



Management Plan

For Antarctic Specially Protected Area No. 116 NEW COLLEGE VALLEY, CAUGHLEY BEACH, CAPE BIRD, ROSS ISLAND

1. Description of Values to be Protected

An area at Cape Bird, Ross Island was originally designated as Site of Special Scientific Interest (SSSI) No. 10, Caughley Beach by Recommendations XIII-8 (1985) and Specially Protected Area (SPA) No. 20, New College Valley by Recommendation XIII-12 (1985) after proposals by New Zealand on the grounds that the area contains some of the richest stands of moss and associated microflora and fauna in the Ross Sea region of Antarctica. This is the only area on Ross Island where protection is specifically given to plant assemblages and associated ecosystems.

SPA No. 20 was originally enclosed within SSSI No. 10 in order to provide more stringent access conditions to this part of the Area. SSSI No. 10 was incorporated into SPA No. 20 by Measure 1 (2000), with the former Area of SPA No. 20 becoming a Restricted Zone within the SPA. The boundaries of the Area were revised from the boundaries in the original recommendations, in view of improved mapping and to follow more closely the ridges enclosing the catchment of New College Valley. Caughley Beach itself was adjacent to, but never a part of, the original Area, and for this reason the entire Area was renamed as New College Valley, which was within both of the original sites. The Area was redesignated by Decision 1 (2002) as Antarctic Specially Protected Area (ASPA) No. 116 and a revised Management Plan was adopted through Measure 1 (2006), Measure 1 (2011) and Measure 1 (2016).

The boundaries of the Area closely follow the ridges enclosing the catchment of New College Valley and cover approximately 0.33 km². Moss in this Area is restricted to localised areas of water-flushed ground, with cushions and carpets up to 20 m² in area. A diverse range of algal species also inhabit streams in the Area, and springtails, mites and nematodes are plentiful on water surfaces and underneath rocks. The Area was previously characterised by an absence of lichens, making the species assemblage in this Area unique on Ross Island. More recently, in 2023, a low abundance of lichen encrustations on moribund moss has been noted.

The susceptibility of mosses to disturbance by trampling, sampling, pollution or introductions of non-native species is such that the Area requires long-term special protection. Designation of this Area is intended to ensure examples of this habitat type are adequately protected from visitors and overuse from scientific investigations. The ecosystem at this site remains of exceptional scientific value for ecological investigations and the Restricted Zone is valuable as a reference site for future comparative studies.

2. Aims and Objectives

Management of New College Valley, Caughley Beach, Cape Bird aims to:

- avoid degradation of, or substantial risk to, the values of the Area by preventing unnecessary human disturbance to the Area;
- preserve a part of the natural ecosystem of the Area as a reference area for the purpose of future comparative studies;
- allow scientific research on the ecosystem, in particular on mosses, algae and invertebrates in the Area, while ensuring protection from over-sampling;
- allow other scientific research in the Area provided it is for compelling reasons which cannot be served elsewhere;
- prevent or minimise the introduction to the Area of alien plants, animals and microbes;
- allow visits for management purposes in support of the aims of the Management Plan.



3. Management Activities

The following management activities are to be undertaken to protect the values of the Area:

- Copies of this Management Plan including maps of the Area shall be made available at adjacent operational research/field stations and at the nearby Cape Bird hut.
- Rock cairns or signs illustrating the location and boundaries, with clear statements of entry restrictions, shall be placed at appropriate locations on the boundary of the Area and the Restricted Zone to help avoid inadvertent entry.
- Markers, signs or structures erected within the Area for scientific or management purposes shall be secured and maintained in good condition, and removed when no longer required.
- Visits shall be made as necessary (preferably at least once every five years) to assess whether the Area continues to serve the purposes for which it was designated and to ensure management and maintenance measures are adequate.
- National Antarctic Programmes operating in the Area shall consult together with a view to ensuring the above management activities are implemented.

4. Period of Designation

Designated for an indefinite period.

5. Maps and Photographs

- **Map 1:** New College Valley, Caughley Beach, Cape Bird, Ross Island – Regional overview. Topographic data source SCAR Antarctic Digital Database v7.3 (2021) / REMA DEM, Coastline, glaciology and ice-free ground from LINZ 1:50K digital data (edited ERA 2024 using satellite imagery). Map specifications: Projection – Lambert conformal conic. Standard parallels – 1st 77° 15'S; 2nd 77° 30'S. Central Meridian – 166° 58'E. Latitude of Origin – 78° 00'S. Spheroid and horizontal datum – WGS84.
- **Map 2:** ASPA No.116 New College Valley – Topography and air access. Data sources: ASPA boundary, hut, contours: Gateway Antarctica (2012); Helicopter landing sites / flight route: Antarctica NZ (2024); Coastline / streams / ice-free ground / glacier extent: digitised ERA from WV3 (23 Dec 2022) / high resolution orthophoto G. Ballard pers. comm. (Nov 2023); Penguin sub-colonies: G. Ballard pers. comm. (Nov 2023). Map specification as for Map 1 except: Standard parallels 1st 77° 14'S; 2nd 77° 16'S. Central Meridian – 166° 25' E.
- **Map 3:** ASPA No.116 New College Valley – Facilities and access. Data sources as for Map 2. Map specification as for Map 2 except: Standard parallels 1st 77° 13'S; 2nd 77° 14'S. Central Meridian – 166° 26'E.
- **Map 4:** ASPA No.116 New College Valley – Facilities, boundaries & vegetation. Data sources as for Map 3 except hut, AWS, Primary Helicopter Landing Site – G. Ballard orthophoto (Nov 2023); Vegetation assessment: B. Bollard pers. comm. (Nov 2023). Map specification as for Map 3 except Central Meridian – 166° 26.5' E.

