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**GEOLOGICAL INVESTIGATIONS FOR
AIRPORT SITES,
CANBERRA AND ENVIRONS, 1976**

by
P.H. Vanden Broek

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SUMMARY

Field mapping has determined the engineering geological suitability of 10 proposed airport sites. One of these sites is to be considered by planning authorities as a future location for a regular passenger traffic and/or general aviation airport for the Canberra region.

Many of the sites have shallow soil cover, and about half are underlain by relatively unweathered hard dacite. The remaining sites are mostly underlain by moderately weathered sandstone or shale, except that to the north of Bungendore, which is underlain by alluvium and lake deposits. A comparative engineering geological assessment indicates that Bungendore is the most suitable for a regular passenger traffic and/or general aviation airport site for the alignments proposed.

A reorientation of runway alignments at Spring Flat, another of the proposed sites, would make it the most favourable site from an engineering geological viewpoint. A further feasibility study for Spring Flat is recommended.

INTRODUCTION

The National Capital Development Commission (NCDC), the Air Transport Group of the Department of Transport, and the Department of Construction are looking at alternative airport sites to serve the Canberra region, because the present airport - Fairbairn airport - may no longer be adequate to serve Canberra's needs in future years. The alternative airport will cater for general aviation (GA; mostly light aircraft) or regular passenger traffic (RPT; mainly scheduled domestic air services), or both. Several sites have been selected for feasibility study, and in August 1975 the Bureau of Mineral Resources, Geology and Geophysics was asked to investigate them for potential geological and hydrological constraints.

The study commenced in January 1976 with a brief aerial inspection of all the designated sites. At a subsequent joint meeting with NCDC, three of the sites were eliminated: Oakey Creek, which is inaccessible and topographically unsuitable; Gold Creek, which is close to urban development; and Hoskinstown, which is near a radio telescope. The 10 remaining sites were investigated further, and the scope of the investigations was broadened to provide a general engineering and environmental geological appraisal. Particular sites are described in terms of their runway alignments, given in tens of degrees magnetic bearing; e.g., Uriarra 1(19 and 32) has proposed runways on magnetic bearing 190° and 320°. The sites were assessed from geological and soils mapping; no seismic traversing or drilling were undertaken. Groundwater and drainage observations were confined to mapping areas of swampy ground and areas where the vegetation indicates swampy ground, and the observation of confined soil water aquifers in erosion gullies.

ENGINEERING GEOLOGY

Rock types ranging from hard unweathered blue-green dacite to soft weathered shale underlie nine of sites; the Bungendore site is underlain by alluvium and lake deposits. The geology of individual sites and the surface distribution of the rock types

at each site is shown in Plates 2 to 7.

Generally the degree of weathering of a particular rock type determines its hardness and strength, and the ease with which it can be excavated. A definition of the terms used to describe the degrees of weathering is given in Appendix 1. The most difficult rocks to excavate are the unweathered volcanics - dacite, rhyodacite, and rhyolite - which underlie half of the sites; most of the remaining sites are underlain by either moderately weathered sandstone or shale.

Soils are described both in accordance with the unified soil classification (Appendix 2) and their pedological profiles (Appendix 3). Skeletal soil mostly covers the higher ground between rock exposures; red earths generally occupy the slopes surrounding the higher ground. Red and yellow podzolic soils cover areas of undulating ground where deeper weathering has proceeded and where erosion has not removed this cover. Alluvium, including dark grey high-plasticity organic clay, underlies low-lying poorly drained areas.

Engineering geological appraisal

The geology, the soils, and an engineering geological appraisal of each site are summarised in Table 1, which also indicates the expected depth to solid rock, as shown by the contours of assessed soil depth in Plates 2 to 7.

Comparative engineering geological assessment

A comparative assessment (value judgement) of each site in terms of its suitability based on engineering geology is given in Table 2. The various parameters (excluding drainage and groundwater conditions) have been given numerical values from 1 to 10, with 1 being for the most suitable and 10 being for the least suitable. Natural drainage and groundwater conditions have been given values from 1 to 5 (with the lower numbers indicating more favourable drainage and less troublesome groundwater conditions) because drainage and groundwater combined were assessed as being roughly equal to one of the other factors.

