Management Plan for

Antarctic Specially Protected Area (ASPA) No.138

Linnaeus Terrace, Asgard Range, Victoria Land

Introduction

Linnaeus Terrace is an elevated bench of weathered Beacon Sandstone located at the western end of the Asgard Range, 1.5km north of Oliver Peak, at 161° 05.0' E 77° 35.8' S,. The terrace is ~ 1.5 km in length by ~1 km in width at an elevation of about 1600m. Linnaeus Terrace is one of the richest known localities for the cryptoendolithic communities that colonize the Beacon Sandstone. The sandstones also exhibit rare physical and biological weathering structures, as well as trace fossils. The excellent examples of cryptoendolithic communities are of outstanding scientific value, and are the subject of some of the most detailed Antarctic cryptoendolithic descriptions. The site is vulnerable to disturbance by trampling and sampling, and is sensitive to the importation of non-native plant, animal or microbial species and requires long-term special protection.

Linnaeus Terrace was originally designated as Site of Special Scientific Interest (SSSI) No. 19 through Recommendation XIII-8 (1985) after a proposal by the United States of America. The SSSI expiry date was extended by Resolution 7 (1995), and the Management Plan was adopted in Annex V format through Measure 1 (1996). The site was renamed and renumbered as ASPA No 138 by Decision 1 (2002). The Management Plan was updated through Measure 10 (2008) to include additional provisions to reduce the risk of non-native species introductions into the Area.

The Area is situated in Environment S – McMurdo – South Victoria Land Geologic based on the Environmental Domains Analysis for Antarctica and in Region 9 – South Victoria Land based on the Antarctic Conservation Biogeographic Regions. Linnaeus Terrace lies within Antarctic Specially Managed Area (ASMA) No.2, McMurdo Dry Valleys.

1. Description of values to be protected

Linnaeus Terrace was originally designated in Recommendation XIII-8 (1985, SSSI No. 19) after a proposal by the United States of America on the grounds that the Area is one of the richest known localities for the cryptoendolithic communities that colonize the Beacon Sandstone. Exposed surfaces of the Beacon Sandstone are the habitat of cryptoendolithic microorganisms, which may colonize a zone of up to 10 millimeters deep below the surface of the rocks. The sandstones exhibit a range of biological and physical weathering forms, as well as trace fossils, and many of the formations are fragile and vulnerable to disturbance and destruction by trampling and sampling.

Cryptoendolithic communities are known to develop over time periods in the order of tens of thousands of years, and damaged rock surfaces would be slow to recolonize. The excellent examples of these communities found at the site are the subject of the original detailed Antarctic cryptoendolithic descriptions. As such, Linnaeus Terrace is considered a type locality with outstanding scientific values related to this ecosystem. These values, as well as the vulnerability of the site to disturbance and destruction, require that it receives long-term special protection.

The Management Plan has been updated to include new provisions agreed within the Guide to the Preparation of ASPA Management Plans (2011), revisions to Antarctic Specially Managed Area No. 2 McMurdo Dry Valleys, observations made during a field inspection of the Area made in January 2012, and the latest measures related to managing the risk of non-native species introductions agreed by the Antarctic Treaty Parties.

2. Aims and objectives

Management at Linnaeus Terrace aims to:

- avoid degradation of, or substantial risk to, the values of the Area by preventing unnecessary human disturbance to the Area;
- allow scientific research on the ecosystem, in particular on the cryptoendolithic communities, while ensuring protection from excessive disturbance, oversampling, damage to fragile rock formations, or other possible scientific impacts;
- allow other scientific research provided it is for compelling reasons that cannot be served elsewhere and that will not jeopardize the natural ecological system in the Area;
- prevent or minimize 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 shall be undertaken to protect the values of the Area:

- Signs showing the location of the Area (stating the special restrictions that apply) shall be displayed prominently, and a copy of this Management Plan shall be kept available, at permanent scientific stations located within 150 km of the Area;
- All pilots operating in the region shall be informed of the location, boundaries and restrictions applying to entry and landings within the Area;
- National programs shall take steps to ensure the boundaries of the Area and the restrictions that apply within are marked on relevant maps and nautical / aeronautical charts;
- Durable wind direction indicators should be erected close to the designated helicopter landing site whenever it is anticipated there will be a number of landings at the Area in a given season. These should be replaced as needed and removed when no longer required;
- Brightly colored markers, which should be clearly visible from the air and pose no significant threat to the environment, should be placed to mark the designated helicopter landing site;
- 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 no less than 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 Programs operating in the region 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: ASPA No. 138: Linnaeus Terrace, Wright Valley.

