OPERATIONAL SERVICES OVERSEAS
CIVIL AVIATION DIVISION 2
BOARD OF TRADE, LONDON, W.C.2

FALKLAND ISLANDS

REPORT ON THE FEASIBILITY OF CONSTRUCTING AN AIRFIELD ON THE CAPE PEMBROKE PENINSULA

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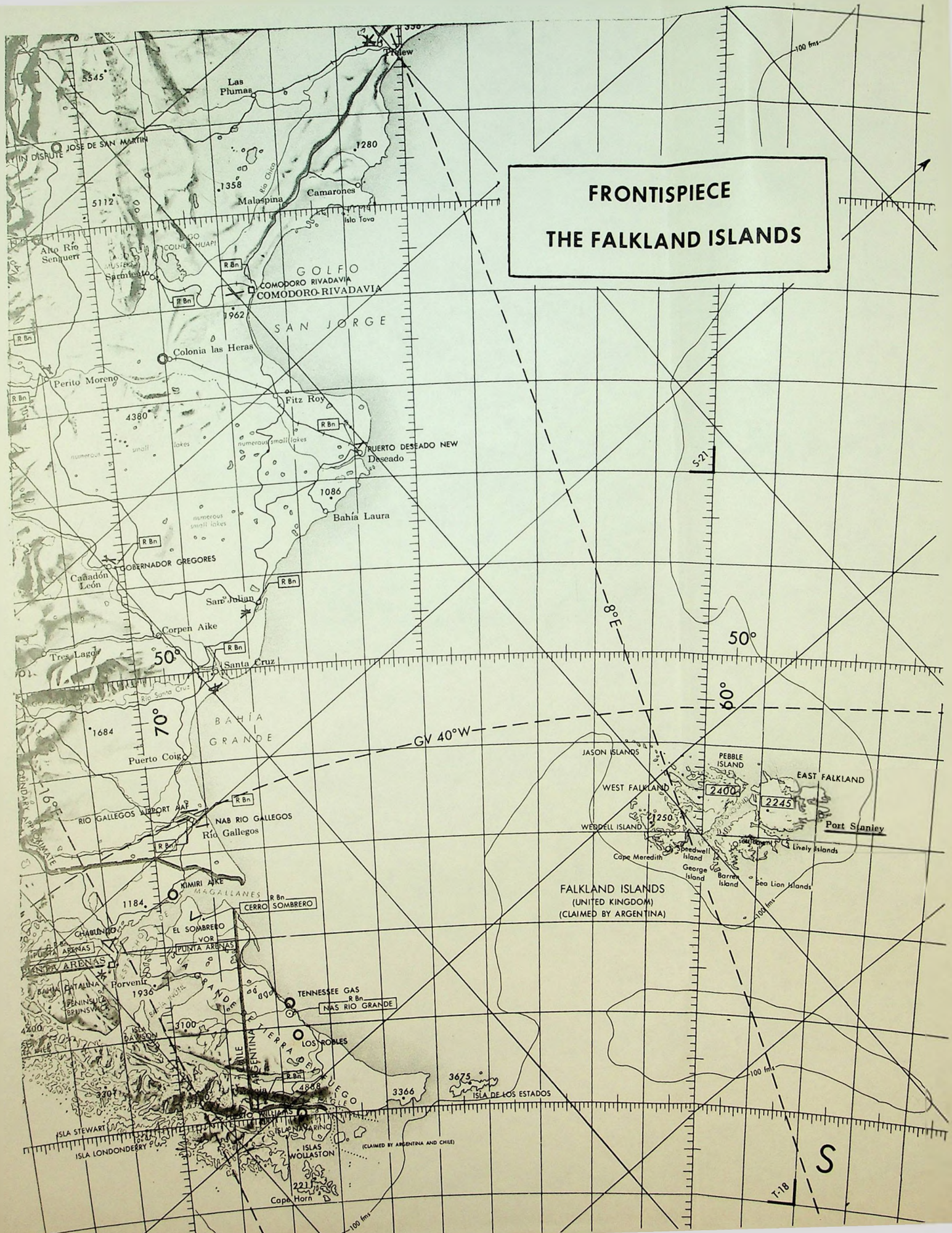
FRONTISPIECE
THE FALKLAND ISLANDS
Trelew
Las Plumas
JOSE DE SAN MARTIN
IN DISPUTE
Río Chico
Malaspina
Camarones
Isla Tova
Alto Río Senguerr
COLHUE HUAPI
Sarmiento
GOLFO
SAN JORGE
COMODORO RIVADAVIA
Colonia las Heras
Perito Moreno
Fitz Roy
numerous small lakes
PUERTO DESEADO NEW
Deseado
Bahía Laura
GOBERNADOR GREGORES
Cañadón León
San Julian
Corpen Aike
Tres Lagos
Santa Cruz
Río Santa Cruz
BAHÍA GRANDE
Puerto Coig
RIO GALLEGOS AIRPORT
NAB RIO GALLEGOS
Río Gallegos
XIMIRI AIKE
MAGALLANES
CERRO SOMBRERO
CHABLINDO
EL SOMBRERO VOR
PUNTA ARENAS
PUNTA ARENAS
Porvenir
BAHIA CATALINA
PENINSULA BRUNSWICK
ISLA DAWSON
TENNESSEE GAS
NAS RIO GRANDE
LOS ROBLES
ARGENTINA
CHILE
TIERRA DEL FUEGO
ISLA STEWART
ISLA LONDONDERRY
ISLA NAVARINO
ISLAS WOLLASTON
Cape Horn
(CLAIMED BY ARGENTINA AND CHILE)
ISLA DE LOS ESTADOS
JASON ISLANDS
PEBBLE ISLAND
EAST FALKLAND
WEST FALKLAND
WEDDELL ISLAND
Port Stanley
Cape Meredith
Speedwell Island
George Island
Barren Island
Lively Islands
Sea Lion Islands
FALKLAND ISLANDS
(UNITED KINGDOM)
(CLAIMED BY ARGENTINA)
GV 40°W
8°E
50°
60°
70°
100 fms
S-21
T-18
S

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INTRODUCTION

1.1 The Government of the Falkland Islands have for many years considered the possibility of providing for an air service from the Islands to the South American mainland. Consideration of this has evolved to the position where it was thought that the provision of a simple basic landing ground on the Islands might induce aircraft operators in South American to operate air services on a charter basis between the Islands, and the mainland; a more sophisticated airfield might be developed once traffic became established.

1.2 Suitable natural landing areas are very difficult to find in the Falkland Islands due to the nature of the terrain. Nevertheless, a possible site has been located close to Stanley, on the Cape Pembroke peninsula; a report on this site was prepared by F/LT Burgess, R.A.F., and some basic preparatory work was carried out by surveyors of the British Antarctic Survey. After consultation with the Civil Aviation Department of the Board of Trade, arrangements were made whereby that Department would carry out an inspection of the Cape Pembroke area and advise on the feasibility of constructing an airfield in that area; an airfield survey team comprising an Operations Officer, Mr. R.J. Wainwright, of the Board of Trade, and a Civil Engineer, Mr. F.J. Botham of the Ministry of Public Building and Works, arrived in Stanley on 2nd April 1969. This is a Report of their work.

2. Terms of Reference

2.1 The Terms of Reference for the survey were as follows:-

> "To carry out air and ground inspection of the Cape Pembroke area of the Falkland Islands, and to report upon the feasibility of constructing an airfield in the Cape Pembroke area, taking into account all technical flight operations and airfield engineering considerations, and having regard to the probable development pattern of air operations between the Falkland Islands and South America".

3. Background Information on the Falkland Islands

3.1 The Falkland Islands lie in the South Atlantic Ocean, between latitude 51° and 53° South and longitudes 57° and 62° West, on the edge of the Patagonian Continental Shelf. The group, consisting of two large islands and about 200 smaller islands, it situated about 400 miles north-east of Cape Horn and about the same distance from the eastern entrance to the Straits of Magellan.

3.2 The capital of the colony is Stanley, which is the only town on the Islands, and which is situated near the extreme north-east corner of the group of islands. The total population of the Islands is approximately 2,000, about half of which live in Stanley. The remainder live in small farming settlements dispersed throughout the Islands. Extensive ranching of sheep for wool represents the sole economy of the Islands at this time, although an effort is being made to develop the processing of kelp, a seaweed which is very abundant all around the coast.

3.3 Communications within the Islands are maintained by cross-country vehicles, by ship, and by air. There arevirtually no roads outside Stanley, and surface communications between settlements depends upon the use of Land-Rover or similar vehicles over rough tracks. Heavy supplies are transported by sea; most of the outlying settlements are situated near the coast, close to navigable water. The air service is operated by two single-engined DH Beaver float-planes; these carry passengers, light freight and mail throughout the Islands, operating over comparatively short sectors. Float-planes are used because it was found to be impossible to establish adequate landing grounds for conventional aircraft, whereas the majority of farms and settlements are close to suitable water areas for float-plane operation.

