OFFICE: 240 4419

STATE OFFICE BLOCK
PHILLIP STREET
SYDNEY 2000

— Regards —

GRAEME McILVEEN

SENIOR GEOLOGIST
ENVIRONMENTAL GEOLOGY SUBSECTION

GEOLOGICAL SURVEY OF NEW SOUTH WALES
DEPARTMENT OF MINES
CAGA CENTRE, 8-18 BENT STREET,
SYDNEY, AUSTRALIA

DEPARTMENT OF MINES
NEW SOUTH WALES

THE GEOLOGICAL SURVEY OF NEW SOUTH WALES

ENVIRONMENMENTAL MONITORING AT MINING LOCALITIES IN NEW SOUTH WALES

EXTRACT FROM GS 1977/279 FOR MINES INSPECTION BRANCH

WOLLONGONG OFFICE

C.A.G.A. Centre, 18 Bent Street, Sydney, N.S.W. 2000

NP 265 D West, Government Printer

GEOLOGICAL SURVEY OF NEW SOUTH WALES
DEPARTMENT OF MINES

Geological Survey Report
No GS 1977/279
Dated December 1977

ENVIRONMENTAL MONITORING AT MINING LOCALITIES IN NEW SOUTH WALES

by

R.W. Corkery

with contributions by

K. Brooks*, G.R. McIlveen and A. Zamberlan*

* Department of Mines Chemical Laboratory

Accompanying plans See attached sheet

Department File No See attached sheet

Map reference

S1/56-1 - 9133
- 9132 - I, II, III, IV
- 9033 - II

S1/56-9 - 9028 - I, II

S1/56-5 - 8931 - II, III

S1/55-16 - 8726 - I
- 8727 - I,II
- 8827 - IV

S1/55-12 - 8628 - IV

S1/55-8 - 8731 - I, III

SH/56-10 - 9436 - III
- 9236 - I
- 9437 - I, IV
- 9336 - I
- 9337 - III, IV

SH/56-11 - 9537 - III

SH/56-6 - 9238 - I, III

S1/55-10 - 8229 - II

SH/56-5 - 9138 III

S1/55-12- 8729 I

DEPARTMENT FILE NUMBERS

COAL

1. Muswellbrook: M72/2002
2. Cessnock (Black Creek):M68/6156, M73/5990
3. South Maitland: M72/3492 (Maitland Main Only)
4. Western Districts: M73/9431, M73/3226, M68/8112
5. Huntley: M74/1467
6. Westcliff: M75/4244

METALLIFEROUS

1. Captains Flat: M70/3088
2. Woodlawn: M71/8497
3. Kangiara: M76/3232
4. Cadia: M72/1369
5. Munga Creek: M73/357
6. Hillgrove: M75/643
7. Urunga: M74/870
8. Wild Cattle Creek: M73/9082
9. Karangi: M68/8935
10. Ottery: T76/3068
11. Mole River: No file.
12. Ardlethan: M74/6098

(No files are kept on sites 13 to 17)

ACCOMPANYING PLANS

GENERAL

Plan No. 7268: Water sampling localities throughout N.S.W.

COAL

1. Muswellbrook: Plan No. 7357: Water sampling stations in the Muswellbrook district.

2. Black Creek: Plan No. 8763: Water sample localities - Black Creek Catchment area
   Plan No. 8764: Pelton Colliery - General surface plan showing water sample localities.

3. South Maitland: Plan No. 8770: Sketch plan of some coal washeries and water sampling stations - South Maitland district.

4. Western Districts: Plan No. 8619: Water sampling sites in the Western Coal Mining district.

5. Huntley: Plan No. 7269: Water sampling stations - Huntley.

METALLIFEROUS

1. Captains Flat: Plan No. 7540: Mine waste dumps, Lake George Mine, Captains Flat. Water sampling stations.
   Plan No. 7541: Locality plan, Lake George Mine, Water sampling stations.

2. Woodlawn: Plan No. 8772: Woodlawn Prospect - Locality plan.

3. Kangiara: Sketch plan in register.

4. Cadia: Plan No. 8765: Cadia prospect - Environmental Survey.

5. Munga Creek: Plan No. 8769: Munga Creek antimony mine - Surface workings.

6. Hillgrove: Plan No. 8767: Water sampling sites - Hillgrove.

7. Urunga: Sketch plan in register.

8. Wild Cattle Creek: Plan No 8771: Wild Cattle Creek antimony mine - Dorrigo.

9. Karangi: Plan No. 8768: Mount Browne copper mine, Coffs Harbour - Locality plan and water sampling localities.

10. Ottery: Plan No. 7290: Tent Hill - Water sampling stations below the Ottery mine.

Sketch plans are available for sites 3, 7, and 11-17 in registers kept at the Geological Survey.