Projection: Lambert conformal conic; Standard parallels: 1st 77° 30' S; 2nd 77° 40' S; Central Meridian: 161° 53' E; Latitude of Origin: 78° 00' S; Spheroid and datum: WGS84;
Data sources: USGS 1:50,000 Series (1970); Contour interval 250 m; ASMA No.2 McMurdo Dry Valleys management plan.

Map 2: ASPA No. 138 Linnaeus Terrace, topography and boundary.

Projection: Lambert conformal conic; Standard parallels: 1st 77° 35' S; 2nd 77° 36' S; Central Meridian: 161° 05' E; Latitude of Origin: 78° 00' S; Spheroid and datum: WGS84;
Data sources Topography & boundary Gateway Antarctica,
derived from an orthophotograph with an estimated positional accuracy of 0.5m, contour interval 5 m; instruments, cairns, former facilities sites: ERA field survey (Jan 2012).

Figure 1: Photograph illustrating some of the fragile rock formations and trace fossils found on Linnaeus Terrace.

6. Description of the Area

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

Linnaeus Terrace (161° 05.0' E, 77° 35.8' S) is a bench of weathered Beacon Sandstone approximately 1.5 km in length and 1 km in width at an elevation of about 1600 m (Map 1). It is located at the western end of the Asgard Range, 1.5 km north of Oliver Peak (161° 02.5' E, 77° 36.7' S, 2410 m). The Area overlooks the South Fork of the Wright Valley, is approximately 4.5 km from Don Juan Pond and ~10 km from the terminus of the Wright Upper Glacier (Map 1).

The lower (northern) boundary of the Area is characterized by the presence of a predominantly sandstone outcrop of approximately 3 m in height which extends for much of the length of the terrace (Map 2). The lower boundary of the Area is defined as the upper edge of this outcrop, and as straight lines adjoining the visible edges where the outcrop is covered by surface talus. The upper (southwestern) boundary of the Area is characterized by a line of sandstone outcrop of about 2-5 m in height, occurring between the elevations of 1660 - 1700 m about 70 m above the general elevation of the terrace. The upper boundary of the Area is defined as the uppermost edge of this outcrop, and shall be considered a straight line between the visible edges where the outcrop is covered by surface talus. The western end of the Area is defined as where the terrace narrows and merges with a dolerite talus slope on the flank of the NW ridge of Oliver Peak. The boundary at the west dips steeply from where the upper outcrop disappears, following the border of the dolerite talus with the terrace sandstone down to the westernmost corner. The east boundary is defined as the 1615 m contour, which follows closely the edge of an outcrop which extends much of the width of the terrace (Map 2). At the southernmost corner of the Area the terrace merges with the slopes into the valley to the east: from this point the boundary extends upward to the 1700 m contour, from where it follows the line of outcrop defining the southwestern boundary.

Winter air temperature at Linnaeus Terrace ranges between -20°C and -45°C, while in January the daily mean is approximately -5°C (Friedmann *et al*. 1993). However, there is extreme daily variation in air temperature at the rock surface, due to alternating wind speeds and solar irradiation patterns. Therefore, cryptoendolithic microorganisms inhabit the more stable temperature zone which begins about 1-2 mm under the rock surface (McKay & Friedmann 1985). Cryptoendolithic microorganisms typically colonize porous Beacon sandstones with a 0.2 - 0.5 mm grain size, with an apparent preference for rocks stained tan or brown by Fe3+ -containing oxyhydroxides. A silicified crust of about 1 mm thickness on many of the rocks probably facilitates colonization by stabilizing the surface and reducing wind erosion (Campbell & Claridge 1987). Five cryptoendolithic microbial communities have been described by Friedmann *et al*. (1988), two of which can be found on Linnaeus Terrace: the Lichen Dominated and Red-Gloeocapsa Communities (Friedmann *et al*. 1988). Linnaeus Terrace is the type locality of the endemic green algal genus *Hemichloris* and of the endemic Xanthophycean algal species *Heterococcus endolithicus*. The Area is unusual in that so many different living and fossil endolithic communities are present within a small area. The main physical and biological features of these communities and their habitat are described by Friedmann (1993) and Siebert *et al.* (1996). More recently, non-invasive techniques, such as *in-situ* micro-spectrometry, have been used to detect the organic chemical footprint of the microbial communities from scans of the rock surface (Hand *et al*. 2005).