3.4 The latest information available concerning financial and trade matters is as follows:-

	1967 - 68	1968 - 69
Public Revenue	£376,733	£339,958
Expenditure	£409,646	£468,502

	1966	1967
Total Imports	£697,168	£711,335
Total Exports	£1,037,890	£824,187

3.5 Communications with the outside world depends almost completely upon 'R.M.S. Darwin', a vessel of 739 registered tons owned by the Falkland Islands Company. This ship, which can carry 40 passengers, averages 12 round trips annually to Montevideo, in Uruguay, and (about once a year) visits Punta Arenas, in Chile. Ships of the British Antarctic Survey also provide occasional communication between Stanley and South America. A small freighter is chartered by the Falkland Islands Company to carry supplies from the United Kingdom and to carry wool back to U.K.; the ship makes three or four voyages per annum, and carries a very limited number of passengers.

3.6 There is no international air service connecting the Colony to the outside world.

4. Development of Air Operations to South America

4.1 Air Routes:

4.1.1 The initial requirement at the Falkland Islands has been declared to be the provision of an air service as a means of improving communications with South America. The route Falkland Islands - Punta Arenas is the most practical route over which this service should initially be operated. The route distance is 488 n.m. and provides the shortest practicable crossing between the Falkland Islands and South America; it does not unduly restrict the size of aircraft which might be flown. Traffic and operational

calculations applicable to this route would provide satisfactory guidance to traffic and operational requirements on routes of similar length to aerodromes in Argentina (e.g. Rio Gallegos, Comodoro Rivadavia) at a later date, if political difficulties are eventually resolved. It is assumed that no political obstacles will be raised by Argentina in respect of flight operations between the Falkland Islands and Chile.

4.1.2 It is unlikely that there would be any requirement for the route Stanley-Montevideo for some considerable time. The long sector distance would require the use of larger aircraft having passenger capacity beyond that likely to be required by potential traffic, and offers no advantage as a means of quickly reaching the mainland and its associated world-wide communications facilities, over the much shorter and quicker route to Punta Arenas.

4.2 Traffic

4.2.1 Traffic carried on air services to the mainland would initially be drawn from that presently carried to and from Stanley by sea. Passenger arrivals in Stanley in 1967 and 1968 were 445 and 412 (an average of 36 arrivals per month); passenger departures from Stanely in 1967 and 1968 were 503 and 438 (an average of 37.5 departures per month). Although there is a demand for sea passages and bookings have to be made well in advance, there does not appear to be any pent-up demand, and it does not appear that any back-log of traffic is built up for any length of time. R.M.S. "Darwin" has normal passenger accommodation for 40 passengers, and can accommodate numbers in excess of this by providing temporary accommodation in the ship's lounge or library. A large proportion of this traffic has consisted of passengers en-route to and from the Colony and the United Kingdom, who have routed via Montevideo to secure favoured sea and air connections (Royal Mail Lines and B.U.A.) at that port. Recent withdrawal of these favoured connections would now make it more convenient, but more expensive, for travellers to U.K. by air to route through Punta Arenas and Santiago if this were possible. Many of these passengers are travelling on home leave, and the cost of thier extra air fare could be balanced against time saved in travelling.

4.2.2 There is no tourist traffic into the Falkland Islands at present, although tourist cruise vessels have occasionally stopped briefly outside Stanley Harbour. There is no accommodation for tourists either in Stanley or the outlying 'Camp' settlements. The colony has none of the attractions usually associated with tourism, other than scenery of the type associated, say, with Galway or the Outer Hebrides, and colonies of seals, penguins and some unusual birds. It has been suggested that tourist development of a highly specialised type (ornithologists, fishermen, naturalists, etc., both professional and amateur) would follow upon any improvement in communication with the South American mainland: magazine articles on the Falkland Islands published in British and American journals have in the past produced up to around 50 written enquiries to Montevideo agents, but very few were taken

any further. If such specialised tourist traffic did develop, it could be satisfactorily routed through Punta Arenas: traffic from North America (from where it could be assumed that such traffic would probably originate) is easily routed down the West Coast of South America through Santiago. However it is considered that such traffic would be very limited both initially and in development potential, and should not be given too much weight when considering the total traffic potential.

4.2.3 A limited number of Falklanders might travel to the mainland for holidays; however, the cost of living in Chile is very high and would probably not encourage such traffic. Although there is a hospital at Stanley, there is a requirement for faster transport of urgent medical cases to the mainland for specialist treatment; this would, however, provide only a small part of air traffic.

4.2.4 All manufactured goods and processed foods are presently imported via the 'Darwin', and the chartered freighter from the U.K. It is considered possible that some of this traffic might eventually be carried by air, although such a development might be limited or be delayed by the high-cost inflated economies of South American countries.

4.2.5 Air Transport operators who have considered the possibility of operations to the Falkland Islands (Van Bokkelen and Rohr of Montevideo, and Taxpa Ltd., of Santiago) believe that there could be sufficient passenger traffic, initially, to justify two flights per week (by light aircraft carrying approximately six passengers) between Punta Arenas and Stanley. An indication of cost is provided by Tama Ltd. of Punta Arenas, who estimated an approximate price of a two-way flight between Punta Arenas and Stanley, using a Beechcraft C.45 H, to be U.S. $900 (i.e. the total charter cost). Assuming that the charterer could provide a full load of, say, six passengers in each direction, the cost to each passenger would be $75, or approximately £32. This compares with the cost of the sea passage at £24 (Premium fare).

4.2.6 It seems unlikely, on the basis of the potential traffic information presently available, that a regular scheduled service would be immediately provided. It does seem probable, however, that the interested operators would appoint agents to organise and co-ordinate passenger and light freight loads for light aircraft, and that such loads might be available, on a charter basis, at fairly frequent and regular intervals.

4.3 Aircraft

4.3.1 It can be accepted that mainland operators would be prepared to fly light twin-engined passenger aircraft, on a charter-hire basis, as soon as an airfield was available. Aircraft already operated, or considered for operation, by local operators include Aerocommander 680F, Beechcraft C.45 H, Piper Navaho, and Beagle B.206. Field length requirements for these aircraft, and approximate payloads available over the critical west-bound sector, are as follows:-

Aircraft	Pay Load	Field length Required
Aerocommander 680F	7 - 8	2,800 ft.
Beechcraft C.45 H	5 - 7	3,100 ft.
Piper Navaho	5 - 7	2,300 ft.
Beagle B.206	6	3,300 ft.

It is apparent that these requirements and those of the immediate future could be met by the provision of field lengths of 3,300 ft. However, it is possible that if an airfield is provided larger aircraft (e.g. HS 748, DC3) carrying freight on a charter-hire basis, would wish to use the airfield. It is difficult to do more than speculate as to the development that might take place at Stanley, but it would seem prudent to recognize the desirability of taking advantage of the availability of labour, equipment and material and to provide maximum runway length as far as is economically reasonable.

4.4 Alternative or Emergency Airfields

4.4.1 No alternative or emergency landing grounds are presently available within the Colony, and it is doubtful whether any could be provided at reasonable cost. Two possible alternative sites in the vicinity of Port Stanley were inspected - one at Goose Green, and one immediately west of Hooker's Point. Both of these sites consisted of areas of thin turf on sand, but both were too small to provide adequate take-off and landing distances on the ground available, and were not capable of extension at reasonable cost. The lack of these alternative or emergency facilities can be balanced to a considerable degree by providing the maximum landing area at the main airfield, and by providing reliable air/ground radio-telephone communications from Stanley over the greater part of the air routes into Stanley. The meteorological situation in the Falkland Islands area, and the Meteorological Office organisation in Stanley, are considered to be such that reliable landing forecasts could be provided, and reliable forecasting covering the whole period of flight from Puntas Arenas could be provided to pilots throughout a flight.

5. The Cape Pembroke Peninsula

5.1 The Cape Pembroke Peninsula is situated at the eastern end of Stanley Harbour, extending from Whalebone Cove eastwards to Cape Pembroke proper. The area under consideration as an airfield site is the western half of the peninsula, immediately east of Whalebone Cove, north and north-east of Canopus Hill. Access to the site from Stanley is by a rough stone road to within about 1,000 yards of the site, when the road becomes only a Land-Rover track.

5.2 Meteorological Conditions

5.2.1 Rainfall: The average annual rainfall is about 25" per annum, and is fairly evenly distributed throughout the year, with more settled dry spells in spring and summer. Monthly averages obtained from observations covering the period of 1874 to 1952 are:-

J.	F.	M.	A.	M.	J.	Jly.	A.	S.	O.	N.	Dec.
2.87	2.53	2.49	2.54	2.57	2.22	2.07	2.01	1.63	1.55	2.02	3.00

5.2.2 Temperature: The average temperature is 43°F but the range is not extreme, maximum and minimum temperatures rarely exceeding 70°F and 20°F respectively.

5.2.3 Cloud Base and Visibility: cloud base and visibility conditions are satisfactory. Local advice is that cloud base rarely deteriorates below 300 feet: statistically, the height of base of the $\frac{7}{8}$ - 8/8 cloud layer is, on average, higher than 1,000 feet on 88.4% occasions. Fog is comparatively rare, visibility less than 1 kilometre occurring, on average, on 2.1% occasions; visibility is better than 2 kilometres on 96.5% of occasions.

5.2.4 Wind: The site is rarely without a significant wind. The average wind speed is about 15 knots, winds reaching 21 - 27 knots (Beaufort Scale 6) on about two-thirds of the days of the year. The predominant winds are North Westerly with only a very small percentage from the Eastern sector. The stronger winds are fairly evenly spread between North - North - West and South -South - West. A Wind Rose diagram showing the frequency of wind direction at Stanley, over the period 1952 - 1961, is shown at Appendix B.

