SPECIAL REPORT 93-1

CRREL

Field Survey of Potential Airstrip Locations

Mt. Howe, Antarctica, 1991

Stephen L. DenHartog

February 1993

Abstract
The blue ice area just west of the Mt. Howe ridge in Antarctica was surveyed with the intent of establishing a runway for large, wheeled cargo aircraft. Site limitations and wind observations precluded selection of an airstrip location. Installation of an automatic weather station to monitor winds at the site will allow determination of site suitability.

For conversion of SI metric units to U.S./British customary units of measurement consult ASTM Standard E380, *Metric Practice Guide,* published by the American Society for Testing and Materials, 1916 Race St., Philadelphia, Pa. 19103.

This report is printed on paper that contains a minimum of 50% recycled material.

Special Report 93-1

U.S. Army Corps of Engineers
Cold Regions Research & Engineering Laboratory

Field Survey of Potential Airstrip Locations

Mt. Howe, Antarctica, 1991

Stephen L. DenHartog

February 1993

Prepared for
NATIONAL SCIENCE FOUNDATION

PREFACE

This report was prepared by Stephen L. DenHartog, Civil Engineer, of the Ice Engineering Research Branch, Experimental Engineering Division, U. S. Army Cold Regions Research and Engineering Laboratory. Funding was provided by the National Science Foundation, Division of Polar Programs under contract OPP-91-40015.

The author thanks Deborah Diemand and George Blaisdell for their technical review of this report. He also acknowledges the contributions of Deborah Diemand, Stephen Moore, Lucy Smith, Wayne Tobiasson and Henry Perk in carrying out this study.

The contents of this report are not to be used for advertising or promotional purposes. Citation of brand names does not constitute an official endorsement or approval of the use of such commercial products.

Field Survey of Potential Airstrip Locations
Mt. Howe, Antarctica, 1991

STEPHEN L. DENHARTOG

INTRODUCTION

Over the past 25 years the U.S. research program at the South Pole has grown and the base has aged. The time is imminent when major rehabilitation and new construction will be necessary. Preliminary estimates suggest that as much as eight million pounds of material will be required at the site for new construction. In addition, the South Pole Station currently consumes about a million pounds of fuel per year, so that some 50 flights for fuel alone are required annually.

Since the early 1960s all transport between McMurdo and the pole has been on U.S. Navy operated LC-130s. These ski-equipped aircraft bring in a payload of about 20,000 lb each trip, reportedly, and consume some two times this weight in fuel each trip. Currently about 140 LC-130 flights are flown to the South Pole per season. This number will surely grow. Delivery of the estimated tonnage for new construction will take about 400 flights.

There are several scenarios that might be more appropriate for supplying the South Pole Station. These range from air-dropping at the pole to inland trans-shipment points. The idea of operating low tire pressure wheeled aircraft from a compacted snow runway at the pole should not be overlooked, but until that technology is proven, other options should be considered. A study to determine the economics and feasibility of all possible options seems warranted a this time.

Following up on the inland trans-shipment possibility, CRREL was tasked by the National Science Foundation to investigate this option at a site near Mt. Howe during the 1991–92 season. The reasons for this initiative are the age and small number of ski-equipped LC-130s and the greater availability of wheeled C-130s, which can carry greater payloads. Surface transport from this site to the pole will encounter few crevasses and little elevation change. The distance is short, a mere 160 nautical miles. Cargo and fuel could be unloaded at such a site and temporarily stockpiled. A tractor train operating out of the pole could pick up the cargo on its own timetable, making round trips perhaps every three days. A small crew, resident on site during the wheeled flying season, would provide weather information for the aircraft and help in the cargo handling.

BACKGROUND

Mt. Howe (Fig. 1) is the closest rock outcrop to the South Pole and is bordered by a large area of snow-free glacier ice that might be suitable for landing conventional wheeled aircraft. It was first visited during the 1960s when the area was surveyed. The site was later visited by a party led by Charles Swithinbank in December 1988 (Mellor and Swithinbank 1989).

Mt. Howe, the highest point of a generally north–south ridge, is at 87° 22' S, 149° 30' W. To the west of this ridge is a snow-free, crevasse-free, area of glacier ice about 1 × 4 miles in extent and 7900 ft above sea level. It is bordered on the east by moraines lying at the foot of the ridge and on the west by crevasses which are, luckily, quite obvious. The crevasses start as snow-filled cracks about 6 in. wide and rapidly (within a few hundred feet) approach 2 ft in width. Beyond this point it appears on the aerial photographs that they continue to get larger and are bridged rather than snow filled. Mellor and Swithinbank (1989) give a thorough site description, complete with a contour map and many photos.

