DEPARTMENT OF NATIONAL RESOURCES

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

1977/57

STROMLO-HIGGINS BULK SUPPLY MAIN, ACT - GEOLOGICAL INVESTIGATIONS 1975, AND REVIEW SINCE CONSTRUCTION 1977

by

R.C.M. Goldsmith

and

E.G. Wilson

1977/57

STROMLO-HIGGINS BULK SUPPLY MAIN, ACT - GEOLOGICAL INVESTIGATIONS 1975, AND REVIEW SINCE CONSTRUCTION 1977

by

R.C.M. Goldsmith

and

E.G. Wilson

CONTENTS

SUMMARY

A geological investigation was carried out along the proposed buried pipeline route from Mount Stromlo to Higgins, ACT in 1975. Seismic refraction traverses and geological mapping provided information on expected excavation conditions, the thickness of soils, and the need for blasting.

The geological report, included in the Information for Tenderers document, omitted geological conclusions on soil thickness and blasting estimates, and the value of the document to the contractor in estimating the amount of blasting was considerably reduced. When construction commenced in July 1976, the entire pipeline route was line-blasted before mechanical excavation, regardless of the geological conditions. Much of the blasting was unnecessary.

Excavation of the trenches was completed by November 1977, but it was not possible to fully evaluate the geological report and its influence on construction because the early construction documents were lost and some of the necessary information was not kept by the contractor; another contributory factor was the fact that continuous line-blasting made accurate logging of the trench excavations difficult.

1. INTRODUCTION

The Stromlo-Higgins Bulk Supply Main project involved the construction of a 10-km buried pipeline (1280 mm diameter) between Mount Stromlo in the south and Higgins in the north (Plate 1). A section of the pipeline was to pass through 300 m of tunnel in the western flank of Mount Stromlo. At the request of the then Department of Housing and Construction (DHC), the Bureau of Mineral Resources carried out geological investigations for the project. In 1974 the feasibility of the tunnel was assessed (Goldsmith & Purcell, 1975) and an assessment of the geology of the pipeline route was carried out in 1975. Diamond drilling along the tunnel-line (Purcell, 1977) and a seismic refraction survey of the pipeline route were also carried out in 1975 (Koelle, 1975).

Construction of the buried pipeline began in July 1976 and was completed in late 1977. Excavation of the trenches was completed by November 1977. The contractor was Abel Drainers, who subcontracted for the construction of the tunnel (Purcell, 1977).

2. SUMMARY OF PIPELINE INVESTIGATION AND GEOLOGICAL REPORTING

The initial request by DHC, in May 1975, was for a geological survey along the route of the proposed pipeline with a view to locating seismic traverses to be carried out by the Central Testing and Research Laboratories (CTRL) of DHC. A preliminary report was forwarded to the design engineers at DHC in July 1975, and geological advice was provided for the selection of locations for seismic refraction traverses.

CTRL carried out the seismic survey in August 1975 and shot 13 traverses totalling 906 m (Koelle, 1975). The survey equipment was a Bison Signal Enhancement Seismograph, Model 1570B. Results of the seismic survey were evaluated and the geological report was amended accordingly. Details of the seismic survey are given in Appendix 1.

The geological report for inclusion in the Information for Tenderers document was further amended in accordance with the DHC requirement that all references to soil thicknesses and estimates of blasting be omitted. The main amendments were the omission of column 5 from Table 2, and the removal of soil isopachs from Plates 2-9.

3. GENERAL GEOLOGY

The geology along the route is shown in Plate 1. Blue-grey dacite crops out on Mount Stromlo and along the southern section of the route. To the north, and stratigraphically lower in the sequence, are rhyodacite, tuffaceous sandstone, ashstone, chert, and agglomerate. This unit is truncated to the north by the Winslade Fault which crosses the route at Uriarra Road. The fault zone is represented by parallel quartz veins striking 045° and is 250 m wide. North of the fault and along the remainder of the pipeline the rock is a purple and green dacite.

4. DETAILED GEOLOGY AND EXCAVATION CONDITIONS

Soil

The term 'soil' refers to slopewash, alluvium, residual soil, and extremely weathered rock that can be excavated by mechanical means along the pipeline route. The distribution of soil cover and estimates of thickness are shown in Plates 2-9.

Table 1 summarizes the surface conditions along the route.

TABLE 1. DISTRIBUTION OF OUTCROP AND SOIL

Outcrop and Soil	Percentage of route (approx.)
Continuous sections of outcrop	5
Scattered small outcrops and rubble	15
Soil and slopewash cover	80
*	
0-1 m	22
1-2 m	23
2-4 m	18
4 m	17

* Section of Table 1 below broken line was omitted from "Information for Tenders"

Rock units

Rock outcrops, continuous and scattered, have been plotted in Plates 2 to 9. Table 2 summarizes the outcrop and excavation conditions of each rock type, as assessed before construction.

