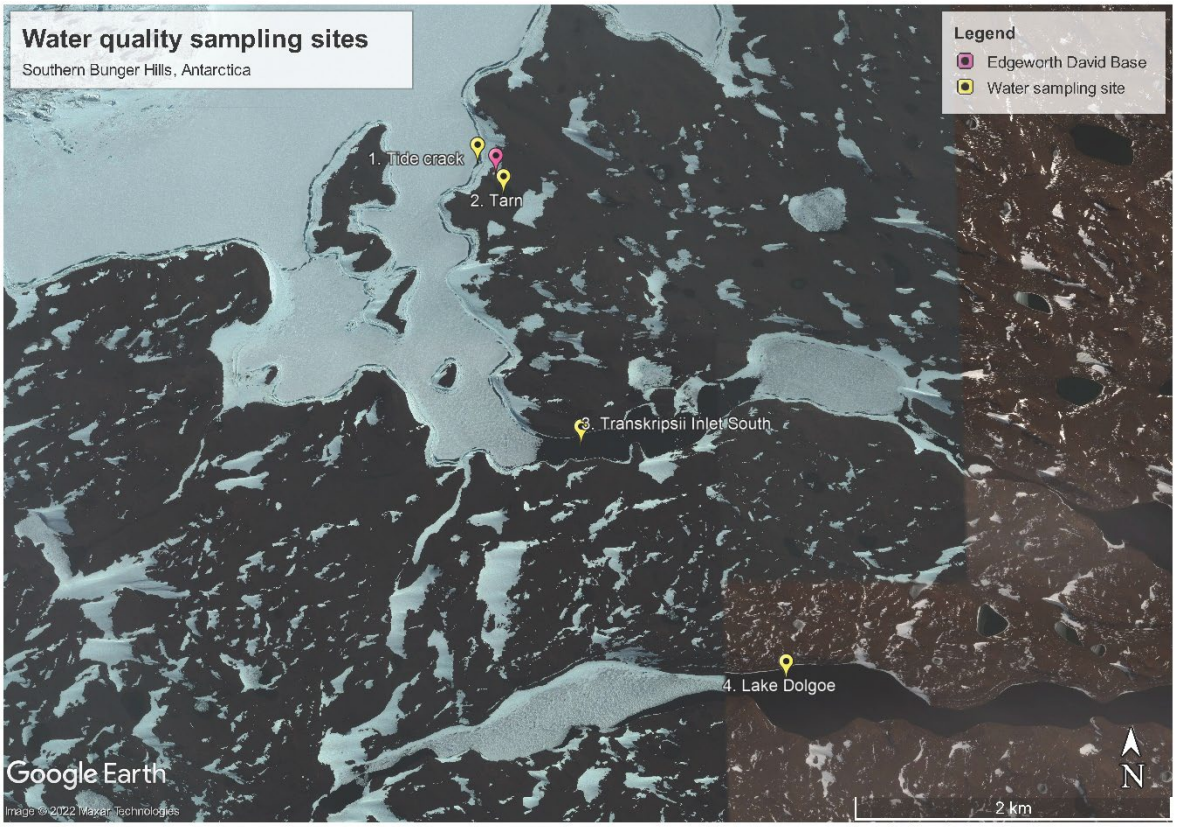
Photograph 3: Existing field huts, showing terrain around proposed field camp.

Photograph 4: Existing disturbance around Edgeworth David Base.

Photograph 5: Existing cleared and marked areas to support tent sites in previous expeditions at Edgeworth David Base.



14 APPENDIX 3 – PROPOSED LOCATION OF WATER SAMPLES



Approximate GPS locations of waterbodies

Site name	Latitude	Longitude
1. Tide crack	-66.249184°	100.600470°
2. Tarn	-66.250977°	100.604132°
3. Transkripsii Inlet South	-66.265140°	100.615067°
4. Lake Dolgoe	-66.278397°	100.643877°

15 APPENDIX 4 – RELEVANT AAD POLICIES AND STANDARD OPERATING PROCEDURES

AAD Environmental Emergency Response Procedures

AAD Field Manual

AAD Incident Reporting System

AAD Standard Operating Procedure Operations Manual:

- Volume 1: Station and Field
- Volume 2: Emergency Response
- Volume 5: Aviation

