DEPARTMENT OF
MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1974/96

MOUNT STROMLO WATER TREATMENT PLANT, A.C.T. - BALANCE-STORAGE FOUNDATION INVESTIGATION, 1972

by

G.B. Simpson

Record 1974/96

MOUNT STROMLO WATER TREATMENT PLANT, A.C.T. - BALANCE-STORAGE FOUNDATION INVESTIGATION, 1972

by

G.B. Simpson

CONTENTS

APPENDICES

FIGURES

APPENDIX FIGURES

SUMMARY

The foundations for a proposed balance storage reservoir on Mount Stromlo, ACT, were investigated by BMR. The proposed site is underlain by purplish-grey rhyodacite and blue-grey dacite. Diamond-drilling and a seismic refraction survey indicated that most of the proposed excavation could be achieved using a D9 bulldozer or equivalent equipment, and that some light blasting may be necessary in the area of maximum cut. Anchoring of rock bolts may be difficult in highly weathered rock behind the upper part of the proposed crib wall. No major ground-water problems are foreseen, provided an adequated drainage system is incorporated in the design of the crib and retaining walls.

INTRODUCTION

In April 1972, the Commonwealth Department of Works (CDW)* requested the Bureau of Mineral Resources (BMR) to undertake the detailed foundation investigation for a proposed balance storage reservoir at the Mount Stromlo Water Treatment Plant (Fig. 1).

The proposed site has a ground slope of about 5° to 10°, and the preliminary design requires a maximum excavation of 40 feet, supported by a retaining wall and a crib wall with rock bolt anchors (Fig. 4). Some filling is proposed in the down-slope foundation area.

Six seismic refraction traverses were surveyed by the BMR Engineering Geophysics Sub-section (Taylor & Bishop, 1972). The proposed site was geologically mapped by G.B. Simpson, and four diamond-drill holes were put down by a drilling crew from the CDW Central Testing and Research Laboratories (CTRL), Melbourne.

GEOLOGY OF THE PROPOSED SITE

Rock types

Rocks of two types occur at the proposed site (Fig. 2):

(a) Purplish-grey rhyodacite+

This rock was not seen in surface outcrop but was intersected in drill-hole 3. In the drill logs it is described as dacite, but on more detailed examination it was found to be a rhyodacite. The rhyodacite is probably part of the Deakin Volcanics Formation of Upper Silurian age; it dips at moderate angles to the southwest, and conformably overlies the Yarralumla Formation about 5 km east of the proposed site (Henderson 1971).

(b) Blue-grey dacite

This rock is seen in outcrops near the proposed site and was intersected in drill-holes 1, 2, and 5. The dacite is part of an unnamed formation of probable Upper Silurian age, and probably intrudes the purplish-grey rhyodacite (Henderson, pers. comm.)

* Now incorporated in the Department of Housing and Construction

\+ For definitions and glossary of terms see Appendix 1.

Seismic refraction survey

Six seismic refraction traverses were surveyed at the site (Figs 2 and 3). Traverse D gave anomalous results at traverse intersection points: depths to the main refractor on Traverse D were between 1.5 m and 3.0 m greater than on all the intersecting traverses. No satisfactory explanation for the anomalous results has been found, but it is suggested that they may indicate 'ridges' attributable to differential weathering in the main refractor interface. (Taylor pers. comm.)

Weathering

The weathering information from the diamond-drill holes was compared with the seismic velocities to give the following approximate correlation.

Velocity		Interpretation
0 - 400 m/s	-	Soil and completely weathered rock
700 - 1400 m/s	-	Completely and highly weathered rock
2500 - 3200 m/s	-	Highly and moderately weathered rock.

Interpretative geological sections were drawn up based on seismic traverses A, B, and C (Fig. 3). Weathering observed in drill core from the area of maximum cut correlated closely with the seismic results from traverses A, B, and C and it was decided not to drill hole 4 at the centre of the tank foundations.

Excavation conditions

Dacite and rhyodacite with a seismic velocity up to 2000 m/s should be rippable using a D9 bulldozer fitted with a No. 9 Series B ripper. The seismic sections therefore indicate that most of the excavation should be achieved using a D9 bulldozer, and that some light blasting may be required in the area of maximum cut.