5.3 Site Potential:

5.3.1 The site area offers suitable ground area to provide, with the minimum necessary ground preparation, an airfield consisting of one main runway of 3,600 ft. length and 100 ft. width, in a strip of 4,000 ft. length and 500 ft. width, and a subsidiary runway of 2,300 feet length and 75 feet width, in a strip of 2,500 ft. length and 260 ft. width. The length and alignment of these runways and strips is firmly determined by topographical and soil engineering considerations. The aircraft manoeuvring area containing these runways is bounded on the North side by Mary Hill, a very large out-crop of stone, and by a broken line of rock outcrop which runs (with some large gaps) in a fairly straight line from Mary Hill to Cape Pembroke. The area is bounded on the east and south-east by ground consisting of thick peat; by Canopus Hill to the south, and by very wet, soft ground sloping down into Whalebone Cove, to the west. The configuration and location of the airfield is shown in Appendices C and D. A more detailed description of the actual surface is contained in paragraph 7.2.

5.3.2 The main runway of 3,600 ft. will accommodate all the aircraft referred to in paragraph 4.3.1. It would also permit the operation of aircraft such as the Handley Page Jetstream, D.C.3, and H.S. 748, subject to varying payload penalties, if traffic developed to the extent that use of such aircraft becomes practicable. For example, it is estimated that the H.P. Jetstream could carry 9 - 10 passengers (50% of maximum available seating) over the critical west-bound sector; the H.S.748, taking account of clearway on take-off, could lift out at least 8,600 lbs, or 45 passengers for the west-bound sector, and could carry maximum payload into the airfield from Punta Arenas.

5.3.3 The subsidiary runway is considerably shorter than the main runway, but would be available primarily to accommodate light aircraft unable to accept large crosswind components on the main runway. This is considered particularly desirable in view of the absence of alternative or emergency airfields, to provide the maximum landing area to aircraft committed to landing. The landing distance provided on the subsidiary runway will permit all the aircraft specified in paragraph 4.3.1 to land at maximum landing weight into a 20 knot headwind; it would also enable a H.S. 748 to land at a little under maximum landing weight into the same headwind. The strip width is wider than the ICAO recommendation for a runway of this length, but is considered desirable because of the prevalence of strong cross-winds.

5.4 Approach and Take-off Areas:

Satisfactory approach and take-off areas can be provided for both runways. Approaches from the east and south east, which would be the normal landing approaches, are quite free of natural obstruction: It would, however, be necessary to remove, or to substantially reduce in height, the telephone poles at the south end of the secondary runway. Take-off to the west is over water, and there is adequate clear air space either for a straight climb-out or, if necessary, for climb-out on a curved flight path turning to the south. Take-off to the north-west would require a turn to avoid Mount Low, but there is adequate clearance to provide a curved take-off area either through West to South, or through North to East.

5.5 Usability

The ICAO recommendation for a maximum permissible cross-wind component applicable to the main runway is 13 knots. However, potential operators have stated, variously, that they are prepared to accept cross-wind components of up to 30 and 40 knots. Although it would be imprudent to accept such high values as criteria for usability, it is reasonable to accept that a higher value than 13 knots can be applied. Using a 15 knot cross-wind limitation as a criterion, the usability of the main runway would be 73% and on the subsidiary runway would be 70%; taken together they would provide a usability of 85%. Taking a higher cross-wind limitation of 20 knots as a criterion, usability of each runway would go up to 84%, and taken together would provide a usability of 93%; except that this might improve only the usability of the airfield by aircraft able to land on the shorter runway; if heavier aircraft eventually came into use, these might be limited by landing distance to the main runway and a usability of 84%.

6. Essential Services

6.1 Radio Communications and Navigation Facilities

6.1.1 The long sea crossing, and the absence of emergency landing grounds in the Colony, make it essential that aircraft leaving South America should be in R/T communication with Stanley as soon as possible after take-off, certainly well before reaching their 'point of no return', to enable them to receive immediate warning of any significant change in forecast landing

conditions at Stanley. Reception range for this purpose should preferably be not less than 500 n.m. at 10,000 feet for this purpose. It is doubtful whether the existing single Redifon GR 49v TX/RX presently in use for the internal Air Service would be capable of providing reliable communication at all times over such ranges. Consideration would need to be given to the provision of additional HF equipment, duplicated for 100% reliability, to cover this requirement. The cost of such equipment, properly engineered and including installation and spares, could cost in the order of £23,000.

6.1.2 It would also be necessary to provide a communications channel between Stanley and Punta Arenas for the exchange of flight plan signals, arrival and departure signals, and other operational messages. Initially, when such messages would not be numerous, this could be done by using the air/ground channel to pass such messages directly to Punta Arenas; this would need to be arranged with Punta Arenas, and would also require that the range of the air/ground facility was adequate to cover ground/ground communication between Punta Arenas and Stanley. This would require a reliable ground/ground range of not less than 500 n.m. Alternatively, these operational messages could be passed on a HF CW(Morse) channel to Punta Arenas, again subject to arrangements being made with that station; it is understood that facilities for operating such a CW channel are already available at Stanley.

6.1.3 There would be a requirement for a non-directional navigation beacon having a range of about 150 n.m. It is possible that this facility could be provided by using the Stanley broadcaster, assuming that it can provide the range and that it's frequency can be used by mainland aircraft; it would also be necessary to arrange for suitable identified CW transmissions to be made when the broadcast station as such, was shut down. It is also possible that use could be made of regular transmissions from the coastal radio station (VPC), with some identification superimposed on the transmission. In the case of both the broadcaster and the coastal station, hours of operation would have to be promulgated. It would also be necessary to confirm that the frequencies used by these stations could be received by aircraft radio direction finding apparatus - such apparatus can generally operate between 200 kcs to 1700 kcs. If neither the broadcaster or coastal station could provide suitable transmissions for the necessary periods, it would be necessary to provide a dual MF non-directional beacon with automatic change-over facilities. Such equipment could cost in the order of £10 - 15,000, depending upon the operational range of the beacon.

6.2 Re-fuelling Service

Refuelling could be carried out by means of hand-pump from 45 gallon drums. A suitable lock-up store would be necessary for the storage of these drums.

6.3 Fire Appliances

A small trailer-type fire tender, capable of being drawn by a Land-Rover, would be adequate to provide fire-cover for light aircraft. A suitable

appliance could cost, with reserve media and equipment, approximately £700 - £1,000.

6.4 Airfield Lighting

No lighting would be required. It is unlikely that night operations would take place in the foreseeable future: day visibility conditions are such that lighting would not be required.

6.5 Terminal Building

A simple building would be required to provide accommodation for Customs, Health and Immigration officials receiving and despatching passengers. It would also serve as the control point for the airfield, and should be provided with an anemometer, and a barometer. It should also be provided with a telephone for communication to the Meteorological Office and to the F.I.A.S. control centre.

6.6 Wind Indicator

A wind cone or direction indicator should be provided, preferably mounted in a suitable position on the eastern side of the airfield.

7. Engineering Works

7.1 Airfield Design Criteria

7.1.1 The following criteria were used as a basis for the design and construction of the airfield:-

	Main Runway	Subsidiary Runway
Runway Length	3,600 feet	2,300 feet
Runway Width	100 feet	75 feet
Runway Slopes:-		
(i) Longitudinal	1.5% max.	2% max.
(ii) Transverse	1.5% max.	2% max.
Runway Change of Slope	1.5% max.	2% max.
Rate of Change of Vertical Curve	0.2% max.	0.4% max.
Strip Length	4,000 feet	2,500 feet
Strip Width	500 feet	260 feet
Strip Slopes:- (excluding runways)		
(i) Longitudinal	2% max.	2% max.
(ii) Transverse	2.5% max.	3% max.

7.1.2 Runway Surfaces

The surfaces should provide good drainage and braking qualities without causing excessive tyre wear. Surface irregularities should not exceed those of a reasonable U.K. road.

7.1.3 Taxiway

Width	50
Clearance from edge to obstruction	85 feet
Strength	As main runway
Longitudinal Slope	3% max.
Transverse Slope	1.5 max.

7.1.4 Apron

A paved parking apron 100 feet square should be provided. The apron should not have slopes exceeding 2% and should not slope towards buildings and flammable stores.

7.2 Site Investigation

7.2.1 The area surveyed, and generally described in paragraph 5, consists of a shallow "basin" bounded on each side by hills, and ridges of quartzite. The floor of the basin is mainly flat falling slowly from east to west then rather more steeply towards Whalebone Cove. The vegetation, where it exists, is a rough grass and small shrub known locally as "Diddle Dee". There are large areas completely devoid of vegetation and these are obviously pond areas during wet weather; local information confirmed this. There is a large pool at the eastern end of the main runway line and this must be drained and filled with suitable material. The whole area is very rough and uneven.