TABLE 1: ENGINEERING GEOLOGICAL APPRAISAL

Site	Bedrock Outcropping			Soil exposed					Foundation conditions	Excavation characteristics	Suitability of material for embankments	Availability of construction materials	Amount of cut and fill required	Natural drainage of site	Groundwater conditions	Major geotechnical constraint
	Type	Weathering	Distribution	Type	Occurrence	Profile (unified)	Thickness (metres)	Internal drainage								
Uriarra 1 (PI 2)	Dacite	SW-HW	Extensive over high ground	Minimal podzolic soil Organic clay	Slopes & depressions Along creek bed	ML/CL-CH CH	1.0 - 2.0 0.5 - 1.0	fair poor	Very good	Very difficult	Good	Good	Large amounts	Good	Fractured rock aquifers only	Very difficult excavation conditions
Uriarra 2 (PI 2)	Dacite	SW-HW	Extensive on slopes	Minimal podzolic soil	Depressions	ML/CL-CH	0.7 - 3.0	fair	Good	Very difficult	Good	Good	Large amounts	Mostly good	Some confined soil aquifers	Difficult excavation conditions
Uriarra 3 (PI 2)	Dacite	SW-HW	Extensive over NE and E edge of site	Yellow podzolic soil Alluvium	Much of the area Adjacent to creek	OL/ML/CH GP-SC	1.0 - 1.5 2.0 - 3.5	poor good	Fair	Difficult in some places	Fair	Good	Medium large amounts	Good	Fractured rock aquifers only	Difficult excavation conditions
Glenwood (PI 3)	Dacite	NW/HW	Irregular	Organic silt Organic clay Yellow-grey mottled clay Ferruginous gravel Clayey alluvium	At the surface over most of the area Beneath organic silt in lower areas Beneath organic clay in lower areas Beneath mottled clay in some places Beneath ferruginous gravel in places	OL OH CH GP-GW SC-CL	≈ 0.5 ≈ 0.5 1.5 - 2.0 ≈ 0.3 ≈ 1.0	fair poor poor good fair	Poor	Good	Fair to poor	Good from existing adjacent quarries	Medium amounts	Poor to very poor	Confined soil aquifers; upward soil water pressures	Poor natural and internal soil drainage. Confined aquifers.
Murrumbateman (PI 4)	Dacite	SW-HW	Extensive on slopes and over higher ground	Skeletal soil Red earth Minimal podzolic soil Podzolic soil	On higher ground On low hills Undulating ground between low hills On flatter areas	ML ML/CL ML/CL-CH OL/ML/CL/CH	0.3 - 0.5 0.5 - 1.0 1.0 - 2.0 2.0 - 3.0	good good fair poor	Good	Difficult to very difficult	Good	Good	Large amounts	Very good	Fractured rock aquifers only	Difficult excavation conditions
Wonders Farm (PI 5)	Sandstone Shale Silicified gravel	NW NW-EW F	Mostly underlying southern part of the area Mostly underlying northern part of the area Capping main area N-S ridge	Skeletal soil Red earth Minimal podzolic soil Podzolic soil	Along N-S ridge On low northern hills In depressions along ridge Underlying lower areas	ML ML/CL ML/CL-CH ML/CL/CH	0.3 - 0.5 0.5 - 0.8 0.7 - 1.2 1.0 - 2.0	good good fair poor	Fair to poor	Difficult along N-S ridge	Good	Poor	Large amounts	Poor	Confined soil aquifers, alluvial aquifers	Difficult excavation conditions, poor natural drainage
Tillygraig (PI 5)	Sandstone Silicified gravel	NW F	Limited, in creeks and along slopes Capping hills	Red earth Minimal podzolic soil	On low hills In depressions	ML/CL ML/CL-CH	0.5 - 1.0 1.0 - 1.5	good fair	Good	Difficult in places	Good	Poor	Medium large amounts	Good	Fractured rock aquifers only	Difficult excavation conditions
Spring Flat (PI 6)	Dacite Shale	SW-HW NW	Scattered over about 1/2 of site Poorly exposed over about 2/3 site	Skeletal soil Yellow podzolic soil Alluvium	Underlies much of the area In depressions Adjacent to main creek	ML ML/CL/CH GP-GW	0.3 - 0.5 1.0 - 2.0 2.0 - 3.0	good poor good	Good	Difficult in places on existing alignment	Good	Good	Medium large amounts on existing alignments	Good	Some alluvial aquifers	Amount of cut and fill on existing alignment
Back Creek (PI 6)	Sandstone Shale	NW NW-EW	Sporadic over about 1/2 site Not well exposed	Skeletal soil Minimal podzolic soil	On slopes In depressions	ML ML/CL-CH	0.2 - 0.5 0.8 - 1.5	good fair	Good	Fairly good	Good	Fairly good	Very large amount	Good	Fractured rock aquifers only	Large hill to east of site
Bungendore (PI 7)	Not exposed			Diverse: Inorganic silt Organic silt Organic clay Yellow-grey mottled clay Fine sand	as shown in Plate 7	ML OL OH CL-CH SW	0.3 - 1.0 0.3 - 1.5 0.3 - 1.5 0.5 - 1.2 > 2.07	good fair poor poor good	Poor	Good	Poor	Fair	Small amounts	Poor	High potentiometric surface of alluvial aquifers related to water levels in Lake George	Flooding of Lake George