FIELD PLAN

The goals for the 1991 field season were to 1) locate a temporary runway adequate for a few "open field" LC-130 landings, 2) deliver equipment that would be used to plane off snow and ice bumps, 3) prepare a 10,000- × 250-ft runway with smoothness adequate for large cargo aircraft including marking and surveying, and 4) if time permitted, to reconnoiter a traverse route away from the site past the first few miles of crevasses. Our work plan called for a Twin Otter to land a four-person party around 26 November. This party was to find and mark a temporary LC-130 runway, which would be inspected by Naval aviation (VXE-6) personnel prior to the first LC-130 flights. Once approved, we planned to deliver by LC-130 a 12G grader, a road brush, fuel and a hut. During and subsequent to these deliveries, the permanent 10,000-ft runway would be sited and marked for grading and sweeping. While the grading was being done it was hoped that the initial field party would have time to travel south with large snowmobiles reconnoitering the initial portion of a future traverse route through the known crevasse fields.

FIELD ACTIVITIES

A party of four was put into the field on 9 December 1991 by Twin Otter. The plane landed into the wind, i.e., directly toward the mountain ridge, about a mile from the moraine. The party consisted of a leader, an engi-

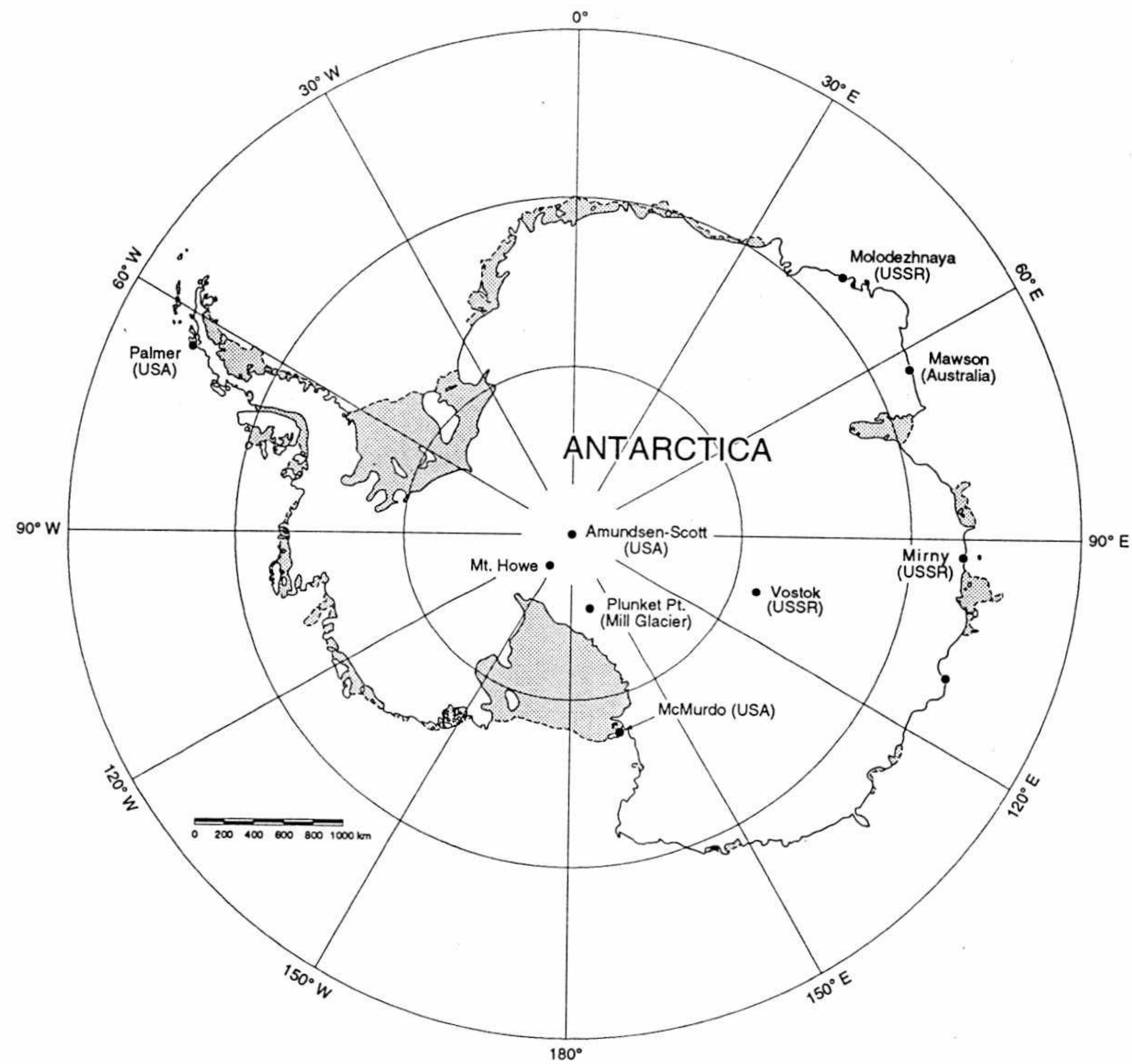

Figure 1. Map of Antarctica.

neer, a surveyor and a field assistant. The engineer originally scheduled for the party was still in McMurdo overseeing the modification of a small Case bulldozer, which was the only piece of equipment in McMurdo that the VXE-6 could deliver to the unprepared site and which we hoped might be able to plane the blue ice. The weather conditions were clear and windy on arrival. At 0600 Z (1800 McMurdo time, which we followed) the wind was blowing from 120° true (T) at 15 knots. The following day a reconnaissance for a temporary landing site was made to the north. A number of Swithinbank's flags from his 1988 visit were found but we could not correlate them with his records and so were unable to get any ablation rate measurements. On the 10th of December we checked out a smooth area aligned with the wind at the north end of the snow-free ice, but it was too short. Later that day we looked at a line to the south that we subsequently flagged and surveyed. On 11 December we remained tentbound due to high winds.