Blue-grey dacite (chainage 00-2175). This rock is hard and strong where slightly weathered and fresh. From station 00 to 1200 rock outcrop is sparse (less than 20%) and much of this section can probably be mechanically excavated to a depth of 2-3 m (seismic traverse 1 - see Appendix 1). Dacite outcrops and rubble occupy hilltops and slopes between Stations 1200 m and 2175 m, covering about 80% of this section of the route. Seismic traverse 2 shows 2-3 m of soil cover in areas between outcrops. The rock is generally closely to moderately jointed, and joints near the surface tend to be open and partly weathered. Joint sets trend 90/150, 85N/080, 90/060, 80S/040 and 80E/015. Blasting was considered to be a requirement for moderately and less weathered rock.

Green rhyodacite (chainage 2175-3400 m). This rock is moderately hard and strong but is closely jointed with partings in many directions reducing the strength of the rock mass. Outcrop is rounded and mostly scattered. Dominant joints strike 010° and dip vertically to 80° west, and are closely spaced. Veins and sheared zones strike between 060° and 090°, dipping vertically. The rock has a tuffaceous texture; biotite, orthoclase, and quartz are the dominant phenocrysts, the first two being easily weathered and tending to make the rock crumbly. Pre-blasting, then ripping will be required over areas of outcrop, but mechanical excavation should be possible over about 30% of the section. Seismic traverses 3 and 4, located on rubble and soil cover, show an average depth of 2 m to unrippable rock. Traverse 5, located in a soil-covered area, shows 1 to 1.7 m of soil cover.

Sandstone (scattered, chainage 2475-3220 m). This moderately hard tuffaceous welded sandstone is interbedded with the rhyodacite. Outcrop is rounded and moderately weathered. Dominant joints strike 005° and dip 70° to 80° west, and bedding generally dips gently southwest, but neither are spaced close enough to affect the excavation conditions. Half of seismic traverse 4 is located on this unit and shows a depth of 2 to 2.5 m to unrippable rock. Traverse 5 may be located on soil-covered sandstone with unrippable rock at depths ranging from 1 to 1.7 m. Pre-blasting was considered a requirement for about 25% of this section.

Table 2

Summary of rock condition along the proposed route as assessed before construction

Rock type	Length of section (m)	Percentage of route	Percentage outcrop (continuous, scattered and rubble)	Length (m)*** and percentage of section where blasting** will be required to excavate to invert	
Blue-grey dacite	2550	26	47	1660	(62)
Green rhyodacite	410	4	59	290	(70)
Sandstone	290	3	19	70	(25)
Ashstone, chert, agglomerate	120	1	30	40	(35)
Quartz (Winslade Fault)	400	4	36	180	(45)
Purple and green dacite	6030	62	16	1500	(25)
Total	9800	100	20*	3680	(37)

** Including pre-blasting

* Continuous outcrop, scattered outcrop and rubble expressed as a percentage of the whole route (from Table 1).

*** This column was omitted from Information for tenderers document.

Ashstone, chert and agglomerate (chainage 2450-3220 m in small amounts). Interbedded with the sandstone and rhyodacite is a sequence of dark grey chert and ashstone and an agglomerate consisting of coarse blocks set in a purple rhyodacitic tuff. Bedding generally dips NNW at 10° to 15°, and dominant joints trend 80N/120 and 80N/160. The chert and ashstone are thinly bedded and where weathered are finely parted; they should be easily excavated without much pre-blasting. The agglomerate is harder and more resistant and would require pre-blasting if intersected; although it has only been mapped adjacent to the route, some agglomerate is to be expected in the excavation for the pipeline.

Quartz (Winslade Fault Zone) (chainage 3400-3775 m). Milky quartz is found in scattered outcrops and rubble over 400 m of the pipeline route and represents the Winslade Fault Zone. No extensive sheared zones are apparent, but joints generally trend 75S/115 and 75N/045 and are closely spaced and discontinuous. Joint surfaces are parted and stained with iron oxides. Seismic traverse 6, located between rubbly outcrop, indicated depths of 1.2 to 1.6 m to unrippable rock. Most of the fault zone was expected to require blasting below about 1.5 m.

Purple and green dacite (chainage 3775-9800 m). About 62% of the route is underlain by purple and green dacite. The area is characterized by sparse outcrop and relatively large thicknesses of slopewash and alluvium on the gentler slopes away from the Molonglo River gorge. Slightly weathered to fresh dacite is exposed in the incised creek gullies and Molonglo River gorge.