Table 2: Comparative engineering geological assessment *

Site	Foundation conditions	Excavation characteristics	Suitability of material for embankments	Progress total 1	Availability of construction materials	Amount of cut and fill required	Progress total 2	Natural drainage of site	Groundwater conditions	Total
Uriarra 1 (GA) (19 and 32)	3	8	3	14	4	6	24	1	1	26
Uriarra 2 (GA) (15 and 24)	3	8	3	14	4	7	25	2	2	29
Uriarra 3 (GA) (23 and 28)	4	7	4	15	4	8	27	1	1	29
Glenwood (GA) (20 and 26)	7	2	5	14	4	5	23	3	3	29
Murrumbateman (RPT) (13)	3	8	4	15	4	9	28	2	1	31
Wonders Farm (RPT) (24 and 35)	7	5	4	16	7	6	29	3	3	35
Tillygreig (GA) (25 and 36)	2	6	4	12	7	8	27	1	1	29
Spring Flat (RPT) (22)	3	6	4	13	4	9	26	2	1	29
Spring Flat (RPT or GA) (28 - 34)	3	5	4	12	4	4	20	2	1	23
Back Creek (GA) (24 and 35)	2	6	4	12	5	9	26	2	1	29
Bungendore (RPT) (33)	7	1	6	14	6	2	22	3	2	27

* Low values indicate more favourable geological conditions. (see text)

Site evaluation

The more preferable sites are those with the lower total assessment numbers as given in Table 2. Environmental considerations may change the order of site preference determined from engineering geological considerations, depending on the value assigned to them in terms of feasibility and economics. Many local environmental impacts, such as excavation scars, could be overcome by expenditure if it were warranted, and would have to be considered in relation to the total cost of a particular project.

CONCLUSIONS

1. Bungendore is the most suitable site for a regular passenger traffic or general aviation airport from an engineering geological viewpoint.
2. Spring Flat would be the most favoured site for a regular passenger traffic or general aviation airport site, if the runways could be realigned within the areas set out on Plate 8.
3. A comprehensive environmental impact statement could significantly alter the conclusions of this report.

RECOMMENDATION

The feasibility of realigning the runways at Spring Flat should be further investigated and considered in the light of this investigation.

APPENDIX 1DEFINITION OF ROCK WEATHERING TERMS

FRESH	: No discolouration or loss in strength
FRESH STAINED	: Limonitic staining along fractures, rock otherwise fresh and shows no loss of strength.
SLIGHTLY WEATHERED	: Rock is slightly discoloured, but not noticeably lower in strength than the fresh rock.
MODERATELY WEATHERED	: Rock is discoloured and noticeably weakened; N - size drill core generally cannot be broken by hand across the rock fabric.
HIGHLY WEATHERED	: Rock is discoloured and weakened; N - size drill core can generally be broken by hand across the rock fabric.
EXTREMELY WEATHERED	: Rock is decomposed to a soil, but the original rock fabric is mostly preserved.