6. Description of the Area

6(i) Geographical coordinates, boundary markers and natural features

Cape Bird is at the northwest extremity of Mount Bird (1,800 m), an inactive volcanic cone which is probably the oldest on Ross Island. New College Valley is located south of Cape Bird on ice-free slopes above Caughley Beach, and lies between two Adélie penguin colonies known as the Cape Bird Northern and Middle Rookeries (Map 3). The Area, comprising veneered glacial moraines at the foot of the Cape Bird Ice Cap, consists of seaward dipping olivine-augite basalts with scoriaceous tops erupted from the main Mount Bird cone.

The northwest corner of the north boundary of the Area is approximately 100 m south of the Cape Bird hut (New Zealand) and is marked by an ASPA sign post (77° 13.128'S, 166° 26.147'E) (Map 4). The north boundary of the Area extends upslope and eastward toward a prominent terminal moraine ridge, approximately 20 m from the Cape Bird Ice Cap and is marked with a rock cairn (77° 13.158'S, 166° 26.702'E).

The eastern boundary follows the terminal moraine ridge from the rock cairn (77° 13.155'S, 166° 26.683'E) southeast until the ridge disappears where it joins the Cape Bird Ice Cap. The boundary continues southeast following the glacier edge to the southern boundary.

The southern boundary is a straight line crossing the broad southern flank of New College Valley, and is marked with rock cairns at the south-western corner of the Area (77° 13.471'S, 166° 25.832'E) and the south-eastern corner of the area on the hilltop 100 m from the Cape Bird Ice Cap glacier edge (77° 13.571'S, 166° 27.119'E).

The western boundary of the Area follows the top of the coastal cliffs of Caughley Beach from the south-western corner rock cairn (77° 13.471'S, 166° 25.832'E) for a distance of 650 m to the northwest corner of the Area (77° 13.128'S, 166° 26.147'E) where the ASPA signpost is.



New College Valley, Caughley Beach is located within Environment S – McMurdo – South Victoria Land geologic based on the Environmental Domains Analysis for Antarctica (Resolution 3 (2008)) and in Region 9 – South Victoria Land based on the Antarctic Conservation Biogeographic Regions (Resolution 6 (2012)). Environment Domain S includes known areas of abundant mosses and lichens at Botany Bay, Cape Geology (ASPA 154), Beaufort Island (ASPA 105) and Canada Glacier in the Taylor Valley (ASPA 131).

Northwest-facing New College Valley drains meltwater from the Cape Bird Ice Cap during the summer. Streams in the Area are fed by melt from perennial summer snow drifts and have eroded their own shallow gullies and channels. The ground is largely covered by stones and boulders of volcanic origin which have been reworked by glacial action. During the peak of the melt (Dec-Jan), running water traverses across much of the ASPA. As the melt increases and the soils absorb the meltwater, the ground in parts of the site, softens significantly, particularly the Restricted Zone. There is evidence of small scale rock and sediment movement at the site from this meltwater action each summer, with small, localised landslides and sediment movement witnessed in parts of site in 2023 (Figure 4). Under the influence of a changing climate (both global and local), increases in volume and shifts in location of water flow through or over the vegetation would inevitably lead to changes in the vegetation distribution, diversity and abundance. The Area would be ideal for assessing the impacts of climate change on Antarctic terrestrial ecosystems dominated by moss vegetation.

The Area includes the full course and catchments of three stream systems that support significant growths of algae and mosses. These include the most extensive ephemeral stream course distributions of the moss *Hennediella heimii* on Ross Island. Surveys have shown that this moss, together with lower occurrences of two other species – *Bryum argenteum* and *Bryum pseudotriquetrum* – are confined almost entirely to the margins of stream courses across the steep till and scoria covered slopes (Map 4). The mosses generally co-occur with cyanobacteria-dominated algal growths, namely rich, red-brown oscillatoriacean mats and occasional reddish-black growths of *Nostoc commune*. Previously this Area was known to lack lichens. However, saprophytic lichen species including *Caloplaca athallina* have recently been found growing on moribund or dead moss in this Area (Figure 5A). This parallels findings of four lichen species on Beaufort Island in 2011; an island 20 km to the north of Cape Bird, which was also earlier characterised by its absence of lichens.

The Area supports a terrestrial invertebrate community including populations of springtails *Gomphiocephalus hodgsonii* (Collembola: Hypogastruridae), mites *Nanorchestes antarcticus* and *Stereotydeus mollis* (Acari: Prostigmata), nematodes (*Panagrolaimus davidi*, *Plectus antarcticus*, *Plectus murrayi*, *Plectus frigophilus*, *Scottinema lindsayae* and *Eudorylaimus antarcticus*), tardigrades (*Acutuncus antarcticus*) and rotifers (*Adineta* spp) with the presence of ciliate and flagellate protozoa noted. The majority of species of terrestrial invertebrates, and their highest abundance, are associated with macroscopic growths of moss and algae and with soils containing high abundance of microscopic algae.

Skuas (*Catharacta maccormicki*) frequently rest on Caughley Beach and overfly, land and nest within the Area. Adélie penguins (*Pygoscelis adeliae*) from the nearby rookeries do not nest in the Area, but have been observed occasionally to traverse New College Valley, and have been observed moulting in the Area in late summer.

6(ii) Access to the Area

Land vehicles are prohibited within the Area and access shall be by foot or by helicopter. Overflight of the Area is prohibited below 50m (150ft) above sea level. Access restrictions apply within the Area, the specific conditions for which are set out in Section 7(ii) below.

6(iii) Location of structures within and adjacent to the Area

Structures known to exist within the Area include a United States Navy Astrofix marker (77° 13.299'S, 166° 26.690'E), cairns marking the boundaries of the Area and the Restricted Zone, a signpost situated at the northwest corner of the Area (77° 13.128'S, 166° 26.147'E) and an approximately one meter square wooden frame (77° 13.226'S, 166° 26.517'E) marking the site of an experimental oil spill from 1982.

A field hut (New Zealand), stores hut and toilet are located north of the northwest corner of the Area (Maps 3 and 4).

