RB. 79/94
DME 774/74

1/1/145

July 1979

SOUTH AUSTRALIAN DEPARTMENT OF MINES AND ENERGY

Amdel Report

No. 1278

REHABILITATION OF BRUKUNGA PYRITES MINE

July 1978 - June 1979

by

J.M. Clayton

Investigated by: Operations Division

Manager, Operations Division: Bruce E. Ashton

Norton Jackson, Managing Director

THE AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES

Flemington Street, Frewville South Australia 5063

CONTENTS

SUMMARY

Background

In 1973 Amdel was requested by the Department of Mines and Energy to investigate the problem of water pollution in Dawesley Creek from the abandoned pyrites mine at Brukunga. Following the investigation of sources of pollution, a number of possible methods for abatement were tested, and in Amdel Report No. 1149 (1977) a series of recommendations for complete rehabilitation were made. This report describes work done during 1978-79 in implementing some of the recommendations.

Objectives

The aims of this project were:

1. To continue the series of monthly samples of creek and mine seepage waters.
2. To monitor the progress of earlier revegetation.
3. To carry out further revegetation trials on the mullock heaps.

Summary of Work Done

Samples of waters from Dawesley and Days Creeks and from mine seepages were taken at monthly intervals and analysed for pH and acid-value. The results were correlated with previous data and a standard series of sampling point reference numbers was prepared to facilitate reference to earlier data.

The revegetation of the tailings dam in 1978 was considered to have been unsuccessful, probably because the seed was sown onto the surface. A contractor was engaged to re-seed the tailings dam and to cover as much seed as possible using harrows.

Six trial revegetation plots were set up on the bank of the southern mullock heap to assess the success of various plant species under different soil treatments.

Successful trials were made of a pneumatic method of distributing lime onto the slopes of the mullock heap. Following these trials the areas sprayed with lime were sown with fertiliser and pasture seeds.

Conclusions and Recommendations

The stream sampling programme has shown that the 1976 diversion schemes have improved the quality of Dawesley Creek, but the water is still not acceptable. It is recommended that the monthly sampling be continued for at least two years after the treatment plant commences operation (Estimated, March 1980).

The progress of the tailings dam revegetation and the trials on the mullock heaps should be monitored for at least two years before any further revegetation is done.

1. INTRODUCTION

Amdel was requested in 1973 by the Department of Mines and Energy to investigate the problem of water pollution in Dawesley Creek from the abandoned pyrites mine at Brukunga. Subsequently, the effect of acid-mine-drainage on the creek has been assessed, a neutralisation scheme examined at pilot scale, and revegetation trials made. Recommendations for the complete rehabilitation of the mine were made by Walker (1977)*.

The recommendations were as follows:

1. As far as practicable, fresh rain water was to be collected in channels and pipes and run directly into the Dawesley Creek, so as to minimise its contact with sulphides. At the same time the most strongly polluted acid-mine-drainage was to be collected in ponds and pumped into the tailings dam lake for release at high creek flow and eventually for treatment by neutralisation.
   This recommendation was accepted and the necessary works were carried out by the Engineering and Water Supply Department during 1976/77.

2. A neutralisation plant was to be constructed to treat acid-mine-drainage from the collection ponds and from the tailings dam. Construction of this plant by the E & WS Department commenced in April 1979, and is scheduled for completion in March 1980.

3. The tailings dam surface, the mullock heaps and the mine benches were to be revegetated to minimise seepage of rain water into the sulphides.

In 1976 a trial area of 1 ha of the tailings dam was divided into plots which were given various treatments of lime and fertiliser and then sown with pasture grasses and clovers. The seed was roughly covered by dragging lumps of steel behind a tractor. The growth of one of the plots was so successful that a recommendation was made to treat the whole of the surface of the tailings dam, and this work was carried out in May 1978.

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*WALKER, W.M. (1977). 'Rehabilitation of Brukunga pyrites mine'. Amdel Report No. 1149.

In June 1977 the slopes of the mullock heaps were sown with a mixture of tree seeds, as there was some evidence that trees could survive in mullock without the addition of lime (Walker, 1977)*.

The revegetation trials were reviewed by R.D. Roberts of the SADME in 1978, and further trials on the mullock dumps were recommended.

The purpose of all the rehabilitation work has been to reduce the pollution of Dawesley Creek by acid-mine-drainage. Samples of water in Dawesley Creek, Days Creek and various mine drainages have been taken intermittently since 1973 and on a regular monthly basis since July 1977. The programme of work approved for 1978/79 included the continuation of the regular monthly stream sampling programme, as well as monitoring the revegetation schemes in progress and the commencement of new trial revegetation plots on the mullock heaps.

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*WALKER, W.M. (1977). 'Rehabilitation of Brukunga pyrites mine - Mullock heap revegetation'. Amdel Report No. 1170.

2. MONITORING OF CREEK POLLUTION

Samples of water and acid-mine drainage from Dawesley Creek, Days Creek and mine seepages have been taken at irregular intervals since 1973 and on a regular monthly schedule since July 1977. Analyses of these samples have been given in earlier reports, but inconsistent reference numbers were allotted to various sampling points. To permit easier comparison of samples, 32 sampling points of interest have been identified as listed in Table 1 and as shown in Fig. 1. Analyses of the samples from major points of interest have been collated and are shown in Tables 2 to 5. The acid values of samples from Dawesley Creek leaving the mine area (sample point 11), from the tailings dam pond (30) and from the tailings dam seepage (31), are shown in Figs 2 and 3 on an annual cycle basis. Fig. 4 shows the acid-values of samples taken from Days Creek near its junction with Dawesley Creek.

2.1 Dawesley Creek Pollution

The acid-values of samples of water taken from Dawesley Creek near the Nairne road bridge about 0.5 km from the southern limit of the mine (sample point 11) indicate large seasonal variations, as shown in Fig. 2. During summer months there was little or no surface flow at the sampling point and very high acid-values were obtained. The data collected in 1977 to 1979 showed that the rains in March and April were sufficient to generate a flow in the creek, and acid-values in samples rapidly fell to below 1000 ppm $CaCO_3$.

The effectiveness of the diversion schemes implemented in 1977 is shown in Fig. 2. The high summer peaks of 1977 to 1979 were all significantly lower than the corresponding 1973 samples, and in 1973 the creek flow was sufficient to dilute the acid-values to less than 1000 ppm $CaCO_3$ only in August/September, compared with the 1977 to 1979 data showing periods of 7 to 8 months with acid values less than 1000 ppm $CaCO_3$.