ABSTRACT

The environmental monitoring programme undertaken by the Department of Mines has comprised regular water sampling since 1971 and stream sediment sampling since 1976. The programme has been able to quantitatively express the degree of pollution which has been directly or indirectly caused by mining. The results of the programme have been used to highlight areas where rehabilitation is required and to demonstrate the effectiveness of rehabilitation undertaken at mining sites. The programme should be continued in those areas where more data is required.

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APPENDIX 1: Summaries of data from the environmental monitoring programme.

APPENDIX 2: Analytical Results - Water and Stream Sediment Sampling, 1971 - 1977. (Copies only available for perusal at Geological Survey of N.S.W. (Sydney) and Department of Mines Chemical Laboratory (Lidcombe).

INTRODUCTION

A routine programme of water sampling and analysis was commenced by the Department of Mines in 1971 to monitor the quality of surface water at locations subject to the possible effects of past, present, and future mining operations. Samples have been collected at either three or six monthly intervals from approximately 200 permanent sites, of which about half are located in the coalfields and the remainder in metalliferous provinces (see plan 7268). More recently, stream sediment samples have been collected from most of the sites in the metalliferous provinces. Samples have also been collected on a "one-off" basis at some localities throughout the state (see plan 7268).

This report presents the results of the analytical work and an assessment of the overall programme to date, and makes recommendations for future modification of sampling sites and procedures. To date, eight Geological Survey reports which utilize data collected during the sampling programme, have been prepared on individual mining areas.

The analytical results of the entire programme are presented in a summary format for each site, while an assessment of the results from the sites has been undertaken on the basis of catchment areas. The summary assessment sheets are included as appendix 1, while the water and stream sediment analytical data (since 1971) are presented as appendix 2. The sheer bulk of the results data precludes copying for attachment to the report. Hence copies of appendix 2 may only be viewed at the Department's Chemical Laboratory (Lidcombe) or the Geological Survey of New South Wales (Sydney).

WATER SAMPLING PROGRAMME

The majority of water samples have been collected on a three monthly basis, primarily to obtain sufficient data to be representative for the area concerned, throughout the entire year. Six monthly sampling was introduced in those areas where surveillance was considered to be warranted, yet not on four occasions annually. Sampling has been conducted only once in some localities, either where it has been considered worthwhile by field officers or as a result of a letter of complaint forwarded to the Department of Mines.

Analyses - All analyses are carried out by the Department of Mines Chemical Laboratory (located at Lidcombe since April 1977). The range of parameters analysed is set out in table 1. It is usual practise to analyse for most parameters when sampling commences in an area. However, after a period of time has elapsed, analysis of only those parameters considered to be important or indicative is continued. Trace metal determinations are made only on samples from metalliferous provinces.

TABLE 1

RANGE OF PARAMETERS ANALYSED IN WATER SAMPLES

SUBMITTED TO THE DEPARTMENT OF MINES CHEMICAL LABORATORY*

pH	
Electrical Conductivity	Zinc
Acidity	Cadmium
Alkalinity	Lead
Sulphate	Copper
Nitrate	Antimony
Chloride	Arsenic
Calcium	Iron
Magnesium	Manganese
Potassium	Nickel
Sodium	Mercury
Suspended Solids	

*Where considered necessary, a number of other parameters also may be analysed.

Records - The analyses of all samples collected are maintained in registers which are kept at the Sydney office of the Geological Survey of N.S.W., the Department of Mines' Chemical Laboratory (Lidcombe), and appropriate District Offices of the Department of Mines. The registers are progressively updated as results become available. Also included within the registers are photographs of each sampling locality, local rainfall records and appropriate locality maps.

Sampling procedures - Water sampling has been conducted in accordance with guidelines prepared by the Geological Survey of N.S.W. and the Department of Mines Chemical Laboratory, as summarized below.

Wherever possible, samples have been taken from:

(i) a primary polluted drain or pollution source,

(ii) a stream downstream of the confluence with a drain or pollution source, and

(iii) a stream upstream of pollution (for background levels).

Depending on the chemical nature of the problem, one or two samples are collected.

(i) Acidified Sample: All metals except mercury*

Plastic 250 ml bottles have 3 ml of 5 molar nitric acid added in the laboratory prior to despatch to the field. (The acid maintains the trace metals in solution). The samples are collected by immersing the bottle in the water until almost full and then using the cap to ladle water to within 1 cm of the top of the bottle.

*NOTE: Samples requiring determinations for mercury are collected in glass containers and returned to the laboratory within 24 hours.

