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DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL INVESTIGATION OF MOUNT GAMBIER PUMPING STATION ACCESS TUNNEL

- E. & W. S. DEPARTMENT -

INTRODUCTION:

A new pumping station is to be built in the Blue Lake crater to supply Mount Gambier with water. Access to this pumping station by a tunnel from the bottom of an old pumping shaft is proposed. The new pumping station is to be built adjacent to the existing station in an area where unstable overhanging lava rock could create some difficulties.

Following a request from the Deputy Engineer-in-Chief, E. & W. S. Department, for a geological investigation of the tunnel route and the stability of the overhanging lava rock, inspection and mapping was done on the 28th August, 1962. The geology and engineering geology of this project is discussed below.

LOCATION & TOPOGRAPHY: PLAN: 62-629

The existing pumping station consists of several pumps installed in buildings on a small bench cut into the slope of the Blue Lake crater at Mount Gambier 21 feet above water level Access to this bench is had by a steep set of iron steps leading down from the old pumping station established on a bench cut into the crater wall at a much higher level. The old pumping station drew water from a circular shaft approximately 150 feet deep, sunk through the lava and underlying limestone. The proposal is to drive an almost horisontal tunnel from or to this shaft along one of two alternate routes shown on the attached plan. The existing level of the floor of the old pump house is R.L. 300 approximately. Invert level of the tunnel is R.L. 180 and

roof level is R.L. 188.

GEOLOGY:

The general geology of the Mount Gambier volcanic cones is discussed by Fenner*. Fenner believes that the volcanic activity in the Mount Gambier area was mostly cataclysmic and of short duration. The extent of the volcanic eruption and its time of duration is less important in the present investigation than its manner. It appears from evidence disclosed by the mapping that the volcanic pipe now occupied by the Blue Lake was drilled through a series of fossiliferous limestones (Gambier Limestone) by an explosive eruption. This initial eruption deposited a thin layer of pyroclastic material consisting of mixed pebbles and granules of vesicular basalt lava and grains of sand and limestone from the sediments through which the volcanic pipe was drilled. The next event was the effusion of a molten lava, very gassy in the initial stages of eruption. This was followed by further series of explosive eruptions which built up the main bulk of the volcanic cone. Following the cessation of cone building, the pipe filling material collapsed leaving a caldera which filled with groundwater which became the present Blue Lake.

Subsequent to the formation of the caldera and perhaps during the formation of the volcanic pile, radial and circumferential joints formed in the rocks elastically competent that is the limestones and the lava principally.

Again following the formation of caldera sub-aerial erosion of the pile commenced modifying its original form to that which exists to-day. At a few locations around the crater piles of talus accumulated where the crater slopes were shallow. The pumping station is excavated in one of these areas.

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* FENNER, C.F. 1924. Craters and Lakes of Mount Gambier, South Australia. Trans. R. Soc. S.Aust., Vol. LXV, 1924, pp. 169-205.

The succession of rocks discussed above is exposed in the present pumping station excavation and the walls of the crater. Gambier Limestone outcrops to approximately R.L. 205 and is overlain by red to red-brown powdery friable silt or silty, very fine grained sand. The limestone as exposed in the pumping station excavation is a white to creamish hollow crystalline finely grained fossiliferous material varying from very hard to soft and moderately friable. Irregular layers of hard crystalline nodular calcareous material parallel to the bedding can be observed in it.

Solution cavities along joints and bedding planes can be observed also in the limestone. One, east of the pumping station extends at least 15 feet back from the present surface in a horizontal plane.

The contact between the limestone and the overlying sand where exposed is undulating and the most probable explanation of its nature is that it represents an old soil resulting from the weathering of the limestone before the volcanic action took place. The next layer superimposed on top of the old soil is the well bedded pyroclastic material. This varies in physical characteristics from hard, well cemented rock to a soft, friable material which can be crumbled in the fingers. In the vicinity of the pumping station site and the old shaft it is 15 inches to 24 inches thick.

Resting on top of the pyroclastics is a layer of grey purple-brown weathering lava. Where examined, lenticular bodies of very highly vesicular and scoriaceous lava with ropey structures in it, occur at its base. These may be up to 6 feet thick and 20 to 30 feet wide or long. The lava whether highly vesicular or more normal is extremely hard and tough. In the vicinity of the pumping station it is 8 to 12 feet thick. Elsewhere around the crater it appears to reach a thickness of 20 to 30 feet. The succession above the lava is not of immediate interest in this investigation.