6(iv) Location of other protected areas in the vicinity

The nearest protected areas are:

- Lewis Bay, Mount Erebus, Ross Island (ASPA No. 156), approximately 25 km SE;
- Tramway Ridge, Mount Erebus, Ross Island (ASPA No. 175) 30 km SSE;
- Cape Crozier, Ross Island (ASPA No. 124) 75 km SE;
- Cape Royds, Ross Island (ASPA No. 121 and No. 157) and Cape Evans, Ross Island (ASPA No. 155) 35 km and 45 km south on Ross Island respectively; and
- Beaufort Island, Ross Sea (ASPA No. 105) 20 km to the north.
- The nearest protected areas with similar terrestrial ecosystem attributes are Canada Glacier (ASPA No. 131), approximately 100 km SW and Botany Bay (ASPA No. 154), approximately 120 km NW.



6(v) Special zones within the Area

Restricted Zone

An area of New College Valley is designated as a Restricted Zone in order to preserve part of the Area as a reference site for future comparative studies, while the remainder of the Area (which is similar in biology, features and character) is more generally available for research programmes and sample collection. The Restricted Zone encompasses ice-free slopes within New College Valley above Caughley Beach some of which are north-facing with snow drifts which provide a ready supply of melt water to foster moss and algal growth.

The northwest corner (77° 13.159'S, 166° 26.073'E) of the Restricted Zone is 60 m to the south and across a small gully from the northwest corner of the Area. The north boundary of the Restricted Zone extends 500 m upslope from the northwest corner to a midway cairn along the northern restricted zone boundary (77° 13.261'S, 166° 26.619'E), then following a faint but increasingly prominent ridge southeast to a point in the upper catchment of New College Valley marked by a cairn approximately 60 m from the ice terminus of the Cape Bird Ice Cap marking the northeast corner of the Restricted Zone (77° 13.368'S, 166° 26.976'E). The Restricted Zone boundary then extends 110 m southwest across the valley to a cairn marking the southeast corner of the Restricted Zone (77° 13.435'S, 166° 26.865'E). The southern boundary of the Restricted Zone extends in a straight line from this cairn (77° 13.435'S, 166° 26.865'E) 440 m northwest down a broad and relatively featureless slope to the southwest corner of the Area (77° 13.328'S, 166° 26.006'E). A cairn is placed on the southwest boundary of the Restricted Zone to mark the lower position of the south boundary (77° 13.330'S, 166° 25.995'E).

Access to the Restricted Zone is allowed only for compelling scientific and management purposes that cannot be served by visits elsewhere in the Area.

7. Terms and Conditions for Entry Permits

7(i) General permit conditions

Entry into the Area is prohibited except in accordance with a Permit issued by an appropriate national authority. Conditions for issuing a Permit to enter the Area are that:

- outside of the Restricted Zone, it is issued only for scientific study of the ecosystem, or for compelling scientific reasons that cannot be served elsewhere, or for essential management purposes consistent with the Management Plan objectives such as inspection or review;
- access to the Restricted Zone is allowed only for compelling scientific or management reasons that cannot be served elsewhere in the Area;
- the actions permitted are not likely to jeopardise the ecological or scientific values of the Area or other permitted activities;
- any management activities are in support of the objectives of the Management Plan;
- the actions permitted are in accordance with the Management Plan;
- the Permit, or a copy, shall be carried within the Area;
- a visit report shall be supplied to the authority named in the Permit;
- the Permit shall be issued for a stated period.

7(ii) Access to and movement within or over the Area

Helicopters are prohibited from landing within the Area. Two helicopter landing sites are located outside the Area. The primary helicopter landing site is located adjacent to the Cape Bird field hut (New Zealand), above Caughley Beach 77° 13.095S, 166° 26.157' E (Map 2). The secondary landing site is below the cliffs on Caughley Beach, 100 m west of the western boundary of the Area 77° 13.221'S, 166° 25.812'E (Maps 2, 3 and 4). The helicopter landing sites at Cape Bird are for support of scientific research and management only.

The flight path is an approach from the south above Middle Rookery (Map 2). Flights north of the helicopter pad may be necessary under certain wind conditions but should follow the recommended aircraft approach and departure routes, and to maximum extent possible, follow the 'Guidelines for the Operation of Aircraft Near Concentrations of Birds in Antarctica' (Resolution 2, 2004). See Map 2 for the recommended aircraft approach routes into and out of Cape Bird.

Overflight of the Area lower than 50 m (~150 ft) above ground level is prohibited. Hovering over the Area is not permitted lower than 100 m (~300 ft) above ground level. Use of helicopter smoke grenades within the Area is prohibited.

Vehicles are prohibited within the Area and all movement within the Area should be on foot. Access into the Area should preferably follow the track from the Cape Bird Hut (New Zealand). Visitors should avoid areas of visible vegetation and care should be exercised walking in areas of moist ground, particularly the stream course beds, where foot traffic can easily damage sensitive soils, plant and algal communities, and degrade water quality. Avoid walking on such areas by walking on ice or rocky ground. Pedestrian traffic should be kept to the minimum necessary consistent with the objectives of any permitted activities and every reasonable effort should be made to minimise effects.



Access to regions south of the Area from the Cape Bird Hut should be made by a route below the cliffs along Caughley Beach.

Overflight and landings within the Area by Remotely Piloted Aircraft Systems (RPAS) are prohibited except in accordance with a permit issued by an appropriate national authority. RPAS use within the Area should follow the Environmental Guidelines for Operation of Remotely Piloted Aircraft Systems (RPAS) in Antarctica (Resolution 4 (2018)).

7(iii) Activities that may be conducted in the Area

- Compelling scientific research which cannot be undertaken elsewhere and which will not jeopardise the ecosystem or values of the Area or interfere with existing scientific studies;
- Essential management activities, including monitoring and inspection.