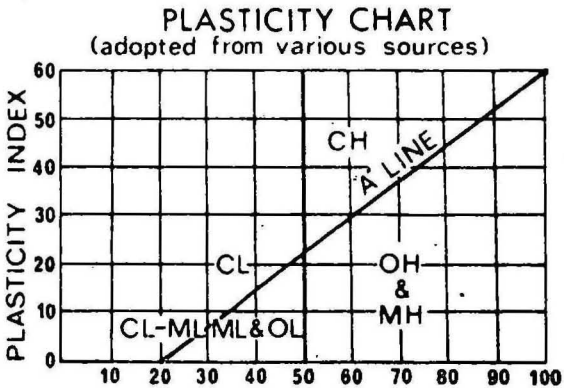
CLASSIFICATION CHART

MAJOR DIVISIONS		SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS More than 1/2 of soil > No.200 sieve size	GRAVELS (More than 1/2 of coarse fraction > no.4 U.S. sieve size)	GW	Well graded gravels or gravel-sand mixtures, little or no fines ^a
		GP	Poorly graded gravels or gravel-sand mixtures, little or no fines
		GM	Silty gravels, gravel-sand-silt mixture
		GC	Clayey gravels, gravel-sand-clay mixture
	SANDS (More than 1/2 of coarse fraction > no.4 U.S. sieve size)	SW	Well graded sands or gravelly sands, little or no fines
		SP	Poorly graded sands or gravelly sands, little or no fines
		SM	Silty sands, sand silt-mixtures
		SC	Clayey sands, sand-clay mixtures
FINE GRAINED SOILS More than 1/2 of soil < No.200 sieve size	SILTS AND CLAYS Liquid limit > 50	ML	Inorganic silt and very fine sands, rock flour, silty or clayey fine sands or clayey silts with low plasticity
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		OL	Organic silts and organic silty clays of low plasticity
	SILTS AND CLAYS Liquid limit > 50	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic clays of medium to high plasticity, organic silty clays, organic silts
	HIGHLY ORGANIC SOILS	Pt	Peat and other highly organic soils

* fines - portion of a soil finer than a no. 200 sieve

GRAIN SIZE CHART

Classification	Range of grain size	
	U.S. Standard Sieve Size	Grain Size in Millimetres
BOULDERS	Above 12"	Above 305
COBBLES	12" to 3"	305 to 76.2
GRAVEL	3" to No. 4	76.2 to 4.76
	3" to 3/4"	76.2 to 19.1
	3/4" to No. 4	19.1 to 4.76
SAND	No. 4 to No. 200	4.76 to 0.074
	No. 4 to No. 10	4.76 to 2.00
	No. 10 to No. 40	2.00 to 0.420
	No. 40 to No. 200	0.420 to 0.074
SILT & CLAY	Below No. 200	Below 0.074



APPENDIX 3BRIEF PEDOLOGICAL DESCRIPTION OF SOIL TYPESSkeletal soil

Skeletal soil is a stony or gravelly residual soil, lacking profile development other than minor organic accumulation at the surface.

Red earth

Red earth is distinguished by its red-brown earthy appearance; that is, a dull mat or dusty porous appearance on the face of freshly broken soil. It exhibits only weak profile differentiation with gradual or diffuse boundaries.

Minimal podzolic soil

This soil is distinguished by a texture contrast between A and B horizons. The upper A horizon is only weakly developed and comprises an organic silt layer. The lower B horizon is usually a yellow clay layer of low to medium plasticity. The boundary between the two horizons is diffuse.

Podzolic soil

This soil is distinguished by strong textural contrast between A and B horizons. The upper horizon consists of a grey organic silt layer underlain by a pale grey sandy or silty layer. The lower horizon comprises a red, yellow, grey, or mottled yellow-grey clay layer of medium to high plasticity. This soil usually overlies an extremely weathered rock which is the C horizon. Boundaries between horizons are very distinct.

Organic clay

This soil comprises a dark grey organic high-plasticity clay which typically occurs in poorly drained low-lying areas.