(ii) Plain Sample: pH, conductivity, total dissolved solids, total suspended solids, turbidity, acidity, alkalinity, hardness, bicarbonate, chloride, sulphate, nitrate, fluoride, boron, sodium, potassium, calcium, magnesium. Plastic 250 ml bottles are used. The bottle is immersed in the water to be sampled and filled to within 1 cm of the top, after it has been rinsed several times with sample water.
Both acidified and plain samples are collected in metalliferous provinces, whilst only plain samples are collected in coal provinces.

Water flow measurements - The extent of any pollution problem becomes more clearly evident when the volume of polluted water is known. Chemical analyses, together with flow data, can give a quantitative assessment of pollution at a particular site, by permitting calculation of load of dissolved species.

During the period 1971 to 1974, the flow at each sampling site was qualitatively related to the flow regime of the stream. Details of the qualitative level of stream flow used are given in table 2. Since 1974, however, a portable Braystroke vane current stream gauge has been used to measure the stream discharge at time of sampling at as many sites as possible. The discharge data is recorded in appendix 2 in units of megalitres per day with 0.1 megalitres per day being the lowermost value.

TABLE 2

SYMBOLS USED FOR THE QUALITATIVE EXPRESSION OF STREAMFLOW

●	NOT FLOWING
○	FLOWING VERY SLOWLY
▲	FLOWING SLOWLY
△	NORMAL FLOW
■	FLOWING RAPIDLY
□	FLOWING VERY RAPIDLY
◒	RESERVOIR OR DAM

STREAM SEDIMENT SAMPLING PROGRAMME

Stream sediment samples have only been collected on a regular basis since February, 1976. Prior to that date, samples were only collected for specific projects. The samples are now routinely collected concurrently with the water samples in the metalliferous provinces of the state.

All samples are analysed by the Department of Mines Chemical Laboratory for all or some of the parameters outlined in table 3. Samples are usually analysed after separation into three particle size fractions ($+80^{\#}$, $-80^{\#}$ $+200^{\#}$, $-200^{\#}$). Copies of the results are available for perusal at the Department of Mines Chemical Laboratory (Lidcombe) and the Geological Survey of N.S.W. headquarters (Sydney).

TABLE 3

RANGE OF PARAMETERS ANALYSED IN STREAM SEDIMENT SAMPLES SUBMITTED TO THE DEPARTMENT OF MINES CHEMICAL LABORATORY *

Zinc	Manganese
Cadmium	Nickel
Lead	Mercury
Copper	Bismuth
Antimony	
Arsenic	
Iron	

*NOTE: Where necessary, other parameters may be analysed.

Samples collected usually vary in mass from 0.5 to 3 kg in weight according to the grainsize distribution. The larger samples are collected when a large volume of coarse fraction is present. Preference is currently towards the collection of stream sediment samples in 2 litre plastic jars.

MINING AND SURFACE WATER QUALITY

Surface water quality depends largely upon the environmental geological setting of the drainage basin. The rainfall pattern and the chemical nature of the leaching, weathering and decomposition products produced within the catchment, generally determines the background water quality. A change in land use from the natural forested state usually results in some degree of change in the water quality in streams nearby. Pollution of water can result from urban and rural land development, the use of agricultural fertilisers, sewage discharges, stormwater discharges and discharges from industrial developments such as mining.

Water pollution problems resulting from mining can be categorised into those related to

(i) coal mining
(ii) base metal mining
(iii) alluvial mining

Coal Mining

Surface water quality in areas of coal mining and beneficiation may be affected principally by:-

i) Groundwater discharged during the de-watering of underground mines and open cuts.
ii) Seepages and surface run-off from areas which have been used for stockpiling coal, colliery waste or overburden.
iii) Discharges from coal preparation plants.

The principal problems occur where the coal being mined contains significant iron pyrite (FeS_2). Oxidation of the pyrite results in undesirable acidity (eg, H_2SO_4), dissolved salts (eg, $Ca\ SO_4$) and precipitation of iron compounds (eg, $Fe(OH)_3$ and $Fe\ SO_4$). Other problems may result from suspended coal or coal washery wastes being eroded and transported by water from surface areas used for the handling of coal and coal wastes. These problems are aggravated in situations where there is inadequate rehabilitation and revegetation of colliery and washery sites.

Base metal mining

Surface water quality in base metal mining and treatment areas may be affected by:-

(i) Groundwater discharged in the de-watering of underground mines and open cuts.

(ii) Seepages and surface run-off from areas which have been used for stockpiling of overburden and mineral treatment wastes.

(iii) Discharges from treatment mills.

The major problems in metalliferous provinces occur where a significant quantity of pyrite (FeS_2) is present with the ore minerals. The sulphuric acid produced from the oxidation of pyrite enables the other metal irons present in the same environment to enter into solution. Acidity, dissolved salts and the precipitation of metal salts are the main pollutants in areas where copper, lead and zinc are mined. Accessory elements such as cadmium, arsenic and iron which are not recovered from the ore are often present in the polluted water in significant quantities.