The recent acid-values are still far from being acceptable levels of pollution in Dawesley Creek, although samples taken from the Nairne Creek adjacent to the South Eastern Freeway crossing have generally all been acceptable, acid-values of 800 ppm to pH 8.1 having been obtained. The addition of slightly alkaline effluent from the acid-mine-drainage treatment plant now under construction to Dawesley Creek is expected to produce a flow at sample point 11, even in late summer, and it is hoped that the present summer peak acid-values will be eliminated. The water may still be unacceptable, however, until the revegetation cover becomes established.

It should also be noted that the creek from Brukunga to at least Dawesley is visually badly polluted by effluents from the oil seeds processing plant at Brukunga.

2.2 Days Creek Pollution

The acid-values of water samples collected from two points along Days Creek (sample points 15 and 16) are given in Table 4 and the data for point 16 (the junction with Dawesley Creek) is shown in Fig. 4. The samples showed some seasonal variations but all the acid-values were very high and not acceptable, although due to the comparatively small Days Creek flow the effect on Dawesley Creek was usually minor. As the upper reaches of Days Creek (before it enters the mine) were frequently dry, the flow at the junction with Dawesley Creek can be attributed to seepages, which appear in Days Creek near the start of the new drainage channel for Seepage E.

Possible sources for the seepages are Seepage E, the northern mullock heap or the apparently permanent springs near the northern end of the main mine bench. The last source is the most likely, as Seepage E is substantially more acidic than Days Creek.

2.3 Mine Seepages

Acid-values of the major mine Seepages E, B, F and D are given in Table 4 (Samples 21, 22, 24 and 25 respectively). These seepages are now all collected in ponds and pumped to the main tailings dam. Acid-values for the water in the tailings dam and the seepages from the tailings dam are also given in the table (Samples 30 and 31) and are shown in Fig. 3. The data for Seepages E, B, F and D are highly variable as they are directly affected by rainfall, and since the collection dams for Seepages F and D were installed, Seepage F is periodically diluted by liquor from Seepage D on route to the tailings dam.

The acidity of the tailings pond (Sample 30) is shown on Fig. 3 to be increasing each year, and the present values can be compared with values of 5000 to 6000 in 1973. This increase in acidity has not yet percolated through the tailings, however, as the acidity of the tailings dam seepages has remained near 6000.

Measurements of the rate of flow of the tailings dam seepage at the point of entry to the collection pond have indicated that there is probably a basic minimum outflow of 70 to 80 *l*/min. which is periodically augmented by rainfall. The available data is given in Table 6.

Very few samples were obtained from the diversion channels designed to collect fresh rainwater on the mine bench and carry it to the creeks, because the channels were usually dry. However, samples taken from the channels collecting rain and run-off from the catchments above the mine and leading to Days Creek all had acid values less than 1000 ppm $CaCO_3$, whereas the southern system of channels carried water with acid values of 6000 to 13,000 ppm $CaCO_3$. The bench area around the southern system of channels therefore needs sealing more urgently than the area around the northern channels.

3. REVEGETATION TRIALS

3.1 Revegetation of Tailings Dam

Revegetation of the whole of the dry surface of the tailings dam was carried out in 1978 as described by Walker (1978)*. Surface sowing only was carried out with no attempt being made to cover the seed. Inspection of the area during 1978/79 found as follows:

1. In August 1978 the grass cover was patchy and appeared to closely follow the tracks of the seed drill, which were quite far apart in some areas. There appeared to be very little clover.
2. In September 1978 the situation was similar except that more clover was found.
3. In October 1978 the general appearance of the tailings dam was quite good, but the grass and clover were drying off, apparently without having set seed. The trial plot, however, had quite good grass and clover cover.
4. In March and April 1978 there appeared to be very little and very patchy regrowth of grasses, and only scattered clover plants.

The 1978 revegetation was therefore adjudged to have failed, the principal cause of the failure probably being the lack of any soil cover the the seeds. As project funds were available it was decided to engage a contractor to reseed the tailings dam and to cover as much of the seed as possible by harrowing the surface after seeding. The following seeds were sown using a superphosphate spreader, and about 1.5 t superphosphate was used (over the whole of the surface) to dilute the seed mixture leaving the machine.

Grasses

Currie Cocksfoot	50 kg
Phalaris Tuberosa	50 kg
Wimmera Ryegrass	50 kg

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*WALKER, W.M. (1978). 'Rehabilitation of Brukunga Pyrites Mine - Neutralisation Plant Design'. Amdel Report No. 1234, August 1978.

Victorian Perennial Ryegrass	50 kg
Demeter Fescue	100 kg

Clovers

Seaton Park sub clover	50 kg
Geraldton sub clover	50 kg
Daliak sub clover	50 kg
Harbinger medic clover	50 kg

All clovers were innoculated and lime pelleted.

The reseeding was completed by 24 June and the contractor reported that he had been able to harrow only about two-thirds of the area, due to the rocky nature of the surface.

3.2 Revegetation of Mullock Heap

3.2.1 Plot Trials

Six small plots, each about 10 m square, were selected near the top of the main southern mullock dump for revegetation trials as recommended by Dr R.D. Roberts in DM 774/2/74 dated 1 February 1978. The treatment for each plot was as recommended by Dr Roberts and was as follows:

Plot 1 - Seed only

Plot 2 - Seed plus 50 kg/ha each of N, P and K, plus 2.5 t/ha ground limestone

Plot 3 - As Plot 2

Plot 4 - Seed plus 50 kg/ha each of N, P and K, plus 10 t/ha ground limestone

Plot 5 - Seed plus 50 kg/ha each of N, P and K, plus 5 kl/ha sewage sludge

Plot 6 - Seed plus 50 kg/ha each of N, P and K, plus 20 kl/ha sewage sludge

Fertilisers were applied to Plots 2, 5 and 6 at the time of seeding and to Plots 3 and 4 after germination of the seed.

The seed mixture used for the trial was not as recommended by Dr Roberts, as some species were unobtainable. The quantities of the seeds available were increased to give a coverage of 200 kg/ha. The following species were obtained:

Perennial ryegrass - Victorian
Currie cocksfoot
Creeping red fescue (Festuca Rubra)
Kikuyu
Couch
Geraldton sub-clover
Serradella (Ornithopus Sativos)
Blue lipin (Lupinus Augustifolius)
Broom (Cytisus Scoparius)
Tree lupin (Lupinus Arboreus)

The 6 plots were sown in May 1979 and in late June some plots appeared to have good germination.

The sewage sludge used was obtained from the Hahndorf treatment works by permission of the E & WS Department. It was a partially weathered and dried solid which had been left in a heap for several years.

