Management Plan

LARSEMANN HILLS, EAST ANTARCTICA
ANTARCTIC SPECIALLY MANAGED AREA NO. 6

1. Introduction

The Larsemann Hills are an ice-free area of approximately 40 km^2 and the southernmost coastal 'oasis' in the Prydz Bay region of East Antarctica. Coastal ice-free areas are rare in Antarctica and as such the Larsemann Hills region is environmentally, scientifically and logistically significant.

In 2007 the Larsemann Hills were designated an Antarctic Specially Managed Area (ASMA) in response to a joint nomination by Australia, China, India, Romania and the Russian Federation. The primary reason for designation was to promote coordination and cooperation by Parties in the planning and conduct of activities in the region – with the view to achieving greater environmental protection outcomes.

The original management plan for Larsemann Hills ASMA No. 6 was adopted under Measure 2 (2007). A revised management plan for the Area was adopted under Measure 15 (2014).

1.1 Geography

The Larsemann Hills are located approximately halfway between the Vestfold Hills and the Amery Ice Shelf on the south-eastern coast of Prydz Bay, Princess Elizabeth Land, East Antarctica (69°30'S, 76°19'58"E) (Map A). The ice-free area consists of two major peninsulas (Stornes and Broknes), four minor peninsulas, and approximately 130 near-shore islands. The eastern-most peninsula, Broknes, is further divided into western and eastern components by Nella Fjord. The closest significant ice-free areas are the Bølingen Islands (69°31'58"S, 75°42'E) 25 km to the south-west and the Rauer Islands (68°50'59"S, 77°49'58"E) 60 km to the north-east.

Based on the Environmental Domains Analysis for Antarctica (Resolution 3 (2008)) the Larsemann Hills is located within Environment D *East Antarctic coastal geologic*. Based on the Antarctic Conservation Biogeographic Regions (Resolution 3 (2017)), the Larsemann Hills is located within Biogeographic Region 7 *East Antarctica*.

1.2 Human presence

1.2.1 History of human visitation

The Larsemann Hills area was first charted in 1935 by a Norwegian expedition under Captain Klarius Mikkelsen. While brief visits were made by several nations during the following 50 years, human activity of a significant or sustained nature did not occur until the mid-1980s. The period 1986 to 1989 saw rapid infrastructure development in the area; an Australian summer research base (Law Base), a Chinese research station (Zhongshan) and a USSR (Russia) research station (Progress) were established within approximately 3 km of each other on eastern Broknes. A 2000 m skiway was also operated by USSR (Russia) on the ice plateau south of Broknes and used for over 100 intra-continental flights during this period. Zhongshan and Progress are operated year round, as is Bharati station which was established by India in 2012/13. Law Base is seasonally operated.

1.2.2 Science

Station-based research includes hydrology, glaciology, meteorology, seismology, geomagnetics, atmospheric chemistry, Global Positioning System (GPS) tracking, atmospheric and space physics, and human physiology. Field-based research in the Larsemann Hills has focused on geology, geophysics, geomorphology, Quaternary science, glaciology, hydrology, limnology, ecology, geoecology, biology, and studies of biodiversity (including molecular), biotechnology and human impacts.

1.2.3 Tourist visits

Sporadic ship-based tourist visits were made to the area in the 1990s. These involved half-day trips, during which passengers were transported ashore by helicopter to view station areas, lakes, bird colonies and other features around eastern Broknes by foot.

1.2.4 Future activities

Continuing human activity in the Larsemann Hills is promoted by the coastal location and ice-free landscape. Commitment to ongoing use by the Parties active in the area is evident both in the development and redevelopment of station facilities, and the staging of inland traverses from the area. Primary attention will be given to safety of road improvements including the proposed levelling of the ridge on the road between Progress and the aerodrome.

1.3 Period of designation

The ASMA is designated for an indefinite period. The management plan is to be reviewed at least every 5 years.

2. Values of the Area

The Prydz Bay region contains a number of rock outcrops and offshore islands which represent a significant fraction of the ice-free component of the East Antarctic coastline. Comprising an ice-free area of approximately 40 km^2, the Larsemann Hills represent the southernmost coastal 'oasis' (69°30'S) in this geographic sector, and the second largest after the Vestfold Hills (~410 km^2), 110 km to the north-east. Such coastal oases are particularly rare in Antarctica. As such, the Larsemann Hills represents a significant biogeographical location of environmental, scientific and logistical value.

2.1 Environmental and scientific values

Much of the scientific research in the Larsemann Hills depends on the natural environment being in a relatively undisturbed state, and for this reason the protection of scientific values will to a large extent contribute to the understanding and protection of the abundant environmental values of the area.

With their geology significantly different from that of other outcrops in the Prydz Bay region, the Larsemann Hills provide a significant geological window into the history of Antarctica. Widespread exposed geological and geomorphological features provide a valuable insight into landscape formation, and the history of the polar ice-sheet and sea level. Many of these features are highly vulnerable to physical disturbance.

Broknes peninsula is one of very few coastal areas of Antarctica that remained partially ice-free through the last glaciation, and sediments deposited there contain continuous biological and palaeoclimate records dating back some 130 000 years.

Stornes and Brattnevet peninsulas are unique in terms of their extensive development of diverse suites of borosilicate and phosphate mineral assemblages that are scientifically significant in their variety and origin. Ongoing research seeks to identify the geologic processes that have concentrated boron and phosphorus to such an extent. Stornes also has sediments containing abundant well-preserved foraminifera, diatoms and molluscs. The outstanding geological values of Stornes, and its value as a reference site for the more heavily impacted Broknes, are afforded protection within Antarctic Specially Protected Area (ASPA) No. 174 Stornes.

The Larsemann Hills contain more than 150 lakes. Although some of the most scientifically important lakes are on eastern Broknes, the lakes of the Larsemann Hills are collectively recognised as the ASMA's most important ecological feature. The lakes are particularly valuable for their relatively simple natural ecosystems. As they are susceptible to physical, chemical and biological modification, a catchment-based approach to management of human activities is appropriate in protecting their scientific values. The snowfields on these catchments and streams are also important subjects for the measurement of natural hydrological processes and any expansion of human impacts.

In addition, a number of lakes in the Larsemann Hills area are characterised by floods, (accompanied by) the destruction of snow and ice dams, damming of water bodies, and the discharge of water through emerging channels. These features are of interest both from the point of view of science and within the framework of measures to ensure the safety of transport operations.

The comparatively benign microclimate and the occurrence of fresh water in summer also support Antarctic life forms. Snow petrels, Wilson's storm petrels and south polar skuas breed in the area, and Weddell seals haul out close to shore to breed and moult. Mosses, lichens and cyanobacterial mats are widely distributed, and found in high concentrations in some locations. The comparative accessibility of these biological sites makes them a valuable and vulnerable characteristic of the area.

Due to the area's short, concentrated and well-documented history of human activity, the Larsemann Hills also presents an excellent opportunity to study and quantify the impacts of humans.

2.2 Logistical values

As the site of the year-round stations of three national Antarctic programs, the Larsemann Hills ASMA is an important logistical support base for access to the southern Prydz Bay region and the Antarctic interior including to Kunlun station at Dome A (China), Vostok (Russia) and the Groves Mountains region. Australia and China have conducted substantial inland traverses supported by facilities in the Larsemann Hills. From 2008 Russia relocated its support base for the resupply of Vostok from Mirny to the Larsemann Hills.

The presence of a Russian-serviced, existing snow airstrip that operates medium-haul aircraft also increases the logistical value of the area, as does the use of Thala Fjord as a backup option for unloading ships to increase the success and safety of cargo operations. Given the long-term nature of the icebergs blocking the sea passage to Progress and Zhongshan stations, the use of the Thala Fjord for sustainable supply of stations on the Broknes Peninsula and for delivery of cargo to inland stations is important. Russia plans to use the Thala Fjord starting from 2021/22 summer season to deliver construction materials and fuel to Vostok station. Access will be via the Stornes Peninsula, along the border with ASPA 174 Stornes, which is currently the only passage between Thala Fjord and the continent. To support safe passage, work has been carried out since 2015 to identify glacial crevasses and hazardous water bodies.

2.3 Wilderness and aesthetic values

Stornes and the minor peninsulas and near shore islands show less evidence of human presence than elsewhere in the ASMA. The aesthetic value of the ASMA's rugged ice-free hills interspersed by lakes and fjords against the backdrops of the Dålk Glacier, near shore islands, icebergs and plateau is noteworthy and warrants protection.

3. Aims and objectives

The Larsemann Hills are designated as an ASMA in order to protect the environment by promoting coordination and cooperation by Parties in the planning and conduct of human activities in the Area.

Through the adoption of this Management Plan, Parties commit to:

- providing guidance on the appropriate conduct of activities to all visitors including personnel involved in national research programs, transitory national program visitors and participants in non-governmental activities;
- minimising cumulative and other environmental impacts by encouraging communication and a consistent, cooperative approach to environmental protection in the conduct of research and support activities;
- minimising physical disturbance, chemical contamination and biological impacts in the region, primarily through appropriately managing vehicle usage;
- preventing contamination of the environment through the implementation of comprehensive waste management practices and the appropriate handling and storage of harmful substances;
- implementing measures needed to protect the environment from the accidental introduction or release of non-native species;
- maintaining the wilderness and aesthetic values of the area;
- safeguarding the ability to conduct scientific research by not compromising the scientific values of the area; and
- improving understanding of natural processes in the area, including through the conduct of cooperative monitoring and recording programs.

4. Description of the Area

4.1 Geography and Area boundary

The ASMA comprises the ice-free area and near-shore islands collectively known as the Larsemann Hills (see Map A), and the adjacent plateau. The ASMA includes the land:

beginning at 69°23′20″S, 76°31′0″E east of the southern tip of Dalkoy and from there,

north to 69°22′20″S, 76°30′50″E north of Dalkoy

north-west to 69°20′40″S, 76°21′30″E north of Striped Island

north-west to 69°20′20″S, 76°14′20″E north-east of Betts Island

south-west to 69°20′40″S, 76°10′30″E north-west of Betts Island

south-west to 69°21′50″S, 76°2′10″E north-west of Osmar Island

south-west to 69°22′30″S, 75°58′30″E west of Osmar Island

south-west to 69°24′40″S, 75°56′0″E west of Mills Island

south-east to 69°26′40″S, 75°58′50″E south of Xiangsi Dao

south-east to 69°28′10″S, 76°1′50″E south-west of McCarthy Point

south-east to coastline at 69°28′40″S, 76°3′20″E north-east to 69°27′32″S, 76°17′55″E south of the Russian airstrip site

south-east to 69°25′10″S, 76°24′10″E on the western side of the Dålk Glacier

north-east to 69°24′40″S, 76°30′20″E on the eastern side of the Dålk Glacier, and north-east returning to 69°23′20″S, 76°31′0″E.