The gently sloping ground south of the river (chainage 3775-6200 m) generally consists of 2 to 3 m of soil, slopewash, and alluvium, with moderately to highly weathered dacite cropping out in gullies and hilltops. Traverse 8 shows that up to 12 m of rippable material overlies unrippable rock; this shallows rapidly as outcrop areas are approached (Traverses 7 and 9). Excavation by mechanical means was generally expected to be satisfactory, but occasional short sections would require blasting.

The section across the Molonglo River is relatively steep and about 60% continuous outcrop is found on the southern bank and in the river bed; in comparison, bedrock on the northern bank is generally covered by slopewash and river sand. Blasting was expected over most of the section between 6200 and 6500 m as the rock is generally moderately hard and strong below about 1 to 1.5 m (Seismic Traverses 10A, B, C, & D). The river crossing lies on slightly weathered rock.

From the river to Higgins Reservoir there is very little outcrop (6500-9800m) except on the hilltops. The middle section (7500-9000 m) consists of a broad open valley with soil generally more than 4 m thick (Seismic Traverse 12 shows 6-7 m of rippable rock); excavation by mechanical means to invert will be possible. Two sections will require blasting:

(1) stn 7000 to 7250. Seismic Traverse 11 is located between 7000 and 7075 and shows an average depth of 2 m to unrippable rock.

(2) stn 9000 to 9500. Seismic Traverse 13, located between 9400 and 9450, shows 3 to 4 m of rippable rock. This traverse may not be representative of this section and it was expected that unrippable rock would generally be found at about 2 m.

5. OBSERVATIONS DURING CONSTRUCTION

Molonglo River crossing

The crossing of the Molonglo River (Plate 1) was achieved by constructing an underwater pipeline encased in concrete over a distance of 42.5 m (from shore to shore). The foundation rock is of good quality in this area and no problems were encountered.

Blasting

The complete pipeline route was line-blasted before excavation regardless of whether the excavation was in hard rock or deep soil. Holes 1 m apart were charged with 1 plug of AN60 and 1-2.5 kg of ANFO per hole. The contractor found that this charge was too great at 8900-9000 m where the ground broke up excessively. At 9000-9200 m the charge was reduced to about 250 g of ANFO and one stick of AN60, and this proved satisfactory.

The portion of the route that would require blasting had been estimated at 37 percent in the original geological report to DHC, and there is little doubt that about 60 percent of the line blasting was unnecessary.

Numerous zones of slightly weathered to fresh rock in the section south from Uriarra Road to Stromlo (0-3400 m) required jackpicking and secondary blasting before invert was reached in the trench. These sections had been predicted in the investigation report.

6. EVALUATION OF GEOLOGICAL CONTRIBUTION

As construction was completed in 1977, it seemed appropriate to ascertain the use made of the geological report, and to evaluate its relevance in the project, in particular the accuracy of the geologists' estimates of overburden, rock condition, and blasting requirements.

A report on the geological investigation was made available to the contractor in the Information for Tenderers document. The contractor could have used information in the report to calculate the amount of blasting required, particularly if he had referred to the seismic sections that were also part of the Information for Tenders document. Amendment of the original geological report by deletion of the soil isopachs from Plates 2-9 and deletion of the geologists' estimates of the blasting requirements would certainly have made a realistic assessment of blasting requirements much more difficult for the contractor; however, failure to use the information that

was available incurred needless expense in line-blasting 60 percent of the route unnecessarily, and where the ground was overblasted it also delayed progress.

Geological input during construction was limited. Site visits were made to consult with DHC supervisors, and to check the geology exposed in the trenches. Advice was neither sought nor given on engineering geological matters during construction of the pipeline, and the geological estimate of subsurface conditions is thought to have been reasonably accurate. Geological advice was given during construction of the tunnel (Purcell, 1977).

During the site visits the DHC site supervisor's daily reports were examined. The early records from July to December 1976 were lost when the site office was burnt down, and detailed records of construction and the supervisor's site reports were destroyed. No other copies were available.

Some information of value was gained from the later construction records. Note was taken of those sections where re-blasting was required, and where light blasting techniques were used to avoid unnecessary rupture of the ground; however, details of the amounts of explosive used for any particular section of the trench were not recorded. A full assessment of the adequacy of the geological report could not be made as insufficient information was available.

The deletion from reports of geological conclusions relevant to a project, which have been arrived at by sound geological observation and reasoning, has been engineering parctice in Australia for a long time. It should be pointed out that this practice often results in higher construction costs and is wasteful of resources. Whilst legal reasons are usually given for the continuance of this practice, it is contrary to advanced practice in major construction in many parts of the world today where construction authorities make all factual information and all professional assessments of that data available to the contractor (Antill, 1976).

7. CONCLUSIONS

1. The geological assessment of subsurface conditions and blasting requirements is believed to have been reasonably accurate, but the method of construction made evaluation impossible.

2. A full assessment of the adequacy of the geological report could not be made as insufficient detail was available from the construction records.

3. The deletion of soil isopachs and estimates of blasting requirements from the geological report that was provided for the Information for Tenderers document may have led to the adoption by the contractor of line-blasting that was not necessary over much of the route.

8. RECOMMENDATIONS

It is recommended that consideration be given for the inclusion of geological assessments as well as factual data in geological reports for Information for Tenderers documents.

REFERENCES

ANTILL, J.M. (1976) - Contractural aspects of latent conditions in tunnelling. Papers presented at the 2nd Australian Conference on Tunnelling 'Design and construction of tunnels and shafts' August, 1976. Aust. Tunnelling Assoc.

GOLDSMITH, R.C.M., & PURCELL, D.C. (1975) - Proposed bulk-supply-main tunnel, Mount Stromlo ACT, preliminary geological investigations, 1975. Bur. Miner. Resour. Aust. Rec. 1975/62 (unpubl).

KOELLE, A. (1975) - Stromlo-Higgins bulk supply main, seismic survey. Central Testing Res. Lab. Rep. 153.

PURCELL, D.C. (1977) - Stromlo-Higgins bulk supply main, Stromlo tunnel section: engineering geology completion report. Bur. Miner. Resour. Aust. Eng. Geol. tech. Note, July 1977.

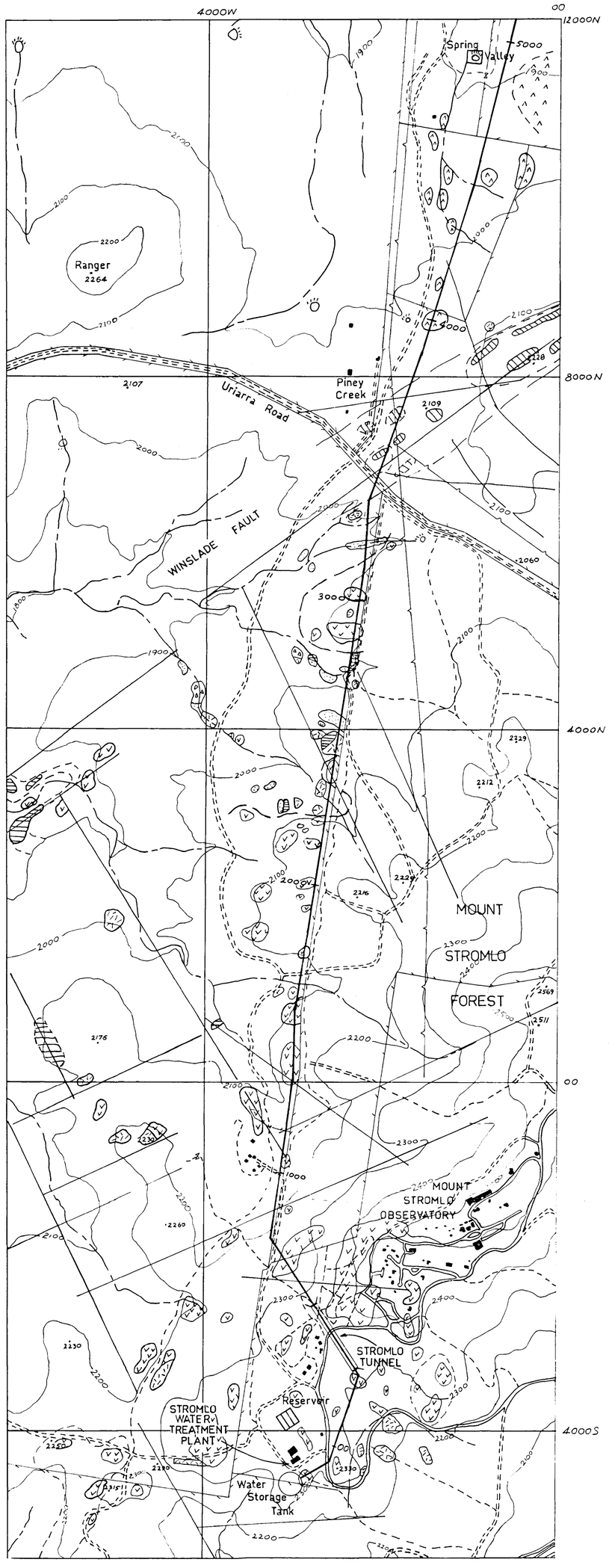
APPENDIX 1 - SUMMARY OF SEISMIC REFRACTION SURVEY

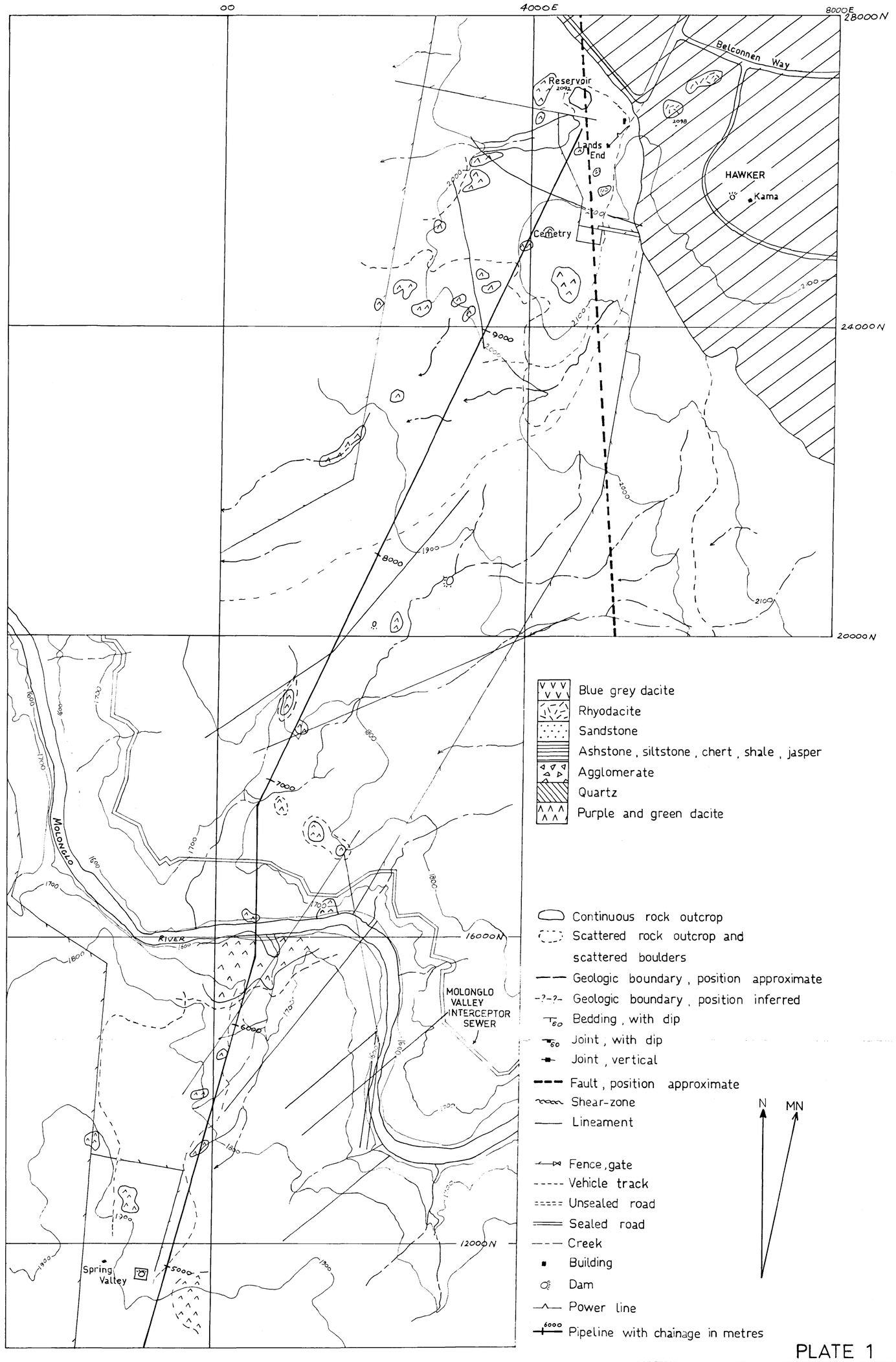
(from Koelle, 1975)

Traverse No.	Station (m)	Traverse length (m)	Velocities and depth	Depth to rippable rock (m)
1	1200-1250	50	370 m/s, 0-2 m 2300-3200 m/s, 2-6 m	2-3
2	1700-1750	50	380-900 m/s, 0-3 m 1500-1700 m/s, 2-12 m	2-4
3	2200-2250	50	380 m/s, 0-1 m 1100-1300 m/s, 1-6 m	2-3
4	2550-2600	50	360-380 m/s, 0-2 m 1200 m/s, 2-7 m	2-3
5	3000-3050	50	350-370 m/s, 0-2 m 1100-1600 m/s, 2-5 m	1-2
6	3500-3550	50	360-380 m/s, 0-1 m 1600-1700 m/s, 1-10 m	1-2
7	3975-4025	50	320-370 m/s, 0-2 m 1700-2000 m/s, 1-9 m	0-2
8	5100-5150	50	350-370 m/s, 0-2 m 900-1100 m/s, 2-12 m	10-12
9	5925-5975	50	360-380 m/s, 0-1 m 1200-1600 m/s, 1-8 m	1-2
10 a+b	6220-6300	80	330-440 m/s, 0-1.5 m 2000-2100 m/s, 1.5-12 m	0-2
10 c+d	6413-6464	51	400 m/s, 0-1.5 m 1600-1700 m/s, 1.5-8 m	0-2
11	6970-7090	120	320-400 m/s, 0-2 m 1400-2200 m/s, 2-8 m	2-3
12	8250-8300	50	350 m/s, 0-1.5 m 1000 m/s, 1.5-9 m	6-7
13	9390-9450	60	360-390 m/s, 0-1 m 800 m/s, 1-4 m 1600-1900 m/s, 3-11 m	3-4

STROMLO–HIGGINS BULK SUPPLY MAIN

GEOLOGY OF PROPOSED ROUTE





Blue grey dacite
Rhyodacite
Sandstone
Ashstone , siltstone , chert , shale , jasper
Agglomerate
Quartz
Purple and green dacite

Continuous rock outcrop
Scattered rock outcrop and scattered boulders
Geologic boundary , position approximate
Geologic boundary , position inferred
Bedding , with dip
Joint , with dip
Joint , vertical
Fault , position approximate
Shear-zone
Lineament

Fence , gate
Vehicle track
Unsealed road
Sealed road
Creek
Building
Dam
Power line
Pipeline with chainage in metres

N MN

Feet 0 800 1600 2400 3200 4000 4800
Metres 0 250 500 750 1000 1250 1500

SCALE 1:9600
CONTOUR INTERVAL 100 feet

PLATE 1

SCALE 1:9600	COMMONWEALTH OF AUSTRALIA BUREAU OF MINERAL RESOURCES CANBERRA, A.C.T.
Base map/survey 1:9600 Planning Series	TITLE GEOLOGY OF PROPOSED ROUTE
Geology by R.GOLDSMITH	
Compiled and checked R.C.M.G. Project geologist / Checked and approved D.C.P. Senior geologist	PROJECT STROMLO-HIGGINS BULK SUPPLY MAIN
E.G.W. Supervising geologist	To accompany Record / Drawn by M.E. / Drawing No. 155/A16/1735

Record 1977/57

STROMLO — HIGGINS
BULK SUPPLY MAIN
GEOLOGICAL
PLAN OF ROUTE

6000 — Pipeline route station in metres.

Proposed seismic traverse

Lower Devonian Siluro-Devonian
- Grey-green rhyodacite. "Weetangera Rhyodacite"
- Purple-green dacite. Stromlo Volcanics

Upper Silurian / Deakin Volcanics
- Blue-grey dacite.
- Green rhyodacite
- Sandstone.
- Ashstone, siltstone, chert, shale, jasper.
- Agglomerate.
- Quartz.

Geological boundary

Continuous rock outcrop.

Scattered rock outcrop and boulders

Soil isopach (m), position approx

60 — Bedding, with dip.

60 — Joint, with dip

Joint, vertical

F — Fault, position approximate

Shear zone

Vein, q=quartz, ep=epidote

SCALE 1: 2500

100 50 0 metres 100 200

200 0 200 400 600 800 feet

PLATE 2
0–1310m

Record 1977/57

I55/N16/1736

STROMLO — HIGGINS
BULK SUPPLY MAIN
GEOLOGICAL
PLAN OF ROUTE

TRAVERSE 4

TRAVERSE 3

TRAVERSE 2

2500m.

2050

1500m.

Sheared floaters (no orientation)

closely jointed

closely jointed

DAM

6000 — Pipeline route station in metres.

Proposed seismic traverse

Lower Devonian
Siluro-Devonian
Upper Silurian

Grey-green rhyodacite. "Weetangera Rhyodacite"
Purple-green dacite. Stromlo Volcanics
Blue-grey dacite.
Green rhyodacite
Sandstone.
Ashstone, siltstone, chert, shale, jasper.
Agglomerate.
Quartz.

Deakin Volcanics

Geological boundary
Continuous rock outcrop.
Scattered rock outcrop and boulders

Soil isopach (m) position approx.

60 Bedding, with dip.
60 Joint, with dip
Joint, vertical
F Fault, position approximate
Shear zone
Vein, q=quartz, ep=epidote

Telephone or telegraph line with pole
Co-axial cable
Railway line
Power transmission line with pole
Contours with contour values
Bench mark. Spot elevation
Trigonometrical station
Photogrammetric control point
Watercourse, intermittent
River or stream, perennial
Tree and position
Edge of timber
Cutting. Embankment
Scour. Rock outcrop
Sand. Marsh
Division boundary
District boundary
Territorial boundary

Road, kerbed
Road, not kerbed
Vehicle Track
Concrete footpath
Foot track
Bridge or culvert
Property boundary, fenced.
Property boundary, unfenced
Fence with gate

SCALE 1: 2500

100 50 0 metres 100 200

200 0 200 400 600 800 feet

PLATE 3

1310 – 2795m

Record 1977/57

ISS/A16/1737

STROMLO — HIGGINS
BULK SUPPLY MAIN
GEOLOGICAL
PLAN OF ROUTE

6000 — Pipeline route station in metres.

Proposed seismic traverse

Lower Devonian
Siluro-Devonian
Upper Silurian
Deakin Volcanics

- Grey-green rhyodacite. "Weetangera Rhyodacite"
- Purple-green dacite. Stromlo Volcanics
- Blue-grey dacite.
- Green rhyodacite
- Sandstone.
- Ashstone, siltstone, chert, shale, jasper.
- Agglomerate.
- Quartz.

Geological boundary

Continuous rock outcrop.

Scattered rock outcrop and boulders

Soil isopach (m), position approx

60 — Bedding, with dip.

60 — Joint, with dip

Joint, vertical

F — Fault, position approximate

Shear zone

Vein, q=quartz, ep=epidote

SCALE 1: 2500

100 50 0 100 200 metres

200 0 200 400 600 800 feet

PLATE 4

2795 – 4360m

Record 1977/57

I55/A16/1738

STROMLO — HIGGINS
BULK SUPPLY MAIN
GEOLOGICAL
PLAN OF ROUTE

6000 Pipeline route station in metres.

Proposed seismic traverse

Lower Devonian
Siluro-Devonian
Upper Silurian
Deakin Volcanics

- Grey-green rhyodacite. "Weetangera Rhyodacite"
- Purple-green dacite. Stromlo Volcanics
- Blue-grey dacite.
- Green rhyodacite
- Sandstone.
- Ashstone, siltstone, chert, shale, jasper.
- Agglomerate.
- Quartz.

Geological boundary

Continuous rock outcrop.

Scattered rock outcrop and boulders

Soil isopach (m), position approx

60 Bedding, with dip.

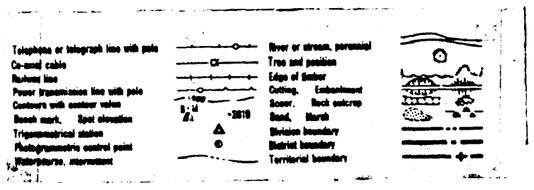
60 Joint, with dip

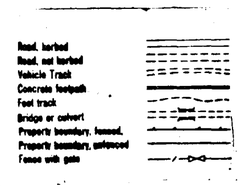
Joint, vertical

F Fault, position approximate

Shear zone

Vein, q=quartz, ep=epidote





SCALE 1: 2500

100 50 0 metres 100 200

200 0 200 400 600 800 feet

PLATE 5

4360 – 5700 m

Record 1977/57

Iss/A16/1739

STROMLO – HIGGINS
BULK SUPPLY MAIN
GEOLOGICAL
PLAN OF ROUTE

6000 — Pipeline route station in metres.

Proposed seismic traverse

Lower Devonian
Siluro-Devonian
Upper Silurian

Grey-green rhyodacite. "Weetangera Rhyodacite"
Purple-green dacite. Stromlo Volcanics
Blue-grey dacite.
Green rhyodacite
Sandstone, ashstone
Limestone.
Agglomerate.
Quartz.

Deakin Volcanics

Continuous rock outcrop.
Scattered rock outcrop and boulders

Soil isopach (m) position approx.

60 — Bedding, with dip.
60 — Joint, with dip
Joint, vertical
F — Fault, position approximate
Shear zone
Vein, q=quartz, ep=epidote

Telephone or telegraph line with pole
Co-axial cable
Railway line
Power transmission line with pole
Contours with contour value
Bench mark. Spot elevation
Trigonometrical station
Photogrammetric control point
Watercourse, intermittent
River or stream, perennial
Tree and position
Edge of timber
Cutting. Embankment
Scour. Rock outcrop
Sand. Marsh
Division boundary
District boundary
Territorial boundary

Road, kerbed
Road, not kerbed
Vehicle Track
Concrete footpath
Foot track
Bridge or culvert
Property boundary, fenced.
Property boundary, unfenced
Fence with gate

SCALE 1: 2400

200 0 200 400 600 800
feet

PLATE 6

5700 – 6025 m

Record 1977/57

Iss. A161740

STROMLO – HIGGINS BULK SUPPLY MAIN GEOLOGICAL PLAN OF ROUTE

6000 — Pipeline route station in metres.

Proposed seismic traverse

Lower Devonian
Siluro-Devonian
Upper Silurian
Deakin Volcanics

- Grey-green rhyodacite. "Weetangera Rhyodacite"
- Purple-green dacite. Stromlo Volcanics
- Blue-grey dacite.
- Green rhyodacite
- Sandstone.
- Ashstone, siltstone, chert, shale, jasper.
- Agglomerate.
- Quartz.

- Continuous rock outcrop.
- Scattered rock outcrop and boulders

1 — Soil isopach (m), position approx

60 — Bedding, with dip.

60 — Joint, with dip

Joint, vertical

F — Fault, position approximate

Shear zone

Vein, q=quartz, ep=epidote

Telephone or telegraph line with pole
Co-axial cable
Railway line
Power transmission line with pole
Contours with contour values
Bench mark. Spot elevation
Trigonometrical station
Photogrammetric control point
Watercourse, intermittent
River or stream, perennial
Tree and position
Edge of timber
Cutting. Embankment
Scour. Rock outcrop
Sand. Marsh
Division boundary
District boundary
Territorial boundary

Road, kerbed
Road, not kerbed
Vehicle Track
Concrete footpath
Foot track
Bridge or culvert
Property boundary, fenced.
Property boundary, unfenced
Fence with gate

SCALE 1: 2400

200 0 200 400 600 800
feet

PLATE 7

6025 – 7570 m

Record 1977/57

I55/A16/174

STROMLO – HIGGINS
BULK SUPPLY MAIN
GEOLOGICAL
PLAN OF ROUTE

6000 — Pipeline route station in metres.

Proposed seismic traverse

Lower Devonian — Grey-green rhyodacite. "Weetangera Rhyodacite"

Siluro-Devonian — Purple-green dacite. Stromlo Volcanics

Upper Silurian — Blue-grey dacite. / Green rhyodacite / Sandstone. / Ashstone, siltstone, chert, shale, jasper. / Agglomerate. / Quartz. — Deakin Volcanics

Continuous rock outcrop.

Scattered rock outcrop and boulders

Soil isopach (m) position approx

60 — Bedding, with dip.

60 — Joint, with dip

Joint, vertical

F — Fault, position approximate

Shear zone

Vein, q=quartz, ep=epidote

Telephone or telegraph line with pole
Co-axial cable
Railway line
Power transmission line with pole
Cuttings with contour notches
Bench mark. Spot elevation
Trigonometrical station
Photogrammetric control point
Watercourse, intermittent
River or stream, perennial
Tree and position
Edge of timber
Cutting. Embankment
Scarp. Rock outcrop
Sand. Marsh
Division boundary
District boundary
Territorial boundary

Road, bitumen
Road, not bitumen
Vehicle Track
Concrete footpath
Foot track
Bridge or culvert
Property boundary, fenced
Property boundary, unfenced
Fence with gate

SCALE 1: 2400

200 0 200 400 600 800 feet

PLATE 8

7570 – 9275m

Record 1977/57

I55/A16/1742

STROMLO – HIGGINS
BULK SUPPLY MAIN
GEOLOGICAL
PLAN OF ROUTE

6000 — Pipeline route station in metres.

Proposed seismic traverse

Lower Devonian
Siluro-Devonian
Upper Silurian
Deakin Volcanics

- Grey-green rhyodacite. "Weetangera Rhyodacite"
- Purple-green dacite. Stromlo Volcanics
- Blue-grey dacite.
- Green rhyodacite
- Sandstone.
- Ashstone, siltstone, chert, shale, jasper.
- Agglomerate.
- Quartz.

- Continuous rock outcrop.
- Scattered rock outcrop and boulders
- Soil isopach (m) position approx
- 60 Bedding, with dip.
- 60 Joint, with dip
- Joint, vertical
- F Fault, position approximate
- Shear zone
- Vein, q=quartz, ep=epidote

SCALE 1: 2400

200 0 200 400 600 800 feet

PLATE 9

9275 – 9900 m

Record 1977/57

I55/A16/1743