3.2.2 Lime Distribution Trials

The eventual requirement is that the whole of the surface of the mullock dumps be revegetated, which will entail the placement of lime, fertiliser and seeds over the steep slopes. It is assumed that hydroseeding techniques can be employed successfully on these slopes, but this technique would employ large volumes of water. It was therefore decided to test the suitability of lime spreading by air blowing.

Keough Sands Depot Pty Ltd were approached and agreed to the hire of their pressurised dry sand tanker. Ground, kiln-dried limestone was purchased from Rowley Industries of Murray Bridge. The lime was stated to be about 55% minus 75 µm and 100% minus 1.5 mm. Three loads of ground limestone were applied to the areas shown in Fig. 5. The lime was fluidised in the tanker and blown through a 75 mm hose at a pressure of about 200 kPa. The hose available was only 40 m long which permitted only areas fairly close to the tanker to be treated. Where firm ground was close to the slope being sprayed, no hose was required (Plate 1).

The results of the tests were quite encouraging as fairly good distribution of lime was achieved. However, the back pressure at the hose outlet was so high that it was only just controllable by two men, and any future work using this technique should employ a smaller size hose, say 50 mm. In order to reach the lower portions of the southern mullock heap, and some areas of the northern mullock heap which are inaccessible by vehicles, a longer hose, say 200 m, would be required. The lime contains considerable fine dust and personnel should wear dust masks and goggles during spraying. It is also desirable that the wind is blowing away from the Brukunga township during spraying to avoid complaints from inhabitants.

Following the successful distribution of lime onto areas of the mullock heaps, the areas were treated by hand sowing with fertiliser and seeds to try and establish some vegetative cover. The fertiliser was added at a rate of about 50 kg/ha each of N, P and K as recommended by Dr Roberts, and the following mixture of grasses and clovers was sown:

Currie Cocksfoot	45 kg
Phalaris Aquatica	30 kg
Demeter Fescue	30 kg
Creeping Red Fescue	30 kg
Couchgrass	15 kg
Victorian Perennial Rye	90 kg
Wimmera Rye	50 kg
Mt Barker sub clover	60 kg
Seaton Park sub clover	60 kg
Daliak sub clover	60 kg
Woogenellup sub clover	60 kg
Geraldton sub clover	60 kg

All clovers were innoculated before sowing, but were not lime pelleted.

The effectiveness of the trials may be seen in the long term not only in the revegetation of the presently bare areas, but also in improvements in the quality of Days Creek and possibly Seepages F and D.

3.2.3 <u>Review of Tree Seeding</u>

Various areas of the mullock heaps were examined occasionally to observe the progress of the growth of various tree seeds which were sown aerially in 1977. The number of plants observed was very small, with plants tending to occur in small areas. The most numerous seedling observed was Pinus Radiata, but some Pseudoacacia plants were also seen. The overall impression at this stage is that the success of the tree seeding was only slight, but as the plants grow larger those concealed behind rocks become visible and the eventual result may still be fairly good. However, only the two species mentioned appear to have survived the very dry conditions following seeding.

4. DISCUSSION

The recommended actions for alleviation of the pollution of Dawesley Creek by the Brukunga pyrites mine included the diversion into the creek of fresh waters, the diversion from the creek of badly polluted waters, the neutralisation of the diverted waters and the revegetation of the site.

The diversion of fresh waters into the creek and the diversion and collection of strongly acidic waters was carried out in 1977, with some immediate benefit to the creek in the early winter months. However, due to pump failures and heavy rains, the collection system occasionally failed and some strongly acidic waters have been permitted to enter the creek. The capacity of the tailings dam to store the collected waters was exceeded in September 1978, which also allowed large quantities of acidic water to enter the creek.

This situation is likely to re-occur until the neutralisation plant is completed, which is expected by March 1980. After the plant starts operating, the tailings dam's capacity to store the diverted acid-waters should not be exceeded unless an exceptionally heavy rainstorm occurs.

The quality of Dawesley Creek is not acceptable even during winter because uncollected seepages are entering the creek. These seepages occur along the foot of each mullock heap but are probably not worth the expense of collection at this stage. The quality of the water leaving the mine will be greatly improved by the slightly alkaline effluent from the neutralisation plant, but the eventual acidity level cannot be predicted, and should be monitored for at least a year after operation of the plant begins.

The revegetation trials on the mine area are continuing. The failure of the 1978 sowing of the surface of the tailings dam is attributed mainly to the lack of cover for the seed. This is in contrast to the established trial hectare in which the seed was covered and the grass is continuing to grow well. The reseeding of the area and the attempt to harrow the seed into the surface should be more successful.

A successful technique for distributing ground limestone onto the inaccessible areas of the mullock dump has been demonstrated, and if the trial plots are shown to produce a satisfactory vegetative cover, the untreated areas should be treated by a similar procedure. However, in treating the whole of the inaccessible areas, the fertilisers and seeds should be mixed with the lime prior to loading the tanker.

5. CONCLUSIONS AND RECOMMENDATIONS

The acid-levels of Dawesley Creek are still not acceptable, but may become acceptable after commencement of operation of the neutralisation plant. It is recommended that the monthly monitoring of the acidity of the creek and seepages be continued until at least 2 years after the plant commences operation.

The revegetation of the tailings dam and the trials on the mullock heaps should be monitored to evaluate their success. It is recommended that this monitoring be continued for at least 2 years, and if the trials on the mullock heaps are successful, the untreated areas should be revegetated.

TABLES 1 to 6

FIGS 1 to 5

PLATE 1

TABLE 1: IDENTIFICATION OF SAMPLING POINTS

1	Dawesley Creek, upstream of mine
2	Dawesley Creek, at bridge weir, North end of mine
3	Dawesley Creek, 70 m into mine
4	Dawesley Creek, 200 m into mine
5	Dawesley Creek, before junction with Days Creek
6	Dawesley Creek, after junction with Days Creek
7	Dawesley Creek, after collection pond for Seepages B and E
8	Dawesley Creek, before collection pond for Seepage F
9	Dawesley Creek, at bridge near Seepage D
10	Dawesley Creek, after Seepage D
11	Dawesley Creek, at bridge for Nairne Road 0.5 km downstream of mine
12	Dawesley Creek, at Dawesley
13	Days Creek, upstream of mine
14	Days Creek, at first pipe
15	Days Creek, at second pipe
16	Days Creek, at junction with Dawesley Creek
17	Channel carrying Quarry Seepage A
18	Downpipe carrying Quarry Seepage B_S
19	Channel carrying Quarry Seepage B_S
20	Channel carrying combined Seepages A and B_S
21	Quarry Seepage E
22	Quarry Seepage B
23	Collection pond for Seepages E and B
24	Quarry Seepage F
25	Quarry Seepage D
26	Quarry Seepage C outlet pipe to Dawesley Creek
27	Small seepage at extreme South of mine
28	Seepage from small mullock dump
29	Ditch near road at North end of mine
30	Tailings dam
31	Tailings dam seepage
32	Nairne Creek at freeway bridge