The intention is however to manage, in accordance with this management plan, the conduct of all substantial human activity associated with the Larsemann Hills.

No artificial boundary markers are in place.

4.2 Climate

A major feature of the climate of the Larsemann Hills is the existence of persistent and strong katabatic winds that blow from the north-east on most summer days. Daytime air temperatures from December to February frequently exceed 4˚C and can exceed 10˚C, with the mean monthly temperature a little above 0˚C. Mean monthly winter temperatures mostly range between –15˚C and –18˚C. Precipitation occurs as snow and rarely exceeds 250 mm water equivalent annually. Snow cover is generally deeper and more persistent on Stornes than Broknes. The pack ice is extensive inshore throughout summer, and the fjords and bays are rarely ice-free.

4.3 Natural features

4.3.1 Geology

The Larsemann Hills (and neighbouring Bolingen Islands and Brattstrand Bluffs) differ from other parts of Prydz Bay, mainly due to the absence of mafic dykes and large charnockite bodies. Bedrock exposures in the Larsemann Hills are composed of supracrustal volcanogenic and sedimentary rocks metamorphosed under granulite facies conditions (800–860˚C, 6–7 kbar at peak) during the early Palaeozoic 'Pan-African' event (~500-550 Ma). Peak metamorphic conditions were followed by decompression. The rocks were subjected to extensive melting and several deformational episodes, and have been intruded by several generations of pegmatites and granites. The supracrustal rocks are underlain by, and possibly derived from, a Proterozoic orthopyroxene-bearing orthogneiss basement.

4.3.2 Geomorphology

The elongated form of the large-scale topographic features of the Larsemann Hills results from compositional layering, folds and faults (lineaments) in the metamorphic bedrock. The landscape is dissected by large, structurally-controlled, steep-sided fjords and valleys rarely exceeding 100 m in depth on land; the longest is 3 km (Barry Jones Bay). The maximum elevation above mean sea level is 162 m (Blundell Peak).

The coastline is generally bedrock, and beaches occur only at the heads of fjords or in isolated sheltered bays. There are several sequences of ice-dammed lakes and associated gorges and alluvial fans. The offshore islands are likely to be roches moutonnees, isolated by the current sea level.

Landforms produced by wind are common, though ice and salt wedging clearly play a considerable role in grain detachment with wind primarily acting as a transporting agent. Periglacial landforms are also widespread, but not particularly abundant or well developed.

True soils are virtually absent due to a lack of chemical and biological soil-forming processes. Surficial deposits are widespread but confined to lower areas and include snow patch gravels, wind-deposited materials, talus and fluvially deposited materials. Very thin soils (less than 10 cm) are also found in association with scattered moss beds and discontinuous lichen. A permafrost layer exists 20–70 cm below the surface in some areas.

On north-eastern Stornes at approximately 69º31'48"S, 76º07'E there is an outcrop of post-depositionally placed marine Pliocene (4.5–3.8 Ma) sediment up to 40 cm thick. These sediments occupy a narrow bench approximately 55 m above sea level and yield abundant well-preserved foraminifera and reasonably well-preserved diatoms and molluscs.

On Broknes, areas that have remained ice-free through the Last Glacial Maximum contain sediment deposits (in lakes) that record climate, biological and ecological changes spanning the last glacial cycle.

4.3.3 Lakes and snowfields

The Larsemann Hills contains more than 150 lakes ranging in salinity from fresh to slightly saline, and in size from shallow ponds to large ice-deepened basins, although most are small (5000–30 000 m2) and shallow (2–5 m). The surfaces of the lakes freeze during winter, and most thaw for up to 2 months in summer, allowing them to be well-mixed by the katabatic winds. Most lakes are fed by snow melt and some have entrance and exit streams that flow persistently during the summer and provide habitat for crustaceans, diatoms and rotifers. Such streams are particularly evident on Stornes.

Small catchment areas and the near pristine waters make the Larsemann Hills lakes particularly susceptible to impacts resulting from human activities. Research has shown that several lakes on eastern Broknes in the immediate vicinity of the station areas and their interlinking roads have experienced modified water chemistries and inputs of nutrients, melt water and sediment. Whilst these lakes clearly exhibit human impacts, the majority of the lakes on Broknes and elsewhere in the Area appear largely unmodified.

The lakes on east Broknes have the longest sediment record of any surface lakes in Antarctica. It appears that the ice sheet did not advance beyond Lake Nella and did not scour Progress Lake so these lakes and the lakes towards the north end of the peninsula are particularly valuable to the science community.

The surface area of the Larsemann Hills' snowfields has increased by an estimated 11% during the last 50 years. In the summer period, a temporal hydrographical net is forming from thawing water from snowfields and glaciers. Streams transport water, ions, suspended matter and pollutants on catchments areas and to the lakes and bays.

According to the results of observations in recent years, a number of lakes in the area are characterised by periodic floods. Detailed studies devoted to these phenomena have been carried out on the water bodies of the Broknes Peninsula since the 2017/2018 season, and include hydrological and geophysical surveys as well as long-term observations of the dynamics of water bodies. The frequency and nature of floods is determined by a number of factors, including the climatic and geomorphological features of each water body. Floods of Kristalnoe (Progress) (LH-59) and Discussion lakes occur almost annually, and of Bolder (LH-73) every few years as critical water levels are reached.

4.3.4 Lake and stream biota

The most diverse and widespread group of primary producers of the continental waterbodies of the oasis is cyanobacteria (blue-green algae), among which there are many species endemic to Antarctica and the Prydz Bay region. Second in terms of species diversity and distribution are diatoms. About 40% of diatom taxa living in the fresh and brackish waters of the Larsemann Hills are endemic to Prydz Bay or to the Antarctic (found mainly in the eastern part of Broknes). Green algae also play a significant role. Desmids are represented by only four species belonging to three genera: *Actinotaenium, Cosmarium* and *Staurastrum*, but often co-dominate in algal communities. They usually live in benthic communities, but species of the genus *Cosmarium* are occasionally noted in the plankton as well. Golden algae occur either in the plankton (species of the genus *Paraphysomonas*) or as resting stages (stomatocysts) on the bottom of the lakes. Dinophyte algae (dinoflagellates) are also found in the plankton of freshwater waterbodies, but their abundance varies significantly from year to year.

The most noticeable feature of the biota of almost all the region's lakes is the presence of vast blue-green felt covers of cyanobacteria (cyanobacterial mats) which have accumulated here since the retreat of the glaciers, and in some places are up to 130 000 years old. These mats are usually from 1 to 10 cm thick, but in rare cases can reach 1.5 m which is not observed in other freshwater Antarctic systems. These mats contain cyanobacteria, eukaryotic algae (green, desmid, diatoms) and resting stages of planktic species of golden algae. The basis of the mat is composed of filamentous cyanobacteria, usually from the genera *Leptolyngbya, Phormidesmis* and *Pseudanabaena*. Similar communities, but of a lesser thickness and different species composition of algae and cyanobacteria, are often found in temporary reservoirs and watercourses and wet seepage areas.

Heterotrophic nanoflagellates are more common than autotrophic nanoflagellates, although their species diversity is small (only three or four species in most lakes). Ciliates are found in low numbers, with *Strombidium* the most common species. A species of *Holyophyra* is also found in most lakes. Rotifers occur sporadically in a number of lakes, and the cladoceran *Daphniopsis studeri* is widespread but found in low numbers.

4.3.5 Seabirds

South polar skuas (*Catharacta maccormicki*), snow petrels (*Pagodroma nivea*) and Wilson's storm petrels (*Oceanites oceanicus*) breed within the Larsemann Hills. While approximate numbers and locations of breeding pairs are documented for Broknes, and particularly eastern Broknes, their distribution throughout the remainder of the area is uncertain.

South polar skuas are present between mid-late October and early April, with approximately 17 breeding pairs nesting on Broknes, and similar numbers of non-breeding birds. Snow petrel and Wilson's storm petrel nests are found in sheltered bedrock fragments, crevices, boulder slopes and rock falls, and are generally occupied from October until February. Approximately 850–900 pairs of snow petrels and 40–50 pairs of Wilson's storm petrels are found on Broknes, with concentrations of snow petrels at Base Ridge and on rocky outcrops adjacent to the Dålk Glacier in the east and the plateau in the south.

Despite the apparent suitable exposed nesting habitat, no Adelie penguin (*Pygoscelis adeliae*) breeding colonies are found at the Larsemann Hills, possibly due to the persistence of sea ice past the hatching period. However birds from colonies on nearby island groups between the Svenner Islands and Bolingen Islands visit during summer to moult. Emperor penguins (*Aptenodytes forsteri*) also occasionally visit.

4.3.6 Seals

Weddell seals (*Leptonychotes weddelli*) are numerous on the Larsemann Hills coast, using the local sea ice to pup from October, and to moult from late December until March. Pupping has been observed on the sea ice adjacent to the small islands north-east of eastern Broknes, and groups of moulting seals have been observed hauled out near the Broknes shore adjacent to the stations and in tide cracks in the fjords to the west. Aerial surveys during the moulting period have noted more than 1000 seals, with multiple large groups (50–100 seals) hauled out in Thala Fjord and on rafted ice immediately to the west of Stornes, and numerous smaller groups amongst offshore islands and ice to the north-east of Broknes. Crabeater seals (*Lobodon carcinophagus*) and leopard seals (*Hydrurga leptony*x) are also occasional visitors.

4.3.7 Micro fauna

Five genera of terrestrial tardigrade (*Hypsibius, Minibiotus, Diphascon, Milnesium* and *Pseudechiniscus*), which include six species, are known to be present in localities associated with vegetation. The lakes and streams provide a series of habitats that contain a rich and varied fauna. Seventeen species of rotifer, three tardigrades, two arthropods, protozoans, a platyhelminth and nematodes have been reported. The cladoceran Daphniopsis studeri, one of few species of freshwater crustacea known to occur in the lakes of continental Antarctica has been identified in most Larsemann Hills lakes, is the largest animal in these systems, and is currently restricted to the Prydz Bay region and the sub-Antarctic islands in the South Indian Ocean Province. It has been continuously present on eastern Broknes through the Last Glacial Maximum, providing evidence that Broknes has acted as an important glacial refuge for the Antarctic biota through one or more full glacial cycles.