Table 1 gives wind speed and air temperature as measured sporadically during our stay. The wind direction at our campsite was the same as noted by Swithinbank: from a very consistent 120° T. On Thursday, 12 December, we were able to lay out a 5000-ft strip on a heading of close to 160°T, which began in the very small crevasses and ended, in our estimation, far enough away from the hills to allow a comfortable takeoff (Fig. 2). This was marked by red trail flags. The wind direction here was a little different and this line had about a 30° crosswind, i.e., from 130°T. A roughness survey was completed for this possible final runway orientation. The Twin Otter then flew a few passes over the proposed short runway.

We had not yet found a place to land an LC-130 under the existing weather conditions and the wind was still blowing. Further search for other possible sites was not possible since the Twin Otter would not be available after 15 December. These circumstances left few options so it was decided to abandon the site for this season on 14 December.

A full spring and summer season of weather data, particularly wind data, would clearly be of great benefit to the assessment of Mt. Howe as a potential airfield site.

RESULTS

No "temporary" runway site was found and so no heavy equipment was delivered to the site. The long dimension runway site as determined by Swithinbank (Mellor and Swithinbank 1989) is a good one if the winds allow landing in that direction.

Figure 2 shows the approximate location of the

Table 1. Meteorological data collected during the survey at Mt. Howe.

Date (1991)	*Time*	*Temperature (°F)*	*Wind speed (knots)*
6 Dec	1800	8	"Windy"
9 Dec	1800	Missing	15 (wind was always from 120T)
10 Dec	0800	Missing	10G15*
10 Dec	1300	Missing	20
10 Dec	1615	Missing	20G25
11 Dec	0700	Missing	25G30
11 Dec	0830	Missing	28G35
11 Dec	1430	+7	26G30
11 Dec	1800	–2	25G30
11 Dec	2000	–4	25G30
12 Dec	0600	–6	17G23
12 Dec	1235	–1	18G23
12 Dec	1735	–2	15G20
13 Dec	0630	0	18G25
13 Dec	1830	Missing	18G23
14 Dec	0700	Missing	20G25
15 Dec	1600	Missing	"Windy from about 090T"

*10G15 means 10 knots gusting to 15.