Alluvium

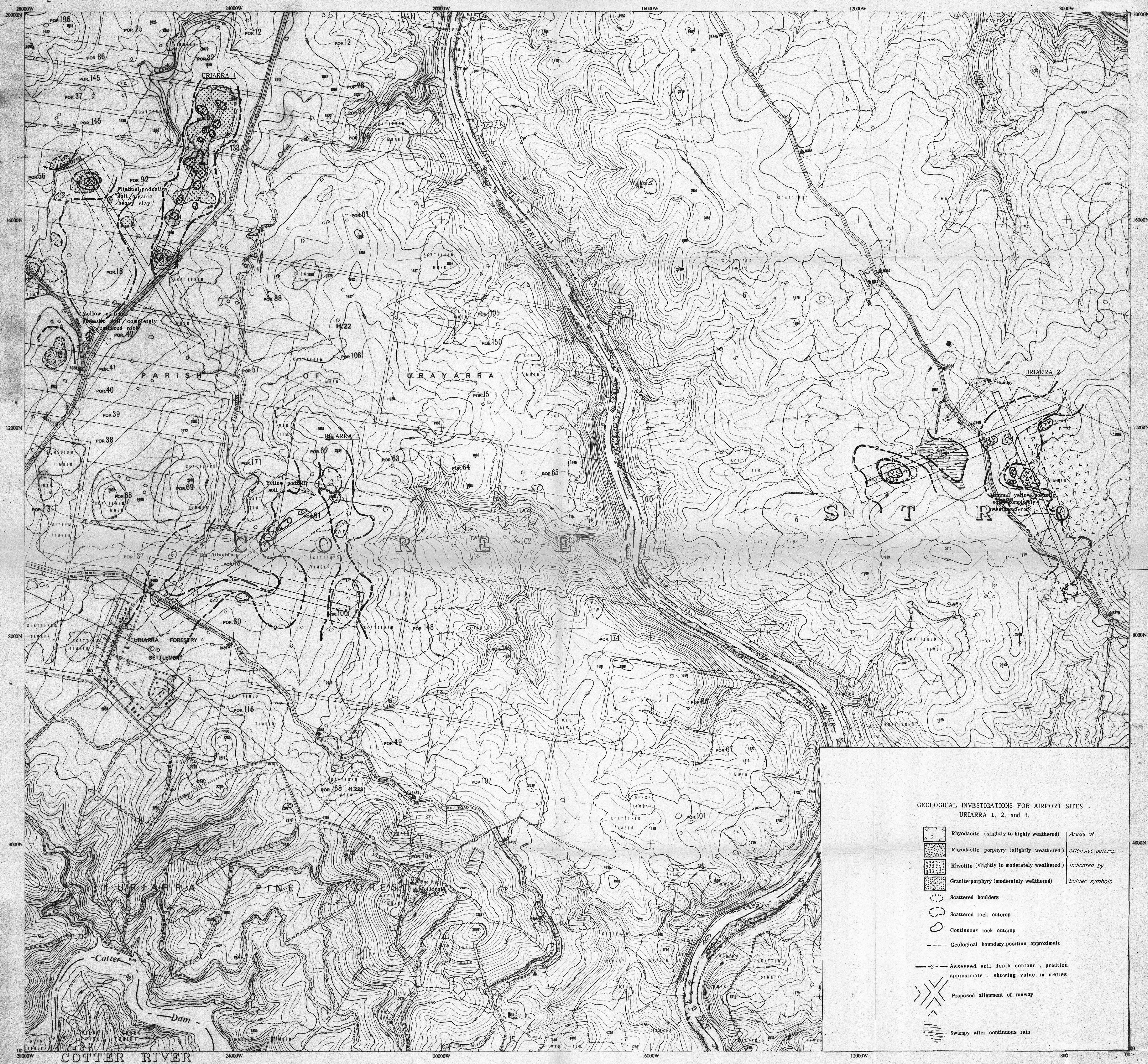
Alluvium is usually restricted adjacent to existing gullies and creeks. It is usually stratified, but may comprise an irregular mixture of gravel, sand, silt and clay.



RESTRICTED CIRCULATION

CANBERRA, ACT.
ALTERNATIVE AIRPORT SITES
INVESTIGATION

Scale 1:100,000



GEOLOGICAL INVESTIGATIONS FOR AIRPORT SITES
URIARRA 1, 2, and 3.

- | | | |
|--|--|--|
| | Rhyodacite (slightly to highly weathered) | Areas of extensive outcrop indicated by bolder symbols |
| | Rhyodacite porphyry (slightly weathered) | |
| | Rhyolite (slightly to moderately weathered) | |
| | Granite porphyry (moderately weathered) | |
| | Scattered boulders | |
| | Scattered rock outcrop | |
| | Continuous rock outcrop | |
| | Geological boundary, position approximate | |
| | Assessed soil depth contour, position approximate, showing value in metres | |
| | Proposed alignment of runway | |
| | Swampy after continuous rain | |

AUSTRALIAN CAPITAL TERRITORY

1:9600 PLANNING SERIES

A	B	A	B
C	D	C	D
E	F	E	F
G	H	G	H

RELEVANT 1:2400 SHEETS

Data plotted from aerial photography
Date of photography Dec. 1965
Co-ordinates are in feet with
origin at Strom Trig. Station

SCALE 1:9600
0 800 1600 2400 3200 4000 FEET

Compiled and Drawn by the Survey Branch, Dept. of the Interior, Canberra, A.C.T.