ENGINEERING GEOLOGY:

Tunnel Route

A geological section along the two alternative tunnel routes is shown on the attached plan. The tunnel back will be close to the contact of the limestone and the overlying red sand. As this sand probably represents an old soil profile, irregular solution of the limestone at the contact can be expected. Therefore a tunnel in the limestone at the proposed level may encounter solution cavities filled with the weathering products of the limestone. These may be either sand or clay or any mixture of the two. Other solution cavities within the limestone are almost certain to be met. The location and dimensions of these cannot be predicted. Because of these geological factors tunnelling should proceed cautiously.

Apart from these factors the limestone should form a good tunnelling medium. Excavation in it will be easy and it is strong enough to support itself except where its contact with the overlying red sand descends close to the excavation level of the tunnel roof. Again except in such situations permanent structural support of the tunnel is probably not necessary. However, it is friable and liable to fretting on exposure as shown by the behaviour of the present pumping station excavation. Therefore arrangements for some form of protective lining may be necessary. It should not be difficult to establish a portal for the tunnel in the existing wall of the pumping station excavation.

Stability of Basalt

The basalt layer above the proposed site of the new pumping station was examined in company with Messrs. [illegible] Martin, and [illegible] Mannon. Some blocks of basalt have commenced to move out along sets of intersecting joints following a very minor amount of excavation at the toe of the basalt layer. It is believed that any extensive excavation for the pumping station further

down the slope will cause a much greater movement of the basalt. It is therefore suggested that before this excavation is done the basalt be removed to an existing circumferential joint line indicated to Mr. Martin in the field and the basalt wall thus left be rock bolted. This bolting should be carried around the basalt layer behind the existing pumping station to a point westward of the proposed access tunnel portal. Rock bolts, if used, should be a minimum length of 15 feet so as to incorporate solid basalt beyond the influence of surface joints.

CONCLUSION AND RECOMMENDATIONS:

The proposed access tunnel for the new pumping station will be entirely in Mount Gambier Limestone 8 to 14 feet below its contact with an overlying old soil profile. Tunnelling conditions should be good but the Supervising Engineer and tunnellers should be prepared to meet rotten ground and running sand in the vicinity of solution cavities formed along joints or in past ages below the old soil. Provision for protective lining of the tunnel to prevent fretting of the limestone may be necessary.

The establishment of a portal in the face of the present pumping station excavation at the easternmost route should be easier than at the intersection of the alternative route with the present surface of the crater slope.

Stabilisation of the basalt above the present pumping station of the proposed tunnel portal and the proposed new pumping station site is required. It is recommended that this be done by excavation of portion of the basalt as discussed with Mr. Martin and insertion of rock bolts from east of the proposed pumping station site to west of the proposed tunnel portal.

W. Johnson
Senior Geologist
FERROUS METALS SECTION

WJ:AGK
14/9/62


ORIGINAL PUMPING STATION
SHAFT Rad - 3'3"
Gate
Steps and path
PROPOSED TUNNEL
ALTERNATIVE PROPOSAL
℄ of Road
℄ of old Track
STONE PUMP-HOUSE
G.I. PUMP-HOUSE
Extent of Bench
Steps
Wooden Walkway
WALKWAY A
WALKWAY "A"
WALKWAY "B"
Steel Hoist
Pipe
LONGITUDINAL SECTION OF ALTERNATIVE TUNNEL
Boundaries of bedded tuff & red sand assumed
Invert
Tunnel
Baseline R.L. 180
WALKWAY "A"
ALTERNATIVE WALKWAY "B"
℄ Shaft 7'6" Diam.
SCALES HORIZONTAL 40 feet to 1 inch
VERTICAL 20 feet to 1 inch
LONGITUDINAL SECTION OF PROPOSED TUNNEL
Bottom of old pump shaft
SCALE OF PLAN
Feet 10 5 0 10 20 30 40 50 Feet
LEGEND
Soils & talus.
Brown tuff "ash" unsorted or stratified pyroclastics with "bombs" of grey vesicular basalt & boulders limestone & quartzite.
Dark grey fine grained to aphanitic basalt with vesicular layers & lenses of highly vesicular scoreaceous basalt at base
Brown prominently bedded pyroclastic & clastic sand or gravel.
Red to red brown silty to very fine sand (Old soil profile).
Cream finely crystalline hard to soft fossiliferous limestone, clastic in part. Solution cavities & caves along joints.
10 174.5 Spot heights (with Number and Reduced Level)

To accompany report by W. Johnson

S.A. DEPT. OF MINES

Associated Drawing	No.	No.	Amendment	Exd.	Date

Req. No.
D.M.
Compiled from

GEOLOGICAL INVESTIGATION
MT GAMBIER PUMPING STATION ACCESS TUNNEL ROUTE
PLAN AND GEOLOGICAL SECTION

Approved | Passed
Director of Mines

Drn.
Tcd. F.B.
Ckd.
Exd.

Scale: 10 feet to 1 inch
62-629
Kd 17
Date 14 - 9 - 62