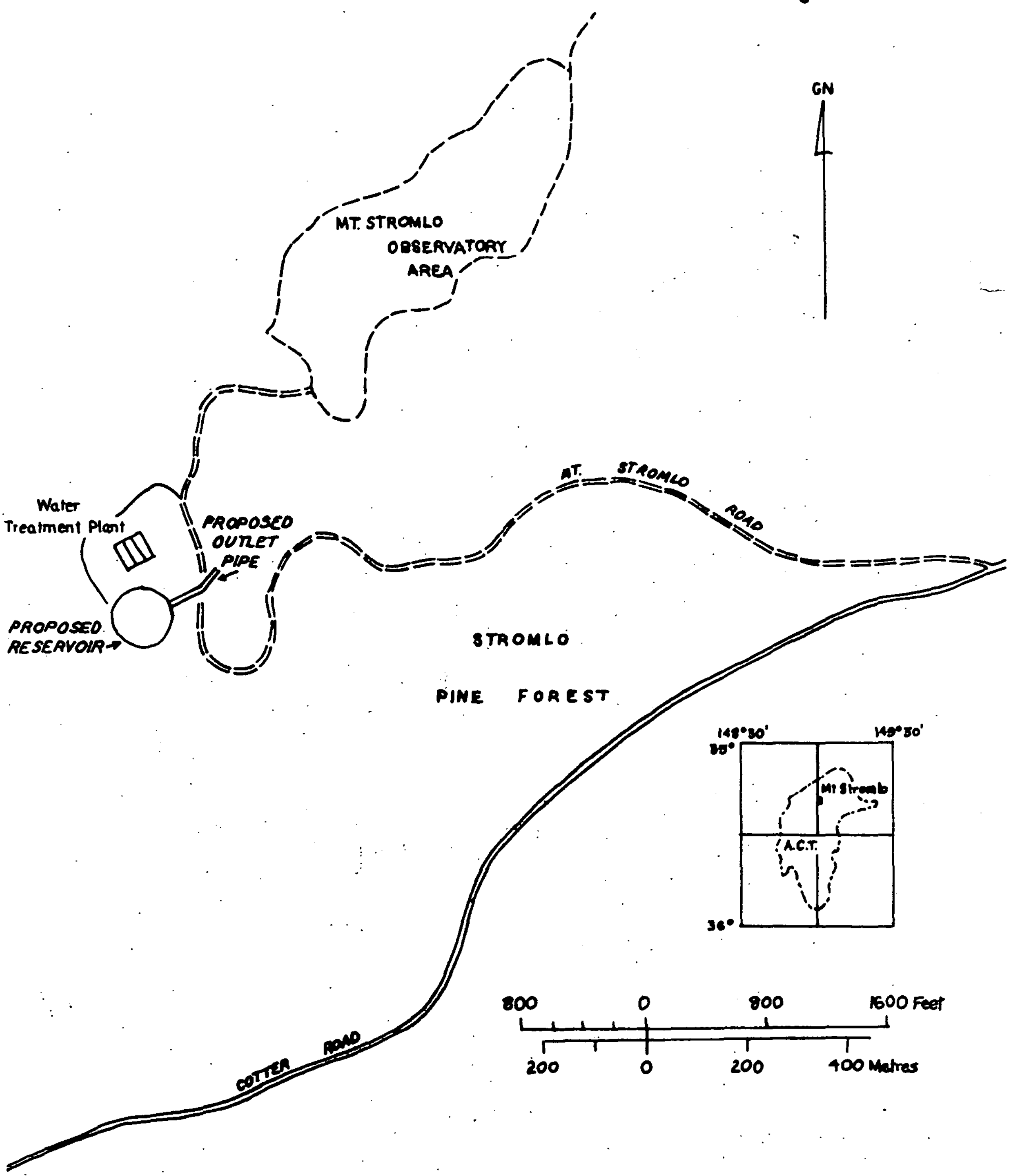
Cut stability

Drill-hole 5 penetrated the eone of maximum cut (Fig. 4). Satisfactory anchorage of rock bolts and anchor bars should be achieved in moderately weathered rock towards the base of the crib wall, but it may be difficult to achieve satisfactory anchorage in highly weathered rock towards th top of the crib wall.

Groundwater

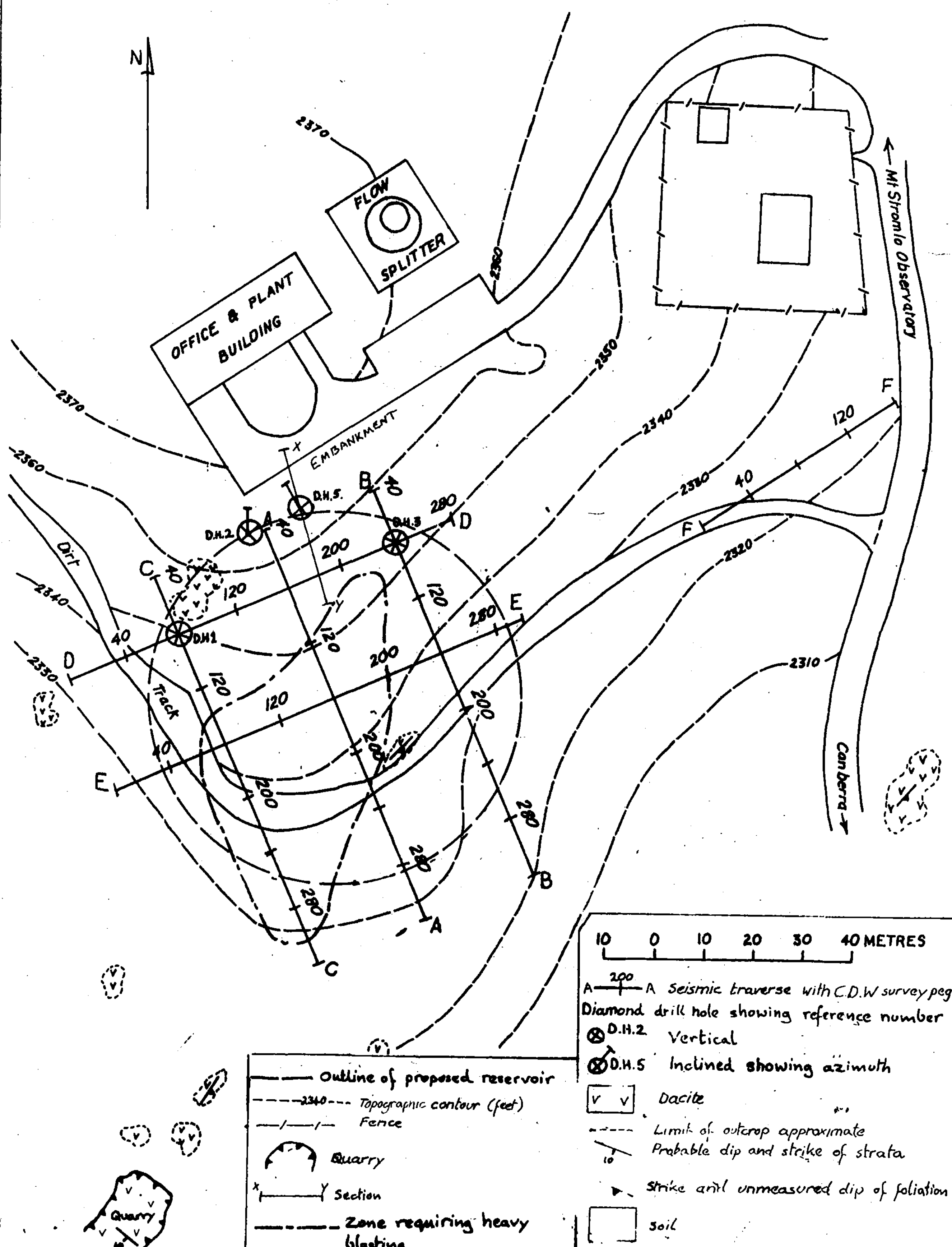
No water was intersected in the drill-holes, and it is concluded that the potentiometric surface is below the level of maximum cut.