7.2.2 To the east of the proposed main strip the land continues mostly flat with a few sand dunes and consists of peat to a considerable depth; it is unsuitable for any future extension. Photographs 1 and 2 of Appendix E indicate the extent of this area; the excavation shown in Photograph 3 was still in peat at the bottom. The shape and appearance of the sand mounds in this area suggests that the peat may have been completely overlain at one time by sand to a considerable thickness all of which has now blown away leaving a few dunes and the exposed peat; if this is true it would be some indication of the eroding power of the wind on the sand when not protected by vegetation.

7.2.3 Borings were taken on the proposed centre line of the main runway at intervals of 200 feet using a 1" diameter "Mackintosh Boring and Prospecting" Auger, to an average depth of 5 feet 3 inches. The results are shown in Appendix D. The borings proved fine, white sand and a water table about 1 foot to 1 foot 6 inches below the surface. At the western end the ground is waterlogged from a depth of about 1- inches below the surface and it was possible to push a steel rod to depths exceeding 9 feet with very little effort.

7.2.4 Permanent markers have been positioned on site at the ends of the proposed centre lines, for both runways consisting of steel tubes cast in concrete.

7.3 Drainage

7.3.1 The drainage of the site poses a difficult problem. The site is bounded by rising ground on either side for much of the runway length, thus effectively trapping the run-off and it will be necessary to commence drainage works at the outset. At the time this survey was carried out unusually dry conditions had prevailed for some time and there was very little rainfall during the ten days the team was on site. In spite of this, the water-table remained very high as shown on the borehole diagrams (see Appendix D), which appears to indicate that the natural drainage of the sand sub-soil occurs only slowly.

7.3.2 It is known that with the existing levels, considerable ponding occurs during wet weather over fairly extensive areas in the lines of the proposed runways and it will be essential to raise the levels, particularly under the runways, and provide adequate drainage channels to collect the run-off from the strip and retain the water-table at a satisfactory depth below the surface. The broad drainage layout is shown on Appendix D: this is considered to be the minimum necessary to ensure maximum usage of the runways at all times.

7.3.3 Each runway will be laid to a camber and "French" type base drains are required parallel to each edge of the runways. Open channels are required parallel to the edges of the strips with outfalls into Yorke Bay and Whalebone Cove. At the south-east the low-lying ground would provide a ponding area into which the drainage at that side of the strip could be directed.

7.4 Proposed Profile

The proposed centre line profile shown in Appendix D, follow the existing ground levels as far as possible:-

Main Runway - level at + 70 feet above high tide mark, Whalebone Cove, from western threshold to chainage 3,600 feet rising to + 71 feet at chainage 3,800 feet and 4,000 feet.

Secondary Runway - rising from + 69.50 feet at each threshold to + 70 feet at centre line of main runway.

These profiles, together with the recommended runway and strip transverse slopes, are the most economical having regard to the quantities of cut and fill required and to overcome the necessity to import fill from off-site.

7.5 Local Construction Materials

7.5.1 Samples of sand taken from the proposed site, clay from a borrow pit near Stanley, all-in crusher-run quartzite aggregate and Uruguayan cement have been despatched to the M.P.B.W. Central Engineering Laboratory at Cardington for testing. The assumptions of usage of these materials made in this Report will be confirmed or amended as necessary when the test results are available, and an Addendum covering any necessary amendments to the Report and details of laboratory tests will be issued in due course.

7.5.2 Quartzite Rock: This rock is used exclusively as concrete aggregate by the local P.W.D. and as-crushed, provides both fine and coarse material. There are unlimited supplies of rock both near Stanley in the Government Quarry and in extensive outcrops which occur at the Cape Pembroke site, particularly at the north side. It is intended that this rock will be used for all concreting and surface dressing in this project. It will be necessary to make provision for washing the aggregate required in the surface dressing.

7.5.3 Fine Sand: Fine, white sand is available in unlimited quantity at a number of beaches both around and close to the site area. The grading is probably too fine for high grade concrete but tests will be carried out to determine this using sand from the site. "As dug" sand from the proposed runway area is to be tested for suitability of stabilisation with cement.

7.5.4 Clay: Deposits of clay are available in quantity but at some considerable distance from the site. Tests are to be carried out to determine its suitability for mixing and compaction with the on-site sand.

N.B. During filling and levelling, difficulties may be encountered in maintaining the natural sand surface at the correct levels until spot turfing and seeding is completed due to wind; assuming satisfactory results of the tests, a mixture of clay and sand should be laid and compacted in the top three or four inches to "hold" the surface.

7.5.5 Soil: Good, loamy top soil is not available in any quantity, and most of the local grass is on peat or sand. However, for the strip areas only, this material would be suitable for spreading and seeding and local turf could be used for spot turfing.

7.6 Airfield Construction

7.6.1 The basic initial requirement at Cape Pembroke is for a simple landing area suitable for use by light aircraft. A good, firm and stable surface can normally be provided by a well drained, compact grass turf.

7.6.2 The present site is unsuitable for the provision of such a grass landing area. Drainage, and grading and levelling, will dry the natural sand surface and expose it to wind erosion: a suitable top soil would have to be laid at least six inches thick and seeded to prevent extensive erosion of this natural sand surface by the prevailing high winds. The heaviest wear and tear on runways is associated with take-off runs and, particularly, landing runs, and occurs within fairly narrow limits based upon the runway centre-line. To support this wear, a grass runway requires a firm deep-rooted growth of even turf in well compacted soil to prevent rutting and tearing of the surface, with subsequent erosion. The peaty soil available around Stanley would not provide a satisfactory base to give the required strength: if a grass runway was to be provided, top soil would have to be imported from South America.

7.6.3 The cheapest alternative to a grass surface and one which, at the same time, will provide a much more satisfactory and durable runway, is to use the fine sand which comprises the material on the site and stabilise it by mixing with cement and rolling. A triple surface dressing of bitumen and chippings would effectively seal the surface.

7.6.4 Considering the relative costs of these two alternatives, the cost of importing top soil would be extremely high whereas the costs of importing bitumen and cement would be very low in comparison. Also, the soil would still have to be laid and compacted before harrowing and seeding could commence. Under these conditions it could prove to be more expensive to lay a grass strip than to do cement stabilisation. With all the costs of drainage, earthworks, roadworks, transportation of construction equipment from the United Kingdom, etc. the actual cost of construction of the runways is only about 25% of the total cost; even if good top soil was available on site, any consequent saving would be negligible when compared with the difference in durability and usability of the two types of construction.

7.6.5 In the final analysis, it is considered that the cheapest and the most useful runway construction is the surface dressed, cement stabilised base.

7.7 Runway Pavement

7.7.1 The runways will be constructed to the specifications laid down in paragraph 7.1.1. The base will consist of 6 inches thickness of cement stabilised sand. The proportions of cement, sand and added water will be shown in the Addendum to the Report containing the laboratory test results. A suitable method of curing the cement stabilised sand will be to spray the surface with bitumen emulsion. This would also serve as a priming coat for the surface dressing. The surface dressing which is to be applied will be liable to damage by "tearing" action when aircraft are turning and since a 100 feet width is barely adequate for "unlocked" wheel turns by the large aircraft which may use the runways, turning circles will be provided at each end of the runways.

7.7.2 The surface of the base will be sealed with a triple bitumen surface dressing using cut-back bitumen to B.S. 3690 and single sized stone of the following sizes:- $\frac{1}{2}$", $\frac{1}{4}$" and pre-coated $\frac{1}{8}$". Types and rates of spread of binder and chippings are dependent on "on-site" tests once the airfield project has started and laboratory test results. A tentative specification is given hereunder for guidance only.

> "First coat of MC2 at 0.15 to 0.18 gals/square yard, $\frac{1}{4}$" chippings at 12-16 lbs./square yard; second coat of cut-back bitumen (viscosity 50-100 seconds) at 0.18 to 0.22 gals/square yard, $\frac{1}{2}$" chippings at 22-28 lbs/square yard; third coat of cut-back bitumen (viscosity 50-100 seconds) at 0.08 to 0.10 gals/square yard, $\frac{1}{8}$" pre-coated chippings at 8-12 lbs/square yard.

7.8 Strips

Strips will be formed by cutting and filling as required using material from the site excavations. Spot turf should be laid on the strip surface as grading and levelling proceeds. As soon as possible thereafter, the space between the turves should be spread with the best available top soil and seeded with grass at the growing season. This treatment is necessary to protect the sand formation from the eroding action of the constant high winds. It will not produce a surface which would be sufficiently durable for landing and take-off and would be unsuitable as a runway surface.

7.9 Earthworks

The earthworks are comprised chiefly of cut and fill-in sand. At the south end of the subsidiary runway for a length of about 500 feet the material is composed of about 3 to 4 feet thickness of peat overlying clay and it will be necessary to remove all the peat and possibly some of the underlying clay and replace with suitable fill. The south-western side of the subsidiary strip contains part of a ridge outcrop of steeply inclined quartzite beds, which may require blasting to remove. Explosives are used at the Government Quarry but in fairly small quantities and difficulty may be experienced in transporting sufficient explosive to the site as neither the "Darwin" nor the "A.E.S." charter ship are provided with magazines. It may prove necessary to break the rock using an hydraulic burster or hammers, or both, and will be a costly operation. A rough estimate of the quantity of rock excavation is 1,500 cubic yards. There is an existing explosives store adjacent to the access road and about two miles from the site.