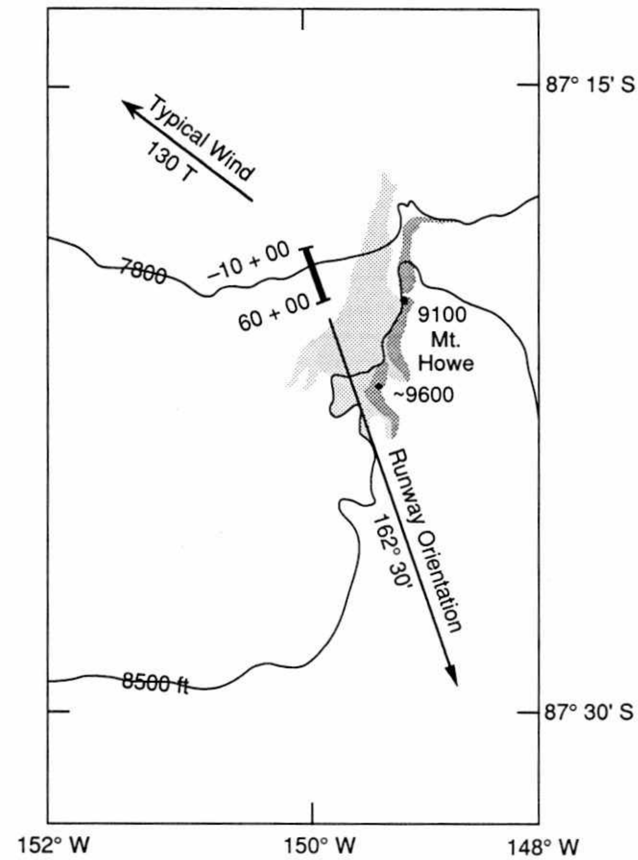

Figure 2. Approximate location of runway 16T at Mt. Howe, Antarctica.

runway we surveyed. This site is a compromise of 1) a minimum length of about 5000 ft, 2) a heading as close into the wind as possible that aims toward the lowest saddle in the ridge while keeping on the crevasse-free blue ice, and 3) a climb-out slope of less than 2°. Figure 3a shows the runway and climb-out profile while Figure 3b shows the runway profile with a 1:35 vertical exaggeration. The slopes measured are acceptable.

Figures 4 and 5 show the results of a centerline roughness survey reduced by two different methods (see Mellor and Swithinbank 1989) and compared to MILSPEC MIL-A-8836B(AS), 6 May 1987. The roughness is well under the specified limits. However, larger bumps on either side of the surveyed line would need to be planed off. Also, the thousand feet or so at the north end is riddled with small crevasses (negative bumps!). As described earlier, these crevasses are insignificant at first, but at the end of the 1000 ft they are over a foot wide and tens of feet long. Although they could not swallow a large aircraft tire, they would cause significant lateral loads.

Although the climb-out profile is at the desired 2°, a flight with the Twin Otter attempting to simulate a larger plane's takeoff was unpleasant. We buzzed the strip at about 40 ft and at the last flag set up a 300 ft/min rate of climb at about 120 knots. The strong wind should have increased the climb angle, but the downdrafts coming over the hill more than offset the wind. It was soon obvious that we would not clear the saddle. Power was added and we made a tight turn. Both the Twin Otter pilot and I decided that this was not a runway for large aircraft.

RECOMMENDATIONS

To assess any potential inland trans-shipment sites, the first step should be the installation of an automatic weather station (AWS), preferably at all potential sites. One was installed at Mt. Howe during January 1992. Data from the Mt. Howe AWS will show if there are any windows in time when the winds are low enough or

