

Abstract

Enough surface water should be available to supply a proposed mining operation at Mt Nicholas. Because of irregular flows in the small streams in the area, a storage would have to be constructed. Surveys to contour the area around proposed dam sites, geological and geophysical surveys, and subsurface investigations should be undertaken for any proposed storage area.

Conditions appear favourable for groundwater to be considered as an alternative to a surface supply. One or more bores drilled in the Permian sediments may be capable of supplying sufficient water. Sites on the edge of the flood plain of the Break O'Day River are probably the most favourable areas for investigation.

INTRODUCTION

The Shell Company of Australia Ltd requested advice on possible water sources for a proposed mining operation at Mt Nicholas. An annual quantity of about 120 million litres of water would be required. Water of reasonable quality is desired, because apart from the main requirement for washing coal, the water would also probably be used for other aspects of the operation, i.e. showers, hot water services.

There are two possible sources of water; surface water from the streams that flow down the slopes of the Nicholas Range and groundwater.

TOPOGRAPHY

The proposed mining site, near the old Mt Nicholas mine, is situated on slopes which rise about 600 m from the flood plain of the Break O'Day River to the summit of Mt Nicholas. The average slope angle is about 10°, but there are localised areas much steeper than this and other areas where the slope is shallower. The streams running down the slopes near the mine area are relatively small, and apart from the stream east of the old railway formation to the mine, are shallowly entrenched.

The Break O'Day River has a flood plain about three kilometres wide in the Mt Nicholas area. Flooding is fairly common during winter.

GEOLOGY

The geology of the area has been mapped by Calver and Baillie (in prep.) and Figure 1 is entirely derived from their work.

The southern slopes of the Nicholas Range are underlain by Triassic lithic sandstone (containing the coal measures) and mudstone beds, with a dominantly quartz sandstone at the base. Basalt is interbedded with and intrudes at shallow angles into the Triassic sediments (Calver and Castleden, 1981; Calver and Baillie, in prep.). Exposures of basalt occur east and north-west of the proposed mine area.

The Permian rock sequence underlying the Triassic sediments consists of pebbly mudstone, pebbly sandstone, fossiliferous siltstone, and massive limestone. These rocks crop out around St Marys (east of the mine site), around the lower slopes of Mt Durham (west of the mine site), and small