7(iv) Installation, modification or removal of structures

No structures are to be erected within the Area, or scientific equipment installed, except for compelling scientific or management reasons, as specified in a Permit. All markers, structures or scientific equipment installed in the Area must be authorised by Permit and clearly identified by country, name of the principal investigator or agency, year of installation and date of expected removal. All such items should be free of organisms, propagules (e.g. seeds, eggs) and non-sterile soil, and be made of materials that pose minimal risk of contamination of the Area. Removal of specific structures or equipment for which the Permit has expired shall be a condition of the Permit.

7(v) Location of field camps

Camping within the Area is prohibited. A field hut (New Zealand), stores hut and toilet are located north of the northwest corner of the Area (Map 3).

7(vi) Restrictions on materials and organisms which may be brought into the Area

To avoid compromising the ecological values, specifically the unique biological assemblages, for which the Area is protected, the following restrictions apply to all activities in the Area:

- Deliberate introduction of plants, animals, microorganisms and non-sterile soil into the Area is prohibited and precautions listed in 7(x) shall be taken against accidental introductions.
- No poultry products shall be brought into the Area.
- No herbicides or pesticides shall be brought into the Area.
- Any other chemicals, including radio-nuclides or stable isotopes, which may be introduced for scientific or management purposes specified in the Permit, shall be removed from the Area at or before the conclusion of the activity for which the Permit was granted.
- Fuel or other chemicals shall not be stored in the Area, unless required for essential purposes connected with the activity for which the Permit has been granted and must be contained within an emergency cache authorized by an appropriate authority.
- All materials introduced shall be for a stated period only, shall be removed at or before the conclusion of that stated period, and shall be stored and handled so that risk of their introduction into the environment is minimised.
- Visitors should also consult and follow as appropriate recommendations contained in the Committee for Environmental Protection Non-native Species Manual (Resolution 4 (2016); CEP 2019)

7(vii) Taking or harmful interference with native flora or fauna

Taking of, or harmful interference with native flora or fauna is prohibited, except in accordance with a Permit issued in accordance with Annex II of the Protocol on Environmental Protection to the Antarctic Treaty. Where taking or harmful interference with animals is involved, this should, as a minimum standard, be in accordance with the SCAR Code of Conduct for the Use of Animals for Scientific Purposes in Antarctica.

7(viii) The collection or removal of materials not imported by the Permit holder

Material may be collected or removed from the Area only in accordance with a permit and should be limited to the minimum necessary to meet scientific or management needs. Similarly, sampling is to be carried out using techniques which minimise disturbance to the Area as well as duplication. Material of human origin likely to compromise the values of the Area, which was not brought into the Area by the Permit holder or otherwise authorised and is not an historical artefact or abandoned relic, may be removed from any part of the Area, including the Restricted Zone, unless the environmental impact of removal is likely to be greater than leaving the material *in situ*. If this is the case the appropriate national authority must be notified and approval obtained.

7(ix) Disposal of waste

All wastes, including all human wastes, shall be removed from the Area.



7(x) Measures that may be necessary to continue to meet the aims and objectives of the Management Plan

Permits may be granted to enter the Area to:

- carry out biological monitoring and Area inspection activities, which may involve the collection of a small number of samples or data for analysis or review;
- to erect or maintain signposts, structures or scientific equipment; or
- for management activities.

Any specific sites of long-term monitoring shall be appropriately marked.

To help maintain the ecological and scientific values of the isolation and relatively low level of human impact at the Area, visitors shall take special precautions against introductions. Of particular concern are microbial or vegetation introductions sourced from soils at other Antarctic sites, including stations, or from regions outside Antarctica. To minimise the risk of introductions, visitors shall thoroughly clean footwear, particularly after any contact with penguin guano from the beach below, and any equipment to be used in the area particularly sampling equipment and markers before entering the Area.

7(xi) Requirements for reports

- The principal permit holder for each visit to the Area shall submit a report to the appropriate national authority after the visit has been completed in accordance with national procedures and permit conditions.
- Such reports should include, as appropriate, the information identified in the visit report form contained in Appendix 2 of the Guide to the Preparation of Management Plans for Antarctic Specially Protected Areas (Resolution 2 (2011)). If appropriate, the national authority should also forward a copy of the visit report to the Party that proposed the Management Plan, to assist in managing the Area and reviewing the Management Plan.
- Parties should, wherever possible, deposit originals or copies of such original reports in a publicly accessible archive to maintain a record of usage, for the purpose of any review of the Management Plan and in organizing the scientific use of the Area.
- The appropriate authority should be notified of any activities / measures that might have exceptionally been undertaken, or anything removed, or of anything released and not removed, that were not included in the authorized permit.

8. Supporting Documentation

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Figure 1: Approach into Cape Bird, Beaufort Island in the background to the north. Photo B. Bollard, University of Wollongong (November 2023).



Figure 2. Moss in the northern valley of ASPA 116. Photo R. Innes, Antarctica New Zealand (December 2023).





Figure 3. Moss in the Restricted Zone, New College Valley. Photo R. Innes, Antarctica New Zealand (December 2023).



Figure 4. Small scale landslide in the lower section of New College Valley. Photos R. Innes, Antarctica New Zealand (December 2023).





Figure 5. Examples of Cape Bird vegetation: A) Mixture of healthy, stressed and moribund moss, some of which is encrusted with white lichen; B) Dry (left image) and wet (right image) cyanobacterial communities amongst moss. Orange quadrats are 25 cm x 25 cm; C) Moss covered in a thin layer of mud washed down the hill (left), moss covered in sediment (right). Photos M. Waterman, University of Wollongong and R. Innes, Antarctica New Zealand (December 2023).

