

Rept. Bk. No. 56/14
G.S. No. 2525
D.M. 1067/58
N.F.M. 143

ENG. GEOLOGY SECTION



**DEPARTMENT OF MINES
SOUTH AUSTRALIA**

GEOLOGICAL SURVEY

NON FERROUS METALS SECTION

GEOLOGICAL INVESTIGATION HAPPY VALLEY RESERVOIR OUTLET TUNNEL

GEOLOGY OF OUTLET TOWER AND CULVERT FOUNDATIONS

- E. & W. S. DEPARTMENT -

by

W. Johnson
Senior Geologist

56/14
64-16

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INTRODUCTION:

The Mines Department was requested to investigate the geology of the outlet tower and culvert by drilling seven holes into rock along the tunnel route from the outlet tower to a point approximately 1600 ft. from the tower. Of these holes, three were to be drilled on the site of the tower and four along the tunnel route. The holes were drilled from a pentagon by diamond drill between December 4, 1962 and December 15, 1962. Mr. R.D. Steel of this Department supervised the drilling and logged the cores and constructed the geological sections accompanying this report.

GEOLOGY AND ENGINEERING GEOLOGY:

The general geology of the Happy Valley tunnel route and Happy Valley reservoir area has been discussed in two previous reports*.

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- * W. Johnson, 1961. Geological Investigations, Happy Valley Reservoir Outlet Tunnel Interim Report.
G.S. 2106, R.B. 53/61, D.M. 1067/58, UAF 99
 - * A.A. Gibson, 1958. Report on the Preliminary Investigation of the Happy Valley Reservoir Inlet and Outlet Tunnels, Hd. Nearlunga.
Unpub. Rept. Dept. Mines, S.A. 47/158, G.S. 1212.
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The particular arm of the reservoir from which the outlet tunnel takes off is underlain by Tapley Hill Slates covered by a varying thickness of superficial alluvium which is in turn overlain by a thin layer of silt deposited since the reservoir was constructed. Previous drilling on dry land indicated that the Tapley Hill Slates are uniform lithologically over a considerable area and are weathered to a depth exceeding 70 ft. The severity of weathering varies with the topographic situation and the geological structures which have dislocated and fractured the rock.

Details of geological conditions at the outlet tower site and along the tunnel route are shown in the accompanying geological sections. All drillholes were terminated in moderately hard weathered Tapley Hill Slate. All except D.D.H. No. 7 penetrated four layers of un-cemented superficial deposits which can be regarded as transported material. These are numbered on the sections in descending order from 1 to 4. Layer 1 is a greyish to bluish-grey, soft and wet, silty clay to clayey silt. This is almost certainly silt deposited since the reservoir was constructed. Layer 2 is a mid-grey and bluish, grey, firm, and moist, silty to very silty clay. This too may have been deposited since the reservoir was built. Layers 3 and 4 consist respectively of brownish to buff and yellow-brown, firm and moist, silty to very silty clay, with some grit and gravel fragments, underlain by a greyish to grey-brown and yellow-brown, silty to very silty clay, usually with abundant shale fragments. These two layers are almost certainly superficial wash deposited in the gullies of the old drainage system in pre-reservoir times. Between drillholes D.D.H. 4 and D.D.H. 6 layers 1 to 4 have a relatively uniform overall thickness with a thinning at D.D.H. 4 over a bedrock high. At the site of Drillhole D.D.H. 7 layers 1 and 2 are missing.

The gravelly silty clay designated as layer No. 4 overlies a highly weathered bedrock converted almost wholly to a silty clay and containing some harder lumps. This layer grades downwards over a narrow zone into less highly weathered bedrock which can be described as a medium hard shale in the engineering sense. Between D.D.H. 5 and D.D.H. 7 highly weathered bedrock is fairly uniform in thickness, varying from 4 to 7 feet. It thins to approximately 2 ft. in D.D.H. 4 and thickens to 12 ft. in D.D.H. 2 at the outlet tower site. Combined layer 3 and 4 also thickens at the outlet tower site and the medium hard bedrock is from 26 ft. to 29 ft. under the reservoir bottom.