4.3.8 Terrestrial vegetation

Sampling of the coastal areas from the Vestfold Hills to the Larsemann Hills indicates that the flora of the Ingrid Christensen Coast is relatively uniform, and restricted to a similar distribution of bryophytes, lichens and terrestrial algae. The nature of the basement rock and the prevailing wind direction in the greater Prydz Bay area likely contribute to the fact that less than 1% of the Larsemann Hills has vegetative cover.

Most terrestrial life, including mosses, lichens and accompanying invertebrates are found inland from the coast. Nevertheless, large moss beds are known to occur in sheltered sites on Stornes and on the larger islands (particularly Kolløy and Sigdøy) where they are associated with Adelie penguin moulting sites, and on nunataks in the southwest. There are seven positively identified moss species in the region: Bryum pseudotriquetum which is most abundant, *Grimmia antarctici, Grimmia lawiana, Ceratodon pupureus, Sarconeurum glaciale, Bryum algens* and *Bryum argentum*.

The bryophyte flora also comprises one species of liverwort (*Cephaloziella exiliflora*) found on an unnamed outcrop south of Stornes and known from only four other Antarctic localities. Lichen coverage is considerable on north-eastern Stornes and Law Ridge on Broknes; the lichen flora of the region comprises at least 25 positively identified species. Studies conducted in nearby locations on the Ingrid Christensen Coast suggest that it would not be unreasonable to expect the Larsemann Hills to exhibit close to 200 non-marine algal taxa and 100–120 fungal taxa.

4.4 Human impacts

Intensive human activity in the region since 1986 has resulted in notable localised alteration of the environment, concentrated on eastern Broknes and the peninsula between Thala Fjord and Quilty Bay. The construction of station buildings and associated facilities and roads has caused physical degradation of the ice-free surface. Breakdown of rocks and exposure of the permafrost layer through repeated vehicle use has caused surface erosion and altered drainage patterns. Chemical contamination of some lakes and soils has occurred through the collection of water, accidental spillage of hydrocarbons, and the local disposal of wastewater. Water withdrawals for station use have depleted lake water volumes on Broknes.

Introduced floral species have been detected (and removed), and there is historical evidence of ingestion of human-derived food by wildlife. Wind-blown litter and surface disturbance through repeated pedestrian access remains an issue.

Stornes, and the minor peninsulas and near shore islands, have been less frequently visited and are less disturbed. Maintaining this well-preserved state, and minimising impacts elsewhere, is a major priority for management of the Larsemann Hills.

4.5 Access to the Area

4.5.1 Land access

Fifteen kilometres of unsealed roads, formed from local material, have been established on eastern Broknes. They include a 6.7 km road linking each of the stations on Broknes and the continental plateau in the south. This road follows the only practical route with regard to avoiding lake catchments and steep slopes. There are four particularly steeps sections – a ridge approximately 0.5 km south of Zhongshan; a series of steep slopes between Progress and Law Base; a section traversing the slope to the west of Lake Sibthorpe; and the ascent to the plateau near the Dålk Glacier. The final kilometre of the route before entering the plateau proper is marked by canes at 50–100 m intervals. There are also vehicle routes within the immediate station areas of Zhongshan and Progress and a short access route connecting Law Base to the main road. Vehicle access over ice-free surfaces within the Area is restricted to these existing roads.

Most of Stornes, the western-most peninsula in the Larsemann Hills, is within the boundary of ASPA 174. Vehicular travel within the ASPA is prohibited.

Sea ice usually persists in the fjords and between the shore and numerous near-shore islands until late in the summer season. Ice conditions are variable at the eastern and western margins of the ASMA due to the presence of glaciers. Sea ice travel must take account of these conditions. In winter, sea ice access to Zhongshan and Progress may be feasible via the beach west of Zhongshan (69°22'30"S, 76°21'33"E) and the beach adjacent to Progress (69°22'44"S, 76°23'36"E), depending on highly variable ice conditions. From the sea ice, it may then be possible to access the main road south of the steep section south of Progress via either the easternmost bay of Nella Fjord (69°22'58"S, 76°22'44"E) or via Seal Cove (69°23'6"S, 76°23'49"E).

The Larsemann Hills can be approached via the plateau from Davis in the north-east (approximately 330 km) and Mawson in the west following the Lambert Glacier traverse route (approximately 2200 km). This comprises a caned route which turns north from a marker at 69o55'23"S, 76o29'49"E and then follows series of canes and drum beacons north to connect with the major access route on eastern Broknes.

4.5.2 Sea access

No anchorages or barge landings are designated for the Area due to the variable sea ice conditions. Vessels usually anchor approximately 5 nm offshore, depending on ice conditions, however vessels chartered by India have reached as close as 50 m away from the site of Bharati.

Access from ships to the eastern shore of Broknes by small boat is difficult and sometimes impossible due to ice debris up to hundreds of metres off shore, blown by the prevailing north-easterly winds. Helicopters are therefore the only reliable means by which persons and supplies can be transported ashore quickly.

Due to the difficult ice and iceberg conditions and access to Broknes Peninsula, since 2010, increasing focus has been on Thala Fjord as the most convenient and safest place for unloading ships. In recent years, Russia has used the unloading site on the Stornes Peninsula to deliver cargo to Progress and Vostok stations. During 2021-2025 a large amount of cargo associated with building works at Vostok station will be transported from this unloading point.

The main sites used are:

- the bay ~250 m NNE of Zhongshan at 69º22'12"S, 76º22'15"E which consists of a ~15 m opening between rock outcrops, and a large flat area on shore for vehicle operations;
- the beach adjacent to Progress (69º22'44"S, 76º23'53"E);
- the beach west of Zhongshan opening into Nella Fjord (69º22'30"S, 76º21'25"E);
- Thala Fjord, 50 m away from the site of Bharati;
- Thala Fjord, the beach, Stornes (69º25'454''S, 76º08'880''E).

In accordance with the management plan for ASPA 174, a permit is required to make landings on all but the south-eastern corner of Stornes.

4.5.3 Air access

Designated helicopter landing and refuelling sites are to be used preferentially for general helicopter operations.

In accordance with the management plan for ASPA 174, a permit is required to overfly or make landings on all but the south-eastern corner of Stornes.

There are two cement helicopter-landing sites (69º22'44"S, 76º21'32"E) at Zhongshan. The southerly pad is 15 m in diameter and displays a painted map of Antarctica. The other pad is about 25 m to its north and is 20 m in diameter. Usually heavy helicopters (e.g. Ka-32) land at the larger pad and lighter aircraft (Dolphins and Squirrels) land at the pad to the south. Landings are usually made from the western side of Zhongshan travelling towards the main building from the direction of the lake and descending gradually above the lake. Pilots should avoid reducing altitude on the southern side of the lake where there is a 58 m hill with radars used for upper atmospheric physics studies.

Progress has a 25 m x 25 m concrete helicopter-landing site at 69°22'38"S, 76°23'11"E, 90 m to the north-west of the largest building in the station area (Map E).

Bharati has a concrete helicopter landing pad at 69°24.40'S, 76°11.59'E – west of the main station building at an elevation of 38.5 m.

The Law Base helicopter-landing site (69°23'20"S, 76°22'55"E) is approximately 60 m east of the base. Helicopters would normally land facing into the north-east prevailing winds.

Small ski/wheeled fixed-wing aircraft operations have previously been conducted infrequently in the region and may be possible on the sea ice adjacent to the stations, though ice conditions vary annually, and the proximity to wildlife colonies make operations on the plateau preferable. Landings have been conducted near the site of the previous Russian runway and existing snow airstrip (centred on 69°26'00"S, 76°19'58"E). Prevailing winds from the north-east and a slight rise in the surface suggest that landing and taking off towards the north-east is preferable.

4.5.4 Pedestrian access

Pedestrian access within the ASMA is not restricted (other than the requirement for a permit to enter ASPA 174 Stornes), but is to be conducted in accordance with the Environmental Code of Conduct at Appendix 1. Established routes should be used to minimise physical disturbance of the land surface and to prevent further track formation. Where surface modification is not apparent, the most direct route between points should be taken, with consideration given to avoiding repetitive use of the same route and avoiding vegetation and other sensitive features such as the margins of lakes and wet seepage areas.

4.6 Location of structures in or near the Area

4.6.1 Zhongshan (People's Republic of China)

Zhongshan is located on the north-eastern tip of eastern Broknes at 69°22'24"S, 76°22'40"E and approximately 11 m above sea level. The station was established in the 1988/89 summer season and has since been operated continuously to facilitate the conduct of year-round scientific research activity by the Chinese Antarctic program. As noted earlier, Zhongshan also acts as the logistical support base for Kunlun station and for scientific research in other inland areas such as Grove Mountains and Amery Ice Shelf. As such, Zhongshan is an important supporting centre for China's inland research in Antarctica.

Station infrastructure

The station supports approximately 60 personnel in summer and 20–25 in winter, with a maximum capacity of 76. The station consists of seven main and several smaller buildings (Map D). Vehicle access to Zhongshan is via the main road from the plateau, and a network of routes link the main buildings within the station area. Two concrete helicopter-landing pads are located west of the main station building (see Section 4.5.3).

Power, fuel delivery and storage

Electrical power is provided by diesel generators. Fuel is transferred from the ship by barge or pipeline, depending on sea ice conditions, and stored in bulk tanks at the southern end of the station area. Between 200 and 300 m3 of fuel are delivered to the station each year.

To avoid activities associated with oil storage and transport damaging the Antarctic environment, a new oil storage facility was built at Zhongshan in 2011. It is located on the eastern side of the station, on the border area with Progress. The facility can store about 500 t of fuel and also houses oil spill prevention equipment. The old oil storage system is routinely checked and maintained. It will be relocated to the new oil storage area to reducing crowding in the station and to improve the safety of its operation.

Water and waste water

Water for generator cooling and shower facilities is drawn from a large tarn immediately west of the station area. Grey water is used to flush toilets after treatment in the powerhouse. Black water is collected and treated in the sewage station and discharged to the ocean after passing through a series of gravity-driven settlement tanks.

Solid waste management

Combustible wastes are separated and burnt in a high temperature, diesel-fuelled incinerator. The quantity of combustible wastes produced requires an incinerator burn every three to four days on average. The ash is collected and stored for return to China. Non-combustible wastes are sorted into waste categories and stored south of the powerhouse for removal by ship.

Vehicles

Vehicles are used in the immediate station area and to transport materials to other sites on eastern Broknes. Maintenance of vehicles, generators and instruments is undertaken in the powerhouse or vehicle workshop. Waste oil is returned to China.