AAD Station and Field Waste Management Guide 2020–2024

AAD Wildlife Approach Distance Guidelines

Cargo Biosecurity Standard Operating Procedure

Environmental Policy on Unmanned Aerial Systems (Drones)

Hazardous Chemicals Management policy and procedures

16 APPENDIX 5 – DRAFT ENVIRONMENTAL MONITORING PLAN

Australian Government

Department of Climate Change, Energy, the Environment and Water

Australian Antarctic Division

AUSTRALIAN ANTARCTIC PROGRAM

Denman Terrestrial Campaign Operational Support Environmental Monitoring Plan September 2022

Project Name and/or EPBC Number	Denman Terrestrial Campaign – Operational Support
Project Location	Edgeworth David Base, Bunger Hills
Principal Contractor details	Australian Antarctic Division, Department of Agriculture, Water and the Environment 203 Channel Highway, Kingston Tasmania 7050 PH: 03 6232 3610
ABN/ACN	ABN: 34 190 894 983
Authorisation Number or Approved Action (EPBC)	TBA
Date of preparation	September 2022

Responsible Officer:	**Authorising Officer:**	**Authorisation Date:**
Environmental Project Officer	AAD Environment Manager	September 2022
AAD eFile ref: D22/42150		**Review Date:** N/A

Issue	**Date**	**Status**
0.1	2022-09-02	Draft – for internal Review
1.0	2022-09-12	Draft for submission with IEE

Contents

1 Introduction

A key objective of the Australian Antarctic Program (AAP) is to protect the unique environmental values of Antarctica and the Southern Ocean and to ensure that environmental monitoring and management are foremost in planning and operations within the organisation. The Australian Antarctic Division's (AAD) Environmental Policy outlines a commitment to continual improvement in environmental performance, and forms the foundation of the AAD's Environmental Management System (EMS) in compliance with the international standard ISO 14001. Environmental monitoring and reporting are key components of the EMS, serving to verify predicted environmental impacts of project activities, assess the efficacy of mitigation actions, and trigger management responses if thresholds are exceeded.

The AAD's environmental monitoring activities form part of an integrated monitoring system that collects, records and reports on performance data collected from a wide range of applications, networks and programs. Environmental monitoring activities undertaken by the AAD include data collection in relation to the main risks and key environmental indicators identified in the AAD Environmental Aspects and Impacts Register.

The Australian Antarctic Division (AAD) has prepared this monitoring plan to accompany the submission of the Initial Environmental Evaluation (IEE) for the Denman Terrestrial Campaign (DTC) Operational Support activities and field operations. These activities include the establishment of suitable field infrastructure, pre-placement of cargo, as well as undertaking practical site investigations for the successful operation of the field camp in future seasons. The activities will be undertaken throughout the 2022-23 season, commencing in November 2022.

1.1 Purpose and objectives

The purpose of this environmental monitoring plan is to outline the key environmental monitoring requirements identified through the environmental impact assessment process for activities pertaining to the operational support of the DTC. It details the monitoring activities, methods, timing, data management, reporting and review requirements, and identifies the roles and responsibilities of project personnel to ensure that environmental outcomes are met.

The objectives of the monitoring plan are to:

- Ensure ongoing compliance with the *Antarctic Treaty (Environment Protection) Act* 1980
- Ensure impacts are avoided or limited consistent with the environmental principles of the Madrid Protocol
- Evaluate the IEE's conclusion that the impacts of the DTC operational support activities are likely to remain minor and transitory
- Inform any changes required to practices or methodologies to comply with any impact thresholds described in the IEE
- Ensure that environmental impacts are not in conflict with the community's expectations in relation to Antarctica's protection, and

- Ensure that any unforeseen and potentially significant impacts associated with the DTC operational support activities, as described in this IEE, are captured and utilised for the future management of similar activities within AAD.

A full breakdown of the environmental impact assessment and mitigation measures to reduce those impacts is provided in the Denman Terrestrial Campaign Operational Support IEE.