Fragile weathered rock formations, such as trace fossils in eroded sandstone and brittle overhanging low rock ledges (ranging from approximately 10 cm up to 1 m in height), are present throughout the Area (Figure 1).

A small area (Map 2) has been contaminated by release of the ^{14}C radioactive isotope. While the contamination poses no significant human or environmental threat, any samples gathered within this area are considered unsuitable for scientific work using ^{14}C techniques.

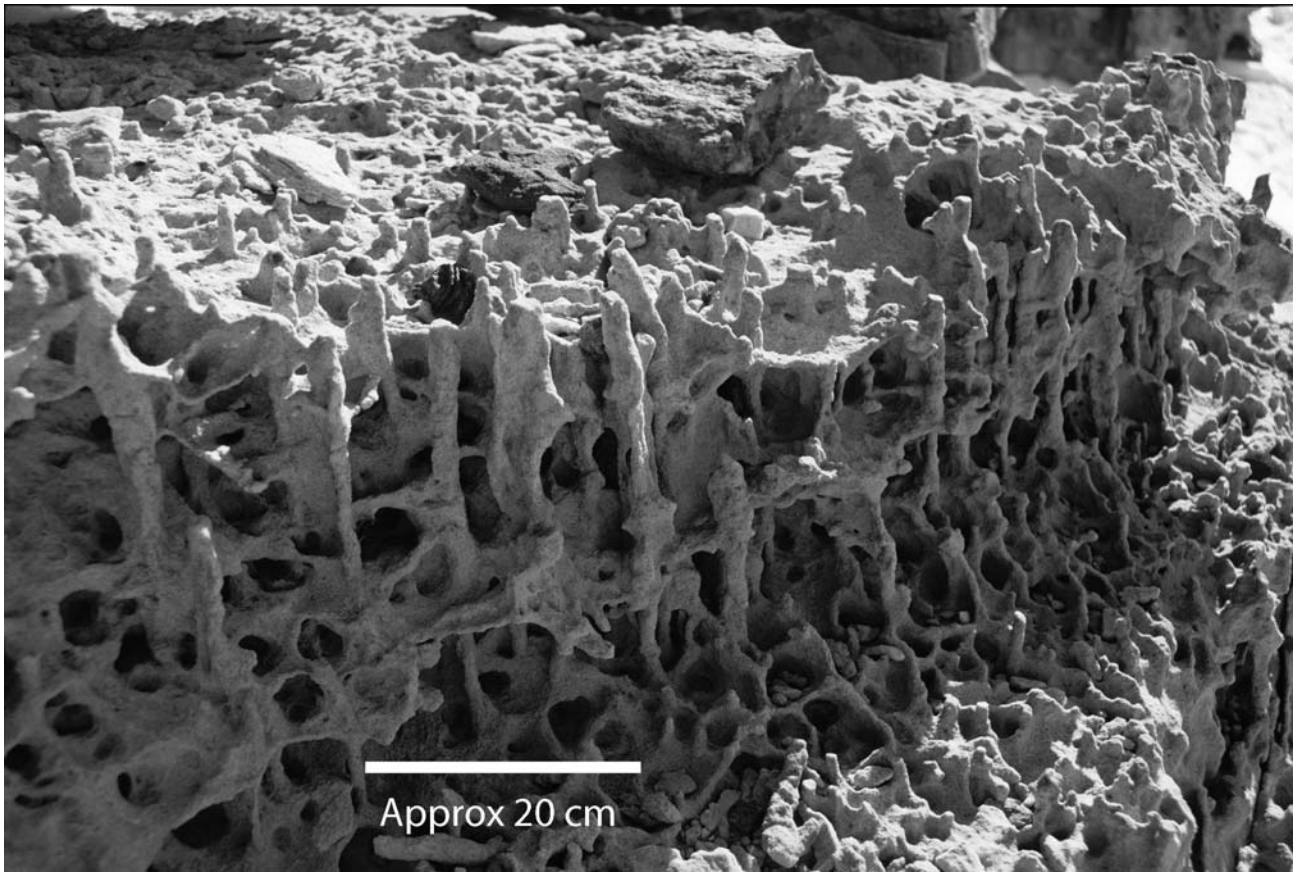

Figure 1: Photograph of the fragile rocks that are common throughout the Area (photo Colin Harris, ERA).