Figure 1



SCALE 1 : 12500	COMMONWEALTH OF AUSTRALIA BUREAU OF MINERAL RESOURCES CANBERRA, A.C.T.
Base map/survey –	TITLE FIG. 1. LOCALITY SKETCH
Geology by –	
Compiled and checked: Project geologist / Checked and approved: Senior geologist	PROJECT MT STROMLO WATER TREATMENT PLANT - BALANCE STORAGE
Supervising geologist	To accompany Record 1974/96 · Drawn by GBS · Drawing No. I55/A16/933

Figure 2



AMENDMENTS			
No.	Description	Author	Checked
A1			
A2			
A3			
A4			
A5			

SCALE: As above

Base map/survey: CDW/Interior

Geology by: G.B. Simpson

Compiled and checked: Project geologist

Checked and approved: Senior geologist

Supervising geologist

COMMONWEALTH OF AUSTRALIA
BUREAU OF MINERAL RESOURCES
CANBERRA, A.CT.

TITLE: Surface geology and seismic traverses

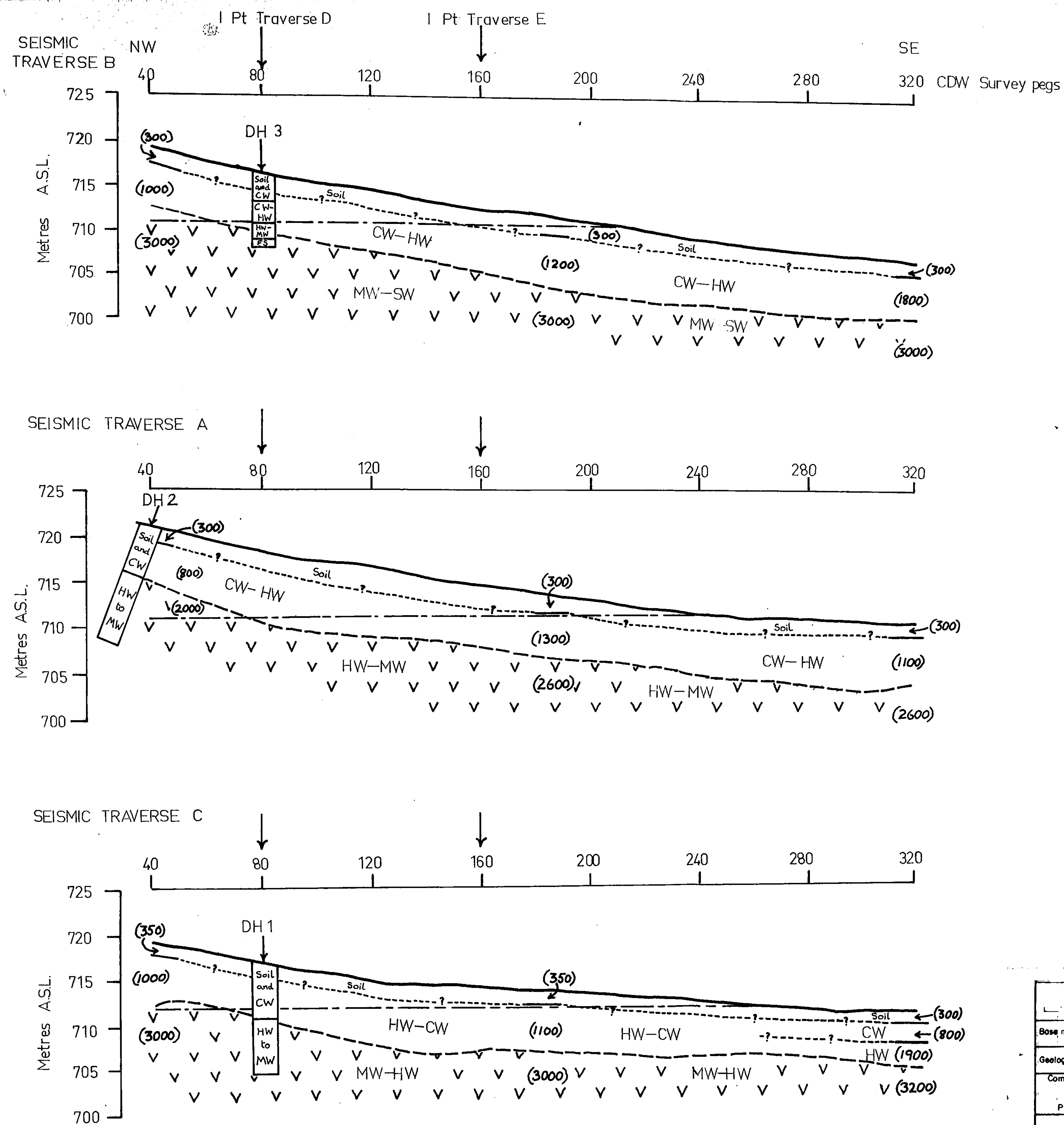
PROJECT: Mt Stromlo water treatment plant. Balance storage