All the layers designated 1 to 5 in the section will probably be unstable when moist and the sides of an open cut excavated in them will be unstable in wet weather. If the tunnel invert is as suggested at about R.L. 542, then it will be in the moderately hard, weathered Tapley Hill Slate from a point approximately 100 ft. from the outlet tower side of D.D.H. 4. From this point to the outlet tower the highly weathered bedrock and moderately hard weathered bedrock interface falls away fairly rapidly. The bearing strength of layers 1 to 4 and possibly layer 5 could be quite low when saturated with water, which presumably will be their normal condition between D.D.H. 4 and D.D.H. 2. Special design provisions will be required to cope with the change in loading between the outlet tower and the culvert and possibly for the change in physical properties which will occur in the foundation material over a zone approximately 200 to 300 feet in length, 1000 ft. south of D.D.H. 4.

CONCLUSION:

The majority of that part of the outlet tunnel to be built as culvert will rest on a moderately hard shale formed by the weathering of Tapley Hill Slate and the main problem in construction will be maintenance of side slopes of the open cut in wet weather. At D.D.H. 7 the interface between soft weathered

bedrock and moderately hard weathered bedrock is at R.L. 571 and it should be possible to establish a tunnel portal here or in close proximity. At the outlet tower site soft clayey silts and soft shales extend to a depth of 25 ft. to 29 ft. Settlement must be anticipated in all layers above these depths.



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APPENDIX

DRILL CORE LOGS

ROTARY DRILL LOG 1

PROJECT:
LOCATION:

HAPPY VALLEY OUTLET TUNNEL TOWER

PURPOSE:

Test of Subsurface Foundation Conditions

<u>Plant No.:</u>	24	<u>Driller:</u>	J. Jensen
<u>R.L. Reservoir Bottom:</u>	541.9'	<u>Depth below bottom:</u>	26'
<u>Date Commenced:</u>	4.12.62	<u>Date Completed:</u>	4.12.62
<u>Bars Logged:</u>	R.D. Steel	<u>Date:</u>	5.12.62
<u>Drill No.:</u>	1067/58	<u>Bar Serial No.:</u>	70/62

Depth		Description
0'	- 2'0"	Light grey and light bluish-grey clayey silt, with few small mica flecks. Soft and wet.
2'0"	- 4'0"	Mid-grey, light grey and bluish-grey silty clay. Firm and very moist.
4'0"	- 6'4"	Mid-grey to bluish-grey and slight brownish-grey, firm and moist silty clay, with few small grit fragments, plant remains and patches of dark organic matter.
6'4"	- 11'0"	Brownish to greyish-brown and buff silty clay. Firm and very moist. Scattered rounded grit and gravel fragments, with small limy nodules and pebbles.
11'0"	- 13'	Brownish and buff silty clay, may be finely sandy in part. Very firm, moist. Few patches dark charcoal matter and odd lime coated stone fragments.
13'	- 16'	Greyish, brown, dark yellow-brown and lesser reddish-brown mottled silty to very silty clay, may be finely sandy in part. Fairly stiff, moist. Irregularly abundant rounded grit, gravel and some stone, ironstained in part.
16'	- 19'	Grey, light grey, grey-brown, brown and yellow-brown mottled silty to very silty clay, with irregularly abundant grit and gravel fragments.
19'	- 21'	Greyish-brown and yellowish-brown silty to very silty clay, with irregularly abundant rounded grit and gravel fragments, some hard and ferruginous.
21'	- 23'	Mainly rounded grit, gravel and small stone fragments, with pockets of light greyish, brown and yellow silty clay. Firm and very moist.
23'	- 26'	Weathered shale. Light greyish, brown and yellow brown mottled. Compact to friable and moist, but with some harder lumps.