6(ii) Access to the area

The Area may be accessed by helicopter or on foot. Access by air is usually from either the Wright or the Taylor valleys. Access over land is difficult but possible on foot from the South Fork of the Wright Valley, although is generally impractical from other directions. Particular access routes have not been designated for entering the Area, although elevated terrain south of the Area means that helicopter access will usually be made from the other directions, particularly from the north over the Wright Valley. 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

A joint US / NZ inspection visit made 17 January 2012 identified evidence of past activities within the Area (Harris 2013). At least four markers (wooden stakes) exist at former experimental sites within the Area (Map 2). These markers could be useful so future researchers can identify and revisit these sites. While weathered, these markers do not appear to represent a significant threat to the values of the Area, and should be left *in situ* and their continued presence kept under review.

A rock cairn has been constructed close to where several small instruments have been installed into rocks (Map 2). A large, torn and faded cloth is stored within the cairn, weighed down by rocks. Future researchers may find the cairn useful to relocate these experimental sites, and it should be left *in situ*. The cloth appears to serve no useful purpose, and should be removed on a future visit.

Three sites with several small instruments embedded into rocks were identified within the Area in January 2012 (Map 2). The instruments at Marker #2 consist of a line of ‘screws’ embedded in the rock. At the other sites, one rock contains three instruments of about 10 mm across, which are fully and securely embedded

into drill holes in the rock. Another rock contains two similar instruments, one of which protrudes above the rock surface by about 10 mm. The instruments are assumed to be old temperature or moisture probes, or similar. The instruments do not represent a significant threat to the values of the Area, and should be left *in situ* and their continued presence kept under review.

Two former helicopter landing sites and campsites in the north-eastern and eastern part of the Area are evident by remnant stone circles (Map 2). These stone circles should be left *in situ* in order to identify sites within the Area that have previously been disturbed.

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

Linnaeus Terrace lies within Antarctic Specially Managed Area (ASMA) No.2, McMurdo Dry Valleys. The nearest protected areas to Linnaeus Terrace are Barwick and Balham Valleys (ASPA No.123), 35 km to the north, Lower Taylor Valley and Blood Falls (ASPA No.172), ~9 km to the south, and Canada Glacier (ASPA No.131), ~48 km to the southeast (Map 1). The nearest Restricted Zone designated under ASMA No.2 is Don Juan Pond, ~4.5 km northeast in the South Fork of the Wright Valley.

6(v) Special zones within the Area

There are no special zones within 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:

- it is issued only for scientific study of the cryptoendolithic ecosystem, or for compelling scientific reasons that cannot be served elsewhere, or for reasons essential to the management of the Area;
- the actions permitted are in accordance with this Management Plan;
- the activities permitted will give due consideration via the environmental impact assessment process to the continued protection of the environmental, ecological, and scientific values of the Area;
- the permit shall be issued for a finite period.
- the permit, or a copy, shall be carried when in the Area;

7(ii) Access to and movement within the Area

Access to and movement within the Area shall be on foot or by helicopter. Vehicles are prohibited within the Area. No special restrictions apply to the routes used to move to and from the Area.

Access on foot

- Movement within the Area should generally be on foot;
- Pedestrians should avoid damage to fragile rock formations: care should be exercised to avoid walking on trace fossils (Figure 1) and brittle overhanging low rock ledges which are easily broken;
- 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 minimize effects.

Access by aircraft

- Aircraft landings within the Area are prohibited unless authorized by permit for purposes allowed for by the Management Plan;
- Helicopters shall land only at the designated site at the west end of the terrace (161° 04.483' E, 77° 35.833' S, elevation 1610 m: Map 2), except when specifically authorized by Permit otherwise for a compelling scientific or management purpose.

- When transporting permitted visitors, pilots, air crew, or passengers en route elsewhere on helicopters are prohibited from moving on foot beyond the immediate vicinity of the designated landing and camping sites unless specifically authorized by a Permit.

7(iii) Activities that are or may be conducted in the Area, including restrictions on time or place

- Scientific research that will not jeopardize the values of the Area;
- Essential management activities, including monitoring and inspection.