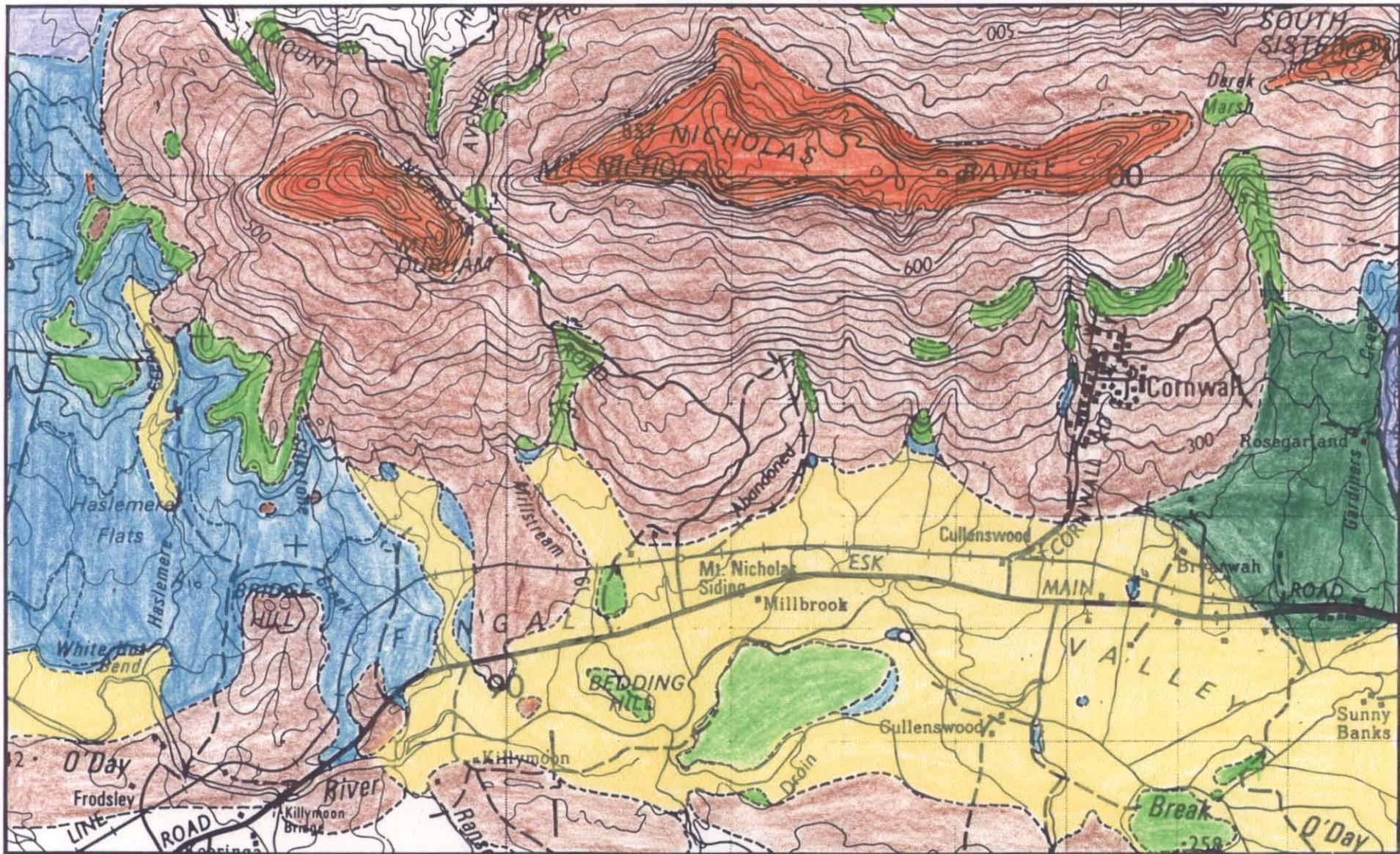
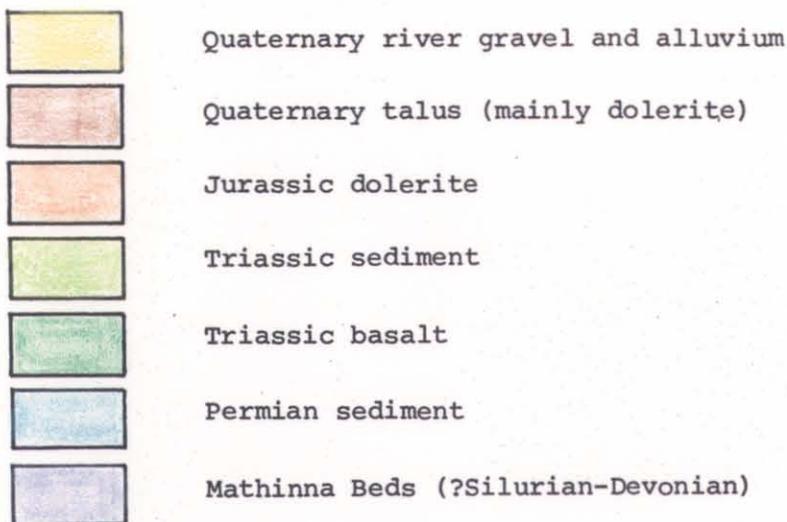


Figure 1. Geology of Mt Nicholas area (approximate scale 1:50 000).





GEOLOGY BY C.R. CALVER AND P.W. BAILLIE

Contour interval 20 m

Approximate scale 1:50 000

Figure 1. *Geology of Mt Nicholas area*

exposures of the upper part of the sequence crop out around the base of the slope of the Nicholas Range near the Break O'Day flood plain.

The top of the Nicholas Range is capped with Jurassic dolerite. Talus from the weathering of the dolerite covers large areas of the slopes and outcrops of the underlying sediments only occur in occasional road cuttings, stream beds, and some of the steeper sloping areas. The talus has probably migrated downslope largely as a result of landslip action in the past.

Mathinna Beds occur to the east and west of the Nicholas Range and a small area of Devonian granite occurs 3.5 km north of St Marys.