END OF HOLE 26' below bottom

DEPTH OF WATER 41'0"

ROTARY DRILL LOG NO. 2

PROJECT:
LOCATION:

HAPPY VALLEY OUTLET TUNNEL TOWER

PURPOSE:

Test of Subsurface Foundation Conditions

<u>Plant No.:</u>	24	<u>Driller:</u>	J. Jensen
<u>R.L. Reservoir Station:</u>	342.05'	<u>Depth:</u>	33'6"
<u>Date Commenced:</u>	5.12.62	<u>Date Completed:</u>	6.12.62
<u>Bore Logged:</u>	R.D. Steel	<u>Date:</u>	7.12.62
<u>Drill No.:</u>	1067/58	<u>Bore Serial No.:</u>	71/63

Depth		Description
0'	- 1'7"	Greyish, grey-brown and mid-grey silty clay, becoming very silty to finely sandy irregularly. Few small plant and grit fragments.
1'7"	- 4'7"	Greyish to mid-grey and slight bluish-grey silty clay, with scattered small lime nodules, grit and gravel fragments and organic pockets. Fairly firm, moist.
4'7"	- 8'6"	Brownish, buff and greyish-brown silty to very silty clay, with few rounded grit and gravel fragments and small lime nodules. Firm and moist.
8'6"	- 10'4"	Brownish to greyish-brown, buff and yellow-brown, silty to very silty clay, with few small limy patches, odd grit and gravel fragments. Firm and moist. Slight ironstaining in part.
10'4"	- 13'0"	Light greyish, brown, light and dark yellow-brown and slight reddish-brown mottled silty to very silty clay. Firm to fairly stiff and moist. Scattered grit and small gravel fragments, few plant remains and pockets of dark charcoal matter.
13'0"	- 14'9"	Greyish silty clay, with brown, yellow-brown and slight reddish mottling. Very firm, moist. Few pockets of dark grey organic matter, scattered grit and ironstained gravel fragments.
14'9"	- 16'6"	Greyish, brown, yellow-brown and slight reddish mottled, firm and moist silty clay, with fairly abundant small lumps of slate and quartzite, some heavily ironstained.
16'6"	- 19'7"	Light grey, light and dark yellow-brown mottled weathered shale. Fairly firm, but friable and moist. Irregular lumps of brownish and reddish-brown harder material.
19'7"	- 24'1"	Mainly light grey very weathered shale, with irregular light and dark yellow and yellow-brown mottling. Firm, moist and fairly friable generally, but with occasional harder more resistant lumps.

Depth	Description
24'1" - 28'1"	Mainly light grey, light and dark yellow-brown, brownish and reddish-brown irregularly mottled weathered shale. Firm to friable, but harder in part. Some dark grey ferruginous mottling.
28'1" - 33'6"	Shale. Coarsely mottled, reddish-brown, light grey, yellowish, brownish and yellow-brown. Fairly hard, breaks easily along cleavage planes. 2 almost vertical, other 45°.

END OF HOLE

33'6" below Reservoir bottom

Depth of water 41'1"

ROTARY DRILL LOG NO. 1**PROJECT:
LOCATION:****HAPPY VALLEY OUTLET TUNNEL****PURPOSE:****Test of Subsurface Foundation Conditions****Plant No.:****R.L. Reservoir Bottom:**

541.92'

Date Commenced:

6.12.62

Barre Lensed:

R.D. Steel

Bucket No.:

1067/58

Driller: J. Jensen**Depth:** 32'6"**Date Completed:** 7.12.62**Date:** 7.12.62**Barre Serial No.:** 72/63

Depth	Description
0'0" - 2'0"	Greyish, mid-grey and brownish-grey soft and very moist silty clay, with few grit and small plant fragments.
2'0" - 3'6"	Mid-grey and greyish slightly silty clay. Firm and moist. Few small grit and gravel fragments.
3'6" - 5'0"	Mid-grey, firm to fairly stiff silty clay, becoming greyish-brown at depth. Fairly abundant small grit and gravel sized fragments of weathered shale.
5'0" - 7'0"	Light brown to light grey-brown and light reddish-brown, firm and moist, very silty clay. Few limy nodules and small greyish clay pockets.
7'0" - 12'6"	Mainly brownish silty to very silty clay, with irregular yellowish-brown and reddish-brown mottling. Firm and moist. Scattered grit and gravel fragments, lime and charcoal pockets.
12'6" - 16'2"	Greyish, brown and yellowish-brown mottled very silty to finely sandy clay and silt. Firm and moist. Scattered grit and gravel fragments, few small organic pockets etc.
16'2" - 17'6"	Weathered shale: Mainly light grey to offwhite clay, with some brown and yellow-brown mottling. Compact, to fairly stiff, with abundant harder slate and shale fragments.
17'6" - 24'6"	Weathered shale: Light grey, off-white, brown, light and dark yellow-brown mottled. Clayey and fairly friable, with irregular harder lumps. Few small limy pockets.
24'6" - 26'6"	Light grey to off-white fine grain weathered shale, with some brown and yellow-brown mottling. Generally semi-hard to somewhat friable, strongly jointed.
26'6" - 29'0"	Coarsely mottled off-white, light grey and yellow-brown shale. Fairly hard, but well broken up by jointing.
29'0" - 32'6"	Pinkish, yellow-brown and slight greyish mottled fairly hard shale. Steeply dipping, jointing steep and spaced about 6".