Resupply

Resupply is generally undertaken once a year in summer. Cargo is brought to shore using either barges or sleds towed behind traverse vehicles.

Communications

Verbal communication with China is largely by short-wave radio, INMARSAT and, increasingly, Broadband Global Area Network (BGAN). BGAN has become the main communication equipment for sending and receiving telephone calls, faxes, emails and scientific data. HF radio is used for communications in the Prydz Bay area and VHF radio is used for local communications. A radio-telephone link also provides contact with Davis (and via Davis to anywhere in the world), and this is used for conveying meteorological data on a daily basis. A Very Small Aperture Terminal (VSAT) satellite communication system has also been installed. It establishes 24-hour uninterrupted communication between the station and China and provides communication services in voice, words and data. Iridium communication is retained for emergencies.

Science

Science programs conducted from Zhongshan are largely of a station-based nature and include meteorology, ozone monitoring, upper atmosphere physics, auroral observations, geomagnetic observations (some in cooperation with the Australian Antarctic program), gravimetric observations, seismology, NOAA polar orbiting satellite image processing, atmospheric chemistry, remote sensing, GPS measurement and human physiology. Activities away from the immediate station area during seasons with summer research programs include environmental evaluation and monitoring of snow and ice, soil, seawater, freshwater, mosses, lichen, wildlife, geology, glaciology and sea ice ecosystems. Inland traverses have also been undertaken to conduct geological, geodetic, glaciological and meteorite studies.

4.6.2 Progress (Russia)

Progress is located on eastern Broknes at 69°23'S, 76°23'E, approximately 1 km south of Zhongshan. The original station was established in 1988 on a plateau 300 m from the western shoreline of Dålk Bay, and from where it was moved in February 1989. The station was occupied sporadically and shut down during the 1993/94 summer and reopened in the 1997/98 summer season for operation as a year-round research facility. The construction of a new wintering complex was completed in 2013. It includes an office/living building, energy complex, garage and new fuel storage infrastructure (Map E). The station is suited to accommodating up to 100 personnel during summer.

Station infrastructure

The main station complex includes:

- an office/living three-storey building intended for accommodation of 50 people (25 people during winter when each person is provided with a single living room), five scientific laboratories (meteorological, 'wet' and dry oceanographic, and for satellite imagery, geophysical and hydrobiological studies), living rooms, a station office, radio-information hub, medical unit, galley, food supply storage, dining/mess room, gym, sauna, toilets and shower cubicles;
- a two-story building of the energy complex ('ZEM') housing a diesel power station, repair shop for up to eight transport vehicles, an automated boiler plant for heating the station (using waste oil products), a desalination plant, the station's sewage treatment systems, and repair shops;
- an observation post for monitoring the satellite constellation orbits of the GLONASS navigation system and geodetic monitoring of the tectonic Earth's crust movements from GPS and GLONASS satellite systems, a geomagnetic pavilion, and radar for monitoring the state of coastal ice and icebergs and for air traffic control of helicopters and low-flying airplanes; and
- a hangar/garage for winter storage of traverse vehicles used to supply Vostok station with continental sledge-caterpillar convoys. (The building was converted into a garage from the old power station complex.)

In addition, the station has four small residential modules (used mainly during the seasonal period) and a number of service buildings for various purposes.

Progress is also equipped with a GPS safety system to track movements of personnel and vehicles within 20 km of the station, displaying them on a monitor in the radio room.

Vehicle access to Progress is via the main road from the plateau and the network of routes linking the main buildings within the station area. The station's helicopter pad is described at Section 4.5.3.

Power, fuel delivery and storage

The station has a power supply complex consisting of a diesel-electric power station with a total capacity of 800 kW, and an automatic boiler for station heating that uses fuel-lubricant waste.

Progress' diesel and aviation fuel storage infrastructure includes fifteen double-walled tanks with a capacity of 75 m3. The tanks have a common pipeline system that provides fuel supply to the consumable tanks of a diesel power station and a system for measuring the level, temperature, density, volume and mass of fuel. There is also a metal rack for the storage of drummed fuel and lubricants, specially provided for the delivery of fuel to the helipad. Expedition ship – shore fuel transfer is through a flexible pipeline.

Water supply

Drinking water and water for household needs is drawn from Stepped Lake which is located to the north-west of the station area. Water is piped to the water treatment plant in the energy complex where reverse osmosis purifies it to drinking water quality.

Waste management

Small, non-combustible wastes are separated and compacted for removal. Kitchen wastes and combustibles are burnt in a high temperature incinerator. Sewage water from the main building is treated by a biological unit and discharged into the bay. The garage/workshop/power plant building is also equipped with a sewage treatment unit. The smaller, old buildings do not have sewage treatment units; human waste is drummed and returned to Russia.

Metal scrap is stockpiled on the beach adjacent to the station, for return to Russia.

Vehicles

Progress is the major transportation base for supporting inland convoys, including convoys to Vostok station. Eight to twelve Kässbohrer Pisten Bully Polar 300 transporters are used for this purpose.

Other vehicles are also used in the vicinity of Progress for scientific and operational acitivites, including fuel and waste transfer, and transporting personnel and equipment to remote areas and the plateau for runway preparation and cargo operations. Such vehicles include cars, wheeled and tracked all-terrain vehicles (ATVs) and snowmobiles. There is also trailer equipment for tractor-sledge convoys. In winter, most of the equipment is located at Progress 1station; in summer, some of the vehicles can be temporarily located on snowfields in the area of the old station (see subsection 4.6.6). During seasonal work, field equipment may be located near the runway at a distance that ensures flight safety.

Larger transport convoys of up to 38 Kässbohrer Pisten Bully Polar 300 and Challenger MT 850 vehicles are planned to deliver construction materials from temporary storage on the plateau to Vostok station from 2021-2025.

Resupply

Resupply is carried out in the summer period (November - March) using the scientific expedition vessels “Akademik Fedorov” and “Akademik Tryoshnikov”. Since unloading cargo directly to Broknes is not feasible, heavy cargo delivered by the vessel is transported across fast ice to the site on the Stornes peninsula (see subsection 4.6.6) for further transportation to Progress station. Other cargo is transported by Ka-32 helicopters. Unloading of fuel and lubricants needed to support Progress and Vostok station activities and tractor-sledge convoys is carried out by a flexible pipeline system, through a temporary base on the eastern coast of the Thala Bay (see subsection 4.6.6).

Communications

The basic system for the transmission of regular information is satellite earth stations for communication with the RAE office and between Antarctic stations (voice telephony channel, information transfer via FTP, e-mail). The transfer of operational scientific and service information is also carried out through the satellite communication system Inmarsat-C, Inmarsat-B and Iridium. If necessary, the communication time in the short-wave range between stations is established. Communication in the VHF band is carried out with scientific and expeditionary aircraft, sledge-caterpillar transportation, employees on field routes, etc.

Science

Progress station is a large scientific base that ensures the operation of year-round (meteorological, oceanological, geophysical) observations and the implementation of many seasonal research programs. During the summer season, scientific research on glaciology, land hydrology, biology, geology, and meteorology is carried out in the vicinity of Progress station. In addition, the station serves as a support base for inland geological and glaciological research.

4.6.3 Bharati (India)

Bharati is located between Thala Fjord and Quilty Bay, east of Stornes, at 69°24.41’ S, 76°11.72’ E, approximately 35 m above sea level. The station was established in the 2012/13 summer to facilitate year-round scientific research activity by the Indian Antarctic program. It is accessible by ship through Quilty Bay but does not have direct access to the mainland by vehicle during summer. During winters the plateau can be accessed through fast ice passages.

Station infrastructure

Bharati consists of one multi-purpose building, a satellite camp and a number of smaller containerised modules (Map F). It can support 47 personnel in the main building. A network of routes links the buildings within the station area. A concrete helicopter-landing pad is located west of the main building (see Section 4.5.3).

Power, fuel delivery and storage

Electrical power is provided by three diesel-fired combined heat and power generating units that are housed within the main building. Fuel to the units is supplied from a day tank adjacent to the power station, which in turn draws fuel automatically from the fuel farm through leak resistant pipelines over a distance of about 300 m.

Jet-A1 fuel is supplied annually from the ship to the fuel farm using leak resistant reinforced rubber hose. The fuel farm comprises13 double-hulled tank containers each of 24 000 L capacity and is located by the shore at 69°24.31’S, 76°11.84’ E, at an elevation of 20 m. It is equipped with oil spill sensors and prevention equipment.

Delivery of fuel to the heat and power generating units, and at the helipad for helicopters and vehicles, is through a network of pipelines, and is automatically controlled through a microprocessor-based centralised building management system. Bharati uses LPG for cooking which is supplied in 10 to 14 kg gas bottles.

Water and waste management

Seawater is drawn from Quilty Bay (east coast) at a depth of about 12 m using submersible pumps, and is lifted to the main building through a network of insulated pipeline over a distance of about 300 m. Seawater is fed into a reverse osmosis plant; the filtered water is re-mineralised and used for drinking, bathing etc.

Wastewater is recycled and used for flushing the toilets. Water from the kitchen is passed through oil traps, and along with the wastewater from the toilets, is filtered and biologically treated. Water of bathing quality as per European standards is put back in Quilty Bay about 100 m downstream of the water intake point. All liquid waste, including from the kitchen, is passed through an oil trap and a slush trap, the products of which are collected in 200 L drums.

Solid waste is separated into biodegradable and non-degradable and collected in 200 L drums for removal.

Logistics

Tracked vehicles – Pisten Bullies and snow scooters – are used for transportation of personnel and materials around the station. The maintenance of vehicles, generators and instruments is undertaken in the vehicle workshop. Waste oil is collected in drums and returned to India.

Resupply is generally undertaken once a year in summer. Until mid-December, cargo is transported ashore using Pisten Bullies and trailers over fast ice. Voyages after the melting of the fast ice use flat bottom barges for carrying cargo.

Communications

HF communications are used to contact neighbouring stations. VHF communications are used for local aircraft, ship and field operations. Iridium open port system provides connectivity to the rest of the world through phone and fax.

Science

Although the station first became operational in March 2012, scientific studies began in 2005 and include environmental evaluation, monitoring of snow and ice, soil, seawater, freshwater, mosses, lichen, wildlife, geology, glaciology and sea ice ecosystems. Geomagnetic/ GPS observations started in 2007.

4.6.4 Law Base (Australia)

Law Base is located towards the southern end of eastern Broknes, approximately 1 km south of Progress and 2 km south of Zhongshan at 69°23'16"S, 76°22'47"E. The Base was established in the 1986/87 summer season.