7.10 Apron and Taxiways Pavements

7.10.1 A 50 feet wide taxiway, 300 feet long will connect the 100 feet x 100 feet apron at a level grade to the main runway some 1,000 feet from the western threshold. The taxiway will be constructed as the runways, i.e. triple surface bituminous surface dressing on 6 inches of cement stabilised sand on natural sand sub-base. It will be laid to a camber or crossfall whichever is most suitable to assist drainage.

7.10.2 The apron will be provided in 8 inches of Pavement Quality concrete on 4 inches of Rolled Dry Lean concrete. The Rolled Dry Lean and Pavement Quality concrete will be hand laid in accordance with M.P.B.W. General Specification No. 201 Airfield Pavements and the bay size for the Pavement Quality concrete will be 12' - 6" x 12' - 6".

8. Future Runway Extensions

8.1 It will not be possible to extend the main runway to the east owing to the extent and depth of peat, but extension westwards to a length of 4,000 feet is practicable. However, at 4,000 feet the ground is waterlogged, becoming more so towards Whalebone Cove and it is not thought that further extension beyond the 4,000 feet would be possible except at very high cost. No further extension of the subsidiary runway will be practicable.

9. Access Road from Stanley

9.1 There is an existing track from Port Stanley to within $\frac{1}{2}$ mile of the site and approximately $3\frac{1}{4}$ miles in length. The construction is of beach gravel and the grading appears to be about 6 inches down. There is an abundant supply of this gravel on the beaches near the site and excavating and loading will present no difficulties. The nominal width of the track is about 10 feet, the depth is variable but probably never less than 15 inches.

9.2 The track is extremely rough by United Kingdom standards but this is quite acceptable to the Islanders; it is one of the better roads outside Stanley. However, there are some very bad sections, as illustrated in Photographs 4 and 5 of Appendix E, which must be repaired. It will also be necessary to construct between 30 and 40 new culverts of varying sizes at positions throughout the length of the road. Some regrading and building-up will be required and the road rolled and compacted as necessary. The surface should be blinded with fine material, preferably from the crushed quartzite.

9.3 From the end of the built-up section, the track continues over natural ground and a trafficked route exists into the Cape Pembroke area. It will be necessary to grade this route for approximately $\frac{1}{2}$ mile to the Terminal Building site and construct a new track in beach gravel.

10. Estimates of Cost

10.1 The estimates of cost given below are sufficiently accurate for comparing two possible development schemes and can be considered as "rough" estimates of the costs of carrying out the works in July 1969. In the United Kingdom the trend over the past three years has been a rise in construction costs of approximately 7% per annum.

10.2 The estimates are based on the assumption that the work will be carried out by a United Kingdom Civil Contractor using imported labour and construction plant, cement and bitumen. Local labour is not available and only very limited assistance would be possible with small items of plant. The costs also assume favourable laboratory reports on the material specimen; in the event that any of the materials are unsuitable revised estimates will be included in the Laboratory Tests Addendum to this Report.

10.3 These estimates do not include the cost of land acquisition if this is relevant, the cost of any communication facilities or electricity to the site. It is understood that there is a remote diesel generating unit available in the Falkland Islands which could be installed by the P.W.D.

10.4 The "Preliminaries" items in the estimates include a sum of £40,000 for shipment of construction plant, transport etc., to and from the United Kingdom to Port Stanley and £10,000 for a labour camp.

10.5 Scheme I

Main Runway	3,600 feet long x 100 feet wide.	Strip 500 feet wide
Subsidiary Runway	2,300 feet long x 75 feet wide.	Strip 260 feet wide.

	£
Preliminaries	70,000
Earthworks	89,000
Drainage	46,000
Pavements	74,000
Roads	15,000
*Miscellaneous	6,000
	300,000

10.6 Scheme II

Main Runway only 3,600 feet long x 100 feet wide. Strip 500 feet wide.

	£
Preliminaries	63,000
Earthworks	62,000
Drainage	30,000
Pavements	54,000
Roads	15,000
*Miscellaneous	6,000
	230,000

Note: a reduction of runway length to 3,300 feet, to provide only for current aircraft referred to in paragraph 4.3.1, would reduce costs only by an estimated £10,000.

11. Conclusions

11.1 It is concluded that a low-cost, natural surface airfield of a satisfactory standard cannot be provided on the Cape Pembroke site. Climate, soil and site considerations combine to make a reliable, all-seasons airfield of even moderate usability a fairly high-cost project.

11.2 Initial traffic would be limited, and it is unlikely that traffic would rapidly increase. Having regard to the small population of 2,000 souls, the specialist agricultural economy of the Colony, and the speculative nature of any future tourist development, it is certain that an airfield would not be an economic proposition within the foreseeable future, and is only feasible if provided by the Government as a necessary social service.

11.3 Of the two airfield development schemes presented in Paragraph 10.5 & 6 of this Report, the two-runway configuration of Scheme 1 is obviously the most desirable; it offers the best usability and, to some extent, safer operation inasmuch that it provides for unexpected significant wind changes. Because of its better usability, it will be more attractive to operators, and this should be reflected in lower charter rates. The alternative single-runway configuration has a lower usability, which would make the airfield less attractive to operators. Delays would be more frequent, which would be reflected in higher charter rates. However, having regard to the limited traffic expected both immediately and in the future, and the considerably lower capital cost, it is considered that Scheme 2 would be adequate to meet the Colony's needs.

* Miscellaneous includes
Terminal Building £2,000

11.4 It is considered that the provision of a reliable air/ground communication channel as specified in Paragraph 6.1 would be of equal priority to the establishment of an airfield.

12. Acknowledgement

12.1 Appreciation is expressed to the Government Officers and private citizens of the Falkland Islands, and to officers of the British Embassies in Montevideo and Santiago, for their kindness in giving advice, information and assistance. The number of persons who gave valuable help is too great to specify in detail, but particular reference must be made to the following Government officials:-

H.E. The Governor of the Falkland Islands, Sir Cosmo Haskard, K.C.M.G., M.B.E.

Mr. W.H. Thompson	Colonial Secretary
Mr. H.L. Bound	Assistant Col. Secretary
Mr. J. Kerr	Director of Civil Aviation
Mr. T. Royans	Superintendent, P.W.D.
Mr. J. Bound	Superintendent of Posts and Telecommunications
Mr. W.H. Roberts	Supervisor, Wireless Station
Mr. D. Boland	Meteorological Office

DISCUSSIONS WITH SOUTH AMERICAN OPERATORS

Van Bokkelen and Rohr S.A. of MONTEVIDEO

Senor Juan Bidergeray

Snr. Juan Bidergeray is the aviation manager of Van Bokkelen & Rohr S.A. of Montevideo. The team met him in Montevideo on 27th March 1969, while en route to the Falkland Islands. Snr. Bidergeray visited the Falkland Islands in 1966, and has seen the Cape Pembroke area. He is still interested in opening an air service between Stanley and Punta Arenas, probably in association with TAXPA of SANTIAGO. Scheduled flights are not envisaged, but Snr. Bidergeray considers that at least two flights a week by light aircraft are feasible. He has in mind the use of Aerocommander, Beagle and Piper Navaho aircraft: if traffic developed adequately, he would consider introduction of Twin-Otter aircraft. A 30 knot crosswind component would be accepted in operating all of the aircraft mentioned.

Snr. Bidergeray had required a two-runway airfield at Stanley, with an alternative/emergency airfield on West Island, but would now be prepared to operate without the latter airfield if a reliable air/ground communication service from Stanley was available to enable a constant check to be kept on landing conditions. Snr. Bidergeray said he had required a paved runway at Cape Pembroke because he considered the natural grass surface to be unsatisfactory; however, if the turf could be improved sufficiently he would be satisfied to use it.

Snr. Bidergeray's longer term plans included the operation of the Falklands airfield by his company, and the operation and servicing of the Beaver float-plane service. He had also considered the possibility of providing hotel accommodation in Port Stanley, and the establishment of a store in Punta Arenas from which to supply a freight service to the Falkland Islands.

TAMA LTDA of PUNTA ARENAS

The team met Snr. Luciano, who is the owner, managing director and chief pilot of this company, in Punta Arenas on 14th April 1969. He speaks very little English, and discussions took place through the British Consul's clerk.

TAMA operate a Beechcraft C.45 H, and require a field length of 3100 feet at Stanley. Snr. Luciano is prepared to accept a 40 knot crosswind component; in order to make sure that there was no misunderstanding this was questioned and confirmed, using diagrams to make sure. TAMA would require an emergency strip of not less than 1950 feet on the western side of the Falkland Islands, "to provide for mechanical failure". It seems somewhat unrealistic to be prepared to fly 285 n.m. on a sea crossing, but to require an emergency strip for mechanical failure on the final overland 115 n.m. TAMA would require Spanish to be used in air/ground communications. Snr. Luciano gave an estimate, as general guidance only, of the cost of engaging his aircraft for the return flight Punta Arenas - Stanley as U.S. $900.