Record:	Drawn by	Drawing No.
1974/96	GBS	I55/A16/934

Figure 3

Mt Stromlo Water Treatment Plant Balance Storage

INTERPRETIVE GEOLOGICAL SECTIONS along seismic traverses



Horizontal scale

10 0 10 20metres

Soil and highly to completely weathered rock

Dacite

Weathering boundary, position approximate

Weathering boundary, position inferred

Natural ground surface

Maximum excavation level

DH 1 — Diamond drillhole, showing depth of weathering (Soil and CW; HW to MW)

(1100) Seismic velocity in metres per second
CW Completely weathered
HW Highly weathered
MW Moderately weathered
SW Slightly weathered
FS Fresh stained

AMENDMENTS			
No.	Description	Author	Checked
A1			
A2			
A3			
A4			
A5			

SCALE *As above*

Base map/survey *CDW modified from BMR seismic sections*

Geology by *GBSimpson*

Compiled and checked: *GBS* Project geologist

Checked and approved: Senior geologist

Supervising geologist

COMMONWEALTH OF AUSTRALIA
BUREAU OF MINERAL RESOURCES
CANBERRA, A.C.T.

TITLE *Interpretive geological sections*

PROJECT *Mt Stromlo water treatment plant : Balance storage*

To accompany Record 1974/96 | Drawn by GBS | Drawing No. I55/A16/1135

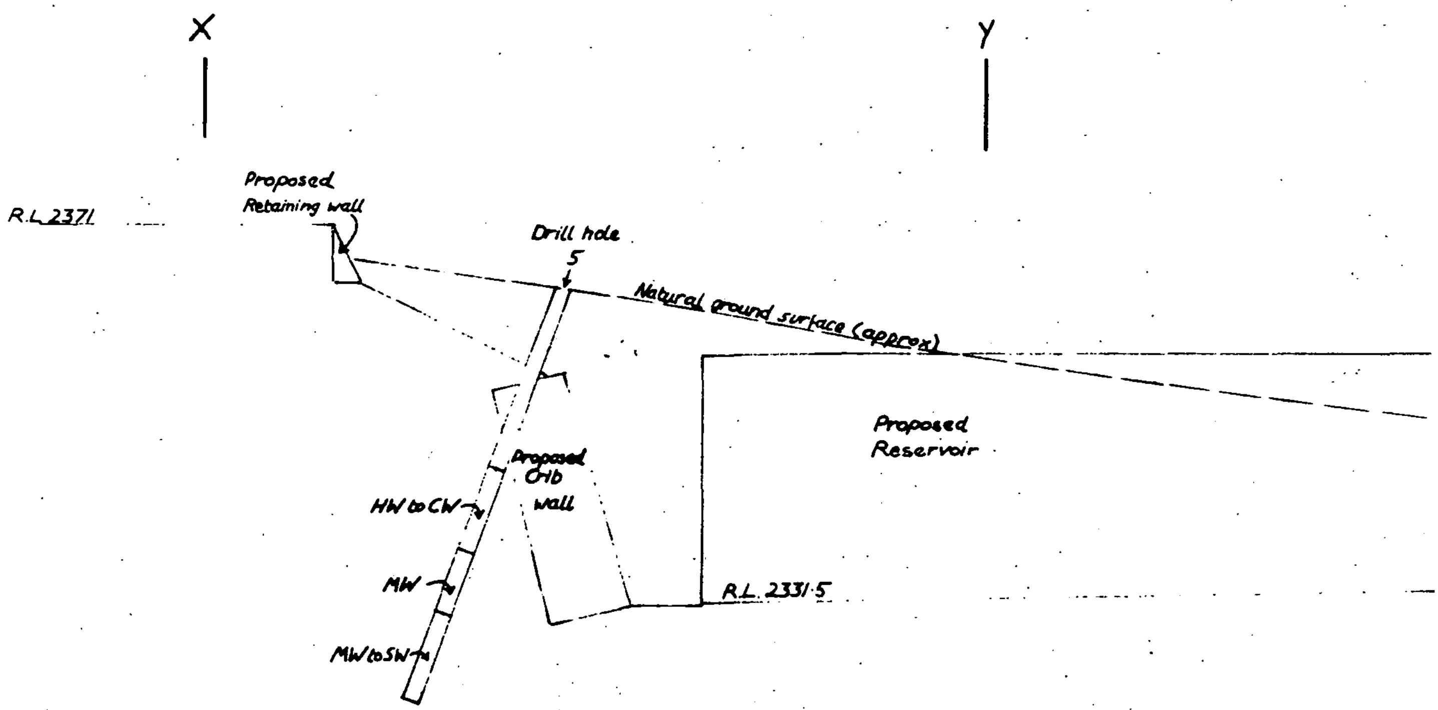


Figure 4

Mt Stromlo Water Treatment Plant : Balance Storage

Section x-y (Fig. 2) showing position of drill hole 5 and preliminary design

Scale V/H = 1, 1:240

0 10 20 Metres

0 20 40 60 80 feet

CW Completely weathered
HW Highly weathered
MW Moderately weathered
SW Slightly weathered