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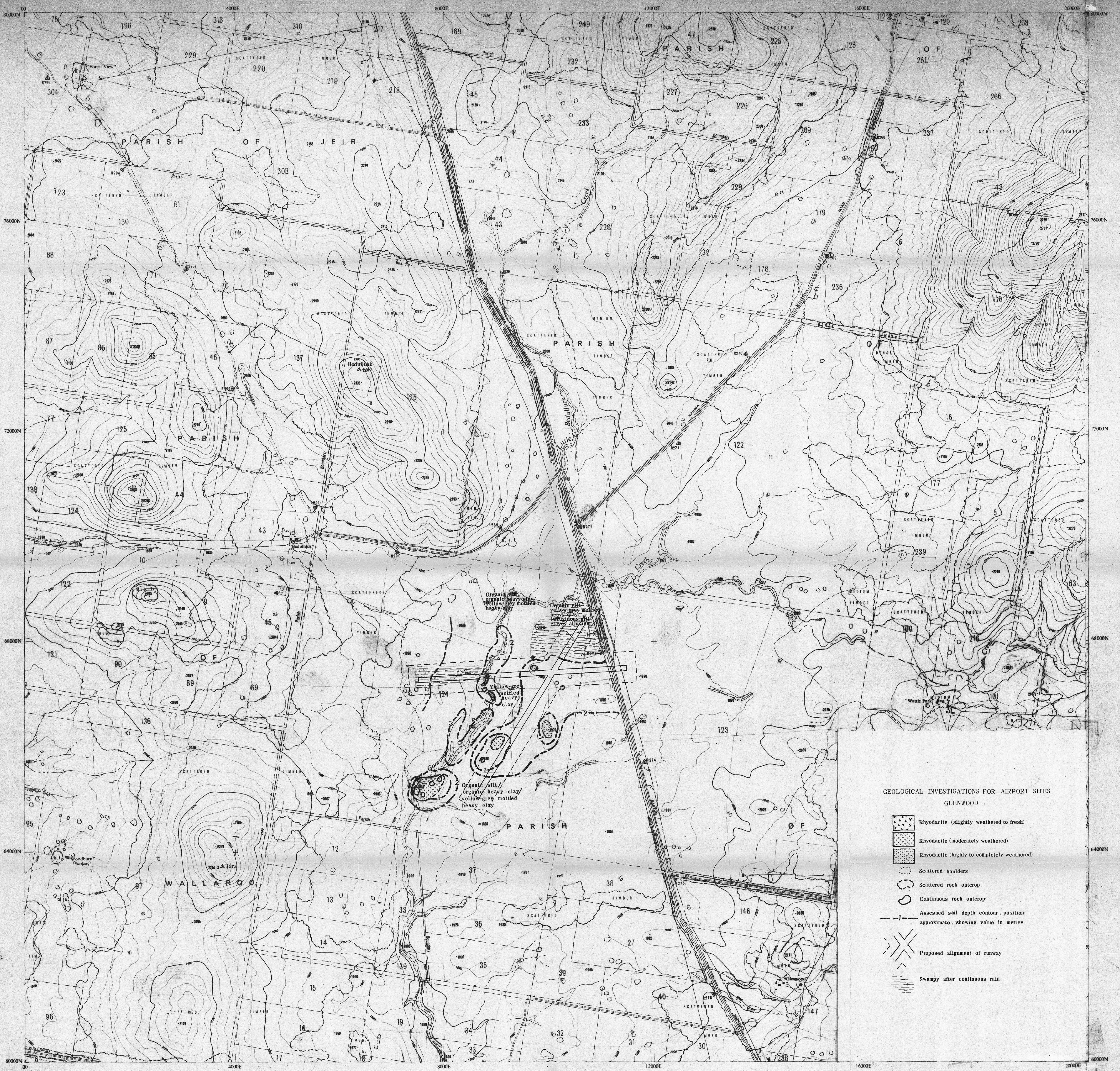
26	27	28
34	35	36
42	43	44