END OF HOLE

32'6" below Reservoir bottom.

Depth of Water 42'6"

ROTARY DRILL LOG NO. 4

PROJECT:
LOCATION:

HAPPY VALLEY OUTLET TUNNEL TOWER

PURPOSE:

Test of Subsurface Foundation Conditions

Plant No.: 24
R.L. Reservoir Bottom: 555.0'
Date Commenced: 10.12.62
Bars Logged: R.D. Steel
Batch No.: 1067/38

Driller: J. Jensen
Depth: 16'6"
Date Completed: 10.12.62
Date: 11.12.62
Bar Serial No.: 77.63

Depth	Description
0'0" - 1'6"	Brownish and greyish-brown, soft and very moist silty clay. Few small organic pebbles, plant fragments, small grit and gravel.
1'6" - 2'6"	Greyish-brown, brown and slight reddish-brown mottled silty to very silty clay. Firm to compact and moist. Small lumps of yellowish weathered shale.
2'6" - 6'0"	Greyish, brownish, yellow-brown and slight reddish-brown mottled firm and moist silty clay, with irregularly abundant fragments of brownish and yellowish-brown, soft weathered shale.
6'0" - 7'0"	Greyish to light yellowish-brown shale. Fairly hard, somewhat broken near top. Steeply dipping.
7'0" - 16'6"	Greyish to yellowish-brown hard massive shale. Some ferruginous staining along joint planes. Slaty cleavage almost vertical. Cross jointing 45°. 9"-1'0" apart.

END OF HOLE

16'6" below Reservoir Bottom

Depth of Water 29'0".

ROTARY DRILL LOG NO. 5

PROJECT:
LOCATION:

HAPPY VALLEY OUTLET TUNNEL TOWER

PURPOSE:

Test of Subsurface Foundation Conditions

Plan No.: 24

Driller: J. Jensen

R.L. Reservoir Bottom: 558.56'

Depth: 20'

Date Commenced: 11.12.62

Date Completed: 11.12.62

Rare Logged: R.D. Steel

Date: 12.12.62

Booklet No.: 1067/58

Rare Serial No.: 78/63

Depth	Description
0'0" - 1'6"	Greyish, to dark grey and greyish-brown soft and very moist clay, with few plant and grit fragments.
1'6" - 4'0"	Greyish to mid-grey and brown-grey very silty clay, with some yellow-brown mottling in part. Generally firm and moist, but with softer moister bands. Scattered grit and gravel fragments.
4'0" - 5'3"	Yellowish-brown and greyish mottled, firm to fairly stiff and moist silty clay. Peckets dark grey organic matter, scattered grit and gravel fragments, generally but abundant from 4'9".
5'3" - 7'6"	Greyish to slight bluish-grey weathered shale, with irregular brown and yellow-brown mottling. Firm and moist generally, but harder in parts. Few root fragments.
7'6" - 11'0"	Greyish weathered shale, with irregular brownish, dark yellow-brown and slight reddish-brown ferruginous mottling. Very silty and somewhat limy in part. Firm to compact and somewhat friable.
11'0" - 12'0"	Light greyish and yellow-brown weathered shale. Fairly hard broken lumps -- 2" size
12'0" - 15'0"	Light grey weathered shale, with brown and dark yellow-brown mottling. Becoming very silty clay to clayey silt irregularly. Firm, moist to somewhat friable generally, but with some harder lumps.
15'0" - 20'0"	Light greyish to slight greenish-grey silty shale, with vague yellow-brown mottling. Generally fairly hard lumps 2" to 3" size, somewhat softer and more friable irregularly. Steeply dipping, jointing near vertical. Some dark grey dendritic staining.