} Dacite *

* Note: Core losses not shown; to be read in conjunction with log of DDH. 5

AMENDMENTS			
No.	Description	Author	Checked
A1			
A2			
A3			
A4			
A5			

SCALE: As above

Base map/survey: CDW

Geology by: G.B. Simpson

Compiled and checked	Checked and approved
Project geologist	Senior geologist
Supervising geologist	

COMMONWEALTH OF AUSTRALIA
BUREAU OF MINERAL RESOURCES
CANBERRA, A.C.T.

TITLE: Section X-Y

PROJECT: Mt. Stromlo water treatment plant. Balance storage

Record:	Drawn by	Drawing No.
1974/96	GBS	I55/A16/935.

Satisfactory drainage should be included in the design of both the retaining and crib walls to prevent the build-up of groundwater seepage behind these structures.

CONCLUSIONS

1. The proposed balance storage reservoir will be founded on weathered dacite and rhyodacite.

2. Seismic refraction survey and diamond-drilling indicate that most of the proposed excavation may be achieved using a D9 bulldozer or equivalent equipment.*

3. Some light blasting may be necessary in the area of maximum cut.*

4. Anchoring of rock bolts may be difficult in highly weathered rock behind the upper part of the proposed crib wall.

5. No major groundwater problems are foreseen, provided an adequate drainage system is provided for in the design of the crib and retaining walls.

RECOMMENDATION

1. An adequate drainage system should be provided for in the design of both the crib and retaining walls.

REFERENCES

HENDERSON, G.A.M., & STRUSZ, D.L., 1970 - Canberra City, A.C.T. - 1:50 000 Geological Map and Explanatory Notes.

TAYLOR, F.J., & BISHOP, I.D., 1972 - Mount Stromlo Water Treatment Plant Storage Reservoir Site - Seismic Refraction survey. Bur. Miner. Resour. Aust. Rec. 1972/121. (unpubl.).

During construction, a zone of hard rock which required heavy blasting was exposed in the central part of the excavation. This area had not been identified in the seismic interpretation because average velocities were determined over large horizontal distances whereas velocities over a number of short distances would have been more effective.

APPENDIX 1

DEFINITIONS OF GEOLOGICAL TERMS

WEATHERING OF ROCK

FRESH	:	No discolouration or loss in strength.
FRESH STAINED	:	Limonite staining along fractures, rock otherwise fresh and shows no loss of strength.
SLIGHTLY WEATHERED	:	Rock is slightly discoloured, but not 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.
COMPLETELY WEATHERED	:	Rock is decomposed to a soil, but the original rock fabric is mostly preserved.

PERCUSSIVE STRENGTH OF ROCK

STRONG TO VERY STRONG	:	Cannot be broken by repeated blows with a hammer.
MODERATELY STRONG	:	Rock broken by 3 or 4 blows.
WEAK	:	Rock is broken by one blow.

HARDNESS OF ROCK

HARD TO VERY HARD	:	Impossible to scratch with knife blade.
MODERATELY HARD	:	Shallow scratches with knife blade.
SOFT	:	Deep scratches with knife blade.

Xenolith

A term applied to rock fragments that are foreign to the body of igneous rock in which they occur. An inclusion.

Soil

Soil is a natural aggregate of mineral grains that can be separated by such gentle mechanical means as agitation in water.

Dacite

The extrusive equivalent of quartz diorite (tonalite). The principal minerals are plagioclase (andesine and oligoclase), quartz, and pyroxene or hornblende or both with minor biotite and sanidine. All of these minerals may occur as phenocrysts in a glassy or finely crystalline groundmass of alkalic feldspar and silica minerals. Biotite, sanidine, and hornblende are more prominent in rocks transitional into quartz latite and rhyodacite. (AGI Glossary of Geology)

Rhyodacite

Extrusive porphyritic igneous rock, intermediate in composition between dacite and rhyolite, with quartz, plagioclase, and biotite or hornblende as the main phenocryst minerals and a fine-grained to glassy groundmass composed of alkali feldspar and silica minerals. Extrusive equivalent of granodiorite or quartz monzonite.

APPENDIX 2

GEOLOGICAL LOGS OF DIAMOND DRILL HOLES 1,2,3 AND 5

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT Mt. Stromlo Water Treatment Plant: Balancing Storage
LOCATION Survey station C80

ANGLE FROM HORIZONTAL -90°   DIRECTION
COORDINATES 3030 W 6330 S   R.L. 2350'(approx)

HOLE NO 1
SHEET 1 OF 1

Rock type / Degree of weathering	Description	Graphic	Depth & size of core		Defects	Water
No core recovered from surface to 20ft.	No core recovered from surface to 20 feet	core loss	NX; NMLC; 10	Zero % core recovery	No core recovered from surface to 20 feet	NOTE: No water flows encountered during drilling
DACITE mostly Highly weathered 25' to 25'6" highly weathered to completely weathered	20' to 41'; 95% to 100% core recovery DACITE, coarse grained porphyritic, low strength Hole ends at 41 feet		20; 30; 40	95% to 100% core recovery	DACITE foliated. foliation dip approximately 25° to 40° Most joints dip at about 0° to 30°, generally open and rough. Fe staining on some joint surfaces. Average joint spacing ranges from 3" to 6" but up to 17"	