SURFACE WATER

The Mt Nicholas area is in a relatively high rainfall belt. Although rainfall figures for St Marys (the longest recorded station nearby) show that rainfall is fairly evenly distributed during the year, summer stream flow rates in the area are unlikely to be sufficient to supply the required water quantity without storage. The stream levels were low in late June when the area was visited; this is due to the below average rainfall for the first six months of 1982.

St Marys rainfall (Bureau of Meteorology records)

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Average for 1905-1978 (mm)	56	92	94	88	94	108	99	93	66	89	76	80	1035
1982 (mm)	27	94	59	27	21	78							

It is difficult to determine catchment areas for the particular streams that pass down the slopes because the streams are shallowly entrenched.

Taking the area marked on Figure 2 as the possible catchment area from which runoff to supply the mine could be most easily obtained, the amount of water available can be estimated, using some assumptions. The catchment area is about 7 km², and if the St Marys average annual rainfall is applied to this, some 7.245 x 10⁶m³ of water would fall on the area. The percentage of direct runoff is not known. The Rivers and Water Supply Commission use graphs which give some 42.5% runoff for areas in this region (D. Steane, pers. comm.). This is the annual amount and is an average figure used for the area including farmland, bush, and mountain areas. If a figure of 20% is taken for talus slopes, runoff for the above area would be 1.449 x 10⁶m³ (or 207 000 m³/km²). This is almost double the required amount per square kilometre of catchment area. If these figures are anywhere near reality, it is apparent that the area could quite easily provide the required quantity of water.

Because the stream lengths are short, rapid rises and falls of water level are likely. A greater percentage of runoff will occur during periods of sustained heavy rainfall related to small cyclonic depressions off the east coast, and storage must be considered for periods of low rainfall. Ideally a storage that holds one year's supply would be the most appropriate volume, but this may be a too conservative objective because some flow is likely in the streams throughout the year. A storage holding a six month supply is probably a reasonable safety margin for dry periods.

SITES FOR STORAGE

There appears to be only three obvious sites in which to store appreciable volumes of water on the slopes. The volume that could be stored is not known in each case.

Existing dam on creek (site 1, Figure 2)

There is an old established dam on the side of a stream near EP915975, where a long wall has been built around a relatively flat piece of land to contain the water. The dam holds only a small amount of water at present as the wall has been breached in at least two places.

Area along old mine road near junction with Mt Nicholas Road

This is a fairly broad flat area (site 2, Figure 2) which could be dammed with a barrier up to about eight metres high and about 150 m long. Very little water flows through the valley and water would have to be diverted from a creek to the west or from the stream that crosses the old mine road to the east (or both).