LINEA AREA TAXPA LTDA (SANTIAGO)

The team met Snr. Carlos Griffin, the Director-Gerente of TAXPA, in Santiago on 16th April 1969. Snr. Griffin is a pilot, licensed to fly his

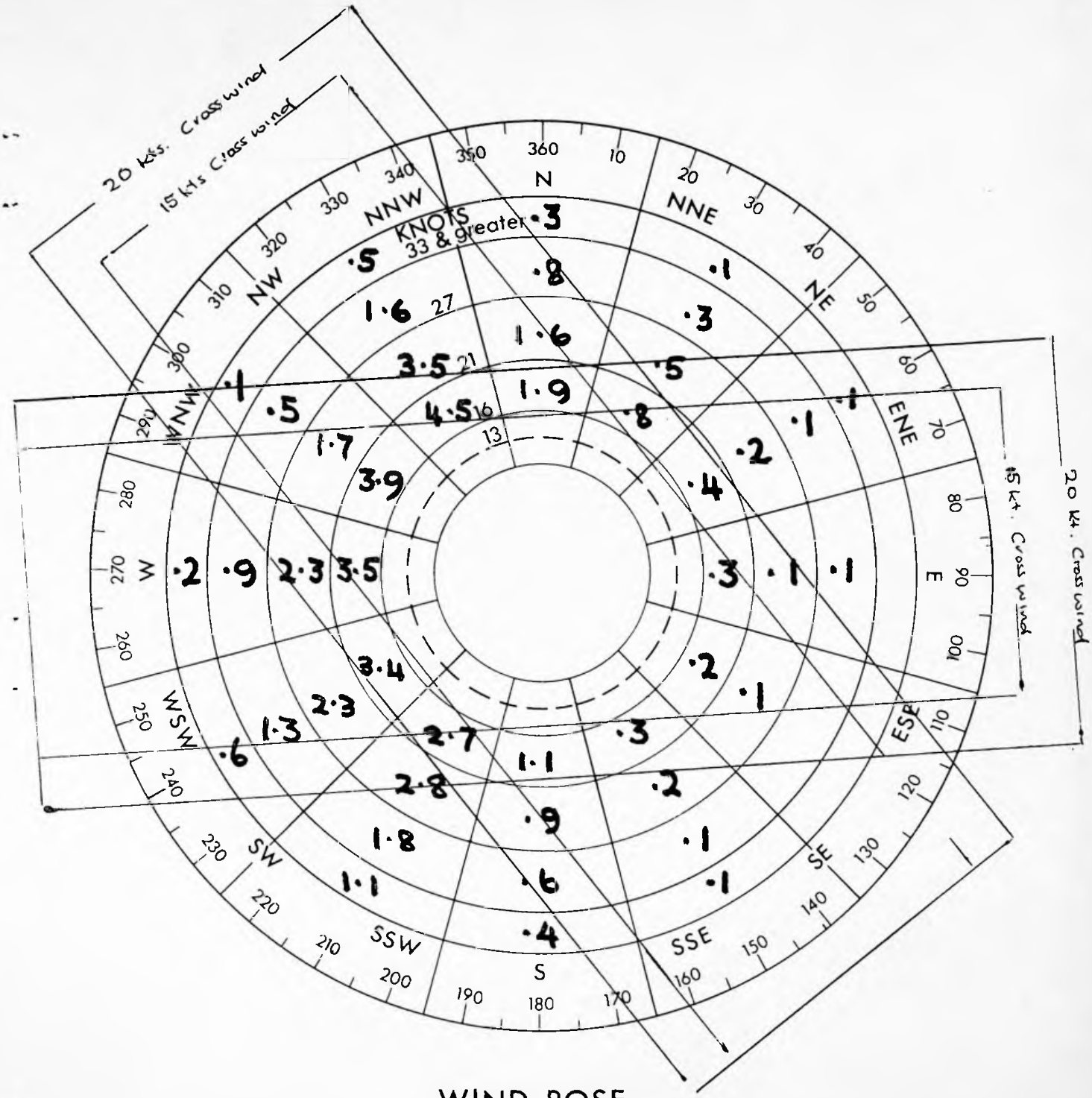
company's aircraft. TAXPA would use Aerocommander 680 aircraft for flights into Stanley, and would require a field length of 2500 feet. They would also consider using a Piper Navaho. TAXPA would operate into the Falkland Islands without alternative or emergency airfields providing that reliable air/ground communication with Stanley was available over the route.

Snr. Griffin said he would operate initially with a 10 knot crosswind, but would accept a higher component when they had experience of the airfield at Stanley. (Note: TAXPA have some association with Snr. Bidergeray of Montevideo; Snr. Bidergeray has stated that he will accept a 30 knot crosswind component. It is felt that Snr. Griffin wished to impress as a careful, cautious operator in stating a low initial crosswind component).

Snr. Griffin said that TAXPA might consider constructing an airfield at Stanley, providing radio beacon and radio communication facilities, at no cost to the Falkland Islands; TAXPA would require a guarantee of one charter per week to justify this investment. Snr. Griffin said that TAXPA had constructed their own airfield, road and hotel on JUAN FERNANDES ISLAND, and were flying tourists into that island over a sea route of 360 n.m. from Chile.

The team do not feel able to comment upon Snr. Griffin's very tentative discussion on providing an airfield at Stanley, which was noted for information. Snr. Griffin has not seen the Cape Pembroke site, and it would be necessary to know, among other things, the standards to which an airfield would be constructed, whether TAXPA would expect to have the sole concession for operating the airfield, and whether other concessions were envisaged.