Antimony usually does not occur with other base metal sulphides (except with minor arsenic) and acidic waters are not necessary for it to enter into solution. Significant concentrations of antimony can occur in streams with a neutral pH.

Alluvial mining

Turbidity problems arise from a wide range of alluvial mining operations. These operations include the extraction of precious gems (eg sapphires and zircons), tin, gold, sand and gravel. Mining may be located either within existing river courses or within buried river channels. There is usually negligible chemical water pollution resulting from any of these activites.

MINING AND THE CLEAN WATERS ACT (1970)

All mining operations in New South Wales must comply with the provisions of the Clean Waters Act (1970). The act is administered by the State Pollution Control Commission (hereafter S.P.C.C.) which is responsible to the Minister for Planning and Environment. The main sections of the Act and its Regulations which affect mining operations can be summarized as follows.

All companies either operating or developing mine sites must satisfy the requirements of Section 16 which prohibits the pollution of waters.

Operating mines may be served with a notice under Section 28 at any time to supply certain information to the S.P.C.C. concerning any aspects of the company's liquid waste disposal operation.

Operating mines located within catchment areas classified by the S.P.C.C. under Regulation 8, must satisfy the requirements for that particular classification. Mining operations within catchment areas not already classified, can still be subject to the requirements of Regulation 8 where a classification of waters has been proposed. It is anticipated that all waters within New South Wales will be classified by the S.P.C.C. by December, 1978.

Operating mines within classified catchment areas must apply for a licence to discharge liquids into classified waters (Section 20). The licence fee is related to discharge.

By issuing a company with a licence, the S.P.C.C. is maintaining an acceptable standard for liquid discharges. Those companies unable to satisfy the quality standards are refused licences either at the time of application or renewal.

In situations where waters are not classified, it is advisable for a company to apply for a licence as Section 16(6) states "Notwithstanding the foregoing provisions of this section, it shall not be an offence against this Act arising under those provisions for a person to pollute any waters if he holds a licence and does not pollute the waters in contravention of any of the conditions of the licence".

Companies developing new mines or augmenting existing mines that will generate waste waters must seek approval from the S.P.C.C. under Section 19 to install, construct or modify any apparatus, equipment or works and for the treatment, storage or discharge of pollutants into any waters.

Companies developing new mines or operating existing mines may be served a notice under Section 21 of the Act to undertake certain works to control the discharge of pollutants.

RESULTS OF THE MONITORING PROGRAMME

For easy reference the results of the monitoring programme have been summarized according to their respective catchment areas. The summary format sheets are included as appendix 1.

A list of Geological Survey reports which have utilized this data in specific investigations is given in the references.

Sampling is suspended in particular areas, or the number of stations and the frequency of sampling is reduced, once "predictable" levels of contamination have been established. It may be restarted at derelict mine sites when rehabilitation commences in order to assess its effectiveness.

Recommendations regarding reduction of sampling in accord with this procedure are made on the Data Sheets for the situation as at June 1977.

CONCLUSIONS

The overall environmental monitoring programme has been able to quantitatively express the degree of pollution which has been directly or indirectly caused by a number of mining operations throughout the state.

Those mines extracting either coal or base metals in which significant pyrite is present are likely to be the areas where most water pollution problems occur.

The monitoring programme has been extremely worthwhile in providing quantitative results in areas where conflicts have arisen between local residents and mining interests.

The planning of rehabilitation projects has been assisted by the monitoring programme and the results have been used to demonstrate the effectiveness of rehabilitation undertaken at mining sites.

Stream sediment sampling has been useful in determining the type and extent of polluted sediment transport. It has been possible to distinguish between sediment fractions and relate these to sources such as tailings or precipitated material.

The monitoring undertaken to date is by no means exhaustive. However, it has been possible to examine water pollution problems in many areas where significant pollution problems are known to occur. Problems of a minor nature will undoubtedly occur around other small mining operations, where however, the water pollution effects should be minimal.

RECOMMENDATIONS

1. The monitoring programme should be curtailed or expanded according to the individual recommendations on the summary sheets in Appendix 1. The specific recommendations are summarized on Table 4.
2. Registers of analytical results should be prepared and distributed to all country offices of the Department of Mines; where possible, the registers should be delivered personally by an officer of the Environmental Geology Subsection.
3. The recording sheets should be redesigned to incorporate values for stream loads.
4. The monitoring programme should be assessed and reported on at least every two years depending upon priorities. The summary format adopted in this report should be retained for reporting.