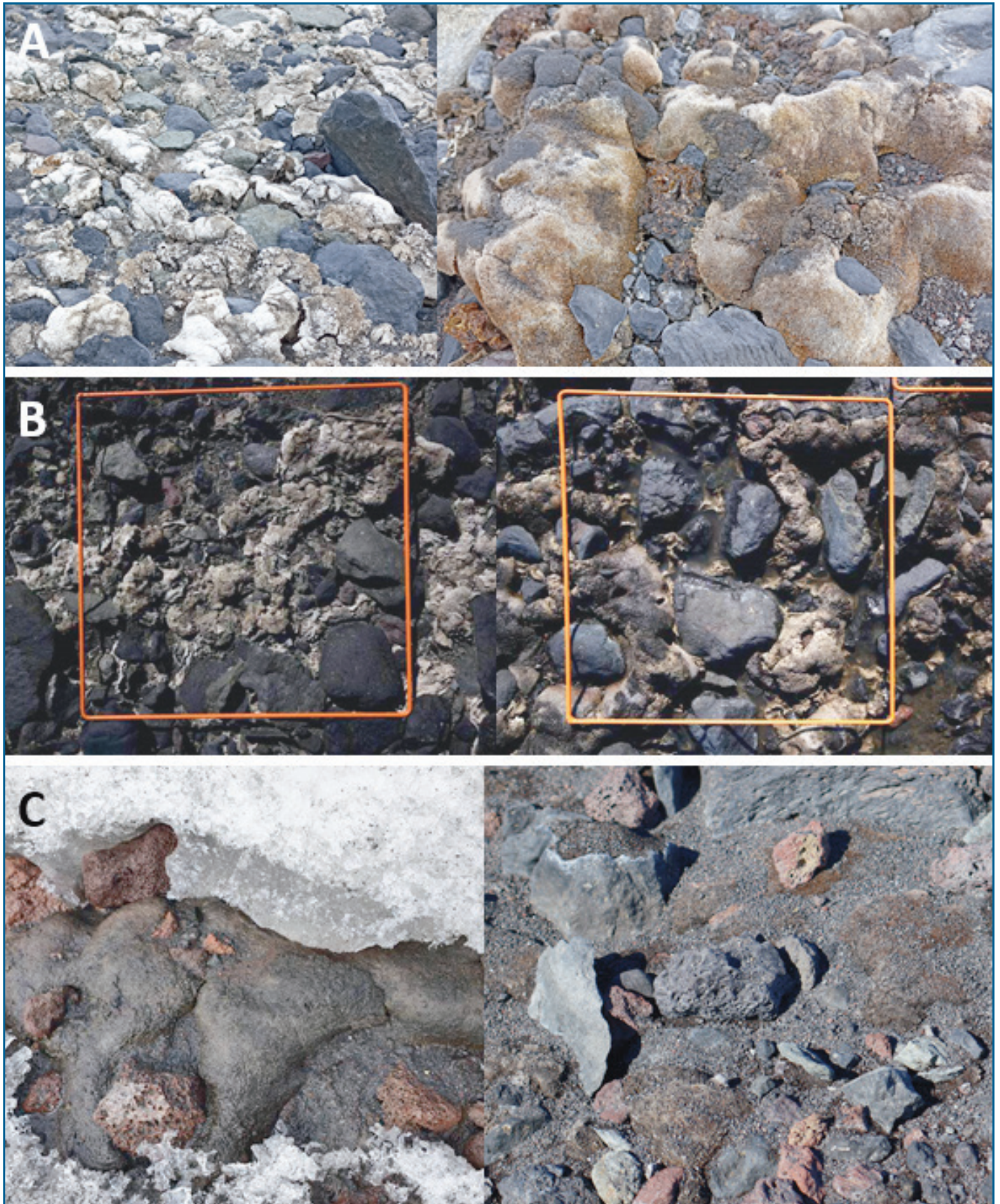


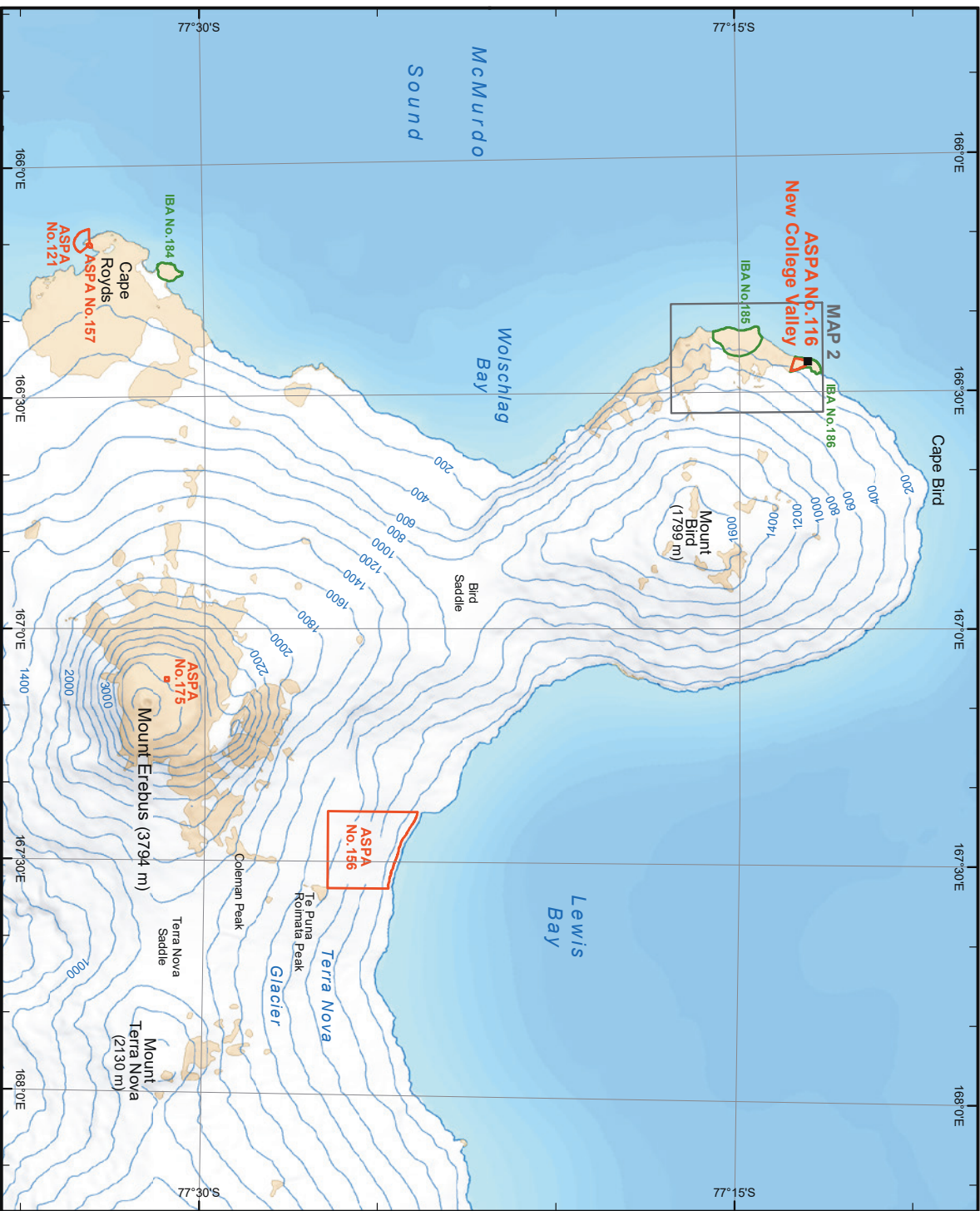
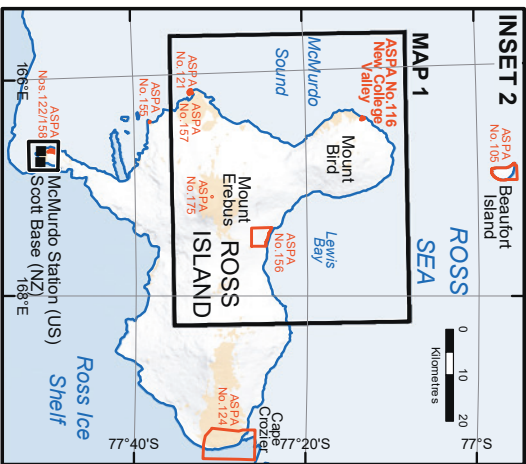
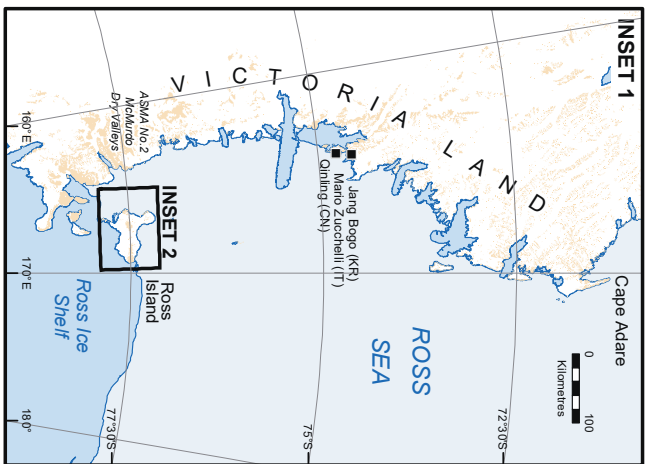


Figure 6. Transition of dry moss cushions to wet algal and cyanobacterial communities to dry moss cushions.
Photo R. Innes, Antarctica New Zealand.