Appendix B



WIND ROSE

B.O.T. (C.A. Dept.) C.Ops.10.D.O. Drg. No. 5863 2-7-69

Percentage Frequencies

PORT STANLEY

Appendix C

P O R T W I L L I A M

Doctor Point

Blanco Bay

Ordnance Point

Gypsy Cove

Tussac Point

Hadossa Bay

Engineer Point

THE NARROWS

Navy Point

Camber

YORKE BAY

Yorke Point

Kelly Rocks

Tussac Islands

The Viper

CAPE PEMBROKE

Mary Hill

Fish Rock

Christina Bay

Whalebone Cove

E Y H A R B O U R

PORT STANLEY

Jetties

Jetty

Canopus Hill

The Canache

Surf Bay

Hookers Point

The Murray Heights

Lookout Rocks

Rookery Bay

Maggie Elliot Rock

Rock

Pebbly Pond

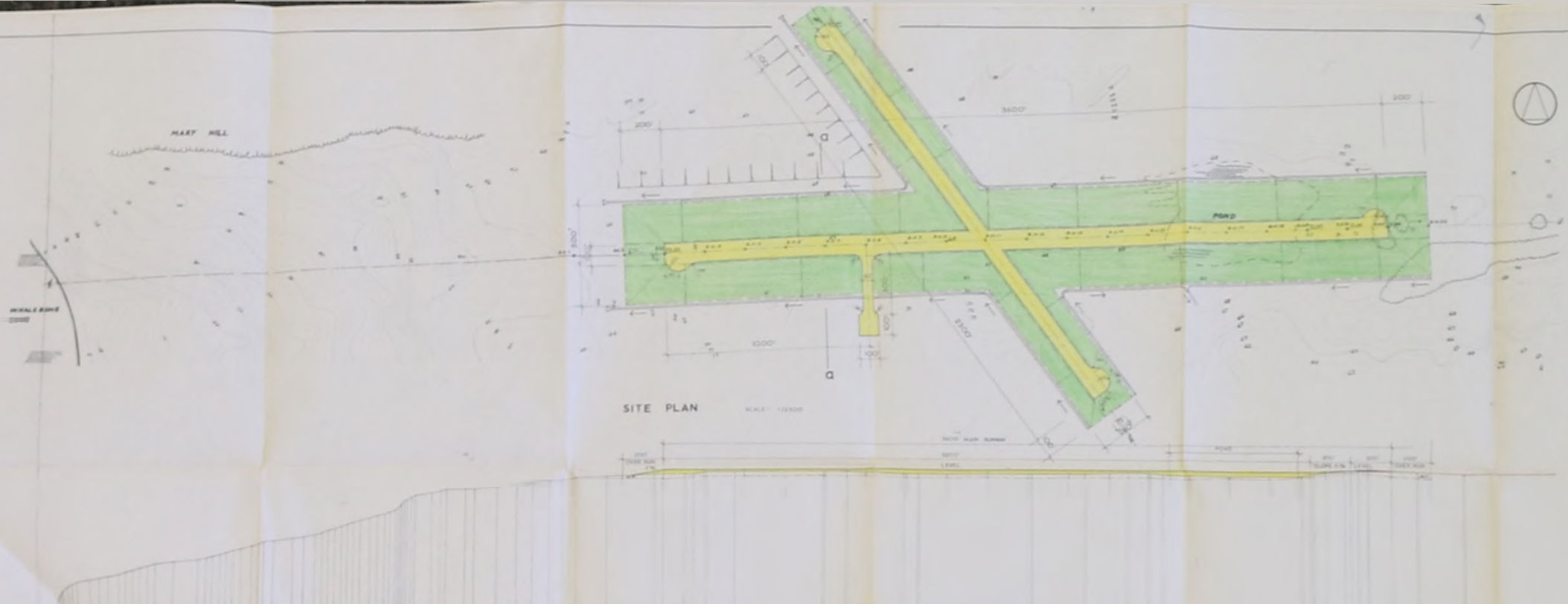
Philip's Point

Eliza Cove

True North

Grid North

Convergence 30°49'E at centre of sheet



SITE PLAN

SECTION ALONG ℄ OF MAIN RUNWAY

SECTION ALONG ℄ OF SUBSIDIARY RUNWAY

TYPICAL SECTION a-a

DETAIL OF BOREHOLES ALONG ℄ OF MAIN RUNWAY

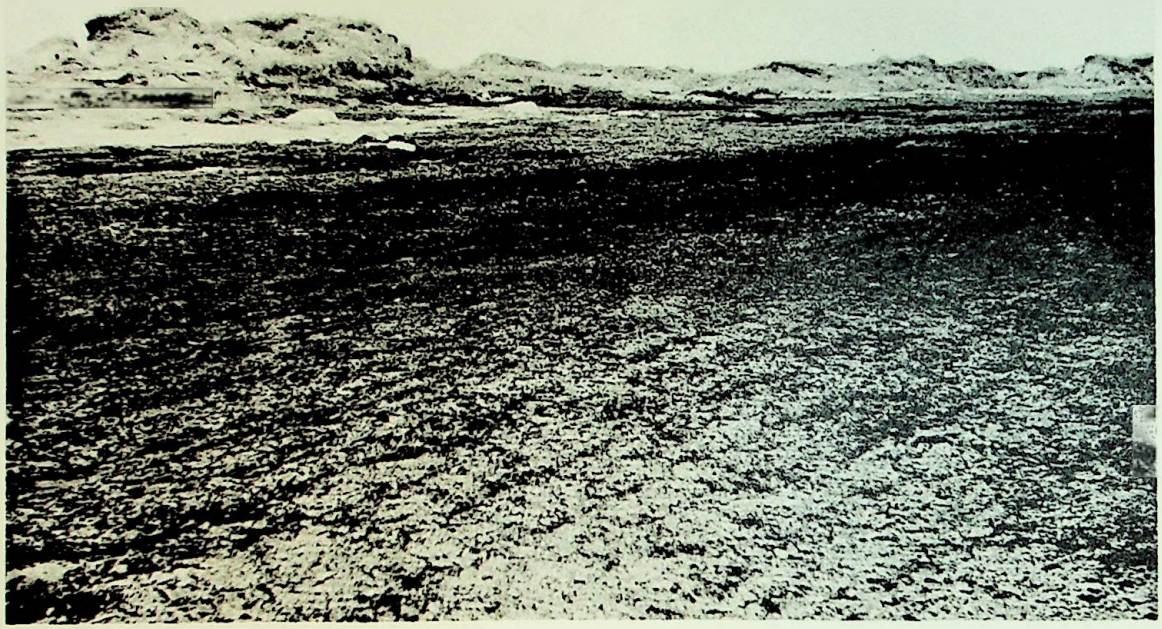
RUNWAYS & STRIPS
LANDING & APPROACH CLEARANCES