DRILL TYPE Craelius
FEED Hydraulic
CORE BARREL TYPE NMLC - Triple tube - inner split tube
DRILLER CDW (CTRL)
COMMENCED May 1972
COMPLETED May 1972
LOGGED BY D.C. Purcell
VERTICAL SCALE 1 inch = 10 feet
CHECKED BY

DACITE

WATER PRESSURE TESTS: Not tested
VERTICAL SCALE -

PHOTOGRAPH REFERENCE SYSTEM
BLACK AND WHITE
COLOUR

I 55/A16/1231

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: Mt Stromlo Water Treatment Plant : Balancing Storage
LOCATION: 9 feet ... west of survey peg A40
ANGLE FROM HORIZONTAL: −70°
DIRECTION: 360° (grid)
COORDINATES: 3007 W 4250 S
RL: ≈365' (approx)

HOLE NO: 2
SHEET 1 OF 1

Rock type & weathering	Description	Graphic	Depth & size of core	Core recovery	Structure	Notes
No core recovered from surface to 14'6"	No core recovered from surface to 14'6"	core loss	NX, NMLC, 10	Zero core recovery	No core recovered from surface to 14'6"	NOTE: No water flows encountered during drilling
DACITE MW and HW	DACITE, coarse grained porphyritic	v				
No core recovered	No core recovered from 16'6" to 18'6"	core loss			No core recovered	
DACITE mainly moderately and highly weathered	DACITE, coarse grained porphyritic. In moderately weathered rock the joint surfaces are ... 14'6" to 43', 90% to 100% core recovery 33' to 34' — dark grey, finer grained xenoliths. Hole ends at 43 feet	v	20, 30, 40	90% to 100% core recovery	The dacite is foliated. Foliation dip approximately 30° to 40° Joint surfaces mainly weathered Joint spacing mainly 2" to 6"	

DRILL TYPE: Craelius
FEED: hydraulic
CORE BARREL TYPE: NMLC triple tube: inner split tube
DRILLER: CDW (IRL)
COMMENCED: May 1972
COMPLETED: May 1972
LOGGED BY: DC Purcell
VERTICAL SCALE: 1 inch = 5 feet
CHECKED BY: [signature]

NOTES

FRACTURE LOG: Number of fractures per foot of core. Zones of core loss are blocked in.
BEDDING AND JOINT PLANES: Angles are measured relative to a plane normal to the core axis.

v	DACITE

MW = moderately weathered
HW = highly weathered

WATER PRESSURE TESTS
PACKER TYPE:
SUPPLY LINE: Not tested
VERTICAL SCALE:

PHOTOGRAPH REFERENCE SYSTEM
BLACK AND WHITE:
COLOUR:

I 55/A16/1232

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT Mt Stromlo Water Treatment Plant : Balancing Storage

LOCATION Survey ... B80

ANGLE FROM HORIZONTAL -90°

DIRECTION —

COORDINATES 2890 N 4...S

RL 2353' (approx)

HOLE NO 3

SHEET 1 OF 1

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION	GRAPHIC LOG	DEPTH & SIZE OF CORE	DEFECTS / JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER PRESSURE TESTS
No core recovered	No core recovered from surface to 10'6"	core loss	NX / NMLC	No core recovered	NOTE: No water flows encountered during drilling
DACITE CW and HW	Purplish-grey DACITE, weak and soft. Dominant mica, quartz and weathered feldspar	v v v	10	11'6" - 0.5 cm clay vein	
No core recovered	No core recovered	core loss		No core recovered	
DACITE CW and HW	DACITE weak and soft	v v			
No core recovered	No core recovered	core loss		No core recovered	
DACITE HW and MW	Moderately strong except near fractures where rock is weak	v v	20	20'6" - clay infilling of open 45° and 70° fractures	
DACITE Fresh-stained	Purplish-grey. Very hard and strong. Quartz and feldspar phenocrysts in fine matrix	v v v v		25'6" - clay coated 45° fracture. Fe staining on parting planes	
	Hole ends at 28 feet		30		

DRILL TYPE Craelius

FEED Hydraulic

CORE BARREL TYPE NMLC - triple tube - inner split tube

DRILLER CDW (CTRL)

COMMENCED May 1972

COMPLETED May 1972

LOGGED BY G B Simpson

VERTICAL SCALE 1 inch = 10 feet

CHECKED BY

NOTES

FRACTURE LOG Number of fractures per foot of core. Zones of core loss are blocked in.

BEDDING AND JOINT PLANES Angles are measured relative to a plane normal to the core axis

v v DACITE

Fe = iron

CW = completely weathered

HW = highly weathered

MW = moderately weathered

WATER PRESSURE TESTS

PACKER TYPE –

SUPPLY LINE Not tested

VERTICAL SCALE –

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE

COLOUR

I55/A16/1233

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT Mt Stromlo Water Treatment Plant : Balancing Storage

LOCATION 25 feet from control point A40, bearing 050° N (grid)

ANGLE FROM HORIZONTAL −70° DIRECTION 330° N (grid)

COORDINATES 2960 W 4240 S RL 2364 ft (approx)