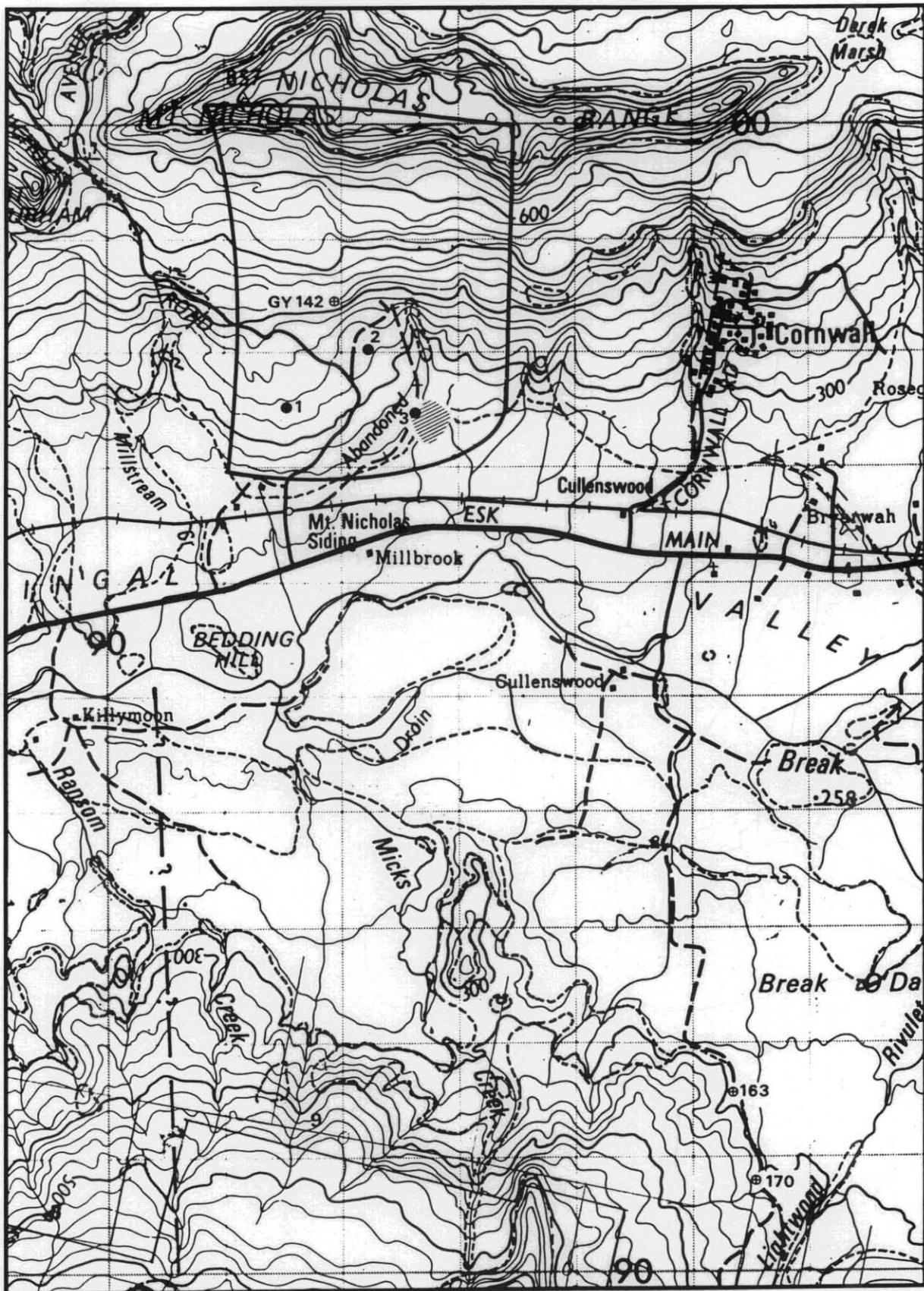
Creek east of old mine railway

This creek is joined by another creek from the west above the Break O'Day flood plain. There is a fairly extensive flat area upstream that could be used as a storage (site 3, Figure 2). A dam up to about 12 m high and 180 m along the axis is possible.

Although other sites may be available in the area, storage volume is likely to be less than the above sites. The Rivers and Water Supply Commission would need to be approached regarding the building of dams, as well as the possible diversion of existing streams.

No estimate has been made of the storage volumes of the possible sites, but site 3 probably has the largest capacity. If these areas are considered

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- Catchment area from which surface water could be collected
- Dam site
- ⊕ Bore hole
- ▨ Area suggested for groundwater investigation

Figure 2. Location of water catchment area and bore holes, Mt Nicholas area.

as possible dam sites, they should be surveyed to determine approximate storage volumes. If a selection of dam height is made, the top water level could be surveyed and this, together with three or four levelled traverses across the storage area, should allow approximate storage volumes to be calculated. If a site is selected for dam construction, a contoured plan with one metre (or two metre maximum) contours of the dam abutments, storage area, and immediate surrounding areas would probably be required to plan investigations, as well as for dam construction.

All of these sites have dolerite talus surrounding them and variations in permeability could pose some leakage problems. Investigations to examine leakage would need to be undertaken, as it is unlikely a cutoff to bedrock is possible over all or even part of the dam walls. Site 3 has probable Permian sandstone on the eastern abutment and rock may be at shallow depth in the valley, but there is probably a thick talus deposit on the western abutment. The other two sites also probably have thick talus deposits along the abutments, although there are suggestions that Triassic sediments may be at shallow depth nearby (e.g. small zones of shale fragments in road cuttings between the old mine road and the flood plain).