TABLE 2: ACID VALUES - DAWESLEY CREEK (as $CaCO_3$ - mg/l)

	Locations (Refer Table 1 and Fig. 1)								
	2	5	6	7	8	9	10	11	12
10/ 8/73	pH 6.7	pH 5.8	120	630	-	660	1,000	840	900
4/12/74	pH 7.8	1,320	1,250	1,300	2,600	11,700	11,400	10,500	-
20/ 1/77	pH 5.6	2,000	2,300	2,700	4,700	8,600	8,400	4,500	3,400
29/ 3/77	-	350	440	500	-	1,480	1,350	1,350	-
4/ 5/77	pH 8.0	pH 6.9	pH 6.8	-	pH 6.3	540	-	800	2,400
23/ 5/77	-	290	730	1,380	-	910	370	600	-
14/ 7/77	pH 7.1	75	230	1,960	-	1,890	1,875	2,540	-
18/ 8/77	pH 7.2	50	60	105	-	310	250	405	-
28/ 9/77	-	275	535	640	-	820	825	875	-
26/10/77	-	25	55	335	475	680	590	645	-
18/11/77	-	310	405	1,380	870	1,220	1,320	1,060	-
16/12/77	3,700	850	945	1,070	1,930	2,490	2,660	1,490	900
12/ 1/78	-	980	1,140	1,190	2,450	4,000	3,880	5,860	D
20/ 2/78	-	1,000	910	1,840	3,140	3,550	4,000	8,550	D
21/ 3/78	425	800	700	-	1,450	2,800	2,800	4,200	-
13/ 4/78	-	pH 7.1	25	40	100	75	210	275	-
30/ 5/78	-	pH 6.8	pH 6.3	pH 6.3	573	820	765	635	-
19/ 6/78	-	pH 6.5	200	100	-	845	850	1,010	-
3/ 8/78	pH 7.8	pH 6.3	290	360	380	350	360	380	420
23/ 8/78	pH 7.1	75	190	195	370	405	390	260	175
14/ 9/78	-	20	260	420[F]	290	340	350	380	4,350
24/10/78	-	230	260	310	595	765[F]	1,800[F]	745	500

...2/

TABLE 2: (Continued)

	Locations (Refer Table 1 and Fig. 1)								
	2	5	6	7	8	9	10	11	12
15/11/78	-	310	425	445	1,135	1,170	1,060	845	1,060
13/12/78	-	275	325	370	1,055	1,185	1,240	1,080	1,000
12/ 1/79	-	1,735	2,185	2,425	10,005	4,735	5,875	D	1,125
13/ 2/79	D	1,465	1,175	1,400	6,840	6,800	7,360[F]	7,300[D]	1,560[D]
15/ 3/79	pH 7.5	600	1,165	1,200	2,010	1,730	1,560	970	960
11/ 4/79	pH 7.8	125	210	100	600	700	625	287	425
10/ 5/79	-	pH 6.1	pH 5.6	pH 5.6	575	160	30	1,270	450
12/ 6/79	pH 7.7	370	490	580	540	560	600	880	1,620

NB: F - pump failure or pond overflowing

D - no surface flow.

TABLE 3: pH VALUES - DAWESLEY CREEK

	Locations (Refer Table 1)								
	2	5	6	7	8	9	10	11	12
10/ 8/73	6.7	5.8	4.7	4.2	-	4.3	3.3	3.6	3.4
4/12/74	7.2	3.7	3.4	3.3	3.0	2.9	2.7	2.7	-
20/ 1/77	5.6	3.4	3.0	3.0	2.9	2.7	2.6	2.6	2.8
29/ 3/77	-	-	-	-	-	-	-	-	-
4/ 5/77	8.0	6.9	6.8	-	6.3	4.3	-	3.3	2.8
23/ 5/77	-	4.1	3.3	3.1	-	3.2	4.2	-	-
14/ 7/77	-	6.2	5.2	3.9	-	3.6	3.5	3.3	-
18/ 8/77	-	6.1	5.7	5.6	-	4.3	4.3	4.1	3.0
28/ 9/77	-	4.4	4.0	4.1	-	3.5	3.2	3.1	-
26/10/77	-	5.8	5.4	4.3	4.1	3.7	3.2	3.1	-
18/11/77	-	3.8	3.8	2.6	3.4	3.1	2.9	2.7	-
16/12/77	2.6	3.8	3.6	3.5	3.0	2.8	2.6	2.9	3.0
12/ 1/78	-	3.7	3.6	3.4	3.1	2.9	2.7	2.8	-
20/ 2/78	-	-	-	-	-	-	-	-	-
21/ 3/78	-	3.4	3.5	-	3.5	3.5	3.1	2.6	-
13/ 4/78	7.1	7.1	6.6	6.7	6.3	6.2	5.9	4.5	-
30/ 5/78	-	6.8	6.3	6.3	4.6	4.5	4.5	4.5	-
19/ 6/78	-	6.5	4.6	4.8	-	4.2	4.1	4.2	-
3/ 8/78	7.8	6.3	4.5	4.4	4.1	4.4	4.5	4.4	4.4
23/ 8/78	7.1	4.9	4.8	4.5	4.3	4.3	4.3	4.5	4.4
14/ 9/78	-	5.5	4.5	3.8	3.9	3.7	3.8	3.8	2.7
24/10/78	-	4.5	4.4	4.2	3.9	3.9	3.0	3.5	3.5
15/11/78	-	4.5	4.4	4.4	3.9	3.8	3.7	3.5	3.1
13/12/78	-	4.2	4.0	4.2	3.7	3.6	3.7	3.5	3.0
12/ 1/79	-	3.8	3.8	2.9	3.3	3.3	2.6	D	2.8[D]
13/ 2/79	D	3.5	3.4	3.3	3.3	3.3	3.2	3.1[D]	3.0[D]
15/ 3/79	7.5	5.0	4.1	3.4	3.5	3.1	3.6	3.7	3.7
11/ 4/79	7.8	4.7	4.2	4.8	4.2	4.0	4.0	4.2	3.9
10/ 5/79	-	6.1	5.6	5.6	4.3	4.3	4.1	3.9	4.2
12/ 6/79	7.7	4.3	3.8	3.5	4.2	4.2	4.2	4.1	3.7

NB: D - no surface flow.