INDEX TO ADJOINING SHEETS

P35

FIRST EDITION

155/A16/1720

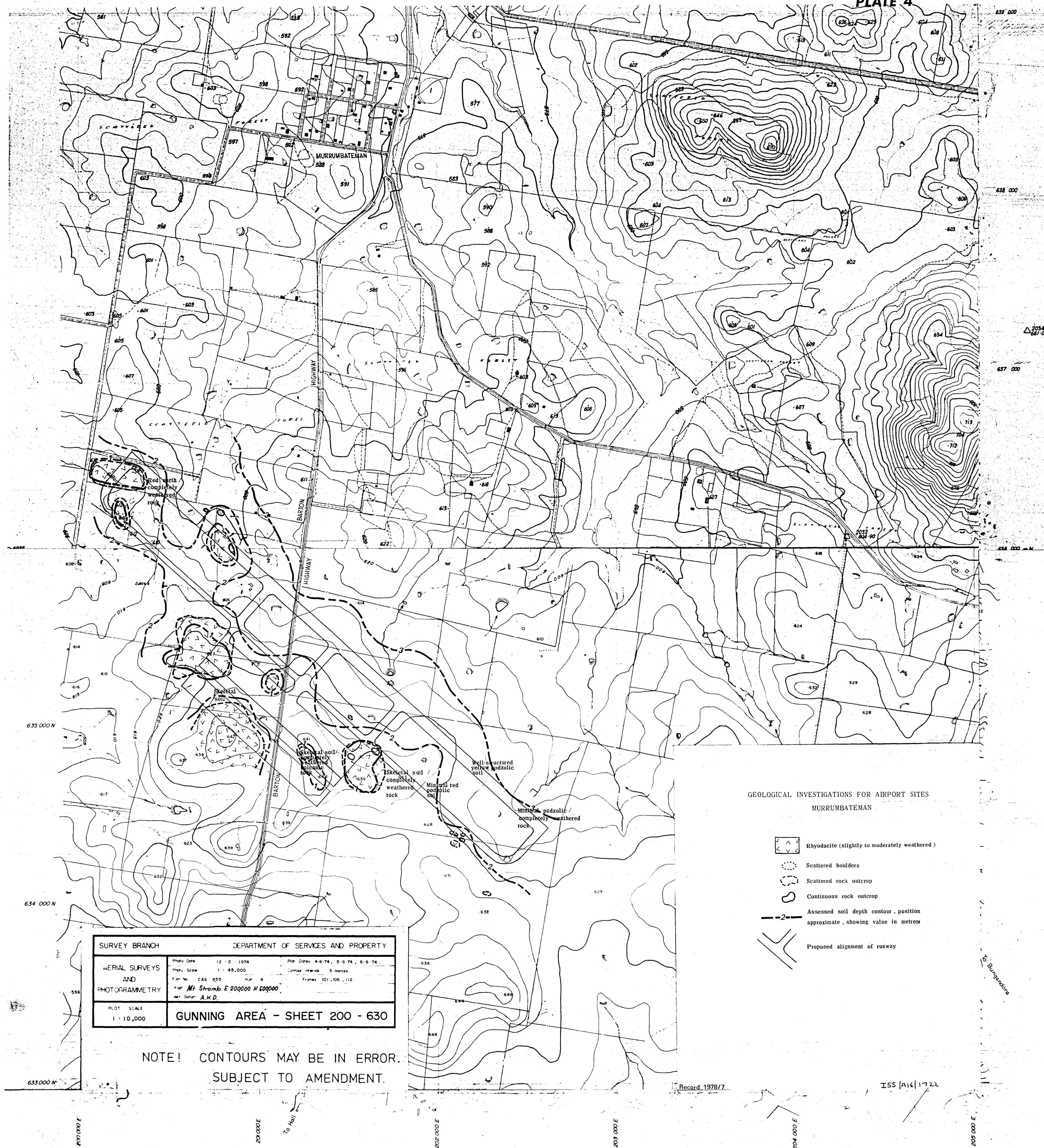


AUSTRALIAN CAPITAL TERRITORY
1:9600 PLANNING SERIES

SCALE 1:9600
Compiled and Drawn by the Survey Branch, Dept. of the Interior, Canberra, A.C.T.
Crown Copyright Reserved

LEGEND
Road, sealed
Road, not sealed
Vehicle track
Railway line
Bridge or culvert
Property boundary, fenced
Property boundary, unfenced
Fence with gate
Co-axial cable
Telephone or telegraph line
Power transmission line
Contours with contour value
Triangulation station
Spot elevation
Watercourse, intermittent
River or stream, perennial
Dam, tank
Edge of timber
Cutting
Scour
Rock outcrop
Sand, shingle
Territorial boundary
Mineral boundary
Division boundary

P12
FIRST EDITION
155/A16/1721
Printed by A. J. Arthur, Commonwealth Government Printer, Canberra, A.C.T.