END OF LOG 20'0"

Depth of Water 25'0".

PERCUSSION DRILL LOG NO. 6

PROJECT:
LOCATION:

HAPPY VALLEY OUTLET TUNNEL

PURPOSE:

Test of Subsurface Foundation Conditions

Plant No.:	24	Driller:	J. Jensen
R.L. Reservoir Bottom:	564.8'	Depth:	20'
Date Commenced:	13.12.62	Date Completed:	13.12.62
Bars Logged:	R.D. Steel	Date:	14.12.62
Batch No.:	1067/38	Bars Serial No.:	79/63

Depth	Description
0'0" - 1'0"	Greyish and brownish mottled, soft and very moist silty clay, with few small plant remains.
1'0" - 1'6"	Small quartzite boulder.
1'6" - 3'0"	Mid-grey and greyish-brown silty clay. Firm and moist. Scattered small lime pebbles, occasional gravel and small stone.
3'0" - 5'6"	Greyish, greyish-brown and yellowish-brown silty clay. Stiff and moist. Scattered grit, gravel and organic fragments and small lime nodules.
5'6" - 7'10"	Mainly light grey silty clay, with irregular brown and dark yellow-brown mottling. Firm to fairly stiff and moist. Scattered grit, gravel and stone fragments and dark organic pebbles.
7'10" - 10'0"	Greyish, brown, yellow-brown and slight reddish-brown mottled silty to very silty clay. Firm and moist. Scattered grit and gravel fragments. Some pebbles of dark yellow and reddish ferruginous mottling.
10'0" - 13'6"	Greyish, yellow-brown and brownish silty clay. Fairly soft and moist. Numerous subrounded grit, gravel and small stone fragments.
13'6" - 14'6"	Greyish-brown and yellowish-brown weathered shale. Compact to firm and somewhat friable. Scattered gravel lumps.
14'6" - 15'3"	Light grey and yellow-brown silty to very silty clay, with abundant gravel and small stone fragments.
15'3" - 17'0"	Mainly greyish to light greenish-grey highly weathered shale, with irregular yellowish and brownish mottling. Soft and very moist. Few hard ironstained nodules.
17'0" - 20'0"	Light greenish-grey shale, with irregular light brownish and yellowish mottling. Generally fairly hard to somewhat crumbly, but with bands of softer clayey material. Fairly abundant dark grey dendritic staining.

END OF HOLE

20'0" below Reservoir Bottom

Depth of Water 18'6".

ROTARY DRILL LOG NO. 7**PROJECT:**
LOCATION:**HAPPY VALLEY OUTLET TUNNEL****PURPOSE:****Test of Subsurface Foundation Conditions**

Plant No.:	24	Depth:	18'6"
R.L. Reservoir Bottom:	578.0'	Driller:	J. Jensen
Date Commenced:	14.12.62	Date Completed:	14.12.62
Bars Logged:	R.D. Steel	Date:	15.12.62
Bucket No.:	1067/58	Bar Serial No.:	80/63

Depth	Description
0'0" - 1'0"	Reddish-brown and brownish mottled firm and moist silty clay, with irregularly numerous shale fragments.
1'0" - 2'6"	Brownish, yellowish-brown, slight reddish-brown and offwhite mottled, firm and moist silty clay, with lumps of weathered shale irregularly.
2'6" - 4'6"	Brownish, offwhite and light yellowish-brown weathered shale with some darker brown ferruginous mottling. Irregularly friable to semi hard and moist.
4'6" - 6'10"	Offwhite and brownish coarsely mottled weathered shale. Semi hard to somewhat crumbly.
6'10" - 11'6"	Generally brownish to yellow-brown shale, with lesser reddish-brown and offwhite mottling. Fairly hard, lumps averaging 2" size.
11'6" - 18'6"	Mainly brownish to yellowish-brown shale, with small bands of ferruginous matter. Joints spaced about 6"-1'0" apart. One 45° parallel to bedding, other about 90° to it, dipping 60°-70°. Some quartz gravel at 13'6"-13'9".

END OF HOLE 18'6"
Depth of Water 6'6".