20. Groundwater conditions at the Tasmania mine, Beaconsfield.

P.C. Stevenson

The conventional conduct of a groundwater investigation involves a geological study, a drilling programme and the pump testing of the bore holes drilled.

This sequence is inappropriate at the Tasmania mine for several reasons. Existing reports on the geology and on the groundwater conditions at the mine give a clearer and more accurate picture of the water situation than could now be achieved using indirect methods from the surface. This report is therefore based on the recorded information and on examination of the rock outcrops of the area.

Thureau (1883) remarked that the Florence shaft at 214 ft* had encountered 'a great deal of water'. By 1887 Robertson was able to give a reasonably consistent view of the hydrology and assumed a connection with the limestone pits along Blyths Creek†. He also indicated that some water could come from a point on Blyths Creek 'further to the west' and he suggested the construction of fluming, and the puddling of the creek bed. This was apparently done as Montgomery (1891) makes no mention of the water problems.

A derivative account in the special edition of the Australian Mining Standard, of 1 July 1898 indicated that the west end of 718 ft level was very wet - 'a roaring torrent' - and that flows were 'always met with in the west end..., from the hanging wall' and in 'broken jointy country'. Some water entered from the eastern or limestone end of the mine, but this (possibly due to the fluming) did not appear to be the major source.

Twelvetrees (1903) indicated that pumping had raised 21 million gallons per week for 9 years with a 225 ft drawdown. The proportions of water from storage and from surface infiltration are unknown. His accounts of water bursts which can be beaten by months of pumping seem to indicate that the water is mainly from storage. He believed that the limestone was the main source and pointed to 'highly permeable broken sandstone and limestone on the east and less pervious slates on the west'. He felt that a pumping capacity of 6 to 8 million gallons per day was desirable in the long term. It is worth noting in passing that his figures amount to 43 million gallons per foot of drawdown.

By 1913 Llewellyn stated that the mine had reached 1500 ft and was pumping 13 million gallons per week, a reduction from 17 million gallons per week in 1912 so that the pumps were in fact winning. In spite of this he said that from past experience every foot the mine was sunk would entail the pumping of 21 million gallons of water.

Cundy and Fawcett (1914) at the time the mine closed, when they were in the best position ever to know the conditions, stated that 'it is tolerably certain however that the water being drained is contained within the limits of two parallel limestone deposits some 1700 ft apart and running in a NW and SE direction. These limestones probably have bands of impervious rocks or pug seams bounding them, sufficient to hold the water back from other parallel water channels that exist on either side. There is justification

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*Imperial units, used in all the earlier literature, have been retained in this report.
†The correct name for the stream, in the area of the mine, is Middle Arm Creek. The name Blyth Creek is now restricted to a tributary of Middle Arm Creek, to the west of Cabbage Tree Hill.

for this conclusion when it is remembered that with all the water raised by the Tasmania company the mines of Tasmania West Extended on the one side and the East Tasmania on the other are unaffected by it'. This assumption has been maintained during the following discussion.

Hudson (1923) recounts how in 1906 the deviation channel on Blyths Creek overflowed and affected the mine 23 hours later, eventually flooding it from the 1000 ft to the 846 ft level. He continues, 'A geological survey of the district disclosed that no places had been located where precautionary work would be any advantage to overcome the water difficulty other than at Blyths Creek where the water had been deviated by fluming. It was shown that nearly the whole flow from this creek entered the mine by the sandstone beds at the west end of the mine'.

He also says that 'the water in Harts shaft on April 3 1923 was 704 ft from surface'.

These accounts pose several questions to which answers must be found, although these must of necessity be based on estimates.

(1) What is the specific yield of the mine, that is, can the figure of 21 million gallons per foot be accepted? This figure can be arrived at crudely by estimating that about
35 years x 52 weeks x 20 x 10^6 gal
= 3.64 x 10^{10} gal (165,000 Ml) was removed in about 35 years.
This divided by 1500 ft depth gives 24 x 10^6 gal (110 Ml) per ft but it has little meaning in terms of specific capacity as it includes infiltrations as well as release from storage.