1.2 Project description

The DTC is a multidisciplinary terrestrial field campaign in the Denman Glacier region of the Bunger Hills, planned for the 2023-24 and 2024-25 summer seasons. The objective of the DTC is to facilitate the conduct of AAD sponsored scientific research to deliver on Australia's national scientific priorities and objectives. To facilitate the efficient delivery of the program, preparations for a temporary camp to accommodate 40 personnel will be made at Edgeworth David Base (EDB) (approximately 440 km west of Casey station and 60 km inland from the Shackleton Ice Shelf) in the 2023-24 season. The operational support field program will occur over a 6-week period within the 2022-23 field season, with additional shorter visits to the site potentially occurring throughout the season. The DTC field camp will be dismantled and remediated in the 2024-25 field season.

This Monitoring Plan relates to work planned for the DTC 2022-23 season only, when 5 people will be stationed at Australia's EDB to conduct the following activities:

- replacement of existing apple and melon huts
- site preparation, including preparations for new tent sites, improvements to existing tent sites, helipad clearing, formation of temporary laydown areas for cargo, marking and possible clearing of paths, and possible drainage diversion
- cargo positioning and storage
- placement of temporary infrastructure for communications and water storage, and
- collection of water samples from various waterbodies in the vicinity of EDB to assess quality for consumption during the DTC 2023-24 and 2024-25 seasons.

2 Monitoring plan scope

The *Denman Terrestrial Campaign Operational Support Monitoring Plan* has been developed and is based on the risk and impacts identified through the IEE development process. This plan identifies the key areas for environmental monitoring of the main impacts and environmental indicators identified in the IEE.

These include:

- Introduction of non-native species
- Habitat and landscape change
- Disturbance of wildlife, and
- Pollution of water, sediments, snow and/or ice.

Any additional monitoring required as part of the activity's Notice of Determination and Authorisation conditions will be incorporated into the abovementioned environmental indicators.

The AAD Science Branch subject matter experts will review data collected under this Plan, as required. A review of the data and evaluation of management measures will be undertaken with key stakeholders from Operations and Safety Branch, Science Branch, and Antarctic and Environmental Regulation (AER) to identify ongoing and additional monitoring, management and mitigation requirements for future field seasons.

Monitoring data collected under this Plan will be made publicly available via the Australian Antarctic Data Centre (AADC) and within one year of its collection.

3 Related Monitoring, Reporting, and Supporting Studies

3.1 Incident management and reporting

The AAD's environmental incident and hazard reporting system is a key component of the AAD's EMS. The system provides the capacity to monitor and track activities or incidents which either directly or indirectly have the potential (near misses and improvements) to impact the environment. This reporting system forms part of a monitoring framework that identifies, prioritises and responds to environmental impacts or risks in real-time. The integration of this reporting system into AAD quarterly and annual reporting allows for the analysis of incidents and trends to identify and monitor environmental impacts and response actions. AAD's environmental incident reporting system provides an evidence-based approach for the development and delivery of continual improvements to the AAD's EMS and Antarctic operations.

3.2 Other monitoring and reporting

The AAD State of Environment database includes a range of indicators relevant to the DTC operational support activities. These indicators are located in the Human Settlements Theme and includes indicators associated with fuel, electricity and water consumption, wastewater and solid waste management, and personnel numbers. This data will be updated annually at the end of the austral summer operations season.

4 Monitoring Approach

4.1 Roles and Responsibilities

The following personnel are responsible for implementing the *Denman Terrestrial Campaign Operational Support Monitoring Plan*:

- **All personnel (including subcontractors)** – responsible for reporting any environmental compliance issues to the DTC Project Manager.
- **DTC Project Manager** – responsible for the coordination of any incident responses and logging of environmental incident information. Responsible for ensuring that the delegated personnel are executing the required monitoring activities and reporting according to the requirements in this environmental monitoring plan.

- **DTC Field Team** – responsible for conducting the environmental monitoring, implementing management measures and rectifying any compliance issues related to these activities.

4.2 Environmental Awareness and Training

All people involved with the DTC operational support activities will receive training to ensure full understanding of their responsibilities when implementing the environmental monitoring plan. The training is in addition to the mandatory training and awareness presentations and are tailored to the role of the individual and their level of involvement in implementing the monitoring plan.

Specific training completed by project personnel include:

- Pre-departure briefings covering the IEE and environmental authorisation, and
- Training relevant to the collection of data.