Station infrastructure

Law Base consists of a prefabricated multi-purpose building, five fibre-glass huts and a small shed for ablutions. All wastes generated are removed.

Power, fuel delivery and storage

A small petrol generator is used to provide electrical power and operated only when required to charge batteries etc. A small solar panel mounted on the roof of the main hut charges batteries to power the HF and VHF radios. Gas is used for cooking and heating the main hut.

Water

Drinking and washing water is generally obtained during summer by collecting and melting snow from a nearby snow bank. Drinking water is also sometimes collected from a small tarn adjacent to the section of road connecting Law Base with the main route between north-eastern Broknes and the plateau.

Logistics

Law Base is variously supported by helicopter from Davis, by stations in the immediate area and from ships resupplying any of these facilities. Quad bikes are occasionally stationed at Law Base. They are used on designated access routes to support summer science programs.

Communications

Law Base is equipped with HF and VHF radios.

Science

Summer research projects have included studies of the area's glacial history, geology, geomorphology, hydrology, limnology and biology, and studies of human impacts.

4.6.5 Compacted snow runway site and associated facilities (Russia)

A snow runway is located 7 km south-west of Progress (Map A). The runway is 1500 m long and 60 m wide and is suitable for ski-equipped aircraft.

Coordinates of the runway control point are: 69°26'00.32"S; 76°19'56.36"E. The runway is accessed via a route along the ice-free plateau, as well as along the initial section of the inland tractor-sledge convoy route.

The runway complex includes four sledge-based container modules, namely a diesel electric power station; an air traffic control station, including meteorological, radio and Internet access facilities; living accommodate for six people; and, at the distant end, an automatic weather station.

4.6.6 Minor structures

Infrastructure including that which is related to Progress station is as follows:

Several caboose, a fuel drums depot and a parking site

Site for some of the vehicles used to prepare the runway at the station's original location (69°24'02"S, 76°24'07"E); this is located on the route from Progress station to the runway and serves as a place for the formation of inland sledge-caterpillar trains.

Caboose on the bank of the Nella Fjord

Located at 69°23'01 "S, 76°22'26"E, this is used to support seasonal oceanographic and hydrobiological sresearch.

Several caboose at the site of the former geocamp

Located at 69°24'25 "S, 76°24'14"E, this site currently contains several caboose. The site was previously intended for airborne geophysical research, which included a runway for An-2 aircraft on ski landing gear, residential buildings for the crew, aviation personnel and members of geophysical research groups; and fuel tanks.

A site with a shelter-caboose on the eastern edge of Stornes

Located at 69°25'27"S, 76°08'25"E, used for unloading heavy cargo delivered from ships to the shore on fixed ice. This location also provides access to the plateau and the airfield.

Temporary fuel storage on the East coast of Thala Fjord

A seasonal fuel depot of bladders (600 cubic m) on the east coast of Thala Bay, where flexible pipelines are used to unload fuel to support Progress and Vostok stations and tractor-sledge convoys.

Temporary open storage of cargoes for Vostok station (2.2 km south outside the ASMA)

A site of 1580 × 440 m for storage of building modules for the new wintering complex at Vostok station, located on the plateau and bounded by corner points with the following coordinates: 69°28’55.303“S, 76°16’50.459”E.; 69°29’09.384“S, 76°16’56.067”E ; 69°29’16.427“S, 76°14’31.970”E.; 69°29’02.345“S, 76°14’26.388”E. A temporary camp consisting of containers to accommodate the personnel involved in logistics operations will be located at the same place. The distance between the northern edge centre of the site and the convoy arrangement/preparation area is 8.2 km along the route. The distance from the ship unloading point in Thala Bay is 13.8 km.

Monitoring site

A long-term monitoring site approximately 250 m north-east of Law Base, which was established in 1990 to measure the rate of surface lowering caused by wind abrasion and salt weathering. The site is situated on exposed coarse-grained yellow gneiss, and consists of 24 micro-erosion sites marked by painted yellow rings. The site should not be crossed on foot as this will affect the measurements of natural erosion. (The practice of using paint or other such permanent means of marking sites is discouraged, and collection of GPS locations is preferable.)

Monuments

A rock cairn laid on 8 February 1958 to mark the first Australian National Antarctic Research Expeditions (ANARE) visit to the Larsemann Hills is located at the highest point on Knuckey Island (69°23’12”S, 76°3’55”E) approximately 1.1 km north-west of Stornes. The cairn contains a note listing the names of the landing party. A memorial to a vice president of the Chinese Arctic and Antarctic Administration is located on the northern side of the hill at the northernmost tip of the eastern Broknes coast, north of Zhongshan. The cement monument contains some of the vice president’s ashes.

‘Kharkovchanka’, an oversnow heavy tractor used in Antarctica from 1959 to 2010, is on a 23 m hill at 69°22’41”S, 76°22’59”E, 183 m from the main office and residential building of Progress and 87 m from the shore of Stepped Lake. Under Measure 19 (2015) it was added to the list of Historic Sites and Monuments as HSM Number 92.

On a hill overlooking the northern shore of Seal Bay at 69°23’01”S, 76°23’38”E, there is a cemetery containing the graves of three members of the Russian Antarctic Expedition:

- Andrey Skurikhin, who died in 1998 (the grave is a metal coffin with a tombstone next to it);
- Yuri Pasko, who died in 2007 (the grave is a metal coffin with a tombstone and a cross next to it); and
- Yuri Dostovalov, who died in 2008 (the grave is a mound of stones with a tombstone).

Each grave is surrounded by a low metal fence. The area of the cemetery is about 30 m2.

Cache

A very small emergency food cache is contained within a plastic box at the summit of Blundell Peak on Stornes (69°6’14”S, 76°6’14”E), the highest peak in the Larsemann Hills.

4.7 Location of other protected areas in the vicinity

ASPA174, Stornes (69°25’S, 76°6’E) is contained within the ASMA. Entry to the ASPA and activities within it require a permit and must be carried out in accordance with the ASPA management plan.

ASPA 169, Amanda Bay (69°15’S, 76°49’59.9”E), lies 22 km north-east of the Larsemann Hills. Similarly, entry to the ASPA and activities within it require a permit and must be carried out in accordance with the ASPA management plan.

HSM 92, the oversnow heavy tractor ‘Kharkovchanka’ that was used in Antarctica from 1959 to 2010 (69°22’41”S, 76°22’59”E), is located within the ASMA, in the vicinity of Progress.

5. Zones within the Area

All activities within the ASMA are to comply with the provisions of the Protocol on Environmental Protection to the Antarctic Treaty and the Environmental Code of Conduct appended to this management plan. In addition, two zones assist in meeting the objectives for managing the area.

5.1 Facilities Zone

The construction of station buildings and associated infrastructure has caused the greatest impact on the Larsemann Hills environment. However, these impacts have been mostly restricted to the immediate station areas and their connecting access routes. As the lakes are recognised as the most important ecological feature of the area, and are susceptible to the impact of human activities undertaken within their catchment limits, a catchment-based approach is the most appropriate means of managing activities in the ASMA. The stations on Broknes are relatively well clustered; most station infrastructure is located in drainage basins that discharge into the sea.

To ensure that this situation is maintained, a Facilities Zone is defined within the ASMA boundary (Map B), and encompasses most of eastern Broknes. The boundary of the Facilities Zone is defined by the Dålk Glacier in the east, the sea in the north, the coast or western margin of impacted catchments in the west, and the ice plateau including the airstrip and access route in the south. The installation of infrastructure within the ASMA will generally be restricted to already impacted areas in the Facilities Zone. The building of new infrastructure elsewhere may be considered based on adequate scientific and/or logistic justification.

5.2 Magnetic Quiet Zone

Several magnetometers are operated at Zhongshan. A circular zone of 80 m radius is defined surrounding the induction magnetometer sensors located in the gully north of the station at 69°22'12"S, 76°22'8"E. A further zone is defined to a radius of 80 m from the magnetometer array centred at 69°22'22"S, 76°21'46"E (Map D), west of the water supply lakes. All ferrous materials are to be excluded from these zones to avoid contamination of magnetic field measurements. Permission to enter must also be obtained. A magnetic quiet zone in Grovnes is planned by India.

6. Management activities

Communication between Parties, between on-ground personnel, and between on-ground personnel and national offices is needed to successfully implement the ASMA management plan. Accordingly, Parties with research programs in the area commit to ensuring appropriate communication at both a national program and on-ground level. Annual discussions to review the implementation of the management plan will be held in conjunction with the annual meetings of the Council of Managers of National Antarctic Programs.

The relevant station and field base leaders will also meet on an annual basis (logistics permitting) and maintain verbal communications throughout the year on issues relevant to the management of the Larsemann Hills region.

6.1 Logistics, including facilities

- Any further track and infrastructure development in ice-free areas will be restricted to that part of eastern Broknes already modified by human activities and delimited by the Facilities Zone (see Section 5.1), unless a location outside the Zone is justified for adequate scientific and/or logistical reasons. This restriction shall not apply to facilities to be set up for ensuring the safety of field workers.
- Environmental impact assessment will proceed as required by Article 8 of the Madrid Protocol before constructing or modifying structures. The Parties proposing to conduct such activities will inform other Parties with active research programs in the area.
- The cooperative use of infrastructure will be promoted in preference to the construction of new facilities.
- The potential impacts of man-made structures on wilderness and aesthetics values will be considered and minimised by restricting new structures to already impacted areas wherever possible, and by locating structures so as to minimise their visibility from surrounding areas. Research may be needed to assist in the full evaluation of such impacts prior to construction activities.
- New fuel storage areas will be bunded and located outside lake catchment boundaries wherever possible. The appropriateness of the current location of fuel storage areas will be examined prior to the plan's next scheduled review.
- Vehicle routes that do not serve the aims of this management plan will be closed and the impacted area rehabilitated wherever possible.
- Options for cooperation in the transfer of personnel, supplies and fuel will be explored.
- As a minimum, waste disposal and management activities will comply with the provisions laid down in Annex II to the Madrid Protocol.
- Wastes and disused equipment will be removed from the Antarctic Treaty Area at the earliest opportunity.
- The Parties with active research programs in the area will jointly develop contingency plans for incidents with the potential to adversely impact on the environment.
- Regular and opportunistic collection of wind-dispersed litter will be undertaken.
- All equipment left in the field will be periodically reviewed for potential removal and its interim protection from wind dispersal and the like will be assessed.
- The rehabilitation of modified and disused sites will be investigated and progressed as appropriate.