GEOLOGICAL INVESTIGATIONS FOR AIRPORT SITES
MURRUMBATEMAN

- Rhyolite (slightly to moderately weathered)
- Scattered boulders
- Scattered rock outcrop
- Continuous rock outcrop
- Assessed soil depth contour, position approximate, showing value in metres
- Proposed alignment of runway

SURVEY BRANCH		DEPARTMENT OF SERVICES AND PROPERTY	
AERIAL SURVEYS AND PHOTOGRAMMETRY	Photo Date	12-2-1974	Plot Dates 4-6-74, 5-6-74, 6-6-74
	Photo Scale	1:45,000	Contour Interval 5 metres
	Film No.	CAS 855	Run 4
	or	Mt Stromlo E 200000 N 600000	
PLOT SCALE		GUNNING AREA - SHEET 200 - 630	
1:10,000			

NOTE! CONTOURS MAY BE IN ERROR.
SUBJECT TO AMENDMENT.

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ISS 1/16/1722

To Bungaree

To Hill



GEOLOGICAL INVESTIGATIONS FOR AIRPORT SITES
WONDERS FARM AND TILLYGREIG

- Gravels, silicified and ferruginised
- Sandstone with some interbeds of siltstone and shale
- Shale and claystone
- Limestone
- Ferruginised, including some ironstone
- Silicified, including some quartzite
- Quartz
- Sheared
- Scattered boulders
- Scattered rock outcrop
- Continuous rock outcrop
- Assessed soil depth contour, position approximate, showing value in metres
- Proposed alignment of runway
- Swampy after continuous rain

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ISS 1A/C 11723

SURVEY BRANCH			
AERIAL SURVEYS, AND PHOTOGRAMMETRY	Photo Date	1-1-71	Plot Date JAN 71
	Photo Scale	1:25,000	Contour Interval 5 m
	Photo Run and Numbers	21/12/10	
	Origin		
VERT. Datum			
PLOT SCALE		A.C.T. 216-624	
1:10,000			



**GEOLOGICAL INVESTIGATIONS FOR AIRPORT SITES
SPRING FLAT AND BACK CREEK**

- Rhyodacite (Slightly to highly weathered)
- Shale and mudstone (Moderately weathered)
- Sandstone with minor beds of siltstone
- Phyllite
- Fault breccia, ferruginised
- Quartz breccia
- Quartz
- Scattered boulders
- Scattered rock outcrop
- Continuous rock outcrop
- Established fault, position approximate
- Fault, inferred
- Geological boundary, inferred and concealed
- Assessed soil depth contour, position approximate, showing value in metres
- Proposed alignment of runway (See Plate B for alternative alignments suggested in this report)
- Swampy after continuous rain

LEGEND

- Road, sealed
- Road, not sealed
- Vehicle track with grid
- Railway line
- Bridge, Culvert
- Property boundary, fenced
- Property boundary, unfenced
- Fence with gate
- Contours with contour value
- Telephone or telegraph line
- Power transmission line
- Beigh mark
- Trigonometrical station
- Spot elevation
- Watercourse, intermittent
- River or stream, perennial
- Dam, Tank
- Edge of timber
- Cutting, Embankment
- Scour, Rock outcrop
- Sand, Marsh
- Territorial boundary
- Parish boundary

P13 AUSTRALIAN CAPITAL TERRITORY
1:9600 PLANNING SERIES
FIRST EDITION

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

RELEVANT 1:2400 SHEETS

Date plotted from aerial photography
Date of photography: March 1968
Co-ordinates are in feet with origin at Strom's Triangle Station

SCALE 1:9600

Compiled and Drawn by the Survey Branch, Dept. of the Interior, Canberra, A.C.T.

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155/A16/1724

Curr and only

But mar oo.

Creek

Wrights

7 Landing ground

0.5  (Deep)

Sand pit

Record 1978/7

Scale: 1:10 000

Lake high-water level for 1963
 Lake high-water level for 1874

DESCRIPTION OF SOIL TYPES

ML	Inorganic silt of low plasticity
OL	Organic silt of low plasticity
CL	Inorganic clay of low plasticity
CL-CH	Inorganic clay of medium plasticity
CH	Inorganic clay of high plasticity
OH	Organic clay of medium to high plasticity
SM	Silty fine sand
SW	Well graded fine to medium sand
GP	Poorly graded gravel-sand mixtures

Thickness (metres)	Symbol	Colour Range
0.5	ML	Pale grey
0.5	OL	Grey
1.0	OH	Dark grey
1.0	CL-CH	Mottled yellow-grey to grey
0.2	GP	Brown
1.0	SW	Pale yellow to grey

Proposed alignment of runway

parallelism =