7(iv) Installation, modification or removal of structures / equipment

- No structures are to be erected within the Area except as specified in a permit;
- Permanent structures are prohibited;
- All structures, scientific equipment or markers installed in the Area shall be authorized by permit and clearly identified by country, name of the principal investigator, 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 can withstand the environmental conditions and pose minimal risk of contamination of the Area;
- Installation (including site selection), maintenance, modification or removal of structures or equipment shall be undertaken in a manner that minimizes disturbance to the values of the Area;
- Existing scientific equipment or markers shall not be removed except in accordance with a permit.
- The small instruments observed within the Area (Map 2) in January 2012 are assumed to be no longer in use, although they do not appear to pose any significant threat to the values of the Area. They could be useful to future researchers as markers of former experimental sites. As such, these instruments should be left *in situ* until the next management plan review, at which time further consideration should be given to whether or not they should be removed;
- Removal of specific structures / equipment for which the permit has expired shall be the responsibility of the authority which granted the original permit, and shall be a condition of the permit.

7(v) Location of field camps

Permanent field camps are prohibited within the Area. Temporary field camps are permitted within the Area only at the designated site in the immediate vicinity of the helicopter landing site (Map 2).

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

In addition to the requirements of the Protocol on Environmental Protection to the Antarctic Treaty, restrictions on materials and organisms which may be brought into the area are:

- deliberate introduction of animals, plant material, micro-organisms and non-sterile soil into the Area is prohibited. Precautions shall be taken to prevent the accidental introduction of animals, plant material, micro-organisms and non-sterile soil from other biologically distinct regions (within or beyond the Antarctic Treaty area);
- Visitors shall ensure that scientific equipment, particularly for sampling, and markers brought into the Area are clean. To the maximum extent practicable, footwear and other equipment used or brought into the area (including backpacks, carry-bags and tents) shall be thoroughly cleaned before entering the Area. Visitors should also consult and follow as appropriate recommendations contained in the Committee for Environmental Protection *Non-native Species Manual* (CEP 2011), and in the *Environmental Code of Conduct for terrestrial scientific field research in Antarctica* (SCAR 2009);
- No herbicides or pesticides shall be brought into the Area;
- The use of explosives is prohibited within the Area;
- Fuel, food, chemicals, and other materials shall not be stored in the Area, unless specifically authorized by permit and shall be stored and handled in a way that minimises the risk of their accidental introduction into the environment;

- All materials introduced shall be for a stated period only and shall be removed by the end; and
- If release occurs which is likely to compromise the values of the Area, removal is encouraged only where the impact of removal is not likely to be greater than that of leaving the material *in situ*.

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

Taking or harmful interference with native flora or fauna is prohibited, except in accordance with Annex II of the Protocol on Environmental Protection to the Antarctic Treaty.

Where animal taking or harmful interference 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) Collection or removal of anything not brought into the Area 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;
- Material of human origin likely to compromise the values of the Area, and which was not brought into the Area by the permit holder or otherwise authorized, may be removed unless the impact of removal is likely to be greater than leaving the material *in situ*: if this is the case the appropriate authority should be notified and approval obtained. At least four markers (wooden stakes) exist at former experimental sites within the Area (Map 2). These markers do not appear to represent a significant threat to the values of the Area and could be useful for future research projects. Therefore, they should be left *in situ* and their continued presence kept under review

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 monitoring and Area inspection activities, which may involve the collection of a small number of samples or data for analysis or review;
- install or maintain signposts, markers, structures or scientific equipment;
- carry out protective measures.

7(x) Requirements for reports

- The principal permit holder for each visit to the Area shall submit a report to the appropriate national authority as soon as practicable, and no later than six months after the visit has been completed;
- Such reports should include, as appropriate, the information identified in the visit report form contained in the Guide to the Preparation of Management Plans for Antarctic Specially Protected Areas. 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, to be used both in 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 undertaken, and / or of any materials released and not removed, that were not included in the authorized permit.