6.2 Introduced species

Parties active in the Larsemann Hills will:

- Educate program personnel, including contractors, about the potential risks to the environment through the introduction of non-native species.
- Ensure that personnel entering the ASMA have clean footwear – through, for example, boot cleaning procedures (preferably before departure for Antarctica) or the issue of new footwear.
- Avoid shipping untreated sand, aggregate and gravel to the ASMA.
- Collect and incinerate or remove from the region any soil or other organic matter found on cargo.
- Remove from the region or contain within station buildings, any non-sterile soil previously shipped to the ASMA.
- Remind program personnel of the Madrid Protocol obligation not to take non-sterile soil to Antarctica, or grow new plants or import plants for decorative purposes.
- Contain within station buildings, any plants grown for food.
- Give priority to incinerating or repatriating food waste.
- Prevent station food, and food waste, from access by wildlife.
- Develop protocols to avoid the biological contamination, or cross-contamination, of the Area's lakes, in particular those outside the Facilities Zone.
- Undertake surveillance for introduced species.
- Share information on the finding of any non-native species introduced through program operations and persisting in the Area – in order to obtain scientific and operational advice, if required, on appropriate eradication or containment actions.
- Jointly implement these measures, where appropriate.

6.3 Wildlife disturbance

- The need to maintain appropriate separation distances from wildlife will be taken into account in the planning and conduct of activities in the area.

6.4 Data management

- The Parties with active research programs in the area will jointly develop, and provide input to, a database for recording relevant management information and metadata records to assist the planning and coordination of activities. Such data sharing will include geographic information, and involve the addition of regional place names to the SCAR *Composite Gazetteer of Antarctica*.
- Efforts will be made to increase knowledge of the environmental values of the ASMA and the impacts of human activities upon those values, and to apply this knowledge to the environmental management of the ASMA.

6.5 Science

- Cooperation with, and coordination of, scientific research will be undertaken wherever possible.

6.6 Monitoring

- The Parties with active research programs in the area will jointly undertake monitoring activities to evaluate the effectiveness of this management plan.

6.7 Monuments

- Activities will be managed to ensure the preservation of existing monuments where such action is considered desirable.
- The placement of further cairns or monuments outside the Facilities Zone is prohibited.

6.8 Exchange of information

To enhance cooperation and the coordination of activities in the ASMA, to avoid duplication of activities and to facilitate the consideration of cumulative impacts, Parties active in the area will:

- distribute to other such Parties details of activities that may have a bearing on the operation of this management plan (that is, proposals to withdraw from or establish new research activities, proposals to construct new facilities, information obtained regarding non-governmental visits etc.); and
- provide reports to the Committee for Environmental Protection on significant developments in the implementation of this management plan.

Other Parties proposing to conduct activities in the region, including non-governmental groups, will inform at least one of the Parties active in the ASMA of their intentions – in the spirit of the aims and objectives of this management plan.

Appendix 1. Environmental Code of Conduct

This Code of Conduct is intended to provide general guidelines to help minimise environmental impacts when in the Larsemann Hills, particularly for activities undertaken away from station areas.

General principles

- The Antarctic environment is highly susceptible to the impacts of human activities, and as a general rule has much less natural ability to recover from disturbance than the environments of other continents; consider this when undertaking activities in the field.
- Everything taken into the field must be removed. This includes human wastes and also means avoiding the use or dispersal of foreign materials that are difficult to collect and remove. Strip down excess packaging before going off-station.
- The collection or disturbance of any biological or geological specimen or man-made artefact may only be undertaken with prior approval and, if required, in accordance with a permit.
- Details of all field activities (such as sample sites, field camps, depots, oil spills, markers, equipment etc.) including the national program contact should be accurately recorded for transfer to a management database.

Travel

- Some biological communities and geological formations are especially fragile, even when concealed by snow. Be alert and avoid such features when travelling.
- Restrict your vehicle and helicopter usage to essential tasks to minimise atmospheric emissions; track formation and physical disturbance of the land surface; impacts on biological communities; wildlife disturbance; and the potential for fuel spills. Over-flying lakes should be avoided.
- Restrict your vehicle use to designated ice-free routes and to the sea ice and plateau ice. Only access facilities using existing routes.
- Plan and undertake vehicle use with reference to the wildlife distances identified in this Code.
- Fully refuel vehicles and other equipment on station before departure, to reduce the need for refuelling in the field.
- Plan activities to avoid the need to refuel or change oil in windy conditions or in areas that might direct accidental spillage into lakes and on vegetation and other sensitive areas. Use fuel cans with nozzles/funnels.
- When travelling on foot, use established tracks and designated crossing points wherever possible.
- Avoid making new tracks. Where established tracks do not exist, use the most direct route that avoids vegetated areas and delicate geological formations (such as screes, sediments, streambeds and lake margins).

Wildlife

- Do not feed wildlife.
- Maintain appropriate distances from wildlife (see table).
- When moving on foot around wildlife, keep quiet, move slowly, and stay low to the ground – increase your distance if disturbance is evident.

Distances at which disturbance may be expected to occur when approaching wildlife on foot

Species	Distance (metres)
Giant petrels and albatrosses, breeding / nesting	100 m
Emperor penguins (in colonies, huddling, moulting, with eggs or with chicks)	50 m
All other penguins (in colonies, moulting, with eggs or chicks)	30 m
Prions, petrels, skuas, on nests Seals with pups and seal pups on their own	20 m
Non breeding penguins and adult seals	5 m

Distance at which disturbance may be expected to occur when approaching wildlife using small vehicles (e.g. quads and skidoos)

All wildlife	150 m

Distance at which disturbance may be expected to occur when approaching wildlife using tracked vehicles

All wildlife	250 m

Distances at which disturbance may be expected to occur when approaching wildlife using aircraft

Birds	**Vertical** *Single-engine helicopters* 2500 ft (~ 750 m) *Twin-engine helicopters* 5000 ft (~1500 m) **Horizontal** ½ nm (~930 m)
Seals	**Vertical and horizontal** *Single-engine helicopters* 2500 ft (~ 750 m) *Twin-engine helicopters* 5000 ft (~1500 m) *Twin-engine, fixed-wing aircraft* 2500 ft (~750 m)

Field camps

- Use existing accommodation where possible.
- Locate campsites as far away as practicable from lake shores, streambeds, vegetated sites and wildlife, to avoid contamination and/or disturbance.
- Ensure that equipment and stores are properly secured at all times to prevent foraging by wildlife and dispersion by high winds.
- Collect all wastes produced at field camps, including human wastes and grey water, for return to station and subsequent treatment or disposal.
- Where possible utilise solar or wind powered generators to minimise fuel usage.

Fieldwork

- Meticulously clean all clothing and equipment before bringing it to Antarctica and before moving between sampling locations, to prevent contamination, cross-contamination and the introduction and spread of foreign organisms.
- Do not build cairns, and minimise the use of other objects to mark sites. Remove markers on completion of the related task.
- When permitted to collect samples, adhere to the sample size specified in your permit and take samples from the least conspicuous location possible.
- Use a drop sheet when sampling soils and backfill soil pits to prevent wind erosion and dispersal of deeper sediments.
- Take great care when handling chemicals and fuels, and ensure you have appropriate materials with you to catch and absorb spills.
- Minimise the use of liquid water and chemicals that could contaminate the isotopic and chemical record within lake and glacier ice.
- Meticulously clean all water and sediment sampling equipment to avoid cross-contamination between lakes.
- Avoid reintroducing large volumes of water obtained from lower in the water column, to prevent lake contamination, or toxic effects on the biota at the surface. Excess water or sediment should be returned to station for appropriate disposal or treatment.
- Ensure that sampling equipment is securely tethered, and leave nothing frozen into the ice that may cause later contamination.
- Do not wash, swim or dive in lakes. These activities contaminate the water body and physically disturb the water column, delicate microbial communities and sediments.

Note: The guidelines laid down in this Environmental Code of Conduct need not apply in cases of emergency.