RUNWAY TAXIWAY FILLET & APRON

DETAIL OF TURNING CIRCLE AT RUNWAY ENDS

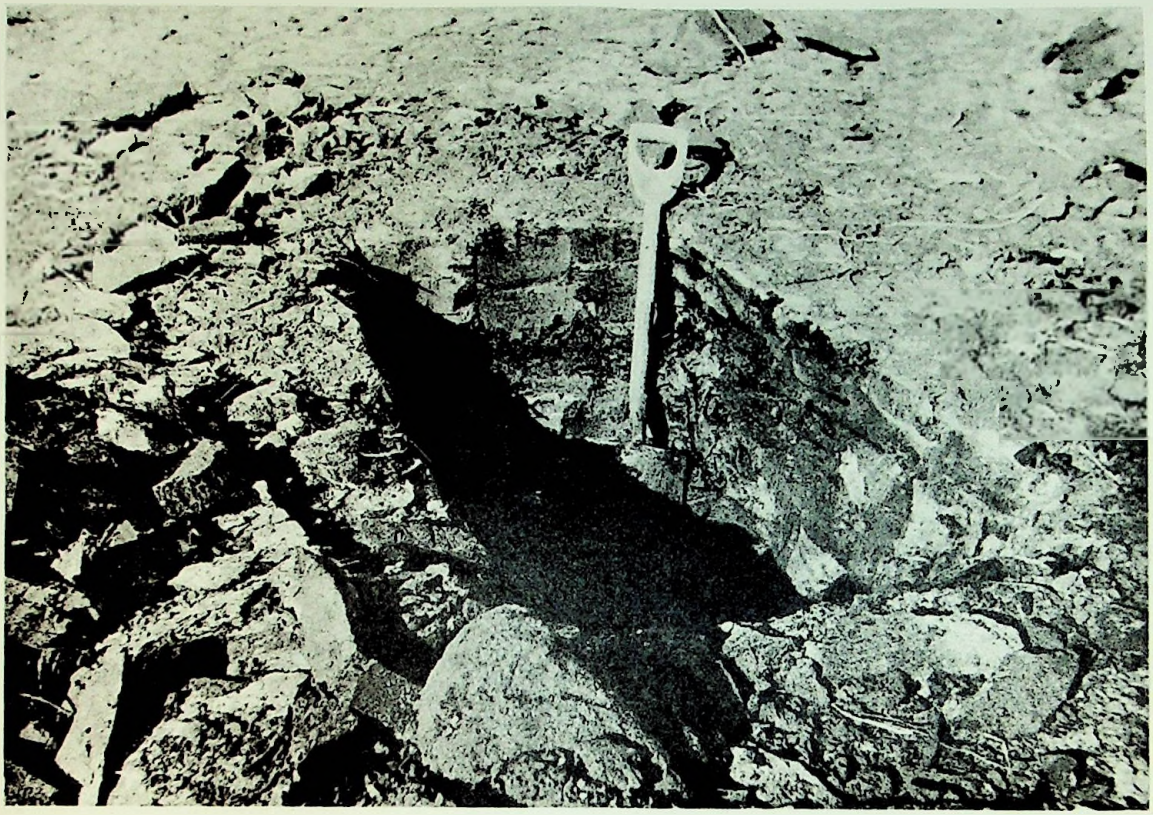
FALKLAND ISLANDS – PORT STANLEY

SURVEY OF SITE AND DETAILS FOR PROPOSED NEW AIRFIELD

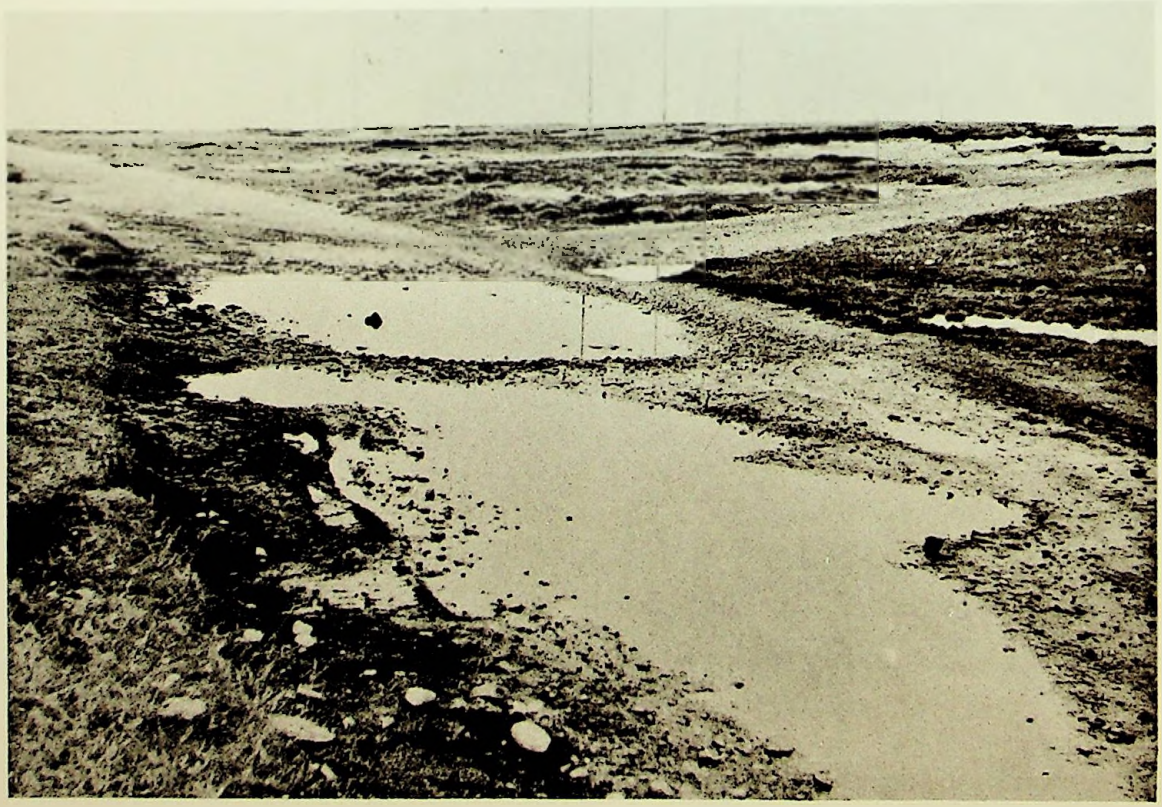


1. Bare Peat Surface east of
Airfield Location

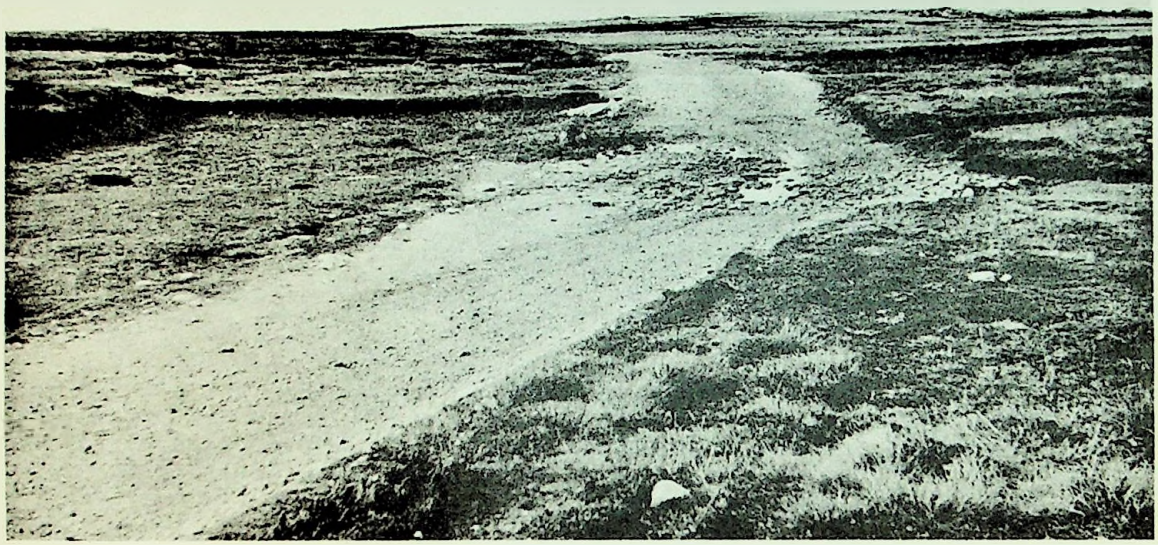
2. Eroded Surface showing blown
sand on Bare Peat east of
Airfield Location



3. Excavation in Deep Peat
in areas shown in
Photographs 1 and 2

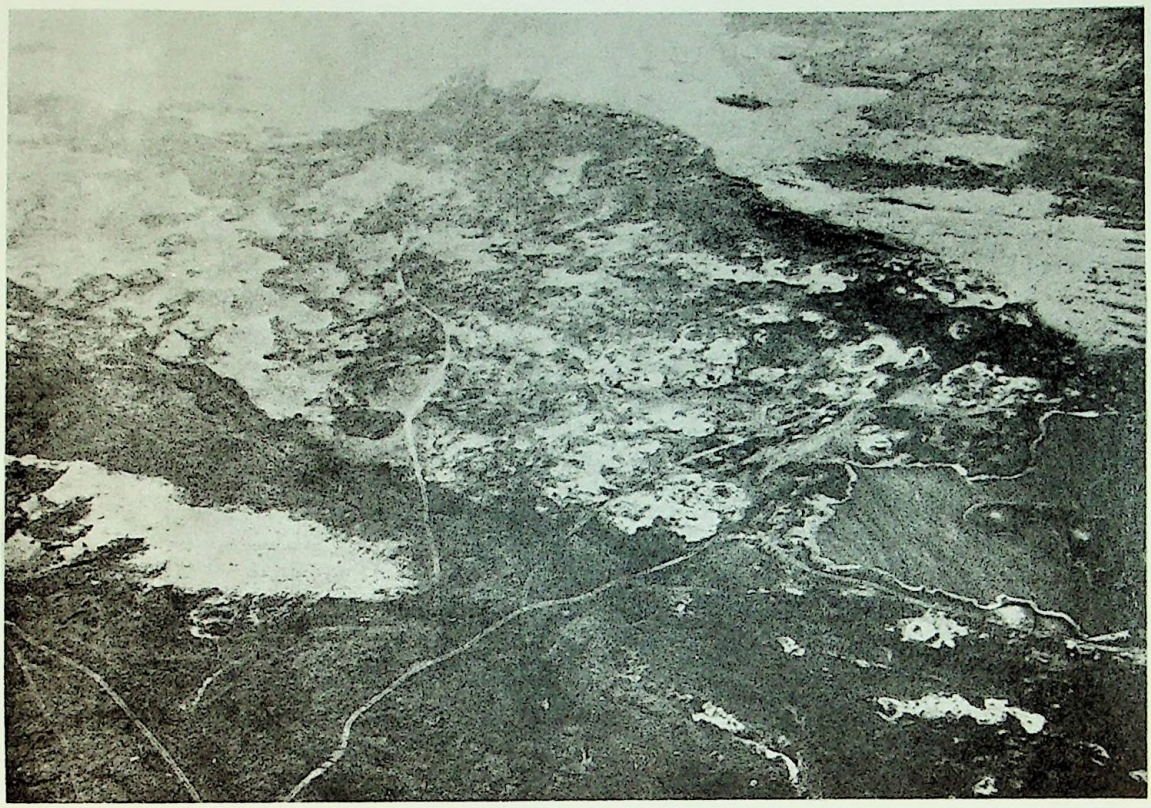


4. Pot-holes in access road between
Stanley and Cape Pembroke



5. Pot-hole in access road between
Stanley and Cape Pembroke

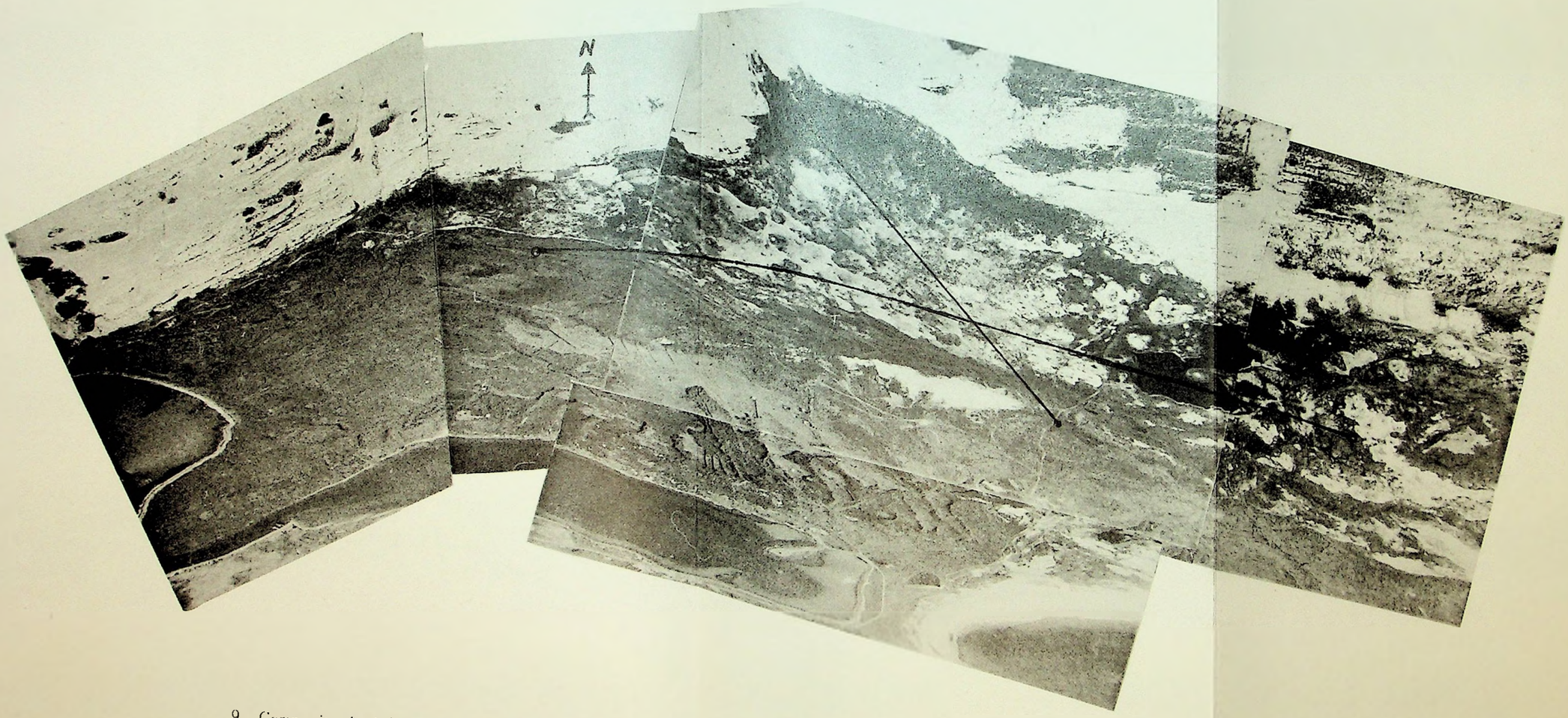
6. Looking west down main runway
centre-line from eastern end



No. 7

No. 8

Aerial views of Airfield Location



9. Composite Aerial View of Airfield Location,
showing surveyed Runway ℄ s

10 Panoramic View of Airfield from Canopus Hill, looking North. Port Stanley is on left side.