TABLE 4: ACID VALUES - MINE SEEPAGES (as $CaCO_3$ - mg/l)

	Locations (Refer Table 1 and Fig. 1)							
	15	16	21	22	24	25	30	31
10/ 8/73	760	3,100	6,000	5,650	66,000	16,300	5,000	5,000
4/12/74	-	-	-	-	96,200	12,500	-	-
20/ 1/77	1,880	4,200	15,400	16,200	19,500	4,200	-	-
29/ 3/77	2,800	5,900	12,800	10,400	22,800	4,200	-	-
4/ 5/77	-	4,600	-	-	-	-	-	-
23/ 5/77	-	1,470	-	-	-	2,570	-	-
14/ 7/77	2,960	3,350	8,470	10,830	18,000	4,400	-	-
18/ 8/77	-	2,940	-	-	-	-	9,120	5,190
28/ 9/77	-	3,410	-	-	-	-	9,275	5,810
26/10/77	-	4,100	13,070	17,500[D]	44,100	4,500	10,400	5,610
18/11/77	-	5,325	17,225	D	54,225	4,225	10,050	5,300
16/12/77	-	5,750	D	D	26,400	5,750	11,975	6,075
12/ 1/78	2,120	7,500	D	D	28,675	5,000	13,675	6,775
20/ 2/78	-	4,700	D	D	65,000	3,630	15,600	8,000
21/ 3/78	-	9,250[D]	-	-	12,500	3,630	15,000	5,400
13/ 4/78	-	5,200	15,000	12,800	14,250	2,250	14,250	6,000
30/ 5/78	2,350	4,030	13,500	11,080	16,890	-	13,400	6,575
19/ 6/78	1,450	4,050	10,200	11,400	13,550	7,650	13,200	8,700
3/ 8/78	650	1,350	9,600	9,200	54,900	2,750	12,200	6,220
23/ 8/78	625	890	8,575	7,500	55,400	3,650	10,150	5,400
14/ 9/78	-	590	7,500	-	40,500	7,200	11,300	7,700
24/10/78	3,800	4,150	9,000	9,125	65,000	3,600	11,250	5,750
15/11/78	5,500	5,350	9,450	D	97,000	1,040	12,350	6,250
13/12/78	D	5,840	9,250	8,250	107,500	3,850	12,925	5,875
12/ 1/79	D	7,925	11,400	D	119,600	2,100	12,450	5,650
13/ 2/79	D	9,175[D]	11,250	D	121,300	2,550	18,830	5,650
15/ 3/79	1,200	3,440	9,400	8,640	13,420	8,380	15,850	5,640
11/ 4/79	D	1,550	10,130	10,125	81,000	1,160	16,750	5,380
10/ 5/79	4,500	4,370	10,400	8,370	6,720	11,000	16,950	5,700
12/ 6/79	2,140	3,550	10,680	11,480	25,000	3,900	15,830	5,830

NB: D - no surface flow.

TABLE 5: pH VALUES - MINE SEEPAGES

	Locations (Refer Table 1)							
	15	16	21	22	24	25	30	31
10/ 8/73	3.5	2.8	3.0	2.8	2.3	2.4	2.6	2.6
4/12/74	-	-	-	-	2.5	2.4	-	-
20/ 1/77	-	-	2.5	2.4	2.5	2.6	-	-
29/ 3/77	-	-	-	-	-	-	-	-
4/ 5/77	-	2.8	-	-	-	-	-	-
23/ 5/77	-	2.9	-	-	-	2.8	-	-
14/ 7/77	3.0	3.0	2.8	2.8	2.5	2.8	-	-
18/ 8/77	-	2.7	-	-	-	-	2.1	2.4
28/ 9/77	-	2.6	-	-	-	-	2.2	2.5
26/10/77	2.7	2.6	2.6	2.4	2.5	2.5	2.1	2.3
18/11/77	-	2.4	2.3	-	2.4	2.5	2.0	2.3
16/12/77	-	2.5	-	-	2.3	2.3	1.9	2.2
12/ 1/78	2.7	2.5	-	-	2.5	2.5	2.1	2.4
20/ 2/78	-	-	-	-	-	-	-	-
21/ 3/78	-	2.6	-	-	2.6	2.9	2.0	2.4
13/ 4/78	-	2.8	2.5	2.7	2.4	2.9	2.0	2.5
30/ 5/78	3.0	2.9	2.8	2.8	2.7	-	2.2	2.7
19/ 6/78	2.9	2.7	2.6	2.6	2.4	2.4	2.1	2.4
3/ 8/78	3.7	3.3	2.9	2.9	2.5	2.8	2.3	2.6
23/ 8/78	3.9	3.4	2.9	2.8	2.5	2.7	2.3	2.5
14/ 9/78	-	3.8	2.8	2.9	2.6	2.6	2.3	2.5
24/10/78	2.9	2.8	2.7	2.6	2.6	2.7	2.3	2.6
15/11/78	2.7	2.7	2.7	D	2.5	3.0	2.3	2.5
13/12/78	-	2.8	2.7	2.7	2.5	2.7	2.2	2.5
12/ 1/79	D	2.5	2.4	D	2.4	2.6	2.3	2.4
13/ 2/79	D	2.6	2.5	D	2.3	2.7	2.0	2.3
15/ 3/79	2.9	3.6	2.5	2.4	2.5	2.4	2.2	3.0
11/ 4/79	D	2.9	2.7	2.6	2.6	3.0	2.1	2.5
10/ 5/79	2.8	2.8	2.7	2.7	2.6	2.8	2.1	2.5
12/ 6/79	2.8	2.8	2.7	2.8	2.5	2.6	2.1	2.6

NB: D - no surface flow.