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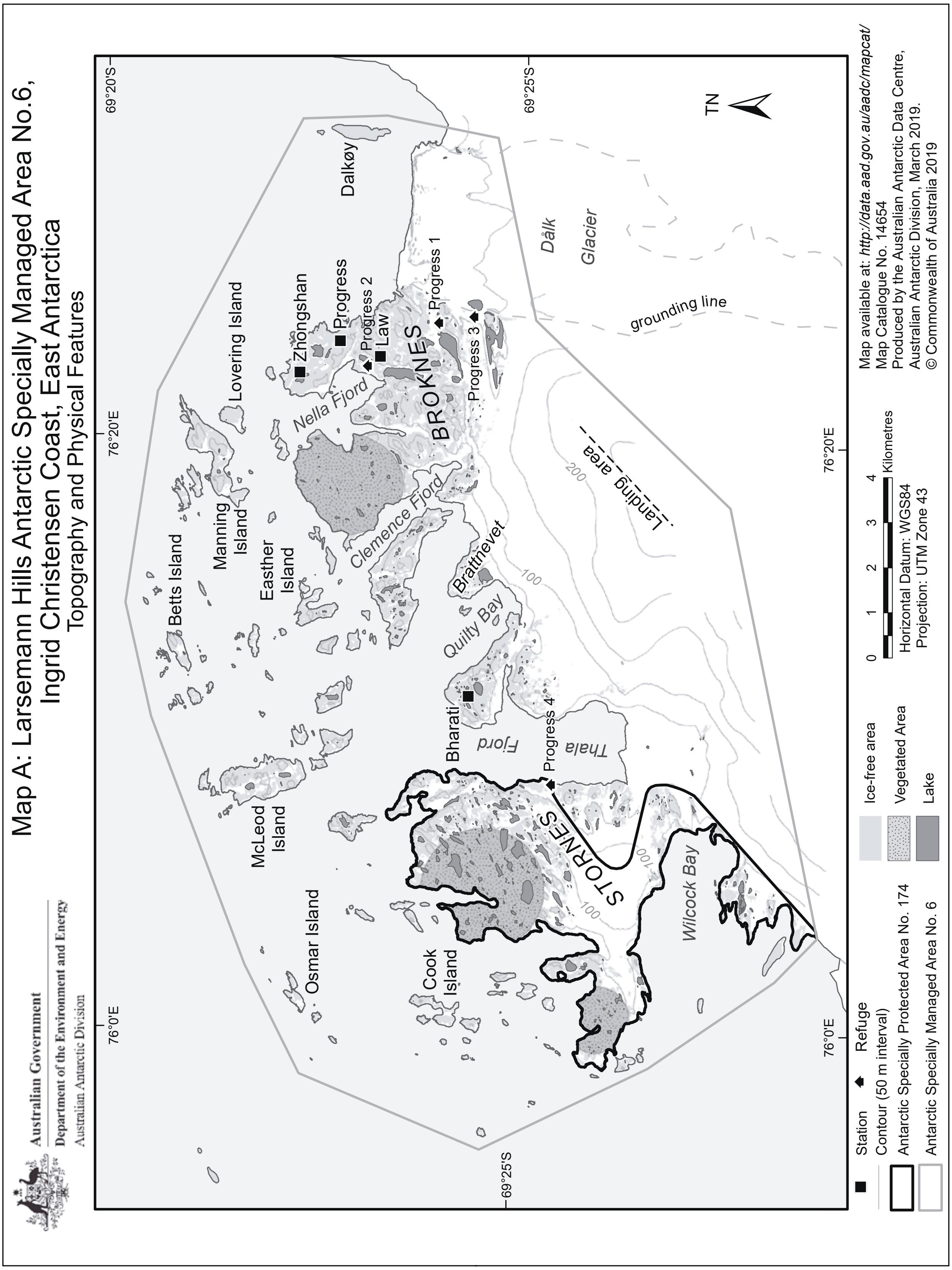
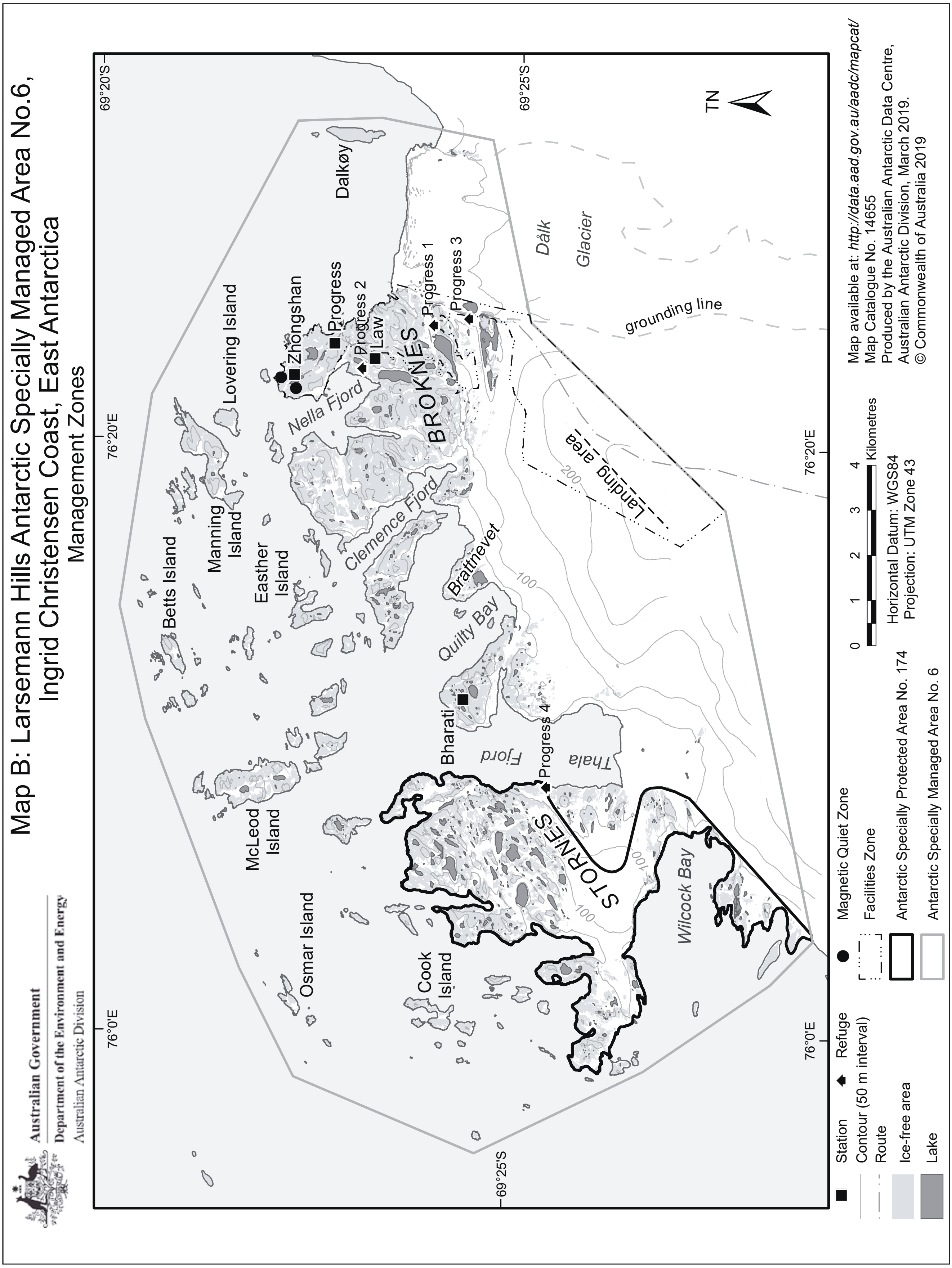
Appendix 4: Larsemann Hills maps

- Map A. Topography and physical features
- Map B. Management zones and ice free areas
- Map C. Detail of northern Broknes
- Map D. Zhongshan station
- Map E. Progress station
- Map F. Bharati station

Detailed maps of the region are available via the Australian Antarctic Data Centre website at: http://aadc-maps.aad.gov.au/aadc/mapcat/search_mapcat.cfm

(Map References # 13130 and 13135)




Map B: Larsemann Hills Antarctic Specially Managed Area No.6,
Ingrid Christensen Coast, East Antarctica
Management Zones
Australian Government
Department of the Environment and Energy
Australian Antarctic Division
69°20'S
69°25'S
76°0'E
76°20'E
TN
Dalkøy
Lovering Island
Zhongshan
Progress
Progress 2
Law
Progress 1
Progress 3
Nella Fjord
BROKNES
Dålk
Glacier
grounding line
Landing area
200
100
Betts Island
Manning Island
Easther Island
Clemence Fjord
Brattnevet
Quilty Bay
Bharati
Fjord
Progress 4
Thala
McLeod Island
Osmar Island
STORNES
Wilcock Bay
Cook Island
Station
Contour (50 m interval)
Route
Ice-free area
Lake
Refuge
Magnetic Quiet Zone
Facilities Zone
Antarctic Specially Protected Area No. 174
Antarctic Specially Managed Area No. 6
0 1 2 3 4 Kilometres
Horizontal Datum: WGS84
Projection: UTM Zone 43
Map available at: http://data.aad.gov.au/aadc/mapcat/
Map Catalogue No. 14655
Produced by the Australian Antarctic Data Centre,
Australian Antarctic Division, March 2019.
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Australian Government
Department of the Environment and Energy
Australian Antarctic Division

Map C: Larsemann Hills ASMA No.6

Detail of Northern Broknes

Mast	Anchorage
Grave	Monument
Refuge	Building
Snow petrel nesting area	
Helicopter landing area	
Spot elevation (metres)	
Contour (20 m interval)	

Road
Route
Lake
Ice-free area
Facilities zone
Magnetic quiet zone

0 200 400 600 800 Metres

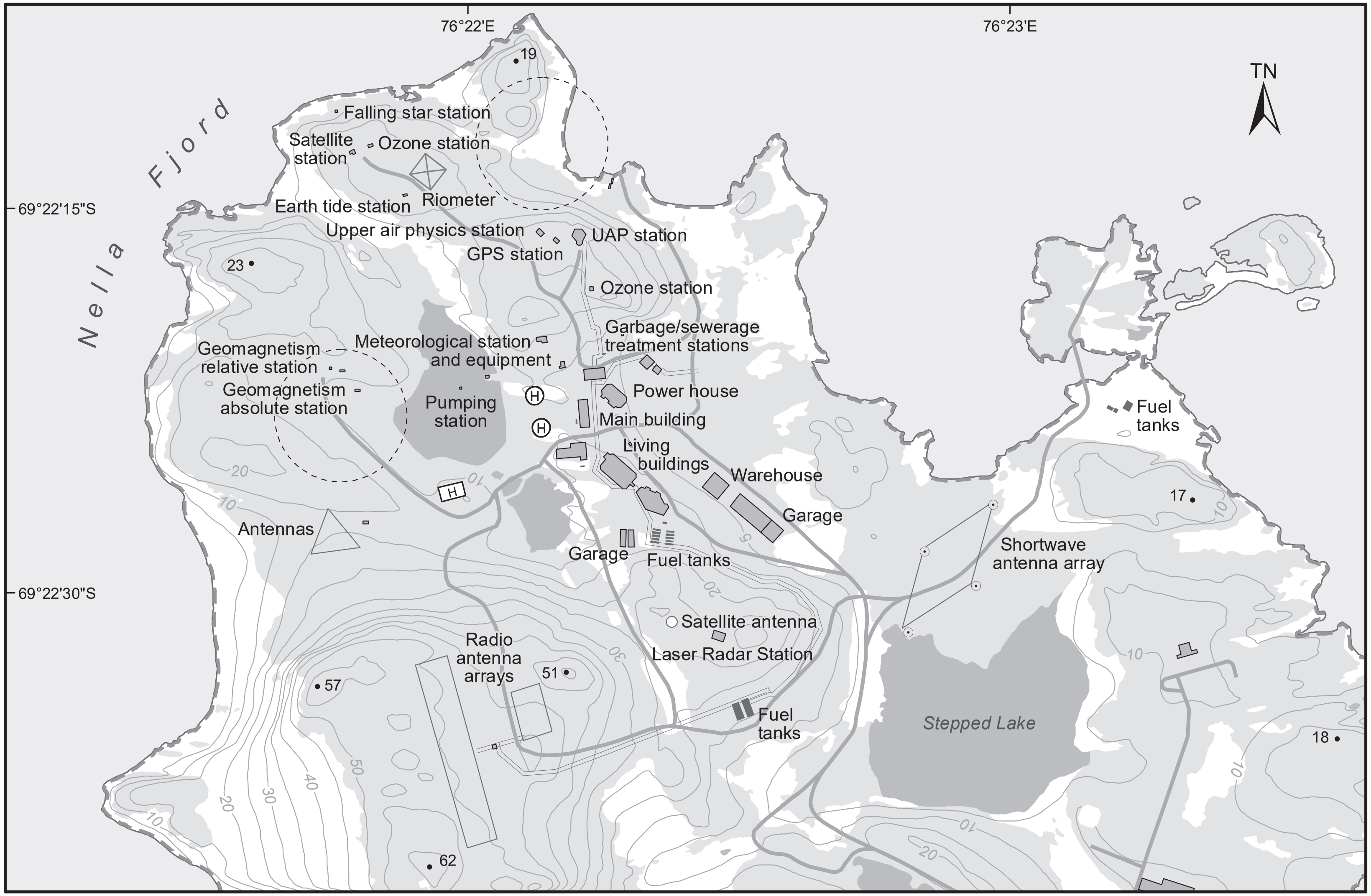
Horizontal Datum: WGS84
Projection: UTM Zone 43

Map available at: *http://data.aad.gov.au/aadc/mapcat/*
Map Catalogue No. 14656
Produced by the Australian Antarctic Data Centre, Australian Antarctic Division, March 2019.