An investigation program could be detailed once a site was selected. This program would involve a detailed geological survey of the area, seismic refraction traverses to aid in determining depth to basement, test pits with a backhoe to examine the nature of the talus (and where possible, basement), together with pump-in or pump-out tests to give some idea of permeability. Drilling would probably be required to examine deeper layers of the talus and to allow water pressure tests to be made in the basement rocks if they are near the surface. Tests on construction materials would need to be undertaken to determine their suitability.

GROUNDWATER

If groundwater can be extracted at a sufficient rate, this would probably be the cheapest solution to the water supply problem, provided the quality is acceptable. Of the two possible sources, the talus and the basement rocks, the latter appears to have the greatest prospect of success.

From coal investigation drilling in the area, it has been found that the talus reaches considerable thicknesses. The talus is likely to have a very variable permeability, depending on the amount of clay between the dolerite boulders. Finding a zone that has good permeability as well as extensive volumes of stored water may be difficult. If a hole was drilled on the slopes in the talus, it might be necessary to drill to about the level of the flood plain to obtain a permanent supply.

Bores would be expected to be more shallow in the basement rocks at flood plain level (probably Permian rocks). Outputs of the required rate have been obtained from similar rocks in some districts, and with the broad valley around the Break O'Day River, prospects of maintaining the flow, once established, must be good.

The most favourable site would be near where the creek east of the old railway formation reaches the flood plain (fig. 2). Here basement rocks should be at shallow depth. The water obtainable would be mainly fissure water, unless porous sandstone was encountered, in which case interstitial water may contribute to a bore. Pump tests over a period of a few days should establish any lateral variations in permeability. If less than the required amount was obtained in one bore, it may be that the bore failed to intersect the average number of joints and fissures occurring in

the surrounding rock and hydraulic fracturing may improve the output. If one bore is unable to supply enough water, one or more extra holes could be drilled. One or two holes to about 60 m depth should adequately test the groundwater potential of the area.

There are few existing water bores in the area; the only bores known are to the east of Fingal. Of four bores recorded in this area, three were successful (the other may have struck water and was abandoned because of insufficient output); quantities pumped from these holes were 114 l/min, 364 l/min, and 303 l/min from river gravel, dolerite, and mudstone aquifers respectively. The holes were drilled to depths of 15.2 m, 33.5 m, and 51.8 m.

One of the disadvantages of groundwater is the possibility that the quality may not be suitable for the uses to which the water is applied. Water from Triassic sediments in other parts of the State often has total dissolved solids contents of 2000-5000 mg/l. Water in the Permian rocks is, on average, better than the Triassic waters.

Some water samples were tested with a conductivity meter which gives a guide to the salinity. The creek at the dam (site 1, fig. 2) has water with about 70 mg/l TDS, while the creek water west of the old mine contains about 120 mg/l TDS. Hole GY142, in an elevated area, contains water with a salinity of about 500 mg/l, while holes 163 and 170 in the Harefield field south of the Break O'Day River (fig. 2) have water with about 1050 mg/l and 250 mg/l total dissolved solids respectively.

From these values it is apparent that the quality of the groundwater is perhaps a little better than expected, which may be a reflection of the higher rainfall. There is a strong chance that groundwater would be suitable for use at the mine.

CONCLUSIONS AND RECOMMENDATIONS

There appears to be sufficient surface water passing near the mine site to supply the mining operation.

Three possible dam sites, which should be capable of holding a large proportion of the yearly requirement, have been briefly examined, but detailed surveys should be conducted if a dam is to be built. A detailed contour plan would be required for any site being seriously considered for a dam. Detailed geological examinations of the site and some geophysical surveys should be undertaken, followed by some subsurface investigations involving test pitting, drilling, and permeability testing. The availability of suitable material to construct the dam would have to be examined.

A groundwater source is a definite alternative that should be examined. It would be considerably cheaper to install a bore or bores than a dam, if a sufficient groundwater supply can be obtained. Hydraulic fracturing could be tried to increase outputs if lower than the required output is obtained. Although quality can be variable in both Permian and Triassic rocks, tests on water samples to date suggest that groundwater in the area should be suitable for most purposes.

As a safety measure, rather than have only one source (a dam or a bore) to supply the water, it would be advisable to have two sources in case of dam failure or bore pump failure, e.g. two small dams; a bore and a dam; or two high yielding bores could be considered.

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[21 July 1982]