5 Duration

The 2022-23 field season will commence in late November 2022 when the field team arrives at Casey station. Weather permitting, the team are expected to be deployed to EDB within a week of arrival and remain on site for up to 6 weeks. Additional shorter visits may be made to EDB after the primary field program, depending on the progress of site preparations, weather and logistics.

6 Monitoring Plan

6.1 Impact summary

The primary impacts described in the IEE for the Denman Terrestrial Campaign Operational Support activities include:

1. Introduction of non-native species into the terrestrial and/or lacustrine environments of the Bunger Hills through the movement of cargo, equipment, stores and personnel
2. Habitat and landscape change resulting from the temporary modification of the landscape in preparation for DTC activities.
3. Disturbance of wildlife through the generation of noise from construction works, vehicle movements and use of remotely piloted aircraft, and inadvertent disturbance during daily camp activities.
4. Pollution of sea water, sediments, snow and ice through the accidental release of fuel, chemical preservatives, and waste products

6.2 Monitoring summary

Objectives	
W-O-1	Detect non-native species or pathogens present in DTC cargo, equipment, and personal items
W-O-2	Document the pre-disturbance landscape at EDB to create a baseline record for remediation activities
W-O-3a	Document presence of wildlife around EDB
W-O-3b	Assess wildlife behaviour changes resulting from DTC activities

W-O-4	Monitor snow, soil and/or surface-water quality in the event of a major spill of fuel, oil, oily water, sewage or waste		
Indicator		**Trigger**	**Management Response/s**
W-I-1	Non-native species or pathogen	Detection of non-native species or pathogen	• Remove biosecurity risk • Review operational measures for prevention
W-I-2	Ground disturbance identifiable on aerial photography	N/A	N/A
W-I-3a	Presence/absence of wildlife	N/A	N/A
W-I-3b	Wildlife behaviour responses to camp activities	Wildlife visibly panicked or distressed	• Temporarily cease activity • Conduct supporting investigations to further determine extent of impact on sensitive receptors • Review and update mitigation measures
W-I-4	Concentrations of contaminants attributable to human sources and measurable using standard analytical techniques	Detectable persistent concentrations of contaminants	• Investigate cause • Repair failure point • Review and update procedures, storage/transportation methods. • Implement required changes to procedure/process.
Method		**Location**	**Frequency**
W-M-1	AAD cargo and voyage biosecurity procedures including inspections and incident reporting	• Cargo and Biosecurity Centre, Hobart • Vessel • Aircraft	Prior to departure of vessel/aircraft. Event.
W-M-2	Pre-disturbance imagery using remotely piloted aircraft	EDB	Start of 2022-23 season, prior to any ground disturbance
W-M-3a	Document presence and location of wildlife species encountered around EDB	Within 1km of EDB	Event
W-M-3b	Document wildlife behaviour responses	Within 1km of EDB	Event
W-M-4	Collection of snow/soil/water from impacted and non-impacted areas. Analytical analyses for contaminants of concern.	Within and outside spill impact area	Event

Reporting		**Frequency**
W-R-2 W-R-3a W-R-3b W-R-4	Report of Activities	Annual
W-R-1 W-R-4	Incident report	Event

7 Reporting and Review

An annual report describing all activities undertaken as required under the ATEP Authorisation for the DTC Operational Support project will be provided to the Antarctic and Environmental Regulation section using the designated report template.

A review of the environmental monitoring plan will be undertaken:

- following significant environmental incidents
- when there is a need to improve performance in an area of environmental impact, identified through incident and annual reporting.

14 APPENDIX 3 – PROPOSED LOCATION OF WATER SAMPLES

15 APPENDIX 4 – RELEVANT AAD POLICIES AND STANDARD OPERATING PROCEDURES

AAD Environmental Emergency Response Procedures

AAD Field Manual

AAD Incident Reporting System

AAD Standard Operating Procedure Operations Manual:

- Volume 1: Station and Field
- Volume 2: Emergency Response
- Volume 5: Aviation

AAD Station and Field Waste Management Guide 2020–2024

AAD Wildlife Approach Distance Guidelines

Cargo Biosecurity Standard Operating Procedure

Environmental Policy on Unmanned Aerial Systems (Drones)

Hazardous Chemicals Management policy and procedures

16 APPENDIX 5 – DRAFT ENVIRONMENTAL MONITORING PLAN