TABLE 6: FLOW RATE OF TAILINGS DAM SEEPAGE

	1973	1975	1977	1978	1979
January				70	80
February				70	
March					80
April					80
May			80		
June					
July	160	110		80	
August				90	
September				135	
October			70	100	
November			70	80	
December					

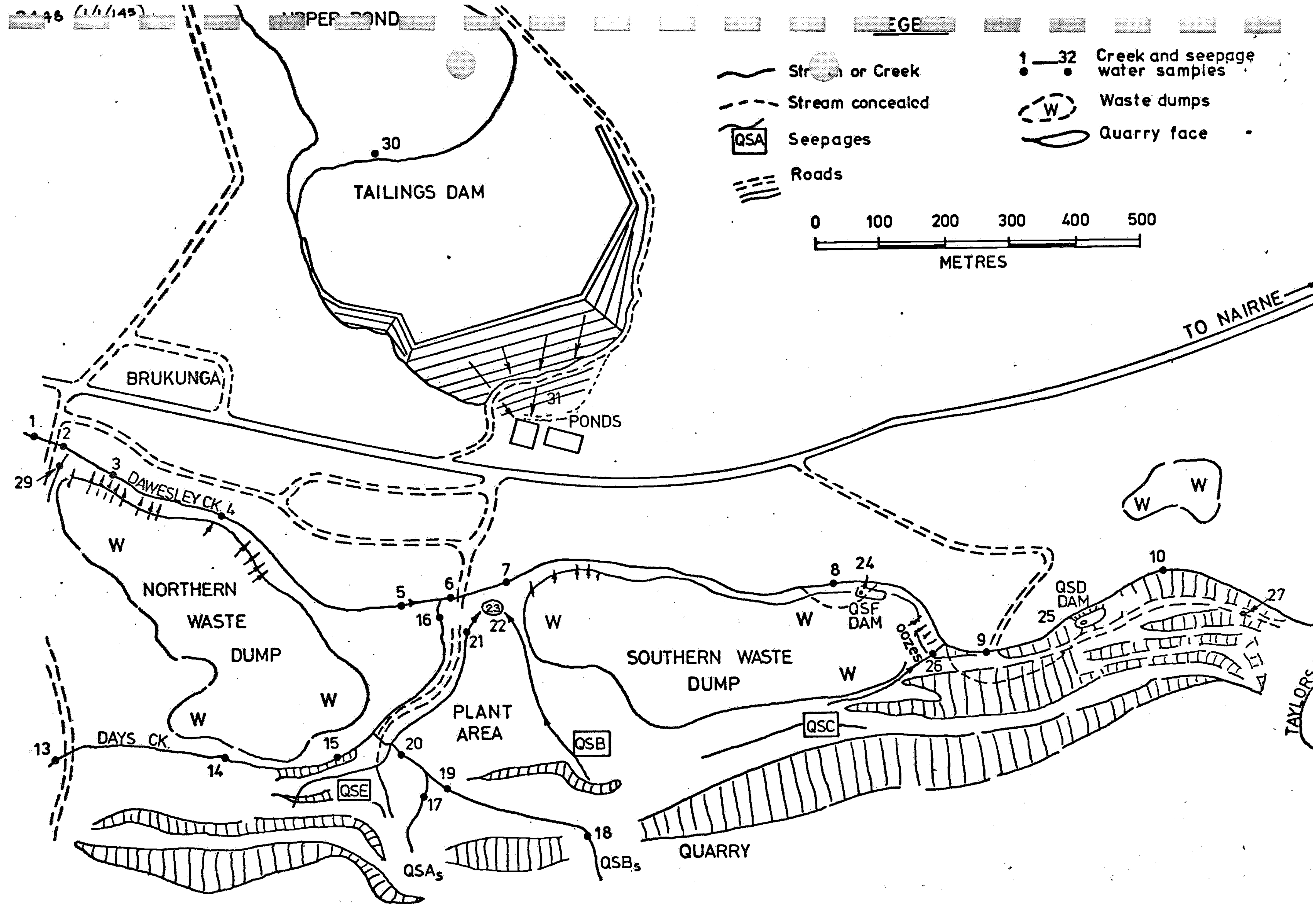

FIG. 1: BRUKUNGA MINE SAMPLE POINTS

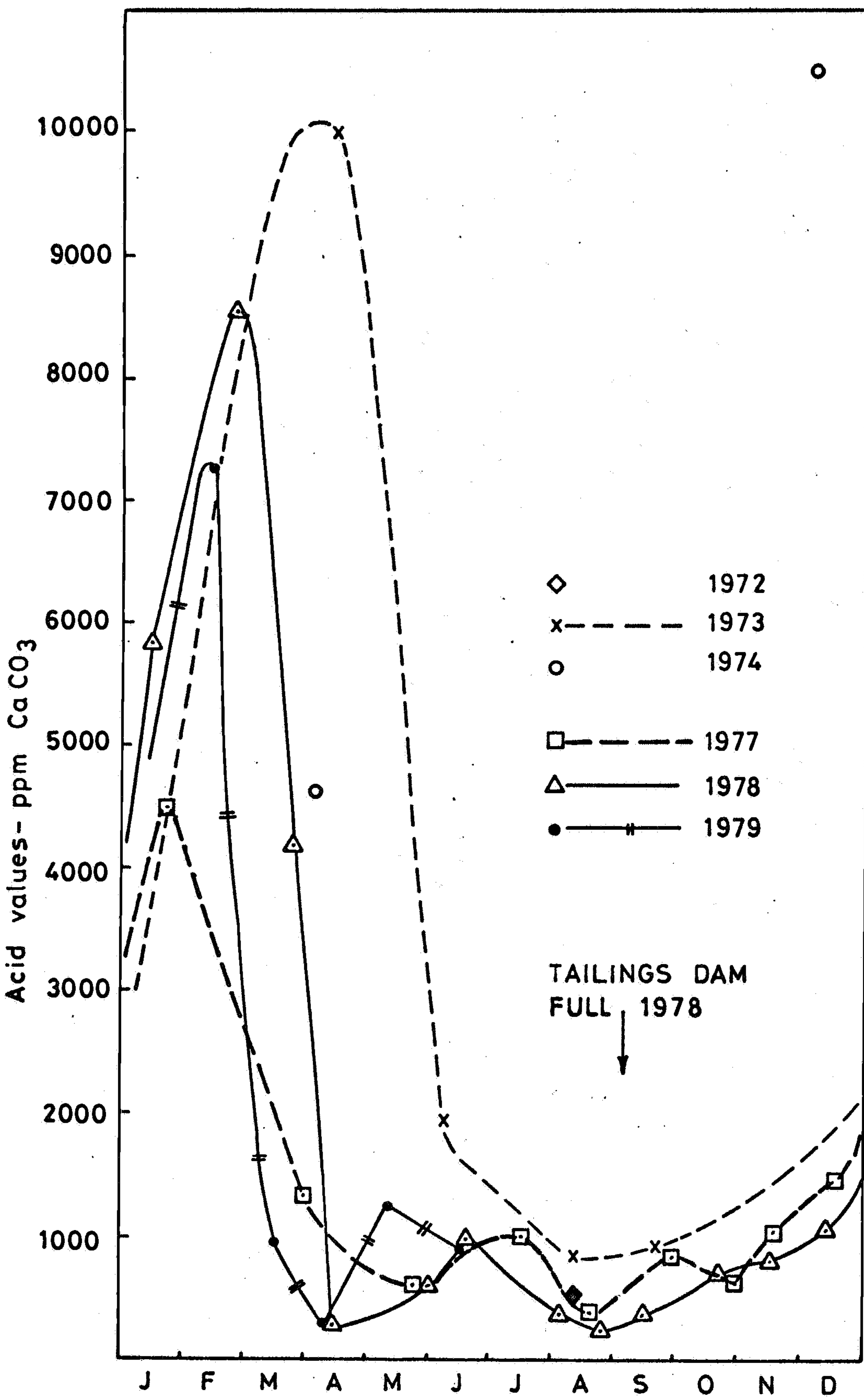

FIG.2: ACID VALUES AT MINE EXIT SAMPLE POINT 11

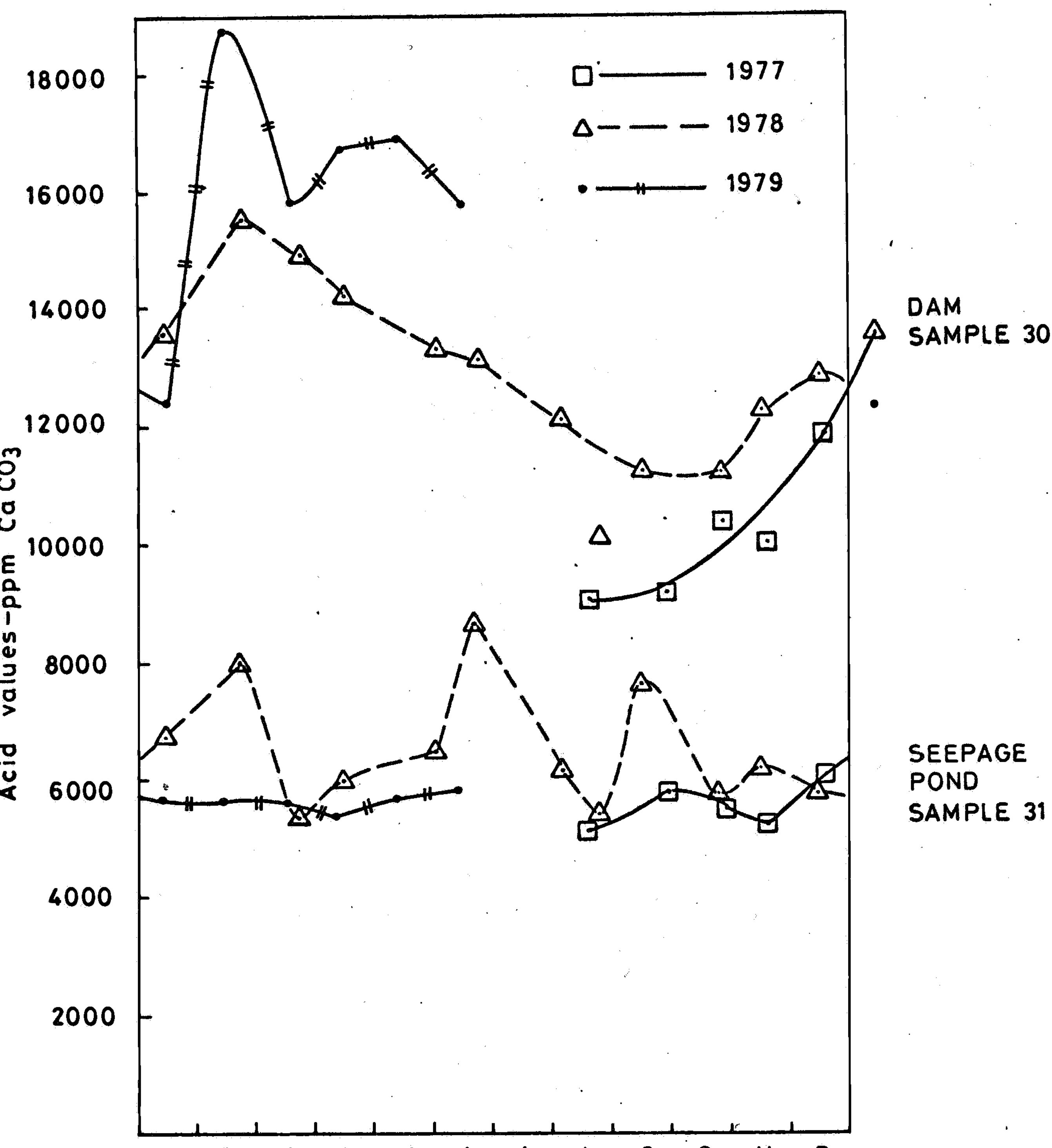

FIG. 3 : ACID VALUES TAILINGS DAM POND AND TAILINGS DAM SEEPAGE