TABLE 4

SUMMARY OF RECOMMENDATIONS ON FURTHER MONITORING OF SPECIFIC SITES

COAL

1.	Muswellbrook	17 stations discontinued. 9 stations continued.
2.	Black Creek	42 stations discontinued. 16 stations continued.
3.	South Maitland	5 stations discontinued. 3 stations continued.
4.	Western Districts	14 stations discontinued. 10 stations continued.
5.	Huntley	Discontinued
6.	Westcliff	Discontinued

METALLIFEROUS

1.	Captains Flat	9 stations discontinued. Sampling at remaining 6 to cease in 1978.
2.	Woodlawn	8 stations discontinued. 10 stations continued.
3.	Kangiara	Sampling to cease in 1978.
4.	Cadia	Discontinued.
5.	Munga Creek	Discontinued until rehabilitation earthworks are commenced.
6.	Hillgrove	6 stations discontinued. 12 stations continued.
7.	Urunga	Discontinued.
8.	Wild Cattle Creek	Discontinued.
9.	Karangi	Discontinued
10.	Ottery	Discontinued until rehabilitation earthworks are commenced.
11.	Mole River	Discontinued.
12.	Ardlethan	Discontinued.
13.	Fishington	Discontinued.
14.	Halls Peak	Discontinued.
15.	Copeton	Discontinued.
16.	Cordillera	Discontinued.
	Peelwood	Discontinued.
	Mount Costigan	Discontinued.
17	Lewis Ponds	Discontinued.

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_____. 1975. Environmental Survey, Hillgrove mining field. Report Geological Survey of N.S.W. GS1975/170. (Unpubl).

APPENDIX 1

Summaries of data from the environmental monitoring programme.

Department of Mines

Sample Localities in N.S.W.-Summary of Data

AREA LOCATION CAPTAINS FLAT (Sites 5-15) Page 1 of 4

RELEVANT FILES M70/3088 RELEVANT PLANS 7540

NAME OF MINE	OWNER	COMMODITY
Lake George (1882-1962)	Abandoned	Cu, Pb, Zn, Au

BRIEF MINING HISTORY: Mining commenced at Captains Flat in 1874 and continued intermittently until 1962. Pollution of the Molonglo River has always been recognised as a problem. However, it wasn't until 1972 when a Joint Government Technical Committee was formed that any permanent remedial measures were proposed. These measures were carried out in March - December 1976 at a cost of approximately $2.3 million

WATER SAMPLING PROGRAMME

*PURPOSE

-Reasons for Sampling: The Molonglo river has been chemically affected by acidic water and heavy metals (especially zinc) since mining commenced. The zinc concentrations were found to be excessively high as far downstream as Lake Burley Griffin. The importance of reducing zinc pollution was emphasized because of the impending Googong Dam on the Queanbeyan River *

-Aims of Programme: To establish the major sources of pollution and determine the extent of pollution within the Molonglo River. The effectiveness of the remedial measures would also be determined once rehabilitation is completed.

*ANALYTICAL RESULTS (†Averaged results – the number of results used are in parentheses)

-Duration of Sampling: September 1972 - Present.

† -Background Water Quality: Site 13 - Satisfactory
pH=6.8(17); E.C.=103(17); Sulphate=11(17); Zn=0.28(18); Cd and Cu below detection limits; Pb - range < 0.004-0.03

† -Contaminated Water Quality: Sites 6,8-11, 14-very poor
pH=3.3(75); E.C=4660(75); Sulphate=3800(75); Cd=0.24(75); Cu=39(75); Pb=0.66(75) Zn=295(75). Sites 5,7,12,15 - Poor
pH=5.9(67);E.C. =260(67); Sulphate=78(67); Cu=0.06(71); Pb=0.054(71); Zn=5.65.

-Changes in Water Quality with time: The quality of water at the sources of pollution (Sites 6,8-11,14) has not changed; however, the quality of water within the Molonglo river appears to have improve especially since late 1974. The acidity has decreased; however, the zinc levels have remained at earlier concentrations.

*ASSESSMENT

-General: The major problem in the Molonglo River is zinc pollution. The remedial measures undertaken have stabilized the tailings dumps and should reduce the zinc load in the Molonglo River. The pH values have increased since late 1974; however, the zinc levels are still significant. Further sampling will establish the degree of improvement in water quality.

-Action Taken: The results have been used in planning the remedial measures.

-Previous Reports (which use or discuss these results): None

-Future Sampling/Recommendations:
Sampling has been discontinued at sites 9,10,11,14.
Sampling should be discontinued at sites 6,8,13,15
Sampling should be continued for a period of 6 months at sites 5, 7, 12.

* which would reduce the diluting affect upon the Molonglo River.