8. Supporting documentation

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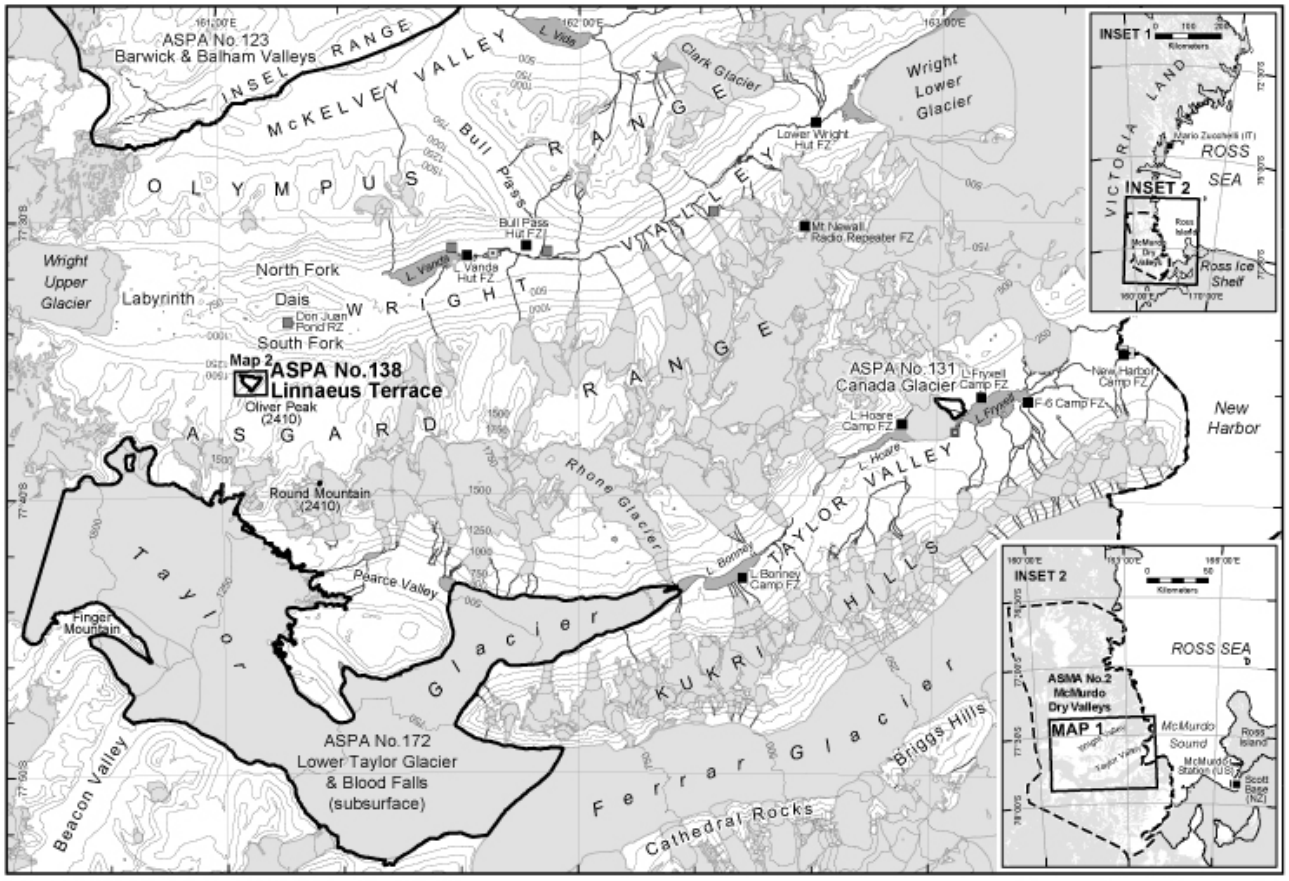