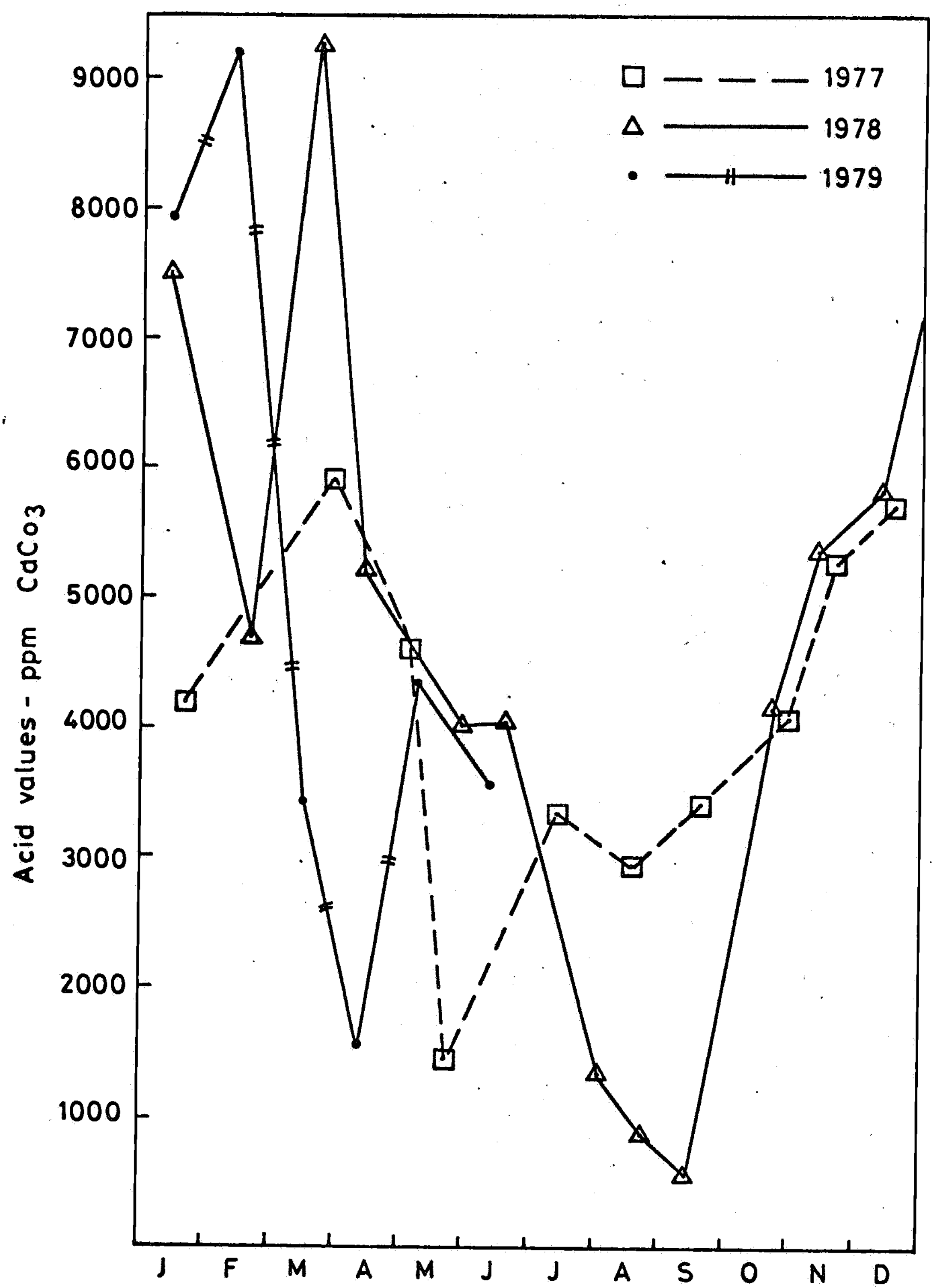

FIG. 4: DAYS CREEK -SAMPLE POINT 16

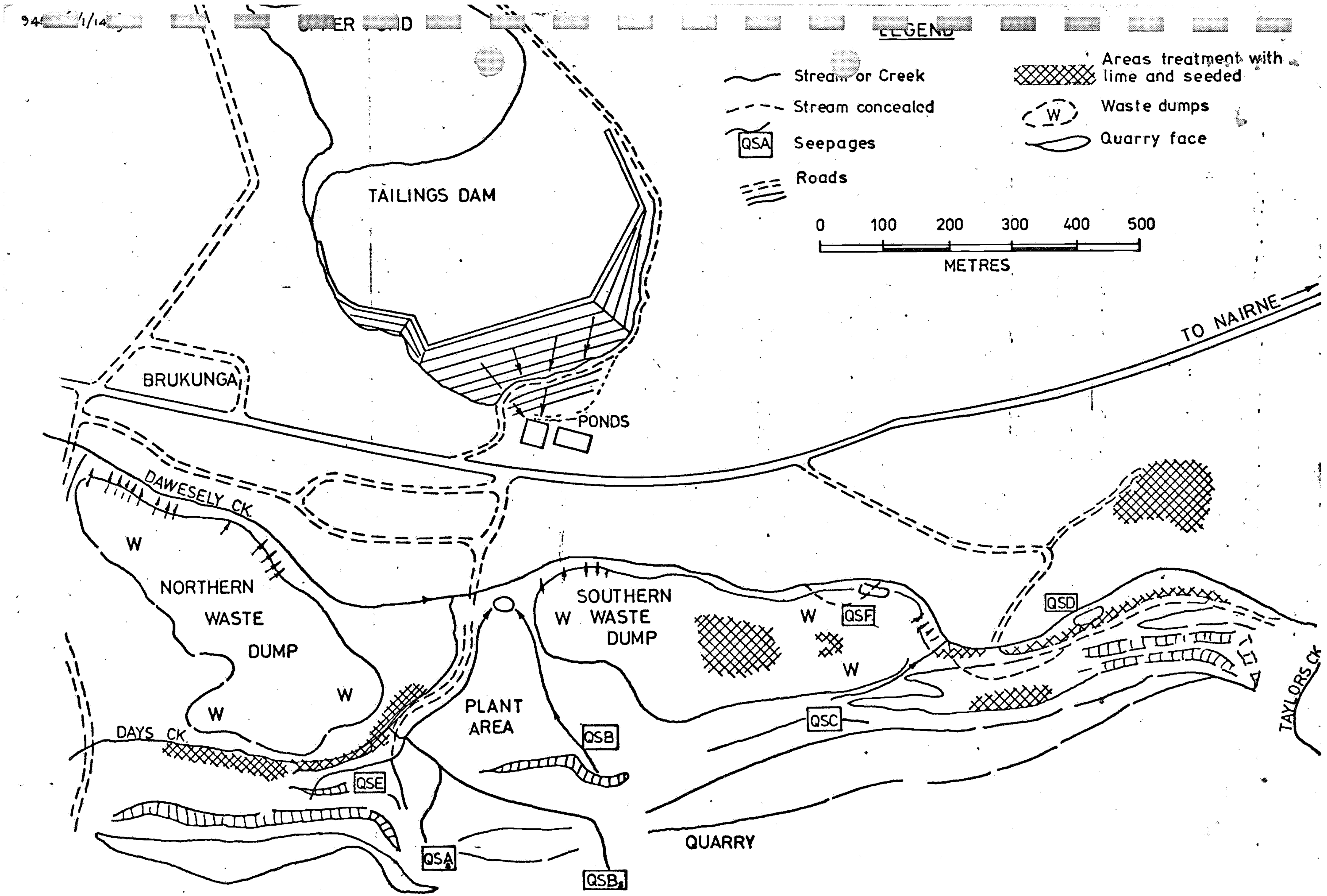

FIG. 5: BRUKUNGA MINE. AREAS OF MULLOCK TREATED WITH LIME.

PLATE 1: PNEUMATIC DISTRIBUTION OF LIME

Photo by courtesy Mt Barker Courier