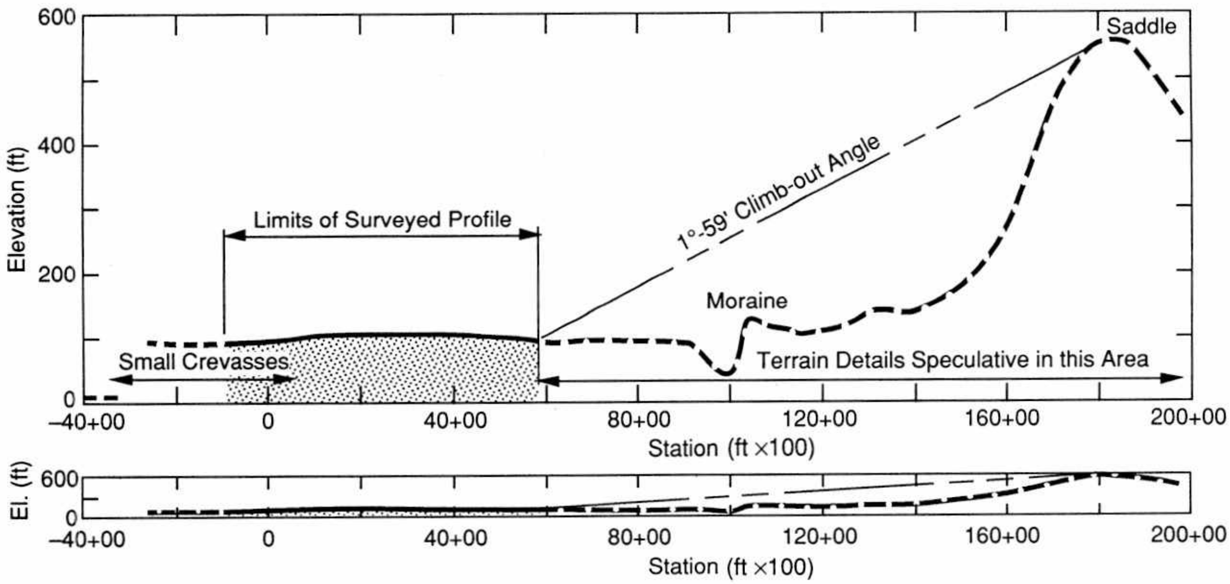

Figure 3a. Mt. Howe runway 16T and climb profile, December 1991. Note that the profile shown deflects right at Sta 50+0 to approximately 175°T. Elevations are based on an assumed datum unrelated to any previous work.

from the proper direction to allow safe take-off and landing of large aircraft. The primary period of interest is October and November when the sea ice runway at McMurdo is open and wheeled aircraft are operating on the continent.

A logistics and economic study should be performed soon, before any serious effort at site development is attempted. This should define the amount and kind of cargo needed at South Pole Station and explore all possible means of delivery. This would include identification of equipment and facilities required, their cost, speed, and scheduling for delivery. In addition, accurate estimates of weight and volume of cargo to go to the pole and realistic delivery schedules must be deter-

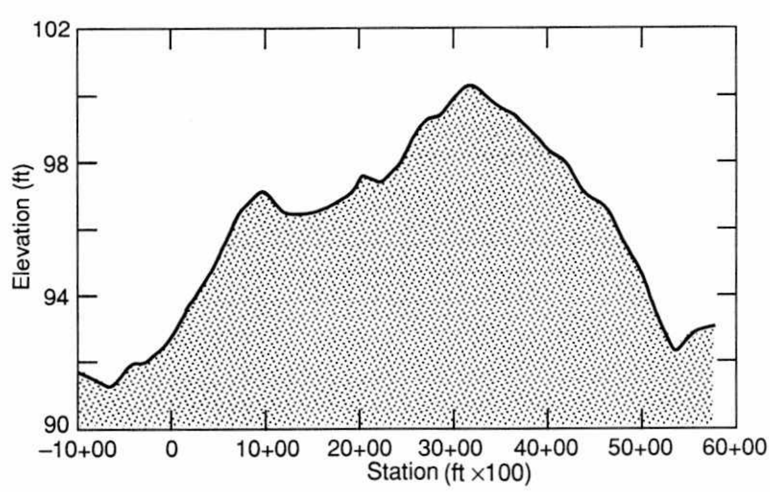

Figure 3b. Mt. Howe runway 16T profile, December 1991. Vertical exaggeration is about 1:35.