(2) How much infiltration from Blyths Creek, from rainfall and from any other source? The annual flow of Blyths Creek, assuming a catchment area of 9 square miles and 12 inches of run-off equals: 9 x 5280^2 x 1 x 6.25 gal
= 1.57 x 10^9 gal/y.
The direct rainfall on the Mine Series rocks between Blyths Creek and Brandy Creek, including Cabbage Tree Hill again assuming an annual infiltration of 12 inches is
7500 x 1700 x 1 x 6.25 gal/y
= 7.96 x 10^7 gal/y.
Blyths Creek is therefore very much more important than direct rainfall.

(3) What other sources are there? The limestone was often assumed to be involved, but eye witness accounts mention mainly the west end of the mine, and the fluming was usually effective as shown by the flooding in 1906 when the diversion was breached. In the later stages of the mine the limestone was therefore ignored as a source of water inflow, as it was by Cundy and Fawcett. The Deep Lead does not appear to have contained major amounts of water, as when it was intersected by cross-cuts, the inrush of water that took place did not produce serious flooding. The Tertiary sediments of the Tamar Valley are not in any case regarded as significant aquifers.
Brandy Creek never attracted much attention as a water source and all accounts insist that the water came from the south and west into the mine workings.

We must therefore return to the first question and try to establish the

specific capacity of the mine.

Several sources of information enable us to estimate this.

The 21 million gallons per foot as calculated above, can be tested by assuming that the Mine Series is contained within its upper and lower beds but has continuity along the strike. Therefore for an available storage of 5% and ignoring infiltration, the water in storage would be contained in rock having a volume of $\dfrac{3.6 \times 10^{10} \times 20}{6.25}$ ft^3.

For a cross section of 1500 x 1700 ft this implies a strike length of $\dfrac{3.6 \times 10^{10} \times 20}{6.25 \times 1500 \times 1700}$ ft or about 8½ miles.

Assuming a cone of depression instead of block drawdown would result in a figure of 17 miles. This appears to be a very high, but not quite absurd estimate and must be considerably modified by the inclusion of a factor for infiltration. High infiltration could easily reduce the size of the cone to reasonable proportions.

The available storage can be better estimated from Hudson's figure of 704 ft by saying:

Direct rainfall infiltration for 9 years (1914-1923) was

$7.96 \times 10^7 \times 9 = 11.5 \times 10^7$ ft^3 of water
to fill a volume of
7000 ft x 750 ft depth x 1700 ft width = 8.9×10^9 ft^3 of rock
Specific yield = 1.3×10^{-2} = 1.3%.

This assumes that no water entered from Blyths Creek because the flume was still effective. If it was only partially so, then this estimate would be too low.

This estimate can also be modified by assuming a cone of depression instead of a block drawdown, giving a figure of 2.6%.

If some infiltration took place, say 10% of the annual flow of Blyths Creek in addition to rainfall infiltration then, again assuming cone drawdown, a value of 7.6% is achieved.

Could this figure be realistic? The historical accounts show that water bursts took place in three well defined beds. If each of these beds was 100 ft thick and the storage of the rest of the Mine Series was 2% then a storage capacity of 33% in the main water-bearing beds would be required to give an overall value of 7.6%. This is not an impossible figure for crushed beds, but at this point speculation has perhaps gone too far.

An inspection of the Mine Series along the Blyths Creek road shows that some storage capacity does exist, mainly in the bedding planes, that pug layers do occur and that some beds are very shattered so that the overall value of 7% for the specific yield is perhaps not unreasonable.

Leakage and infiltration are seen to be almost insignificant in comparison with the total amount of water to be removed down to 1500 ft. Even Blyths Creek would take 23 years to fill the voids which took 35 years to pump out. The highest pumping rate possible is required to dewater, but thereafter, relatively small amounts are required to maintain the level, always assuming that adequate fluming controls infiltration from Blyths Creek.

As soon as pumping is begun, the drawdown behaviour will be worthy of close study, as almost immediately it will be possible to refine these estimates considerably.

In view of the large storage involved, normal scale bore hole pumping would not produce significant results. It is worth attempting Lugeon type pump-in tests on the part of any diamond bore holes which penetrate the Mine Series, and which can be isolated by packers.

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