AREA LOCATION CAPTAINS FLAT (Sites 5-15)

STREAM SEDIMENT SAMPLING PROGRAMME

*ANALYTICAL RESULTS

-Duration of Sampling: February 1976 - Present.(Sites 5,6,7,12,13,15 only).

-Background Stream Sediment Analyses: Site 13. The sediment from Site 13 shows evidence of being disturbed and polluted. An attempt to obtain sediment in the area, but not influenced by mining activity, to give a background value should be made.

-Contaminated Stream Sediment Analyses: Sites 6,8-11,14 poor, Site 6 only site collected on regular basis,Pb, 800-5,000ppm; Zn,650-5,500; Cu, 100-950ppm; As, 35-300ppm; Cd, <1-7. Generally metals concentrated in finest fractions, high Fe (6%) indicates enrichment due to adsorption on precipitated Fe oxides. Site 8 very high Fe (up to 35%), reflects high metal content of main spring from mine. Sites 5,7,12,15, poor,generally metals concentrated in finest fractions, Pb,Zn,Cu main contaminants; Pb,900-9,500; Zn,800-10,000; Cu,100-1,000; Cd, <1-11; High Fe in some fractions would indicate enrichment due to adsorption on Fe oxides.

-Changes in Stream Sediment Analyses with Time: Pb,Zn and Cu in the most recent samples (June 1977) collected are the lowest since beginning of programme. This may indicate effectiveness of remedial measures undertaken in the area. Arsenic values in sediments have all been lower since the October 1976 flood.

*ASSESSMENT

-General: Since the October 1976 flood, arsenic values have fallen significantly. Pb and Zn are the main pollutants and the most recent samples taken (June 1977) are all significantly lower than previous results. This is encouraging as the lowering in values may be a function of the revegetation which is now finished. Copper values also reflect this trend. The very high lead values in the sediments indicate this element is being precipitated in the upper reaches of the Molonglo River.

-Future Sampling/Recommendations: Sampling should be continued at sites 5,6,7,12 and 15 on a six monthly basis to ascertain whether the trend for Pb,Zn and Cu mentioned above is due to the remedial measures or for some other reason, eg. seasonal. A background site remote from any previous mining area should be found to give a sediment so comparisons can be made.

Sample Localities in N.S.W.-Summary of Data

AREA LOCATION CAPTAINS FLAT (Sites 1-4) Page 3 of 4

RELEVANT FILES M70/3088 RELEVANT PLANS 7541

NAME OF MINE	OWNER	COMMODITY
Lake George (1882-1962)	Abandoned	

BRIEF MINING HISTORY: Mining commenced at Captains Flat in 1874 and continued intermittently until 1962. Pollution of the Molonglo River has always been recognised as a problem. However, it wasn't until 1972 when a Joint Government Technical Committee was formed that any permanent remedial measures were proposed. These measures were carried out in March-December 1976 at a cost of approximately $2.3 million.

WATER SAMPLING PROGRAMME

*PURPOSE

-Reasons for Sampling: The Molonglo river has been chronically affected by acidic water and heavy metals (especially zinc) since mining commenced. The zinc concentrations were found to be excessively high as far downstream as Lake Burley Griffin. The importance of reducing zinc pollution was emphasized because of the impending Googong Dam on the Queanbeyan River which would reduce the diluting affect upon the Molonglo River.

-Aims of Programme: To establish the major sources of pollution and determine the extent of pollution within the Molonglo River. The effectiveness of the remedial measures would also be determined once rehabilitation is completed.

*ANALYTICAL RESULTS (†Averaged results – the number of results used are in parentheses)

-Duration of Sampling: September 1972- Present

† **-Background Water Quality:** Not applicable

† **-Contaminated Water Quality:** Sites1-4. Variable pH=6.3(64) (Range 3.15 to 7.9) E.C. = 290(64) (Range 90 to 985) Sulphate=92(64) (Range 12 to 370) Zinc =5.5(66) (Range .02 to 26)

-Changes in Water Quality with time: The pH values have increased significantly since 1974, except during periods of high flow. In the upper reaches (Sites 2, 3, 4) there has been little change in the concentration of zinc; however, it is significantly lower at site No 1.

*ASSESSMENT

-General: The extent of zinc pollution in the Molonglo River appears to be confined to the upper reaches of the River (about Site 2). Further sampling will establish the effect of the remedial measures on the downstream water quality.

-Action Taken: The results have been used in establishing the extent of pollution in the Molonglo River, downstream from Captains Flat.

-Previous Reports (which use or discuss these results): None

-Future Sampling/Recommendations:
Sampling has been discontinued at Site No 2.
Sampling should be continued at site No 1, 3 and 4 for a period of 6 months.

AREA LOCATION **CAPTAINS FLAT (Sites 1-4)**

STREAM SEDIMENT SAMPLING PROGRAMME

*ANALYTICAL RESULTS

-Duration of Sampling: **February 1976 - Present**

-Background Stream Sediment Analyses: **Not applicable.**

-Contaminated Stream Sediment Analyses: **Sites 1-4. Variable, zinc and lead main contaminants, copper minor; highest in finest fractions; decrease in concentrations with distance downstream; highest values in times of high flow; Range -25+80 mesh, zinc, 2,300-300ppm, lead, 900-45ppm; +80-150 mesh, zinc, 2,300 -300ppm, lead, 900-75ppm; -150 mesh, zinc, 3 200-500ppm, lead, 1,700-100ppm.**

-Changes in Stream Sediment Analyses with Time: **Zinc - no change in concentration in three size fractions analysed.**

Lead - decrease in concentration since Oct. 1976 (flood); lowest lead concentration at Site 1 recorded in June '77.

*ASSESSMENT

-General: **The high zinc values, particularly in the fine size fractions, indicate the zinc pollution upstream in the Molonglo. There is no evidence of any decrease in zinc concentrations in the sediments since sampling began. There appears to have been a marked decrease in the lead concentration of sediments since the October 1976 flood.**

-Future Sampling/Recommendations: **Further sampling should be continued at sites 1, 3 and 4 to establish that the decreasing trend in lead concentrations in stream sediments is continuing and also to establish the effect (if any) of remedial measures upstream on stream sediments.**

Department of Mines

Sample Localities in N.S.W.-Summary of Data

AREA LOCATION WOODLAWN (Lake George Catchment)

RELEVANT FILES M1970/453 RELEVANT PLANS 5925, 5924, 8772.

NAME OF MINE	OWNER	COMMODITY
Woodlawn	Woodlawn Mines Ltd.	Cu, Pb, Zn, Ag

BRIEF MINING HISTORY Small copper, lead, zinc and silver mines have been scattered throughout the area since the early 1900's. In 1968, Jododex discovered a large stratiform orebody on the Woodlawn property. Stripping of the gossans for the purpose of recovering silver commenced in April, 1977 and the major open cut and mill is planned to commence in mid 1978.

WATER SAMPLING PROGRAMME

*PURPOSE

-Reasons for Sampling: The mine at Woodlawn will be a very large mine when fully operating and its impact on the environment could be substantial. Whilst developing the site etc. background water quality data could be collected.

-Aims of Programme: To establish the water quality in the vicinity of the proposed mine site and in the streams nearby.

*ANALYTICAL RESULTS (†Averaged results – the number of results used are in parentheses)

-Duration of Sampling: August 1971 - Present.

† -Background Water Quality: Saline (Sites, 4-7, 10-12, 17)
pH = 7.3 (84); E.C. = 1230 (84); Sodium = 135 (40); Sulphate = 85(84); Chloride = 270 (64), Magnesium = 60 (64)
on most occasions, metals (Cd, Cu, Pb and Zn) below detection limit.

† -Contaminated Water Quality: "Not applicable yet".

-Changes in Water Quality with time: Salinity values vary according to flow.

*ASSESSMENT

-General: The water in the Lake George catchment is only of medium quality with significant concentrations of chlorides, sulphates, sodium and magnesium. The water at site No. 7 appears to have the least overall salinity.

-Action Taken: The results are compiled for future reference, especially for comparisons when the mine opens.

-Previous Reports (which use or discuss these results):

Foskett, W.E., 1971b: Geol. Survey Report GS 1971/401 (Unpubl).

-Future Sampling/Recommendations:

Sampling has been discontinued at sites 4, 5, 7, 11 and 12
Sampling should continue at sites 6, 10, 17.

AREA LOCATION WOODLAWN (Lake George Catchment).

STREAM SEDIMENT SAMPLING PROGRAMME

*ANALYTICAL RESULTS

-Duration of Sampling: February 1976 to present. Sites 6,11,10,17 are now collected regularly.

-Background Stream Sediment Analyses: Sites 4-7,10-12,17. Site 7 can be considered an undisturbed background sediment for the area Zn, 25ppm; Pb 20ppm; Cd < 1ppm. Site 6 shows natural higher Zn and probably Pb compared with 7. (Zn, ~50ppm; Pb ~25ppm; Cd <1ppm). Sites 10,11 and 17 are outflows from dams and when these are flowing sediments are collected. Site 11 has shown Pb and Zn contamination (Pb ~180ppm; Zn ~100ppm) but this appears to be a function of outflow.

-Contaminated Stream Sediment Analyses: Not applicable.

-Changes in Stream Sediment Analyses with Time: Unsure, as work at the mine progresses, heavymetal values in stream sediments can be expected to increase.

*ASSESSMENT

-General: There has been sporadic occurrences of high Zn and Pb values at sites 11 and 10. As the tenor of work at the mine site increases, these values may increase so monitoring of site 6,11, and where possible 11 and 17 should be continued.

-Future Sampling/Recommendations: As mentioned above, there is evidence now that even with the developmental work being done at the mine the metal values of stream sediments may be changing. This may be a seasonal factor so future sampling should be carried out to decide whether any changes in metal concentrations are due to seasonal factors and/or mine development work.

Sample Localities in N.S.W.-Summary of Data

AREA LOCATION WOODLAWN (Wollondilly River Catchment).

RELEVANT FILES M1970/453 RELEVANT PLANS 5925, 8772, 5924.

NAME OF MINE	OWNER	COMMODITY
Woodlawn	Woodlawn Mines Ltd	

BRIEF MINING HISTORY : Small copper, lead, zinc and silver mines have been scattered throughout the area since the early 1900's. In 1968, Jododex discovered a large stratiform orebody on the Woodlawn property. Stripping of the gossans for the purpose of recovering silver commenced in April, 1977 and the major open cut and mill is planned to commence in mid 1978.

WATER SAMPLING PROGRAMME

*PURPOSE

-Reasons for Sampling: The mine at Woodlawn will be a very large mine when fully operating and its impact on the environment could be substantial. Whilst developing the site etc, background water quality data could be collected.

-Aims of Programme: To establish the water quality in the vicinity of the proposed mine site and in the streams nearby.

*ANALYTICAL RESULTS (†Averaged results – the number of results used are in parentheses)

-Duration of Sampling: August 1971 - Present.

† -Background Water Quality: Saline (Sites 1-3,8,14-16,18,19) At site 9 water quality is quite satisfactory. pH=7.5 (90); E.C. = 2500 (90); Sodium = 185 (41); Sulphate = 90(90); Chloride = 760 (70); Magnesium = 160 (71) On most occasions, metals (Cd, Cu, Pb, Zn) below detection limits or very low concentrations.

† -Contaminated Water Quality:

Non applicable

-Changes in Water Quality with time: Salinity values vary according to flow.

*ASSESSMENT

-General: The water in Crisps Creek and its tributaries is often quite saline with significant concentrations of sodium, magnesium, chlorides and sulphate. The water in the Mulwaree River is of satisfactory quality prior to its junction, with Crisps Creek. Downstream from this junction (Site 1), the salinity values increase due to the influence of Crisps Creek.

-Action Taken: The results are compiled for future reference, especially for comparisons when the mine opens.

-Previous Reports (which use or discuss these results):

Foskett W.E., 1971b: Geol. Survey Report GS 1971/401 (Unpubl.)

-Future Sampling/Recommendations:

Sampling has been discontinued at sites 14 and 15.
Sampling should be discontinued at site No. 9.
Sampling should be continued at sites 1-3, 8, 16, 18, 19.

AREA LOCATION WOODLAWN (Wollondilly River Catchment)

STREAM SEDIMENT SAMPLING PROGRAMME

*ANALYTICAL RESULTS

-Duration of Sampling: February 1976 to present. Sites 3,16,8,18,19 and 1 are sampled regularly.

-Background Stream Sediment Analyses: (Sites 1-3,8,14-16, 18,19). Site 3 is background but shows enrichment in Pb and Zn compared with Sites 8,19 and 1 which are downstream. Site 3: Pb,35-100; Zn, 75-210; Downstream Sites 8,19 and 1, Pb < 10-50ppm; Zn, 60-100ppm. Site 18 (Background); Pb, < 10-25ppm; Zn, 5-80ppm.

-Contaminated Stream Sediment Analyses: Site 2, which is now sampled as outflow from dam and called Site 16, shows high Pb and high Zn (Pb, 230-450ppm; Zn, 1,100-2,400). Cadmium also shows a high value (3-18ppm).

-Changes in Stream Sediment Analyses with Time: Site 2 or 16 (see above) has shown a gradual increase in both Pb and Zn since Feb. 1976. For Pb from 200 to 400ppm and for Zn from 400 to 2,000ppm. Cadmium has also increased from 3 to 10ppm.

*ASSESSMENT

-General: The sediment in the overflow from the dam at Site 2/16 has shown an increase in Zn and to a lesser extent in Pb since Feb. 1976. This can only be expected to get greater as work at the mine progresses. No pollution is evident yet at Sites 1,19 and 8.

-Future Sampling/Recommendations: The Sites 3,16,8,18,19 and 1 should be regularly sampled, particularly in the next 18 months as the developmental work at the mine site progresses. The increase in lead, zinc and cadmium at W2/16 warrants close monitoring.