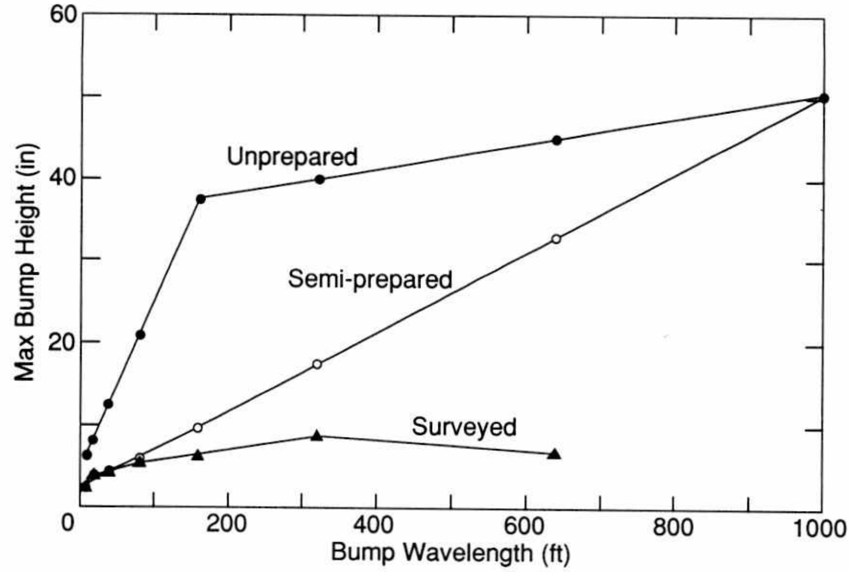

Figure 4. Mt. Howe runway 16T spectral analysis (3-point method) of surface roughness.

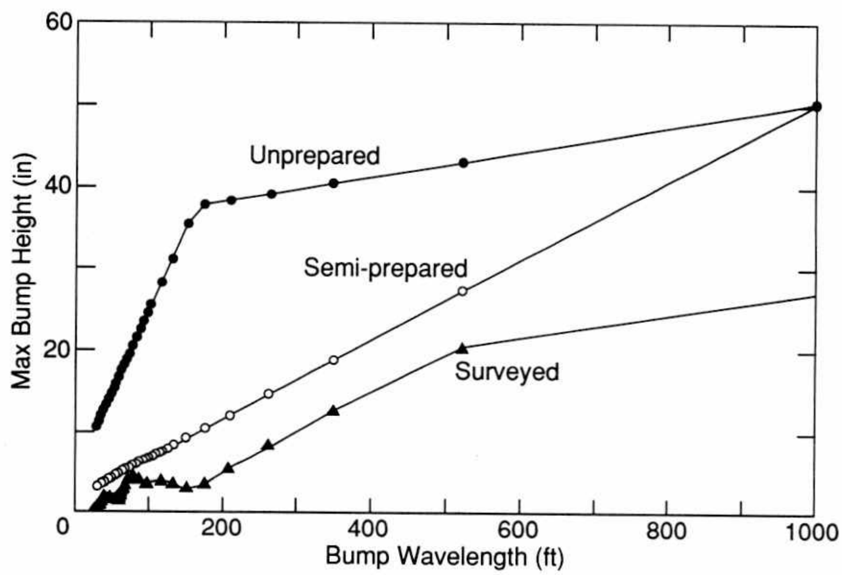

Figure 5. Mt. Howe runway 16T spectral analysis (Fourier analysis) of surface roughness.

mined. Until these numbers are agreed upon by all parties (National Science Foundation, Antarctic Support Associates and the users) it is impossible to compare accurately the effectiveness of different cargo delivery concepts. Personnel and priority cargo should clearly continue to be delivered directly to South Pole Station by LC-130 from McMurdo. Early in 1993, we should know if the economics encourage large, wheeled cargo aircraft and if the winds allow the use of the Mt. Howe site.

LITERATURE CITED

Mellor, M. and C. Swithinbank (1989) Airfields on Antarctic glacier ice. USA Cold Regions Research and Engineering Laboratory, CRREL Report 89-21.

☆U.S. GOVERNMENT PRINTING OFFICE: 1993-700-059/60046

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	February 1993	

4. TITLE AND SUBTITLE
Field Survey of Potential Airstrip Locations: Mt. Howe, Antarctica

5. FUNDING NUMBERS
NSF-DPP 91-40015

6. AUTHORS
Stephen L. DenHartog

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Cold Regions Research and Engineering Laboratory
72 Lyme Road
Hanover, N.H. 03755-1290

8. PERFORMING ORGANIZATION REPORT NUMBER
Special Report 93-1

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
National Science Foundation
Division of Polar Programs
Washington, D.C.

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited
Available from NTIS, Springfield, Virginia 22161.

12b. DISTRIBUTION CODE

13. ABSTRACT (*Maximum 200 words*)

The blue ice area just west of the Mt. Howe ridge in Antarctica was surveyed with the intent of establishing a runway for large, wheeled cargo aircraft. Site limitations and wind observations precluded selection of an airstrip location. Installation of an automatic weather station to monitor winds at the site will allow determination of site suitabiliy.

14. SUBJECT TERMS
Antarctica, Glaciers, Ice runways, Mt. Howe, South Pole Station

15. NUMBER OF PAGES
11

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL