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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD 1968/110

PRELIMINARY GEOLOGICAL REPORT ON PROPOSED NORTH MOLONGLO OUTFALL SEWER, A.C.T., 1967

by

G.A.M. Henderson

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Restricted

CANCELLED

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SUMMARY

A proposal to excavate a 4½ mile tunnel for a new outfall sewer from Commonwealth Avenue, near London Circuit, to a new sewerage treatment works to be built near Coppins Crossing, is under consideration. Two alternative routes are being considered; both are expected to provide similar tunnelling conditions. Surface geology indicates that a tunnel would meet porphyry and volcanics west of Black Mountain and sandstone under Black Mountain. East of Black Mountain some shallow drill holes have been put down around the University at various times and indicate mainly shale or siltstone bedrock; limestone was revealed in drill holes at the Ward Bridge over Sullivan's Creek. Although much of the tunnel would be in hard strong rock requiring little or no support, weathering penetrates to tunnel level under Sullivan's Creek, probably near the Hotel Acton, under Black Mountain Creek, and wherever cover is low. The sections in weathered rock would almost certainly need steel support and extensive lining. Four major faults cross the tunnel line; they are expected to have associated zones of crustal and decomposed rock. Most of the tunnel would be below the water table and wet conditions can be expected. Water inflows, however, would probably be slight except close to major faults and where limestone occurs. If limestone with solution joints and cavities is encountered, extremely high rates of water inflow may occur. Augering, diamond drilling and geophysical surveys are recommended to obtain information on conditions at tunnel level in critical areas of shallow cover and to test any areas where limestone is known or suspected.

INTRODUCTION

In October 1966 the Commonwealth Department of Works, Canberra requested that the Bureau include in its 1967 programme an investigation of the proposed routes for a major outfall sewer tunnel. Geological information was required as a guide in estimating the cost of a tunnel from Commonwealth Avenue, near London Circuit, to a point near Coppins Crossing. Two alternative routes are being considered, as shown on Plates 1 and 2. Both routes provide for a tunnel about 4½ miles long. A new sewerage treatment works would be sited close to the outlet of the tunnel. The geological investigation was carried out during April and May, 1967.

GENERAL GEOLOGY

The project would involve tunnelling through a variety of rock types of Silurian and Ordovician age: porphyry and volcanics west of Black Mountain; sandstone under Black Mountain; and shale, siltstone and possibly limestone east of Black Mountain. The sedimentary rocks are folded, and several major faults are known to cross the tunnel line.

PROPERTIES OF THE VARIOUS ROCK TYPES

The various rocks which would be encountered in the tunnel all have characteristic hardness, strength, joint spacing and mode of weathering. A brief description of the main rock types likely to be met in the tunnel is given below.

Porphyry

The porphyry, where fresh, is very hard, strong and massive. Joints are irregularly spaced, ranging from a few inches to four or five feet. Porphyry weathers in a very irregular fashion. Fresh rock crops out at the surface in places, but generally as floaters surrounded by detrital sandy clay and soft, completely weathered rock. Below the surface, at a depth which varies considerably from place to place, porphyry grades down into fresh, sound rock. The transition zone may consist of either blocks of fresh rock with iron-stained and clay-filled joints, or of completely decomposed rock - now represented by soft, but non-plastic, material in which the texture of the original rock may still be seen.

Crystal Tuff

Crystal tuff has a wide range of compositions, physical properties and weathering characteristics. The crystal tuff which occurs along the tunnel lines, however, resembles porphyry in composition, and its physical properties are expected to be similar to those of the porphyry.

Rhyolite

The rhyolite is an extremely hard, strong, siliceous rock. Joint spacing is generally closer than in porphyry or crystal tuff, and probably does not exceed one foot. It is less susceptible to weathering than porphyry, and jumbled blocks of rhyolite on the surface probably indicate that hard fresh bedrock occurs at shallow depth.

Sandstone

The sandstone, where fresh, is a very hard, strong, massive to well-bedded rock. Where fresh rock occurs on Black Mountain it could more accurately be described as a quartzite. Moderately hard to hard weathered rock occurs close to the surface, and grades down into fresh rock. In the transition zone weathered rock tends to occur adjacent to joints. Joint spacing generally ranges from about 6 inches to 3 feet. Gently dipping bedding planes and thin shale beds act as planes of weakness in the partly weathered rock near the surface; in fresh rock, however, parting along bedding would probably be less pronounced than that in the partly weathered rock.

Shale

No fresh shale has been observed in the vicinity of the tunnel line but, if encountered, it would probably be a moderately hard and strong, bedded rock. Cohesion between beds would be generally good to fair. Joints would be more closely spaced than in the sandstone and would range from about one inch to one foot apart. Shale weathers first to a weak, moderately soft rock with clay on joints, and ultimately to clay containing weathered shale fragments. The clay is slightly to moderately plastic.

Limestone

The Silurian limestone of the Canberra area, where fresh, is a strong, moderately hard, crystalline rock. It is massive to well-bedded. Joints are generally widely spaced. Limestone is subject to solution by percolating groundwater, resulting in open joints and cavities, which may extend irregularly to considerable depths below the present surface. Near the surface limestone weathers to a soft clay.

Soil and Scree

Soil and scree occurs to an unknown depth on the lower slopes of Black Mountain. It generally consists of soft, poorly consolidated soil containing diverse proportions of angular to sub-rounded fragments of sandstone. Most of the sandstone fragments are only a few inches or less across but some much larger blocks occur.

Alluvium

Alluvium can range from unconsolidated gravel or sand to unconsolidated clayey silt and firm clay. Most of the alluvium along the proposed tunnel line is probably fine-grained silt and clay; its thickness is unknown, but it is unlikely to occur at tunnel level at any point except near Sullivan's Creek.

ENGINEERING GEOLOGY

All the rock materials likely to be encountered are, where fresh, strong enough for an unlined, unsupported tunnel. Any difficulties that arise would be related to one or more of the following: structural defects in the rock mass (faults, shears, joints and bedding); weathering; and inflow of groundwater.

STRUCTURAL DEFECTS

Jointing

Jointing would affect tunnelling conditions, mainly in respect to the amount of overbreak. Where joint planes are clay-coated, or have been opened by faulting and shearing, overbreak could be considerable, and steel supports would be required. Tight joints would be less likely to cause overbreak, and no support, or at the most rock bolts, would be needed.

Open joints, probably occurring mainly in fault and shear zones, would allow the inflow of groundwater. The inflow, however, would be restricted where joints are clay-coated.

Where parting occurs along joints, joint orientations would affect the amount of overbreak. Joint orientations in relation to the tunnel alignments are discussed under the notes on the proposed routes.

Faulting

The major known faults would probably involve tunnelling through a zone of crushed and disturbed rock; the zones of dislocation are possibly deeply weathered, giving rise to clay-filled fractures. A zone of clay, up to a few feet wide, may also occur along the fault planes. The length of tunnel in a fault zone would probably be from a few feet to about 200 feet, if the tunnel crossed the fault at right angles, but longer if at an acute angle.

Overbreak would be greater in a fault zone than in sound rock and support requirement would probably range from steel support, through rock bolts and mesh, to rock bolts at selected points. Generally, where steel support is needed, only light steel (with or without lagging) would be required but small zones may require strong steel support and lagging. Concrete lining would probably be needed as final treatment wherever steel supports are used during tunnelling.

The remarks in the preceding two paragraphs apply to the four major faults shown in Plate 1.

Other faults and shear zones with similar conditions could also be encountered. Many small faults would probably occur, but most would be fairly narrow and would affect only a short length of tunnel.

Bedding

Bedding plane joints, i.e. partings along bedding planes, where gently dipping, could cause some overbreak. Thin interbeds of soft weathered rock could also have the same effect. Gently dipping bedding is known to occur in the Black Mountain Sandstone, and probably also occurs in the shale east of Sullivan's Creek.

EFFECTS OF WEATHERING

Weathering tends to reduce the strength of the rock, and make it more susceptible to overbreak. This may result in the need for roof support, ranging from rock bolts in slightly weathered rock, to full steel support, and subsequent concrete lining, in very decomposed rock.

Commonly weathering is inhomogeneous. This is particularly so in the porphyry and crystal tuff, in which weathering along joints may produce unsafe conditions in the tunnel roof and lead to substantial overbreak. Weathering along joints and shears in all rock types would reduce the strength of the rock mass and increase support requirements. Inhomogeneously weathered rock may also cause difficulties in drilling and mucking.

The effect of weathering in water problems is referred to below.

INFLUX OF GROUNDWATER

Most of the tunnel would be below the water table. The water table ranges in height above the proposed tunnels according to the local recharge, permeability of the rocks and base level of discharge of the groundwater at Lake Burley Griffin, the Molonglo River or creeks. A section in from both the proposed outlets would be almost at the water table. It is estimated that the water table reaches a maximum height of about 140 feet above the proposed tunnel line in the area north of Scrivener Dam. An attempt to indicate the most probable water table level along the tunnel route has been made in Plate 9. Very little direct data are available and the estimate is based on knowledge of general groundwater levels in the A.C.T. Seasonal variations in level probably range from about 5 to 15 feet.

The greatest difficulty with water inflow into the tunnel can be expected if limestone with small caves, solution joints and cavities is encountered. Extremely rapid rates of water inflow could occur under these conditions and could require special, and expensive, tunnelling techniques.

In very weathered material the amount of water inflow may not be great because joints and fractures tend to be sealed by clay. Where only slightly weathered, however, open joints in the rock could allow a moderate inflow of water. Weathered sandstone would contain less clay on joints than the other rocks; this would result in greater water inflows.

Zones of fracturing near faults and shears may have fairly high permeability, but permeability could be restricted to some extent by the presence of clay and pug where advanced weathering extends to tunnel level, and along fault planes.

Generally the tunnel would be wet but, except in cavernous limestone and alluvium, serious problems of water control should not be encountered.

NOTES OF PROPOSED ROUTES (See Plate 2)

Route BCD, Outlet to Chainage 12260 feet

Outcrops in the area indicate that the tunnel would be in crystal tuff from the outlet to about chainage 1420 feet, rhyolite and tuff from 1420 to 1800 feet, and porphyry from 1800 to 12260 feet.

Weathered rock would be encountered for some distance in from the outlet portal. The depth of weathering is unknown, but probably once the thickness of overlying rock reaches 30 feet, rock bolting and light steel support in a few places would be the most support needed.

The tunnel would be comparatively close to the surface under Black Mountain Creek, and possibly a section of the tunnel below the creek would be in weathered rock. The creek is about 20 feet deep and apart from one large mass of fresh porphyry in the west bank, probably a floater, the material exposed by the creek is completely weathered. The west bank consists mostly of completely weathered porphyry. In the east bank the material is soil and scree derived from Black Mountain. As the surface on which the scree was deposited was probably very uneven, scree may reach tunnel level at one or more points.

Apart from weathered material near the outlet, and possibly under Black Mountain Creek, this section of the tunnel should generally be below the weathered zone. Some shear and fault zones would probably be encountered, and perhaps a few pockets of deep weathering but, in the main, the tunnel should be in strong, fresh rock. Overbreak due to unfavourably oriented joints would be the only problem in the fresh rock.

In areas of shallow cover where weathered material occurs, and in any other places where the rock is weakened by weathering or faulting, rock bolting and short sections of steel support would probably be needed.

The tunnel would probably be wet, but volumes of water large enough to create serious difficulties should not be encountered.

Route YCD, Outlet to Chainage 12260 Feet

The alternative route would encounter rock types and conditions similar to those expected for route BCD. Weathering would occur near the outlet portal, and possibly under Black Mountain Creek, but the tunnel would be mainly in fresh rock, apart from shear and fault zones.

Outcrops indicate that crystal tuff would occur from the outlet to about chainage 2620 feet, rhyolite and tuff from chainage 2620 to 3300 feet, and mostly porphyry from 3300 to 12260 feet. From about chainage 7420 to 8670 feet tuff and rhyolite, with much replacement by quartz, crops out at the surface; these rocks are expected to occur at tunnel level.

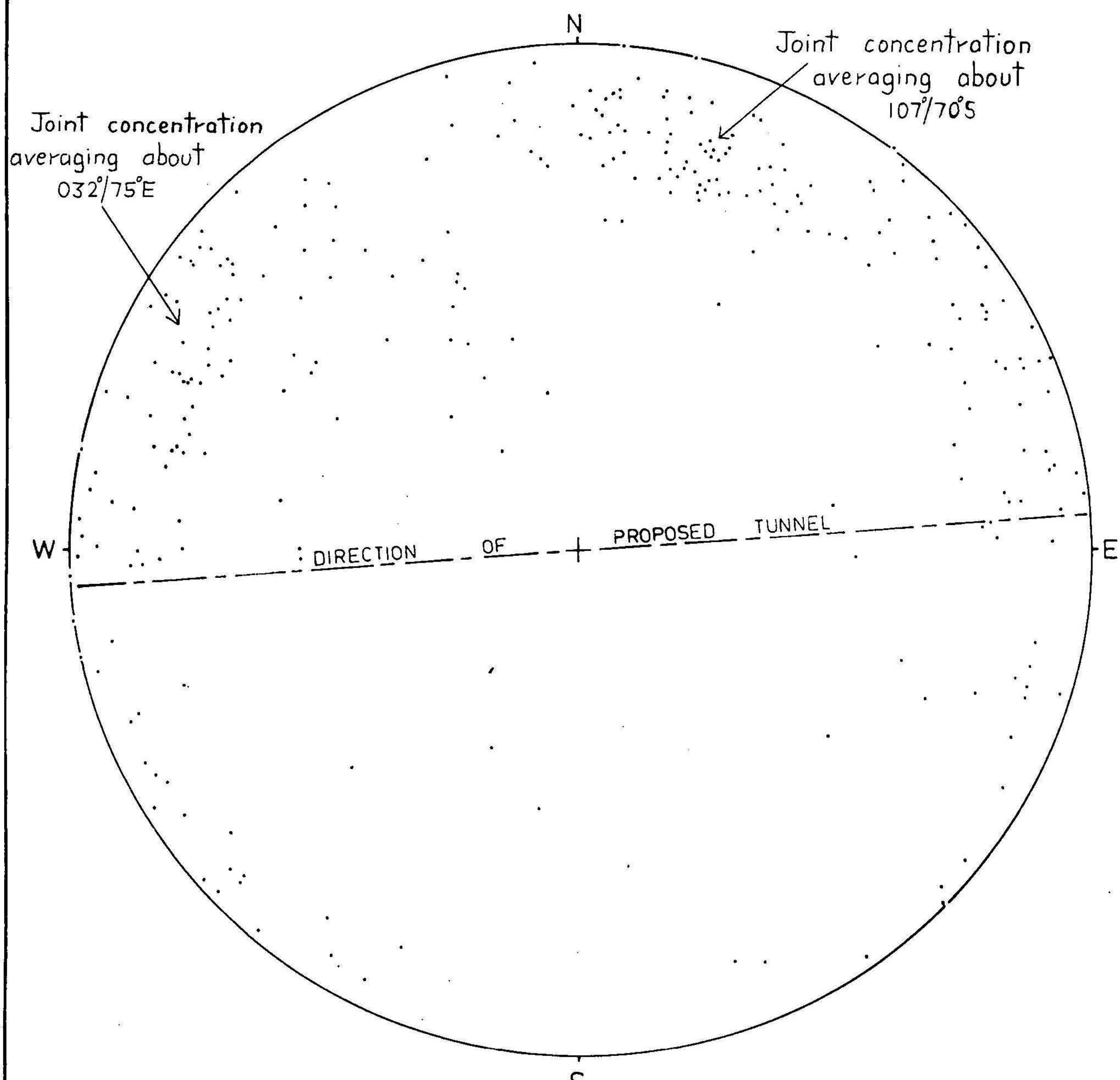
Joint orientations in the porphyry for both the alternative routes would probably be nearly random, when taking the whole length of tunnel in this rock into account. At any particular place, however, one or two directions would probably be prominent. Possible overall preferred orientations, if they do occur, may be indicated by the preferred orientations at Scrivener Damsite. The most common joints there strike around 032 and 122 degrees, with lesser ones around 008 and 107 degrees; these joints are mainly steeply dipping. The orientations of the two proposed tunnel lines are 086 and 056 degrees.

Chainage 12260 to 12860 feet (common to both tunnel lines)

At about chainage 12260 feet the tunnel would cross the Deakin Fault. This fault strikes at about 140 degrees, which is about 54 degrees to the proposed tunnel alignment. Between this fault and the Black Mountain Fault, at about chainage 12860 feet, the tunnel would probably be in interbedded sandstone and shale. The thickness of the beds and the ratio of sandstone to shale is not known. The rocks are unlikely to be extensively weathered, other than in the fault zones, but joints

Fig. 1

POLES TO JOINTS IN BLACK MOUNTAIN SANDSTONE



True bearings

Plot of poles to 282 joints, lower hemisphere equal area stereographic projection.

Bureau of Mineral Resources, October 1967

To accompany Record 1968/110

may be clay-coated, resulting in overbreak and the need for rock-bolting to prevent slabs of rock from falling from the roof. Gently dipping bedding plane joints in this section could also cause overbreak and require bolting. Serious inflows of water are not expected except possibly in the fault zones.

<u>Chainage 12860 to 19650 feet</u> (common to both tunnel lines)

The tunnel would cross the Black Mountain Fault at about chainage 12860 feet. The fault strikes at about 020 degrees, which is about 66 degrees to the tunnel line; it probably dips steeply to the west.

To the east of the fault and under Black Mountain the tunnel would be in sandstone, probably hard strong fresh rock for most of the section. The sandstone is thickly bedded with a few beds of shale up to 6 inches thick. The bedding dips gently, mainly around 20 to 30 degrees; the bedding plane joints could cause some overbreak and require bolting to prevent minor falls. Overbreak could also be caused by failure of gently dipping beds of shale.

Joints in the sandstone are well exposed in cuttings along the Black Mountain Road and, apart from bedding plane joints, mostly dip at angles greater than 60 degrees (see joint stereograms - Figure 1). The most common directions average about $107^{\circ}/70S$ and $032^{\circ}/75^{\circ}E$. Because of the large number of joints measured it was impossible to plot them individually on the plans; instead the dips and strikes of several adjoining, similarly oriented, joints were averaged and plotted as one joint. (It should be noted that the strike directions of the preferred joint orientations correspond with two of those at Scrivener Damsite. This could be indicative of a general regional joint pattern.)

Towards chainage 19650 feet the tunnel would approach the South Black Mountain Fault; the position of the fault is not known accurately. If the fault dips to the north, or lies to the north of the position shown on Plate 1, it could intersect the tunnel at a small angle, producing poor rock conditions over a considerable distance. However, once the position of the fault has been established, the tunnel could be relocated to reduce the length of poor ground to a minimum, or perhaps to avoid the fault altogether.

<u>Chainage 19650 to 21670 feet</u> (common to both tunnel lines)

A number of shallow auger and percussion drill holes put down within the University grounds indicate that the tunnel would be mostly in shale and other fine-grained sediments along this section; the drill holes, however, did not penetrate more than one or two feet into bedrock. (The locations of drill holes are shown on Plate 8 and geological logs of drill holes appear in Appendix 1.) Below extensions to the Animal Breeding Units shale bedrock was encountered at around R.L.1823 feet.

Several auger and percussion drill holes were put down to test the foundations for the Ward Bridge over Sullivan's Creek; the bridge is about 100 feet north of the proposed tunnel line. On the east side of the creek limestone was encountered at a depth of 33 feet (R.L.1797 feet); on the west side of the creek one hole reached limestone at a depth of 63 feet (R.L.1767 feet), after passing through soft material, probably weathered shale. Apparently a bed of limestone dips gently to the west; the thickness of the limestone cannot be established from the information available. Solution channels possibly occur in the limestone as water is reported to have flowed into one of the drill holes at a constant rate for some time. (This was before the filling of Lake Burley Griffin.) If solution channels do occur in the limestone large inflows of water into the tunnel can be expected. Limestone was also encountered during piling for a building west of Sullivan's Creek (for location see Plate 8).

Unconsolidated alluvium may occur for some distance under Sullivan's Creek. If this is the case, tunnelling conditions could be extremely difficult and an open trench may be cheaper and easier to excavate. Alternatively, the invert of the tunnel could be lowered by use of a siphon under the creek to a level where strong fresh bedrock, free of open joints or solution channels, occurs. Another possible solution would be to relocate the tunnel to pass under Sullivan's Creek at a point farther upstream (see below). The merits of the alternative possibilities would need investigation by drilling and water pressure testing. The maximum depth at which solution channels or cavities could occur in any limestone in this area is not known; solution channels in limestone beneath the Secretariat Building, Parkes, are known to extend down to R.L.1733 feet, (see Appendix 1).

Apart from the immediate vicinity of Sullivan's Creek, the tunnel along this section would probably be in shale. At tunnel level the shale would probably be slightly weathered but is unlikely to be completely decomposed. Shallow dipping bedding plane joints and clay on joints would probably cause some overbreak and require rock bolting, and possibly steel support. Water inflow through the shale would be slight.

At about chainage 21670 feet the tunnel would cross the Acton Fault. The fault at this point strikes at about 160 degrees, which is 40 degrees to the tunnel line.

Chainage 21670 to 24500 feet

Bedrock along this section is likely to be mainly shale. It is probably weathered to some extent, and as in the preceding section, shallow dipping bedding plane joints and clay on joints could cause some overbreak; rock bolts or possibly steel support would be needed. Very weathered shale possibly occurs along some of this section, particularly near the Hotel Acton, where the cover would be least. Steel supports may be needed where highly weathered shale is encountered.

Lenses of limestone may be encountered in places along this section; where limestone is intersected, water inflows could be considerable - possibly even large enough to require special and expensive tunnelling techniques. Calcareous shale and mudstone, fine-grained sandstone, tuffaceous sediments and rhyolite may also be present.

POSSIBLE ALTERNATIVE ALIGNMENTS

The present tunnel alignment is considered to be satisfactory from a geological viewpoint, except for the proposed section under Sullivan's Creek and possibly near the South Black Mountain Fault. Should the proposed route under Sullivan's Creek prove likely to be difficult and expensive, an alternative route, to pass under the creek at some point farther north, may be cheaper. However cavernous limestone may be present along this alternative alignment; any proposed routes should be investigated thoroughly by drilling to define likely tunnelling conditions, and permit the cheapest route to be selected.

When deciding the final alignment of the tunnel the following factors should be borne in mind: the smaller the angle at which the tunnel crosses a major fault, the greater would be the length of tunnel in a fault zone; the tunnel should not be aligned parallel to a prominent joint direction; where there are two prominent joint directions, as under part of Black Mountain, the most favourable direction for a tunnel is to bisect the joint systems; finally, the outlet end of the tunnel should be aligned at right angles to the slope of the land surface to obtain a thick cover in as short a distance as possible.

CONCLUSIONS

1. The excavation of a tunnel along either of the two proposed routes is feasible. From a geological viewpoint neither one or other of the proposed routes is to be preferred. However, an alternative alignment from Commonwealth Avenue to cross the Acton Fault and Sullivan's Creek farther north should be considered together with the presently-proposed alignment.

2. The greater part of the tunnel would be in hard strong rock with good tunnelling conditions and little need of support.

3. Four known major faults cross the tunnel line; they would probably contain zones of crushed and decomposed rock. The widths of the zones are not known. Other fault zones probably cross the route for the tunnel.

4. Extremely difficult tunnelling conditions in alluvium or very weathered material may be encountered under Sullivan's Creek, and for some distance each side. Poor tunnelling conditions in weathered material could also be met near either of the proposed outlet portals, under Black Mountain Creek, and near the Hotel Acton.

5. Limestone occurs close to the tunnel line beneath Sullivan's Creek, and possibly occurs between the Acton Fault and Commonwealth Avenue. Limestone, if cavernous, could yield very substantial flows of water, and add greatly to the difficulty and expense of tunnelling. A siphon under Sullivan's Creek may overcome tunnelling problems there.

6. Water inflow should not pose serious problems except where cavernous limestone, unconsolidated alluvium or scree are encountered. However, most of the tunnel would be below the water table and wet conditions could be expected.

7. As an alternative to a siphon under Sullivan's Creek, a route to cross the creek farther north could be considered, and investigated if engineering considerations warrant it. Some realignment under Black Mountain may also be advisable to avoid the South Black Mountain Fault.

FURTHER INVESTIGATIONS REQUIRED

1. To test the depth to hard bedrock, augering is recommended in areas of shallow cover along the proposed tunnel line, and along any other route selected for investigation. Augering should be carried out initially at the following places: at Sullivan's Creek and for some distance either side, depending on results; near the Hotel Acton; at Black Mountain Creek; and at the outlet site for the selected tunnel route.

2. A seismic survey is recommended to supplement the augering, and to provide information on depths of weathering along as much of the tunnel line as possible, particularly in areas of shallow cover. A resistivity survey may also be useful between Commonwealth Avenue and the Acton Fault to indicate any areas of cavernous limestone. A geophysical survey to locate the South Black Mountain Fault is also recommended.

3. When the results of augering are known further investigations by diamond drilling should be carried out. Drill hole locations will depend to some extent on the results of augering; the holes should be designed to obtain information on rock type, degree of weathering and permeability at tunnel level. Targets would include areas of low cover, fault zones and places where the presence of limestone is known or suspected. Water-pressure testing of drill holes is necessary to obtain information on the permeability of the bedrock and likely inflows of water.

ACKNOWLEDGEMENT

The information on building foundations and drilling in the University area was supplied by Mr B.A.J. Litchfield, University Architect, Australian National University.

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APPENDIX 1

Geological Logs of Drill Holes at Ward Bridge, Australian National University, Acton, and Secretariat Building Site, Parkes.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: WARD BRIDGE, A.N.U.
LOCATION: 12950N, 31100E (Approx. Stromlo Co-ords)
ANGLE FROM HORIZONTAL: 90°
DIRECTION:
COORDINATES:
R.L. 1833·7'

HOLE NO. A1

SHEET ___ OF ___

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC.	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST Loss in gallons per minute per foot	PHOTO REF. NO. CORE BOX	CORE BARREL
	Fill material		4'0"								
	Brown clay		32'0"								
	Brown sandy clay		50'0"								
	END OF HOLE						50 FEET				

DRILL TYPE: 3½" Power Auger
FEED:
CORE BARREL TYPE:
DRILLER:
COMMENCED:
COMPLETED: 1962
LOGGED BY: Driller
VERTICAL SCALE: 10 feet: 1 inch

NOTES

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

WATER PRESSURE TESTS

PACKER TYPE:
SUPPLY LINE:
VERTICAL SCALE:
Figures given are gauge pressures
Test sections are indicated graphically by blocked-in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE:
COLOUR:

I55/A1b/298-2

M(Pf)99

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: WARD BRIDGE A.N.U.

LOCATION: 12950N. 31100E (Approx. Stromlo Co-ords)

ANGLE FROM HORIZONTAL: 90°

DIRECTION:

COORDINATES:

R.L. 1831·25'

HOLE NO. A2

SHEET ___ OF ___

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC.	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST Loss in gallons per minute per foot	PHOTO REF. NO. CORE BOX	CORE FRAMES
	Fill material		3'0"								
	Dark grey clay		8'0"								
	Brown sandy clay		30'0"								
	Brown clay with 'gravel'		35'0"								
	Hard 'gravel'		36'0"								

DRILL TYPE: 3½" Power Auger

FEED:

CORE BARREL TYPE:

DRILLER:

COMMENCED:

COMPLETED: 1962

LOGGED BY: Driller

VERTICAL SCALE: 10 feet : 1 inch

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

WATER PRESSURE TESTS

PACKER TYPE:

SUPPLY LINE:

VERTICAL SCALE:

Figures given are gauge pressures

Test sections are indicated graphically by blocked-in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE:

COLOUR:

I55/A16/298-3

M(Pf)99

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: WARD BRIDGE, A.N.U.

LOCATION: 12950N, 31100E (Approx. Stromlo Co-ords)

ANGLE FROM HORIZONTAL: 90° DIRECTION:

COORDINATES: R.L. 1830·4'

HOLE NO. A4

SHEET ___ OF ___

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST Loss in gallons per minute per foot	PHOTO REF. NO. CORE BOX / CORE BARREL
	Grey clay		4'0"							
	Brown clay with a little 'gravel'		33'0"							
	Gravel		34'0"							
	Brown sandy clay		39'0"							
	Brown clay with 'gravel'		46'0"							
	END OF HOLE						46 FEET			

DRILL TYPE: 3½" Power Auger

FEED:

CORE BARREL TYPE:

DRILLER:

COMMENCED:

COMPLETED: 1962

LOGGED BY: Driller

VERTICAL SCALE: 10 feet: 1 inch

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

WATER PRESSURE TESTS

PACKER TYPE:

SUPPLY LINE:

VERTICAL SCALE:

Figures given are gauge pressures
Test sections are indicated graphically by blocked-in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE:

COLOUR:

I55/A16/298-4

M(Pf)99

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: WARD BRIDGE, A.N.U.
LOCATION: 12950N, 31100E (Approx. Stromlo Co-ords)
ANGLE FROM HORIZONTAL: 90°
DIRECTION:
COORDINATES:
R.L. 1834·2

HOLE NO. Ab

SHEET ___ OF ___

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC.	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST Loss in gallons per minute per foot	PHOTO REF. NO. CORE BOX	CORE BARREL
	Stiff grey clay		6'0"								
	Grey-brown clay		33'0"								
	Yellow-brown clay & 'gravel'		36'0"								
Shale	Stiff, brown, clayey										
	Brown		39'0"								
	END OF HOLE						39'6"				

DRILL TYPE: 3½" Power Auger
FEED:
CORE BARREL TYPE:
DRILLER:
COMMENCED:
COMPLETED: 1962
LOGGED BY: Driller
VERTICAL SCALE: 10 feet: 1 inch

NOTES

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

WATER PRESSURE TESTS
PACKER TYPE:
SUPPLY LINE:
VERTICAL SCALE:
Figures given are gauge pressures
Test sections are indicated graphically by blocked-in strips

PHOTOGRAPH REFERENCE SYSTEM
BLACK AND WHITE:
COLOUR:

I55/A16/298-5

M(Pf)99

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: WARD BRIDGE, A.N.U.

LOCATION: 12950N, 31100E (Approx. Stromlo Co-ords)

ANGLE FROM HORIZONTAL: 90°

DIRECTION:

COORDINATES:

R.L. 1830' (Approx.)

HOLE NO. B1

SHEET ___ OF ___

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST Loss in gallons per minute per foot	PHOTO REF. NO. CORE BOX	CORE SAMPLE
	Fill material		2'0"								
	Black swamp material, organic silt to clay		9'0"								
	Grey-brown clayey sand with some fine gravel		12'0"								
	Light brown gravelly clayey sand. Becoming yellower and more gravelly with depth. Coarser gravel than above.		31'0"								
	Hard, compact gravel		32'10"								
Limestone	Hard, blue-grey		35'0"								
	END OF HOLE						35 FEET				

DRILL TYPE: 5" Percussion

FEED:

CORE BARREL TYPE:

DRILLER:

COMMENCED:

COMPLETED: 1962

LOGGED BY: Driller

VERTICAL SCALE: 10 feet: 1 inch

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

WATER PRESSURE TESTS

PACKER TYPE:

SUPPLY LINE:

VERTICAL SCALE:

Figures given are gauge pressures
Test sections are indicated graphically by blocked-in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE:

COLOUR:

I55/A16/298-6

M(Pf)99

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT WARD BRIDGE, A.N.U.

LOCATION 12950N, 31100E (Approx. Stromlo Co-ords)

ANGLE FROM HORIZONTAL 90° DIRECTION

COORDINATES R.L. 1830'(Approx.)

HOLE NO. B2

SHEET OF

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST Loss in gallons per minute per foot	PHOTO REF. NO.	CORE BOX	CORE BARREL
	Black swamp material, organic silt to clay.		4'0"									
	Soft, dark grey clay		9'0"									
	Brown grey, clayey sand with some fine gravel.		22'0"									
	Red-brown highly plastic clay and some fine gravel.		29'0"									
	Yellow-brown highly plastic clay and fine gravel.		32'9"									
	Hard compact gravel		33'9"									
Limestone	Hard, blue-grey		35'9"									
	END OF HOLE						35'9"					

DRILL TYPE 5" Percussion

FEED

CORE BARREL TYPE

DRILLER

COMMENCED

COMPLETED 1962

LOGGED BY Driller

VERTICAL SCALE 10 feet: 1 inch

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

WATER PRESSURE TESTS

PACKER TYPE

SUPPLY LINE

VERTICAL SCALE

Figures given are gauge pressures
Test sections are indicated graphically by blocked in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE

COLOUR

I55/A16/298-7

M(Pf)99

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: WARD BRIDGE, A.N.U.

LOCATION: 12950N, 31100E (Approx. Stromlo Co-ords)

ANGLE FROM HORIZONTAL: 90°

DIRECTION:

COORDINATES:

R.L. 1830' (Approx.)

HOLE NO: B3

SHEET ___ OF ___

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION: LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES: JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST: Loss in gallons per minute per foot	PHOTO REF NO: CORE BOX	CORE BARREL
	Dark grey silty clay		2'0"								
	Grey and yellow-brown highly plastic clay.		26'9"								
	Brown, highly plastic clay with some fine gravel, becoming redder and sandier with depth.		52'0"								
	Clayey 'gravel'		53'0"								
	Yellow-brown clay with a little gravel										
	Hard compact 'gravel'		63'0"								
Limestone	Hard, blue-grey		65'6"								
	END OF HOLE						65'6"				

DRILL TYPE: 5" Percussion

FEED:

CORE BARREL TYPE:

DRILLER:

COMMENCED:

COMPLETED: 1962

LOGGED BY: Driller

VERTICAL SCALE: 10 feet : 1 inch

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

WATER PRESSURE TESTS

PACKER TYPE:

SUPPLY LINE:

VERTICAL SCALE:

Figures given are gauge pressures. Test sections are indicated graphically by blocked in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE:

COLOUR:

I55/A16/298-8

M(Pf)99

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT WARD BRIDGE, A.N.U.
LOCATION 12950'N, 31100'E (Approx. Stromlo Co-ords.)
ANGLE FROM HORIZONTAL 90° DIRECTION
COORDINATES R.L. 1830'(Approx.)

HOLE NO. B4
SHEET OF

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS, ETC	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST Loss in gallons per minute per foot	PHOTO REF NO. CORE BOX / CORE BARREL
	Topsoil and dark grey, soft silty clay.		7'6"							
	Brown, highly plastic clay, with sparse fine gravel.		16'0"							
	Brown-red, highly plastic clay, with some fine gravel.		26'0"							
	Tightly packed, red-brown clay and gravel. Very firm.		33'6"							
	Fairly loose gravel									
Shale	Hard, brown		36'0"							
	END OF HOLE						36 FEET			

DRILL TYPE 5" Percussion
FEED
CORE BARREL TYPE
DRILLER
COMMENCED
COMPLETED 1962
LOGGED BY Driller
VERTICAL SCALE 10 feet: 1 inch

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

WATER PRESSURE TESTS
PACKER TYPE
SUPPLY LINE
VERTICAL SCALE
Figures given are gauge pressures
Test sections are indicated graphically by blocked in strips

PHOTOGRAPH REFERENCE SYSTEM
BLACK AND WHITE
COLOUR

I55/A16/298-9

M(Pf)99

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT ANIMAL BREEDING UNITS, A.N.U.

LOCATION 12525'N, 31015'E (Stromlo Co-ords.)

ANGLE FROM HORIZONTAL 90° DIRECTION

COORDINATES R.L. 1843·79'

HOLE NO 1

SHEET ___ OF ___

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION LITHOLOGY, COLOUR, STRENGTH, HARDNESS ETC	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG	LIFT & % CORE RECOVERY	CASING	STRUCTURES JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST
	Fill material		4'0"						
	Reddish-yellow and brown silty sand.		10'0"						
	Reddish-yellow and brown silty, clayey, fine sand.		13'9"						
	Yellow-brown silty sand.		15'0"						
Weathered shale	Yellow and brown with hard bands.		17'6"						
	END OF HOLE						17'6"		

DRILL TYPE 3½" Power Auger

FEED

CORE BARREL TYPE

COMMENCED 2/10/62

COMPLETED 2/10/62

LOGGED BY Driller

VERTICAL SCALE 5 feet: 1 inch.

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

WATER PRESSURE TESTS

PACKER TYPE

SUPPLY LINE

VERTICAL SCALE

Figures given are gauge pressures
Test sections are indicated graphically by blocked in strips

PHOTOGRAPH REFERENCE SYSTEM

BLACK AND WHITE

COLOUR

I55/A16/298-1

M(Pf)99

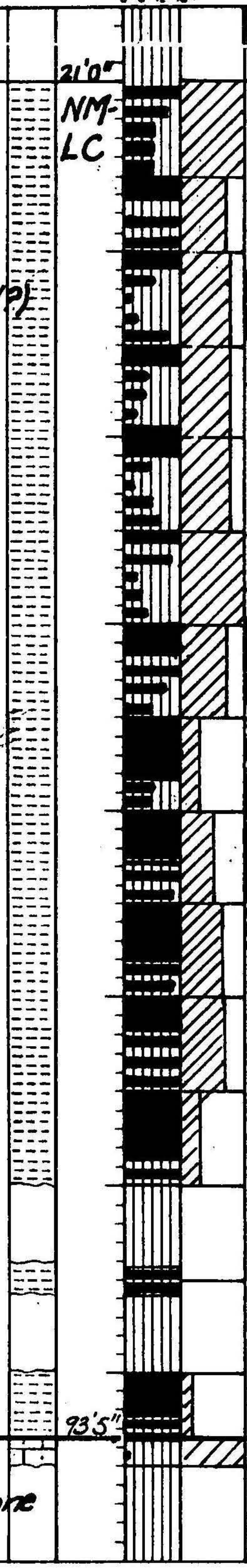
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: Secretariat Site — HOLE NO: D.D.30 — R.L.: 1852' approx.

LOCATION: 00'N ¢ 'A', 407'W ¢ 'B' — ANGLE FROM HORIZONTAL: Vertical — DIRECTION: —

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION	DEPTH & SIZE OF CORE	STRUCTURES: JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES
Very weathered shale and siltstone	Very weathered shale and siltstone, altered to clay in many places. Weathered rock is broken (or brecciated?) in several sections, eg. 60'-80'. Fragments of fresh limestone at 64'. Water worn quartz pebbles at 90'-90'10".	21'0" NM-LC … 93'5"	Core loss due to washing, from 21' to 80'. Cavity. Cavity. Core washed away.
Slightly weathered limestone	Slightly weathered brown & blue limestone with numerous vugs.		Cavity.



DRILL NO: —
TYPE: Mindrill E1000
DRILLER: K. Smith
COMMENCED: —
COMPLETED: —

LOGGED: J.K. Hill

VERTICAL SCALE: 10' : 1"

I55/A16/298-10

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT Secretariat Site HOLE NO DD30 R.L. 1852' approx.

LOCATION 00'N ℄A', 407'W ℄B' ANGLE FROM HORIZONTAL Vertical DIRECTION —

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG (0 6 12 18+)	LIFT & CORE RECOVERY %	CASING	STRUCTURES JOINTS VEINS SEAMS FAULTS CRUSHED ZONES	WATER LEVEL	WATER PRESSURE TEST Gallons per minute per foot loss
Slightly weathered limestone.			NMLC				Cavity		
							Cavity		
			AX.				Cavities and core loss.		
			120'0"						
Fresh limestone	Fresh dark blue-grey limestone, no vugs.						All core lifts not marked.		
			140'0"						
	End of hole.								

DRILL NO Mindrill E1000

TYPE

DRILLER K. Smith.

COMMENCED

COMPLETED

LOGGED J.K. Hill

VERTICAL SCALE 10' : 1in.

I55/A16/298-11

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: SECRETARIAT SITE — HOLE NO: D.D.37 — R.L.: 1850' approx.

LOCATION: 168' N. ¢ A, 234' W ¢ B. — ANGLE FROM HORIZONTAL: 90° — DIRECTION: -

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION	DEPTH & SIZE OF CORE	STRUCTURES: JOINTS, VEINS, SEAMS, FAULTS, CRUSHED ZONES
		NX casing, 20'0"	
Moderately to very weathered shale.	Soft, weak rock. Much alteration to plastic clay.	NMLC, 30', 40', 46'0"	Broken zones occur throughout. Core loss due to washing away of clay.
Slightly to moderately weathered limestone.	Moderately hard, moderately strong, blue to brown rock. 20" to 4" core lengths.	49'6"	
		49'6" – 51'11"	CAVITY.
	Very weathered, soft, weak rock from 54'6" to 57'0".	62'5"	
	Fragments of limestone and shale with much brown, plastic clay.	62'5" – 67'6"	Part, at least, of this zone is a near-vertical joint widened by solution and infilled with clay & rock fragments.
		70'0"	
		70'0" – 71'4"	CAVITY.
		72'6"	
Fresh limestone.	Hard, strong, blue-grey rock. 24" to 3" core lengths	80', 90', 98'8"	Pyrite present between 78' and 85'. Solution evident from 82'0" to 82'6".
	END OF HOLE		98' 8".

FRACTURE LOG: 0 6 12 18+ — LIFT & CORE RECOVERY % — CASING — WATER LEVEL — WATER PRESSURE TEST: Gallons per minute per foot loss

DRILL NO: 6-A-35
TYPE: MINDRILL F55
DRILLER: J. MORGAN
COMMENCED: 21-3-66
COMPLETED: 23-3-66

LOGGED: E.J. BEST

VERTICAL SCALE: 10 FEET : 1 INCH

I55/A16/298-12

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT SECRETARIAT SITE. **HOLE NO** D.D.46 **R.L.** 1850' approx.

LOCATION 37' S of ¢A, 390' W. of ¢B (Section C) **ANGLE FROM HORIZONTAL** 90° **DIRECTION** –

ROCK TYPE & DEGREE OF WEATHERING	DESCRIPTION	GRAPHIC LOG	DEPTH & SIZE OF CORE	FRACTURE LOG (0 6 12 18+)	LIFT & CORE RECOVERY %	CASING	STRUCTURES (JOINTS VEINS SEAMS FAULTS CRUSHED ZONES)	WATER LEVEL	WATER PRESSURE TEST (Gallons per minute per foot loss)
			NX casing 20'0"						
Very weathered shale.	Soft, weak rock, extensively decomposed to clay. Irregular patches of bleached shale and clay scattered throughout.		NMLC 30' 42'0"						
Fresh limestone.	Hard, strong, blue-grey rock. 4" to 30" core lengths. 5' 6" stick of core recovered.		50' 60' 70' 80'9"				Minor solution evident at 56' 8", and between 57' 3" and 57' 8".		Last drilling water at 43' 3".
	END OF HOLE						80' 9"		

DRILL NO 6-A-35
TYPE MINDRILL F55
DRILLER J. MORGAN
COMMENCED 15-2-66
COMPLETED 18-2-66

Fracture log:- Number of fractures per foot of core. Zones of core loss are blacked in.

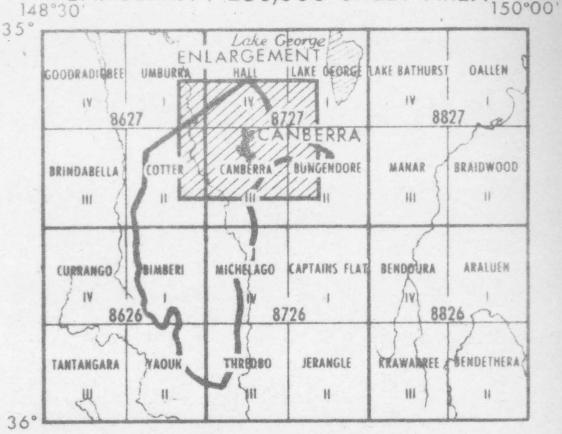
LOGGED E.J. BEST

VERTICAL SCALE 10 FEET : 1 INCH.

I55/A16/298-13

NORTH MOLONGLO OUTFALL SEWER
LOCALITY MAP

CANBERRA 1:250,000 SHEET AREA



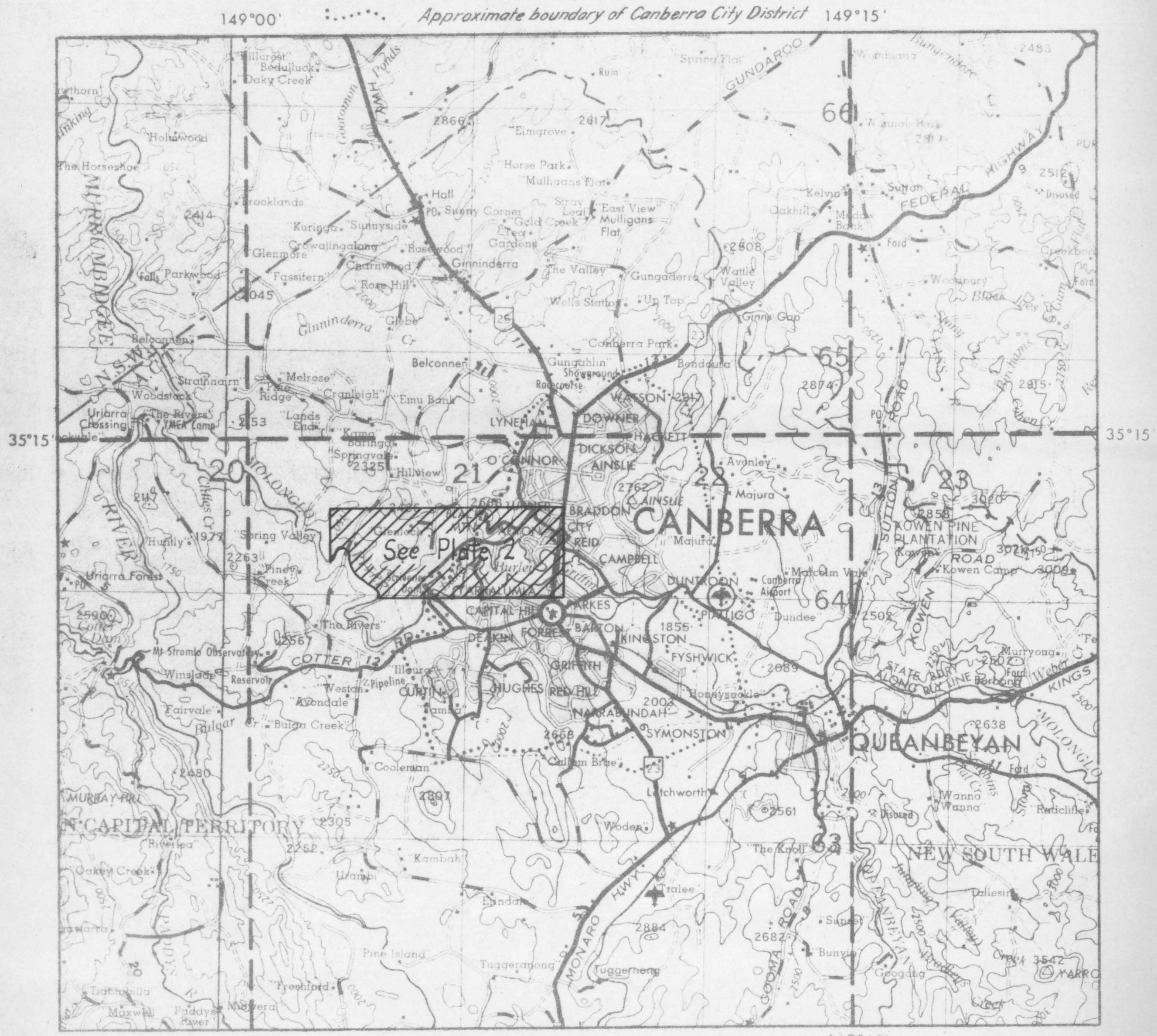
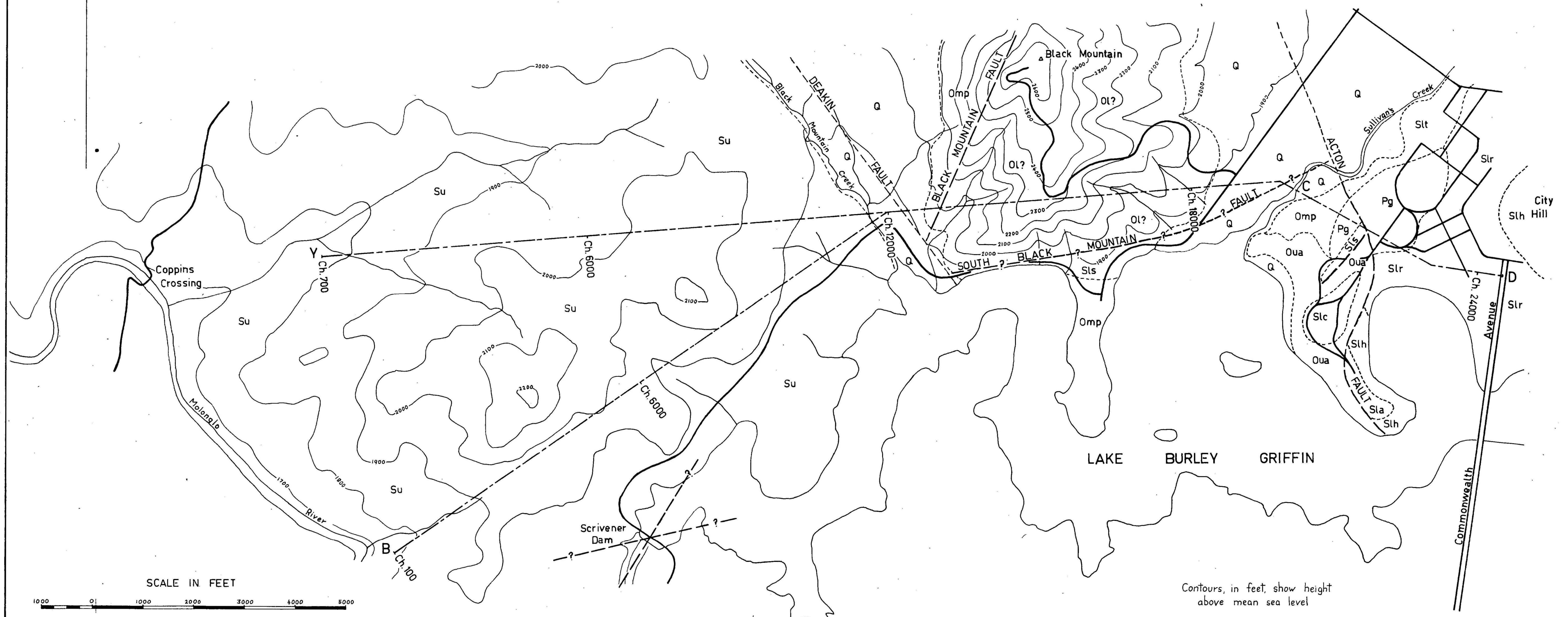


PLATE 2

NORTH MOLONGLO OUTFALL SEWER

INTERPRETATION OF SURFACE GEOLOGY ALONG TUNNEL LINES



REFERENCE

Q	Alluvium & scree
Pg	Gravel
Su	Porphyry & crystal tuff
Sla	Limestone
Slh	Shale
Slr	Interbedded shale, limestone & tuffaceous sediments
Slt	Calcareous mudstone
Sls	Shale
Slc	Sandstone
Oua	Siliceous black shale
Omp	Interbedded sandstone & shale
Ol?	Sandstone with minor thin shale beds

- Geological boundary, position approximate
- Established fault, position approximate
- Fault, inferred
- Fault, concealed
- Fault, inferred and concealed
- Road
- Proposed tunnel line

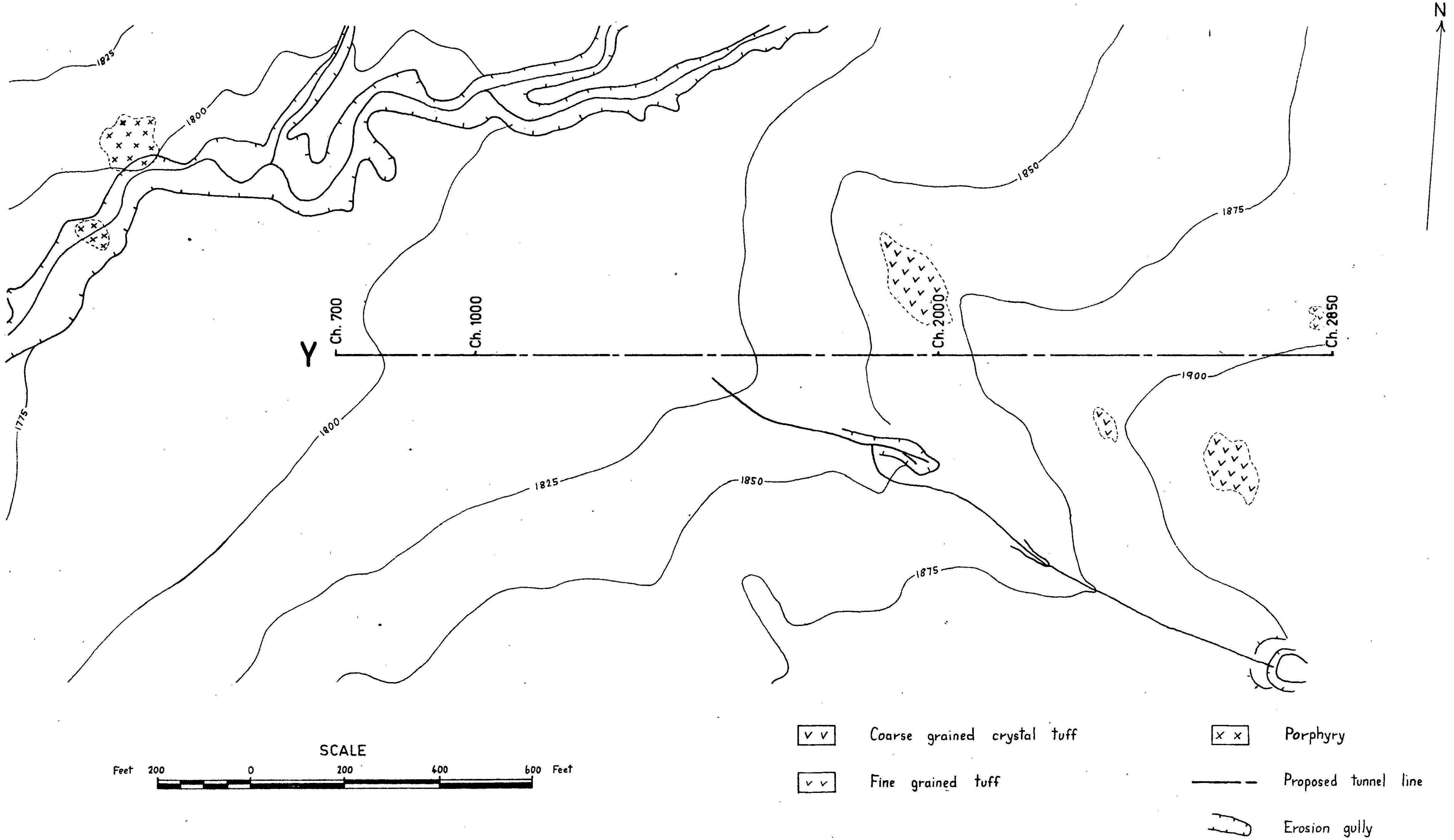
Bureau of Mineral Resources, Geology and Geophysics, July 1967 — Base map adapted from NCDC drawing TP 214/65 — To accompany Record 1968/110 — I55/A16/290

PLATE 3

NORTH MOLONGLO OUTFALL SEWER

ROUTE YCD - OUTLET TO CHAINAGE 2850 FEET

SHOWING SURFACE GEOLOGY



Bureau of Mineral Resources, Geology and Geophysics, July 1967

Base map adapted from Australian Capital Territory Detail Series GbD

I55/A16/291

To accompany Record 1968/110

NORTH MOLONGLO OUTFALL SEWER

ROUTE YCD - CHAINAGE 2850 TO 9900 FEET
SHOWING SURFACE GEOLOGY

Bureau of Mineral Resources, Geology and Geophysics, July 1967

Base map adapted from Australian Capital Territory Contour Series H6C

To accompany Record 1968/110

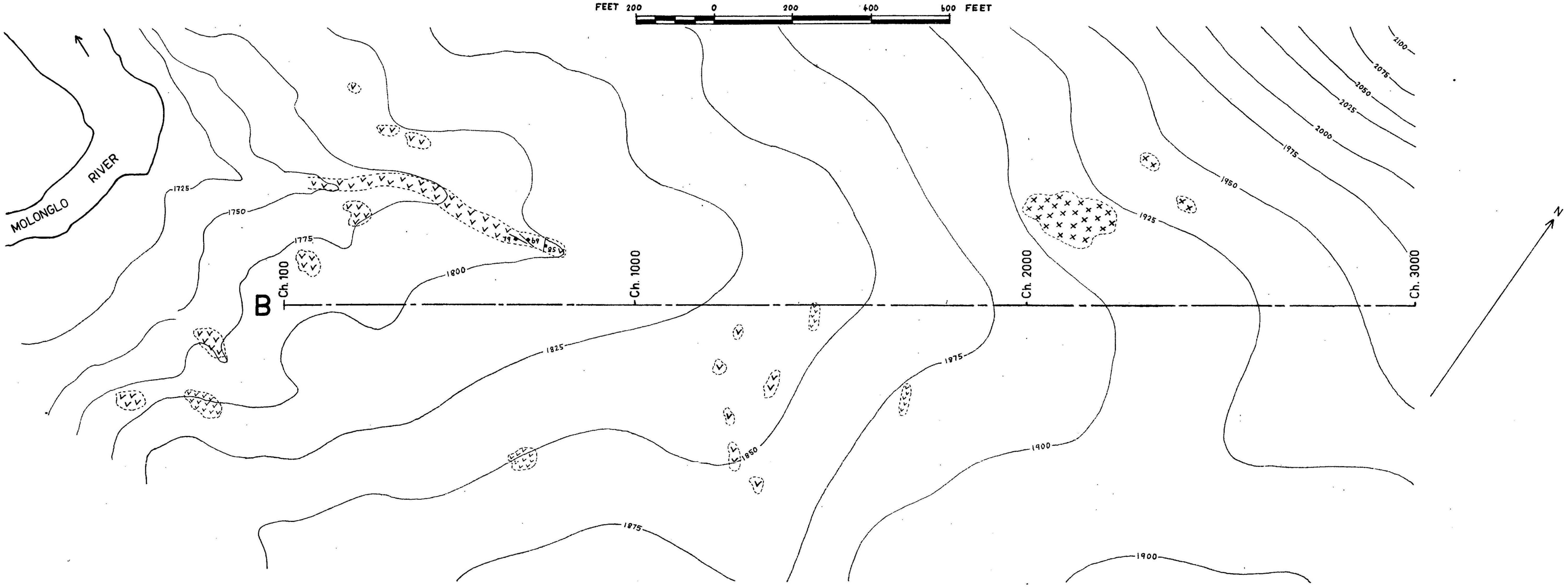
I55/A16/292

PLATE 5

NORTH MOLONGLO OUTFALL SEWER

ROUTE BCD - OUTLET TO CHAINAGE 3000 FEET

SHOWING SURFACE GEOLOGY



—— - - Proposed tunnel line

Outcrop

Porphyry

Coarse grained crystal tuff

Fine grained tuff and rhyolite

Joint showing dip

Bureau of Mineral Resources, Geology and Geophysics, July 1967

Base map adapted from Australian Capital Territory Detail Series G7B & H7A

I55/A16/293

To accompany Record 1968/110

NORTH MOLONGLO OUTFALL SEWER

ROUTE B C D - CHAINAGE 3000 TO 9900 FEET
SHOWING SURFACE GEOLOGY

Joint showing dip   Outcrop of porphyry

SCALE
FEET 200 0 200 400 600 FEET

Proposed tunnel line

Bureau of Mineral Resources, Geology and Geophysics, July 1967

Base map adapted from Australian Capital Territory Contour Series H6C & H7A and Detail Series H6D

To accompany Record 1968/110

155/A16/294


PLATE 7
N
NORTH MOLONGLO OUTFALL SEWER
CHAINAGE 9900 TO 16950 FEET SHOWING SURFACE GEOLOGY
Alluvial gravel
Soil and scree
Interbedded sandstone and shale
Sandstone
Porphyry
Dip and strike of bedding
Average dip and strike of joint system
Erosion gully
Proposed tunnel lines
SCALE
Feet 200 0 200 400 600 800 1000 Feet
Ch. 9900
Ch. 10000
Ch. 11000
Ch. 12000
Ch. 13000
Ch. 14000
Ch. 15000
Ch. 16000
Ch. 16950
LADY DENMAN DRIVE
BLACK MOUNTAIN DRIVE
Bureau of Mineral Resources, Geology and Geophysics, July 1967
Base map adopted from Australian Capital Territory Detail Series H6D
To accompany Record 1968/110
I55/A16/295

PLATE 8

NORTH MOLONGLO OUTFALL SEWER

CHAINAGE 16950 TO 24500 FEET

SHOWING SURFACE GEOLOGY AND DRILL HOLE INFORMATION

(See Plate 2 for generalized geology; all exposures of rock not shown)

AUSTRALIAN CAPITAL TERRITORY

DETAIL SERIES

To accompany Record 1968/110

Detail plotted from aerial photography on Wild A8 Stereoplotter

Date of photography February 1964

Co-ordinates are in feet with origin at Strom Trig. Station

INDEX TO ADJOINING SHEETS

SCALE

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

Geology by Bureau of Mineral Resources, Geology and Geophysics, July 1967

J6C

FIRST EDITION

I55/A16/296

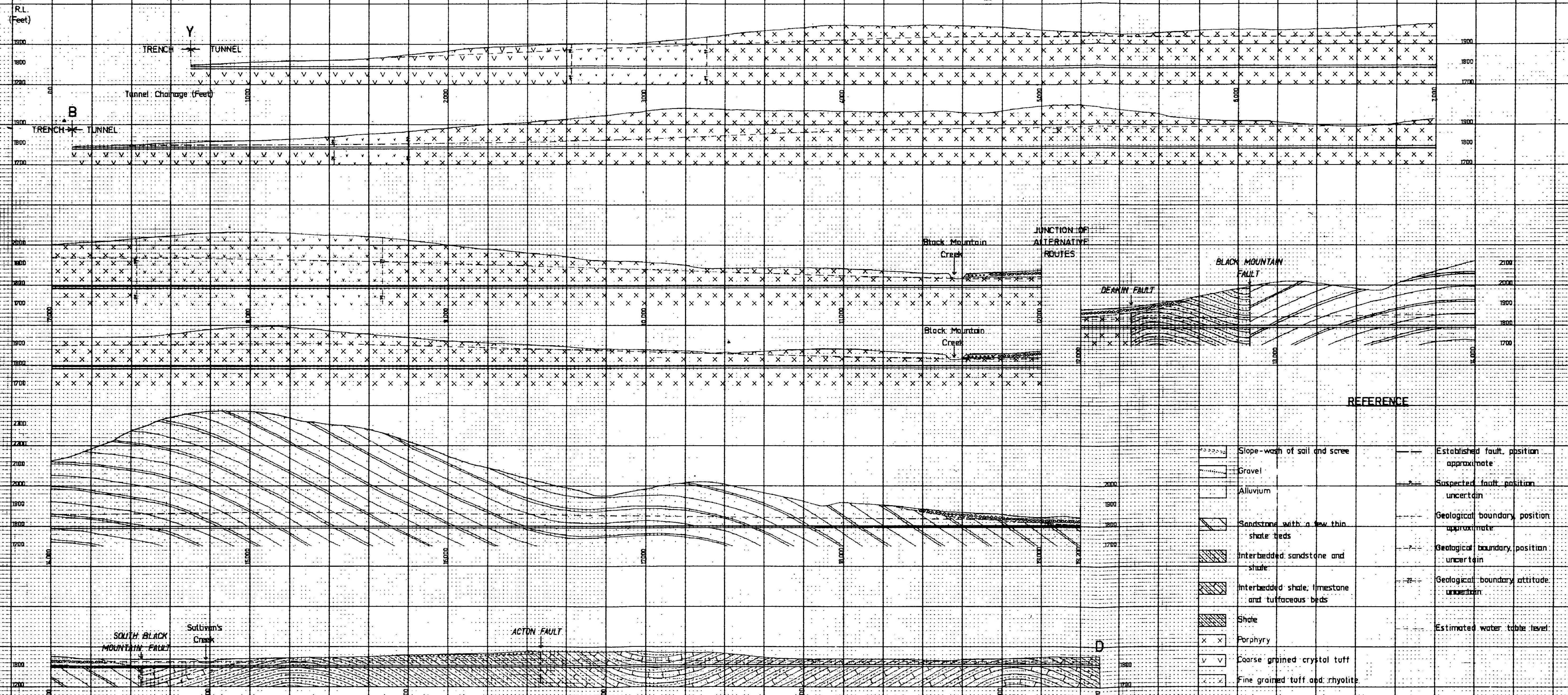
PLATE 9

NORTH MOLONGLO OUTFALL SEWER

GEOLOGICAL SECTIONS ALONG PROPOSED TUNNEL LINES

SCALE

Feet 400 0 400 800 Feet



Bureau of Mineral Resources, Geology and Geophysics. October 1967

To accompany Record 1968/110

155/A16/297