HOLE NO 5

SHEET 1 OF 1

Rock type / weathering	Description	Graphic	Depth (feet)	Defects / remarks
No core recovered	No core recovered from surface to 20 feet	core loss	NX; NMLC; 10	No core recovered
DACITE HW and CW	HW DACITE is soft and weak. CW DACITE has no percussive strength	v v v	20	
No core recovered	No core recovered	core loss		No core recovered
DACITE HW and CW		v v		
No core recovered	No core recovered	core loss		No core recovered
DACITE HW and CW		v v		
No core recovered	No core recovered	c. loss	30	No core recovered
DACITE, MW	DACITE moderately strong becoming weak near joint partings	v v v v		30° and 70° fractures prevailing. Some joint partings clay coated with Fe staining. DACITE foliated. Foliation dip approximately 30° to 40°
DACITE MW and SW	Grey DACITE with some Fe staining. Quartz and feldspar phenocrysts. Moderately strong Hole ends at 46 feet	v v v v v v	40	
			50	

NOTE: No water flows encountered during drilling

Craelius Hydraulic

NMLC - triple tube - inner split tube

CDW (CTRL)

Commenced May 1972

Completed May 1972

Logged by G.B. Simpson

Vertical scale 1 inch = 10 feet

Checked by

v v	DACITE

Fe = iron

CW = completely weathered

HW = highly weathered

MW = moderately weathered

SW = slightly weathered

Not tested

I55/A16/1234

APPENDIX 3

NOTES ON OBSERVATIONS MADE DURING CONSTRUCTION

Heavy blasting was required to excavate slightly weathered and fresh rock from the central area indicated in Figure 2. The blasting was required from near the natural ground surface to the floor of the completed excavation.

The zone of hard rock was not defined satisfactorily in the seismic interpretation, although in the area of maximum cut the correlation between seismic results, diamond drilling, and observations made during construction was good.

The time/distance curves were re-examined in the light of observations during construction. It became clear that the original seismic interpretation had not been carried out in sufficient detail and that average velocities over large horizontal distances had been determined whereas velocities calculated over short distances would have been more significant. The decision not to drill DH4 centrally on the site compounded the problem.

The significance of the discontinuities shown on seismic sections D and E (Appendix 4) were thought to be caused by a road, when in fact they were boundaries between completely weathered material and slightly weathered rock.

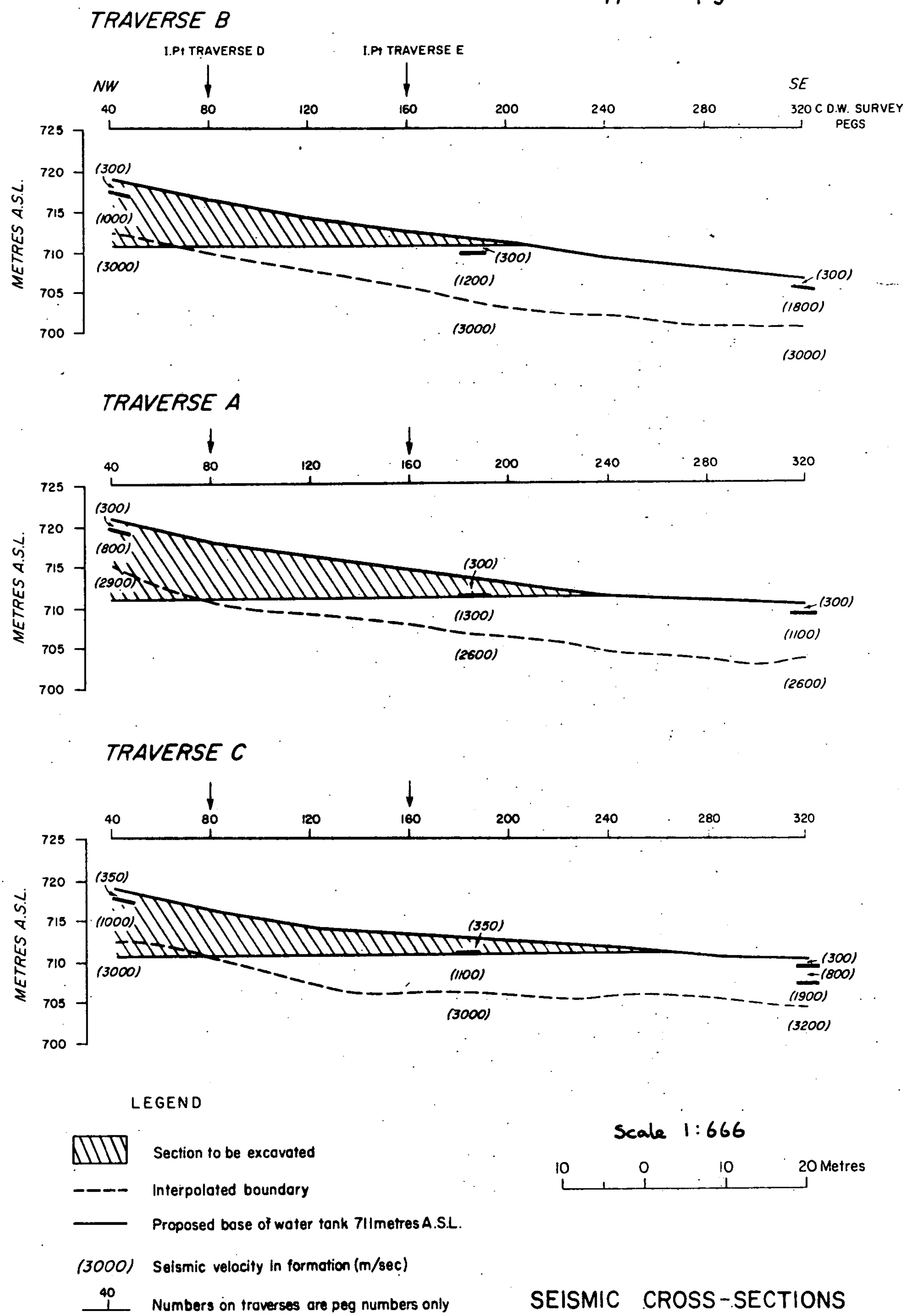
The following suggestions were made by F.J. Taylor (pers. comm.) for application to future seismic refraction surveys on shallow foundations.

1. When rock is close to the surface the determination of intermediate velocities is extremely critical.
2. Do not use first point to determine this velocity.
3. Do not try to draw a velocity through one or two points.
4. Use 2-metre spacing of geophones.
5. More shots are necessary if the plots between the centre and one end differ.
6. The velocity in the rock should be determined by the geophones from the first (say) 20 metres and should not be influenced by points later than this.
7. The geophones within 20 metres of the shot must all have good breaks. If any cross-feed, 50 Hz or other background noise is recorded on these traces the spread must be re-shot.

APPENDIX 4

SEISMIC CROSS-SECTIONS A, B, C, D, E AND F

Appendix figure 1



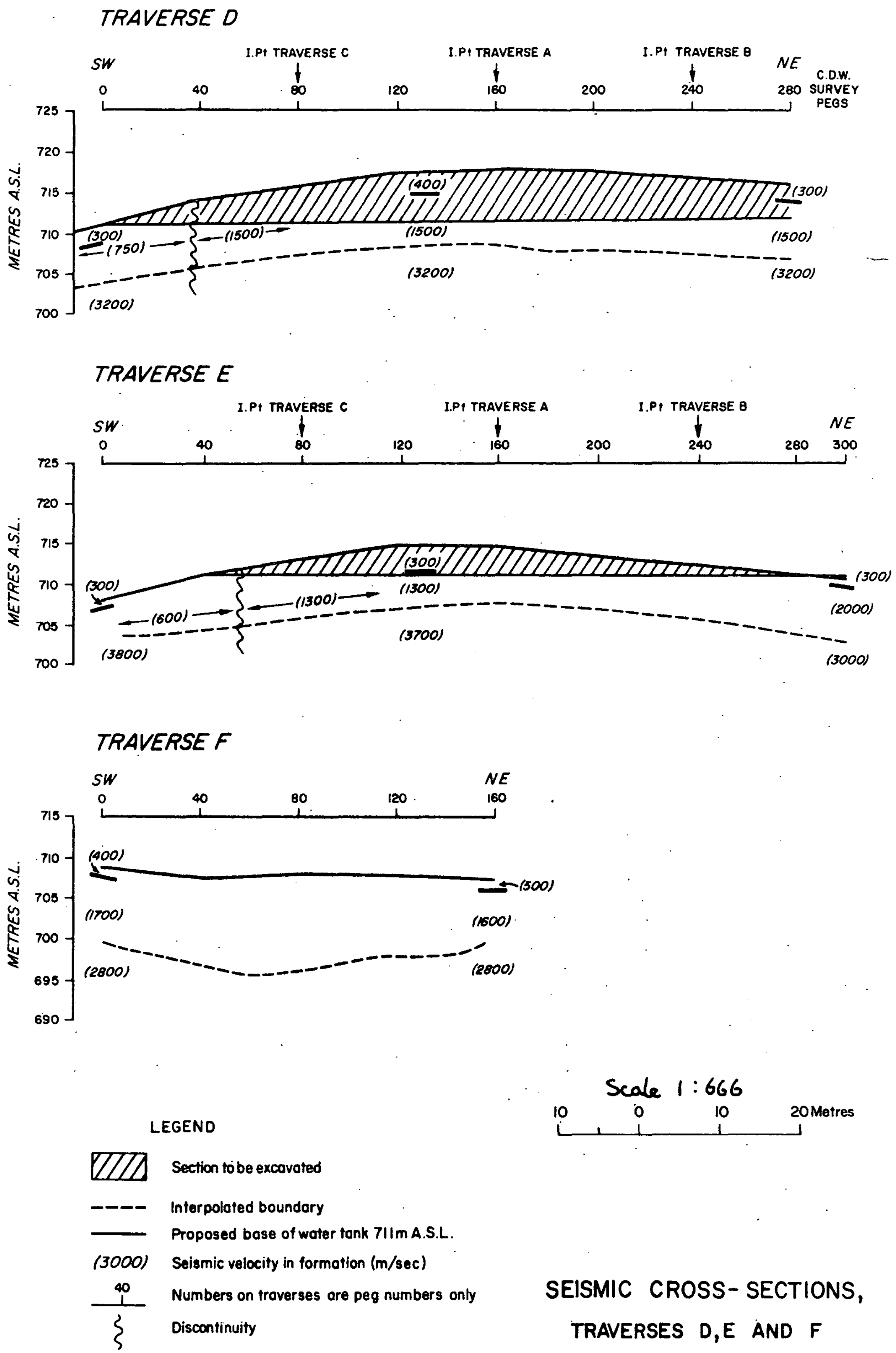
SEISMIC CROSS-SECTIONS

TRAVERSES A, B AND C

To accompany Record No 1974/96

ISS/A16/1136

Appendix figure 2



SEISMIC CROSS-SECTIONS, TRAVERSES D,E AND F

To accompany Record No 1974/96

I55/A16/1137