Figure 7. Transition of wet algal and cyanobacterial communities (middleground) to dry moss cushions (foreground).
The yellow tape measure is 3 m and the black rod is 1 m. Photos M. Waterman, University of Wollongong (December, 2023).





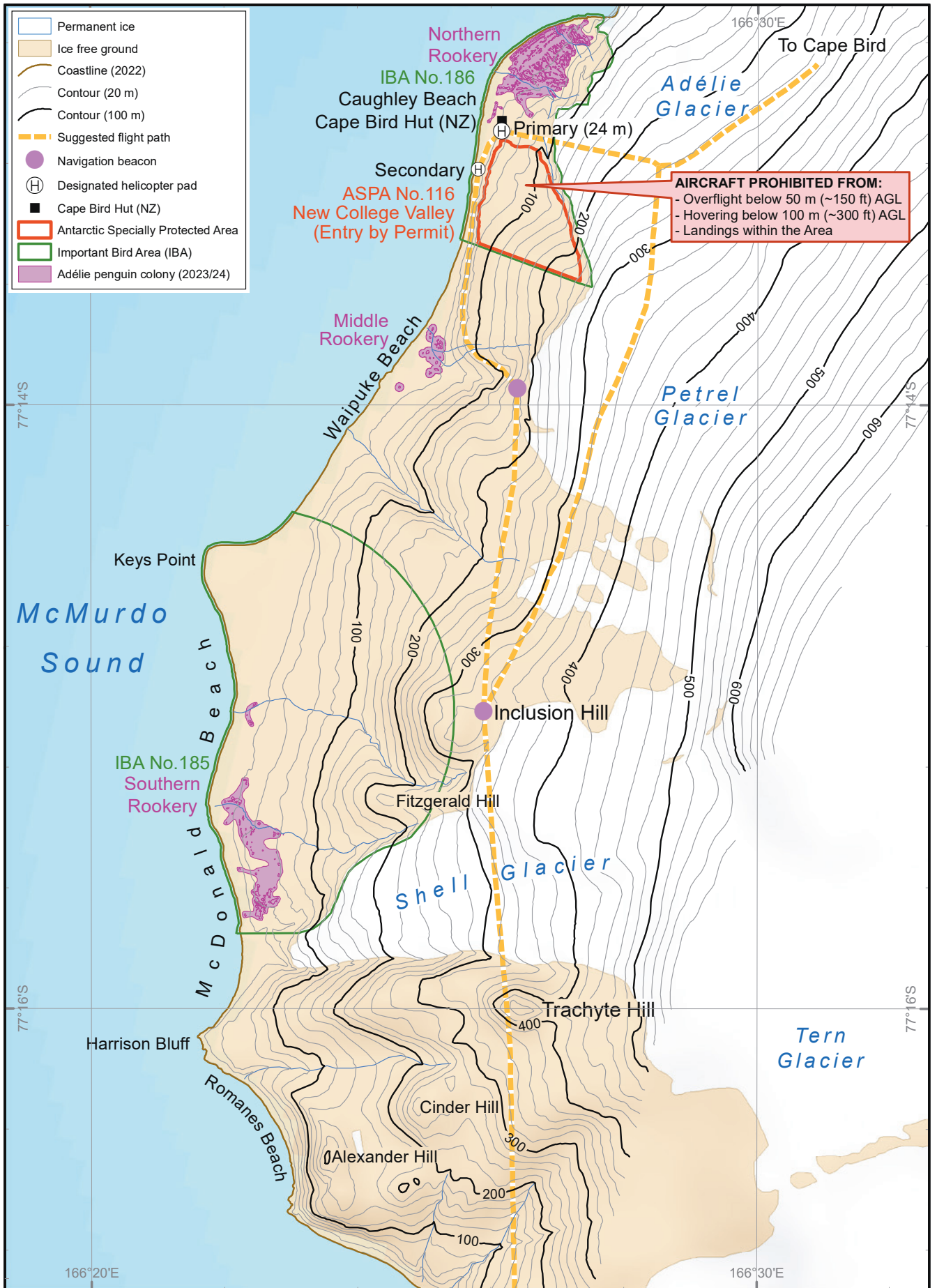
Map 1: ASPA No. 116 New College Valley, Caughley Beach, Cape Bird - regional overview