Australian Government
Department of Agriculture, Water and the Environment
Australian Antarctic Division

Map D: Larsemann Hills Antarctic Specially Managed Area No. 6

Zhongshan Station



- Spot elevation (metres)
- Mast
- Helicopter landing area/base
- Contour (5 metre interval)
- Road
- Cable trays
- Building
- Lake
- Ice-free area
- Facilities zone
- Magnetic quiet zone

0 100 200 300 Metres

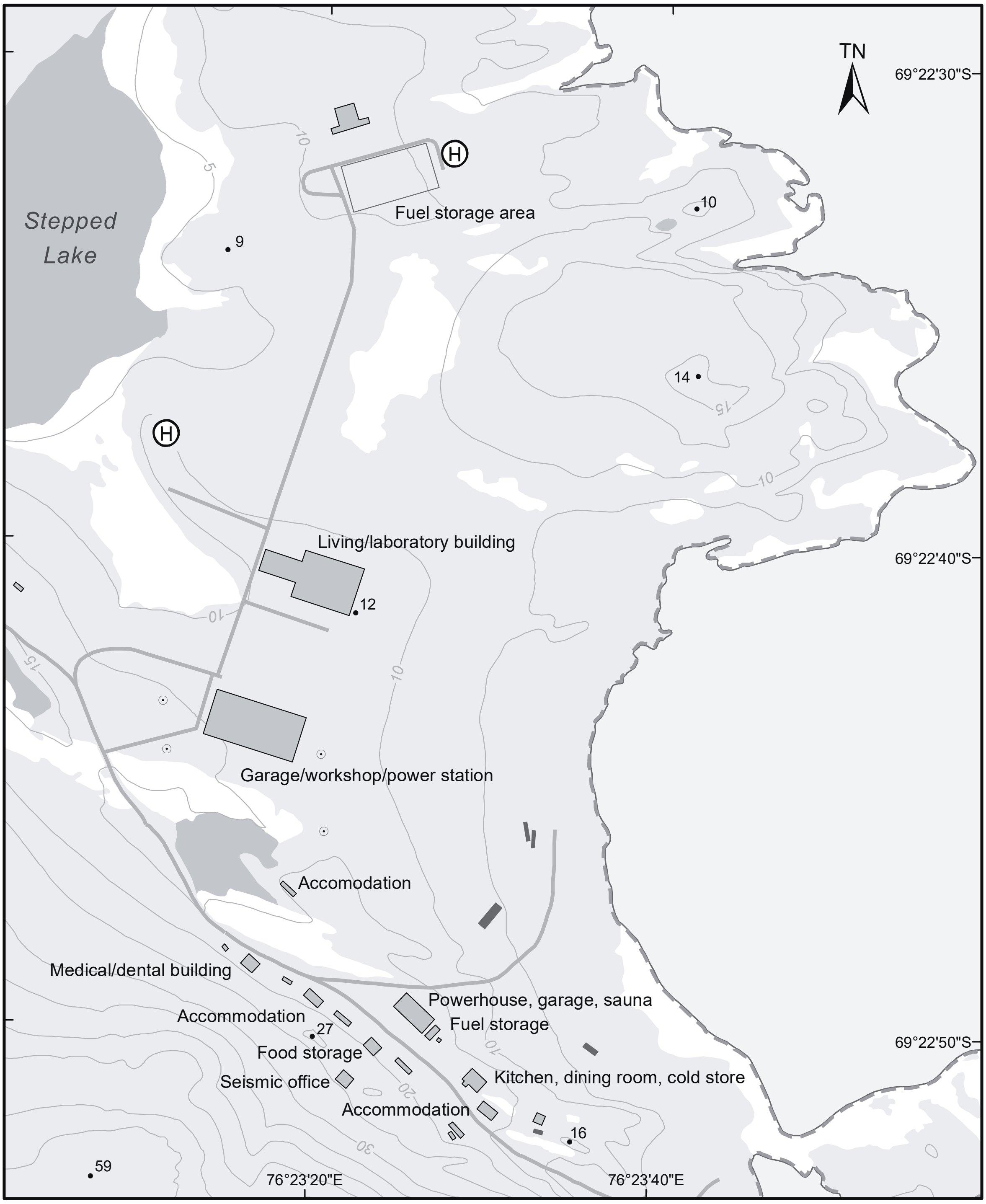
Horizontal Datum: WGS84
Projection: UTM Zone 43

Map Available at: *http://data.aad.gov.au/aadc/mapcat/*
Map Catalogue No. 15404
Produced by the Australian Antarctic Data Centre, Australian Antarctic Division, March 2021

Australian Government
Department of the Environment and Energy
Australian Antarctic Division

Map E: Larsemann Hills Antarctic Specially Managed Area No. 6

Progress Station

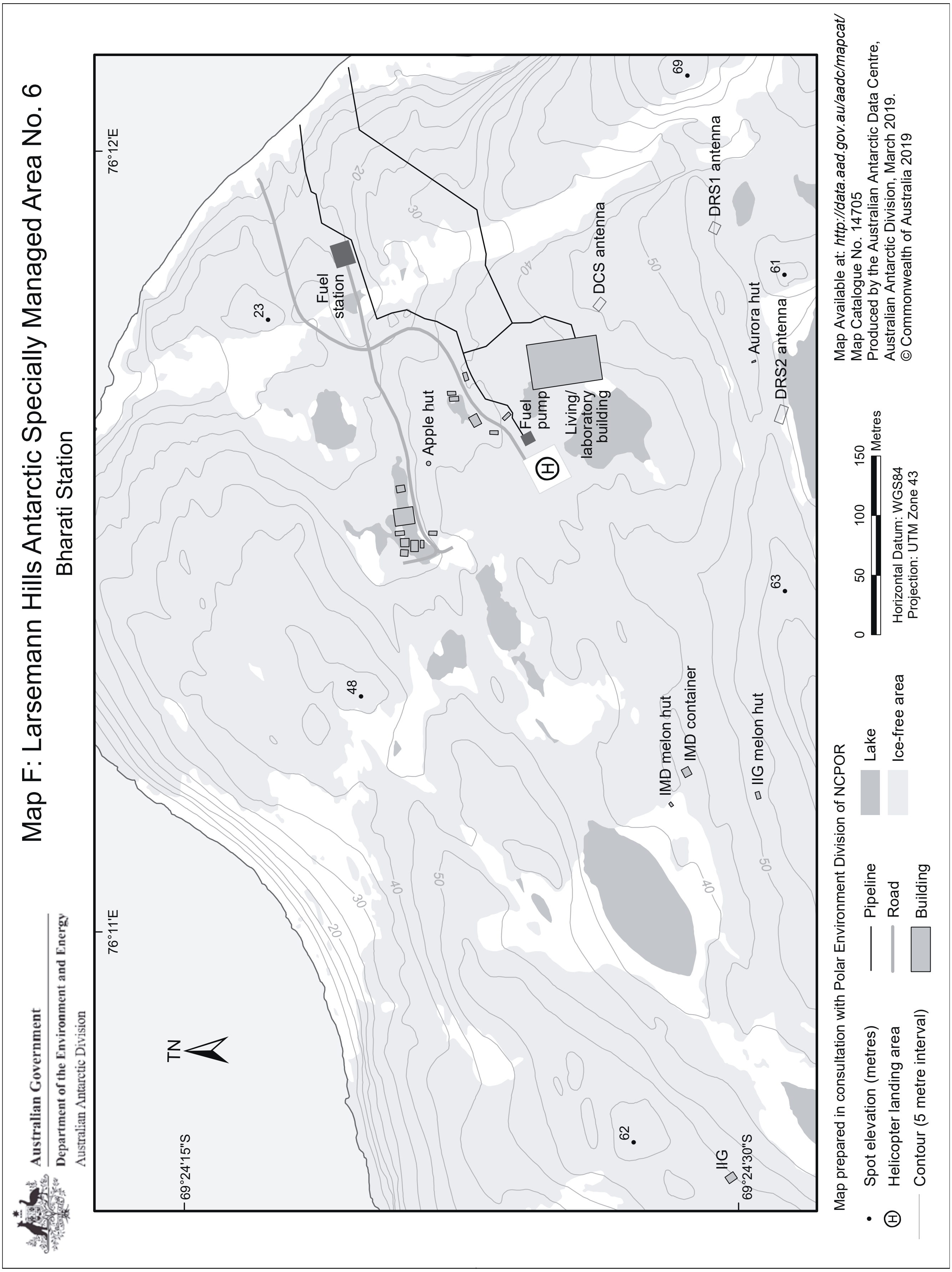


Spot elevation (metres)
Mast
Helicopter landing area
Contour (5 metre interval)
Road
Facilities zone
Building
Lake
Ice-free area

0 50 100 150 Metres

Horizontal Datum: WGS84
Projection: UTM Zone 43

Map Available at:
http://data.aad.gov.au/aadc/mapcat/
Map Catalogue No. 14658
Produced by the Australian Antarctic Data Centre, Australian Antarctic Division, March 2019.


Map F: Larsemann Hills Antarctic Specially Managed Area No. 6
Bharati Station
Australian Government
Department of the Environment and Energy
Australian Antarctic Division
TN
69°24'15"S
69°24'30"S
76°11'E
76°12'E
Fuel station
Apple hut
Fuel pump
Living/ laboratory building
DCS antenna
DRS1 antenna
DRS2 antenna
Aurora hut
IMD melon hut
IMD container
IIG melon hut
IIG
23
48
61
62
63
69
20
30
40
50
Map prepared in consultation with Polar Environment Division of NCPOR
Spot elevation (metres)
Helicopter landing area
Contour (5 metre interval)
Pipeline
Road
Building
Lake
Ice-free area
0 50 100 150 Metres
Horizontal Datum: WGS84
Projection: UTM Zone 43
Map Available at: http://data.aad.gov.au/aadc/mapcat/
Map Catalogue No. 14705
Produced by the Australian Antarctic Data Centre, Australian Antarctic Division, March 2019.
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