Map 1: ASPA No. 138: Linnaeus Terrace, Wright Valley

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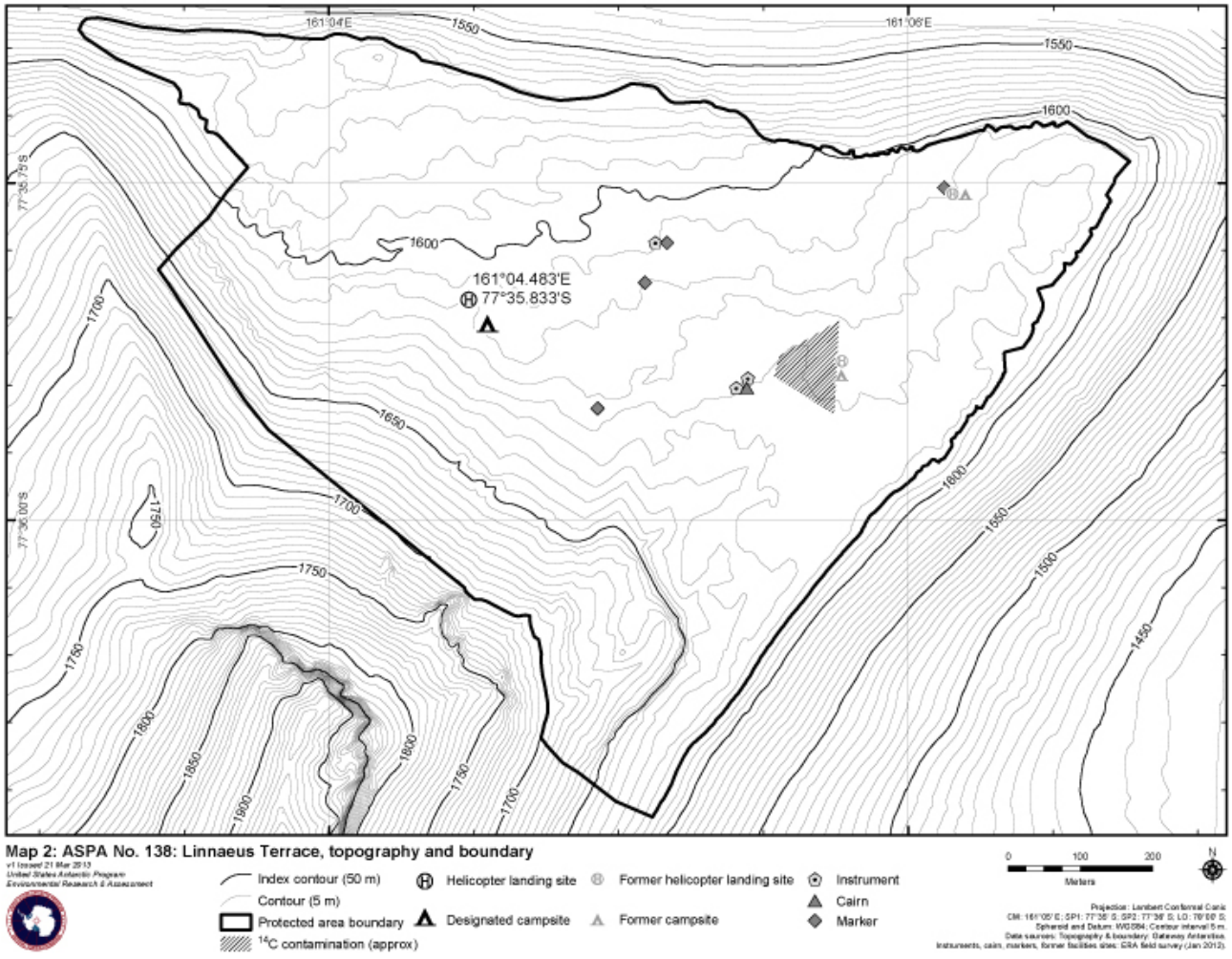
Contour (250 m)
Stream
Ice free ground
Permanent ice
Lake / pond
Protected area boundary
ASMA Boundary
Facilities Zone (FZ)
Restricted Zone (RZ)
Scientific Zone (SZ)
Visitor Zone (VZ)

0 5 10 N
Kilometers

Projection: Lambert Conformal Conic
CM: 161°53'E; SP1: 77°34' S; SP2: 77°49' S; LO: 76°50' S;
Spheroid and Datum: WGS84; Contour interval 250 m.
Data sources: USGS 1:50,000 Series (1978);
ASMA No.2 McMurdo Dry Valleys management plan.



Map 2: ASPA No. 138: Linnaeus Terrace, topography and boundary

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Environmental Research & Assessment

Index contour (50 m)
Contour (5 m)
Protected area boundary
^{14}C contamination (approx)
Helicopter landing site
Designated campsite
Former helicopter landing site
Former campsite
Instrument
Cairn
Marker

Projection: Lambert Conformal Conic
CM: 161°05' E; SP1: 77°35' S; SP2: 77°36' S; LO: 76°58' S;
Spheroid and Datum: WGS84; Contour interval 5 m.
Data sources: Topography & boundary: Gateway Antarctica.
Instruments, cairn, markers, former facilities sites: ERA field survey (Jan 2012).