02 April 2024 (V1.0)
 Environmental Research & Assessment
 Antarctica
 New Zealand

- Permanent ice
- Ice-free ground
- Contour (200 m)
- Protected area boundary
- Important Bird Area
- Cape Bird Hut (NZ)

0 10 20
 Kilometres

Projection: Lambert Conformal Conic
 Spheroid: Antarctic Basepoint 1960
 Elevation: International Geodetic Reference System 1960
 Topography from REMA / SCAR Antarctic Digital Database v7.3 (2021);
 Coastline, glaciology and icefree ground from LINZ 1:50K digital data
 (edited ERA from satellite imagery)

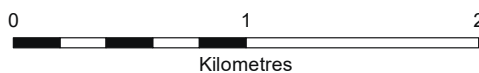


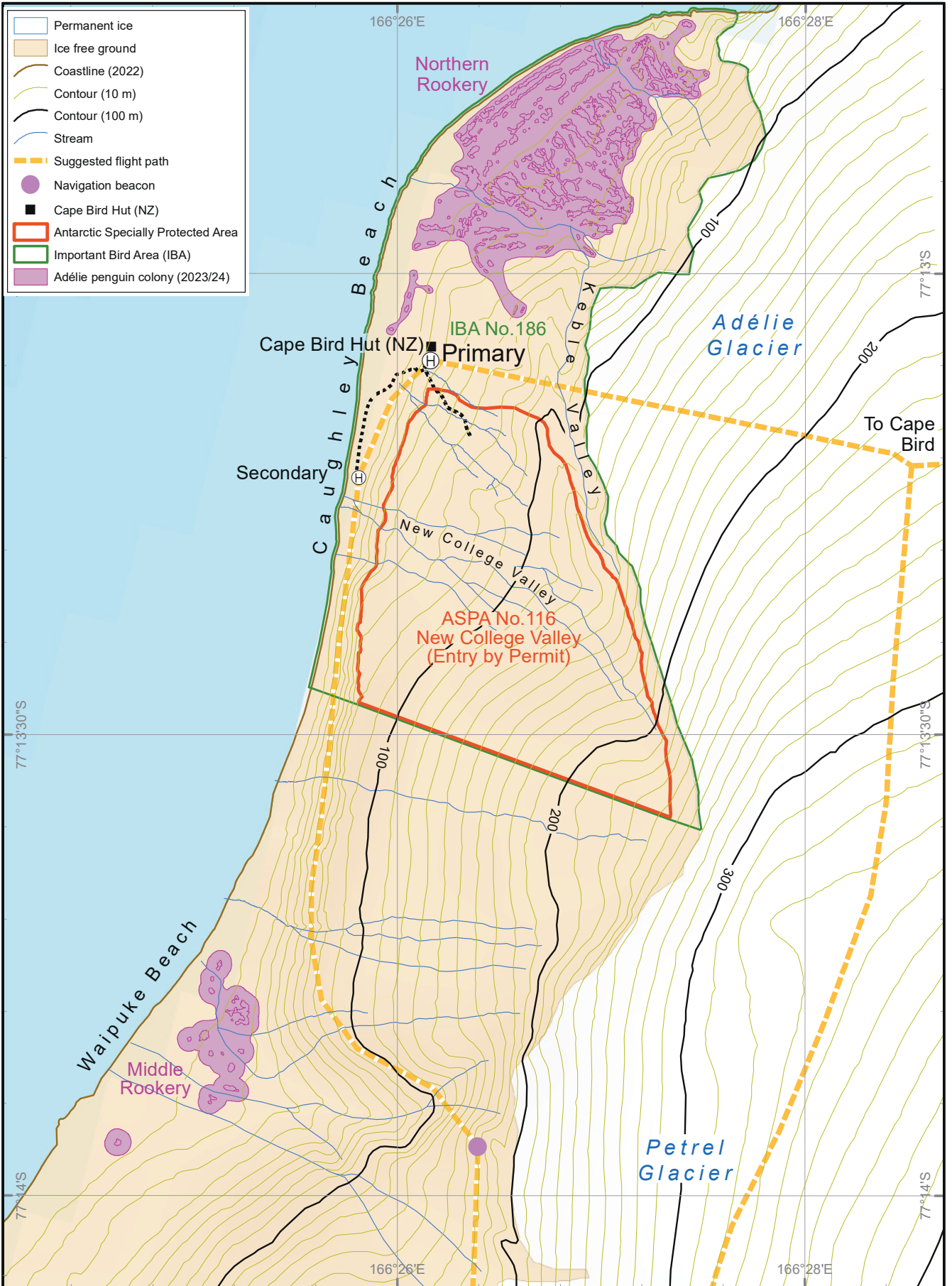
- Permanent ice
- Ice free ground
- Coastline (2022)
- Contour (20 m)
- Contour (100 m)
- Suggested flight path
- Navigation beacon
- H Designated helicopter pad
- Cape Bird Hut (NZ)
- Antarctic Specially Protected Area
- Important Bird Area (IBA)
- Adélie penguin colony (2023/24)

AIRCRAFT PROHIBITED FROM:

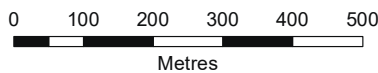
- Overflight below 50 m (~150 ft) AGL
- Hovering below 100 m (~300 ft) AGL
- Landings within the Area

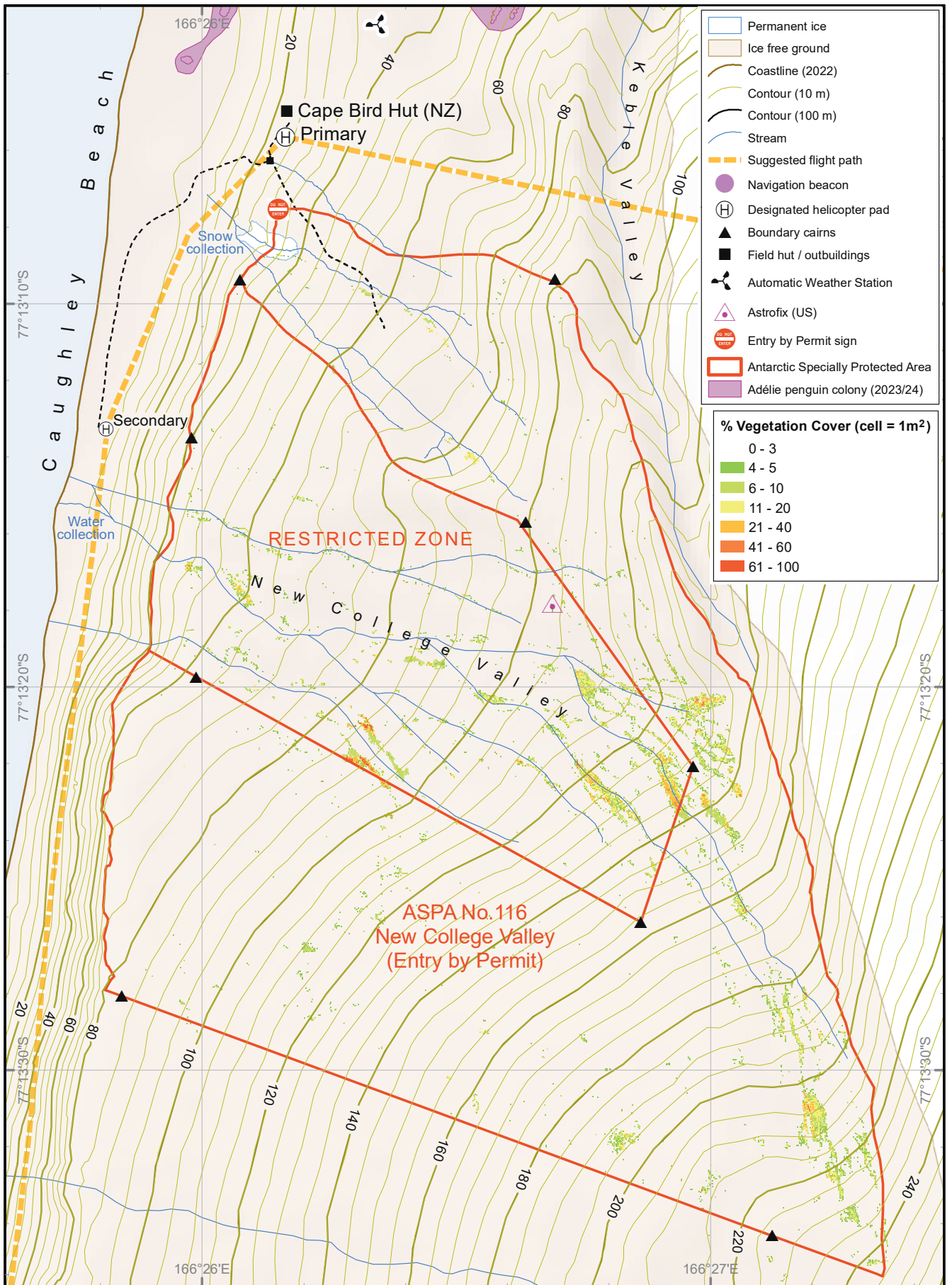
Map 2: ASPA No.116 New College Valley - Topography & air access





Map 3: ASPA No.116 New College Valley - Facilities & access





Map 4: ASPA No.116 New College Valley - Facilities, boundaries & vegetation

Projection: Lambert Conformal Conic

Horizontal datum: WGS84; Vertical datum: MSL;

Data sources: boundary, contours: Gateway Antarctica (2012);

Helicopter landing sites / flight route: Antarctica NZ 2024;

Coastline / streams: digitised ERA from WV3 (23 Dec 2022) /

high resolution orthophoto Ballard pers.comm. (Nov 2023);

Hut, emergency cache, AWS, HLS - Ballard orthophoto (Nov 2023);

Vegetation assessment: B. Bollard pers.comm. (Nov 2023);

