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# RETICULATION OF MINE SERVICE WATER IN TWO AUSTRALIAN COAL MINES

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## ABSTRACT

The importance of forward planning of mine reticulation systems is outlined together with the classifications of mine service water distribution systems. Design criteria for mine water distribution systems which will influence the overall efficiency of operation are given. Two case histories regarding mine service water distribution and reticulation from the New South Wales Coalfield are also included.

## INTRODUCTION

An estimation of mine serivce water requirements is necessary in deep underground mines for the detailed design of mine pumping systems. A fresh water supply to underground workings is maintained for the following reasons:

- Fire fighting - in most countries it is a statutory requirement.
- Dust suppression - in drills, production machinery, and coal clearance systems.
- Hydraulic sand stowing.
- In hot deep mines cold water drilling is used for cooling purposes.
- Washing down of equipment, structures and roadways.
- Replenishment of hydraulic fluid.

The used water ultimately mixes with the groundwater which finds its way to the main sump from where it is pumped to the surface. In arid areas, mine water may be treated and recirculated for underground and surface usage. Surplus water is either utilised in or around the mine or disposed of in an environmentally acceptable manner. In a closed circuit layout, fresh water is added to make up inevitable losses. In a situation where a mine discharges pollutants such as acidic and ferruginous water, a close circuit layout may not be economical as an inclusion of a water treatment plant is necessary within the circuit. Consequently, there is a need for adopting a detailed design approach to meet fresh water reticulation requirements of individual mines. An unplanned reticulation system may result in insufficient water supply, inefficient layouts and consequently, financial losses.

The paper outlines design criteria for planning reticulation systems for mine service water and presents two case histories assessing service water requirements at two collieries in the New South Wales Coalfield, Australia. Examples of open circuit and closed circuit layouts are given.

## MINE SERVICE WATER DISTRIBUTION SYSTEMS

A study of mine service water distribution systems will be concerned with the usage of service water; groundwater make and quality; effects of pollutant and requirements of chilled water for improving the mine environment. Distribution systems can be classified into the following categories:

- Open circuit
- Closed circuit
- Integrated circuit incorporating cold water refrigeration and service water in hot deep mines.

### Open Circuit

Open circuit distribution is used in situations where the make of water is excessive or the quality of groundwater make is such that it cannot be economically treated to justify recirculation. However, the mine water should be discharged at the surface in an environmentally

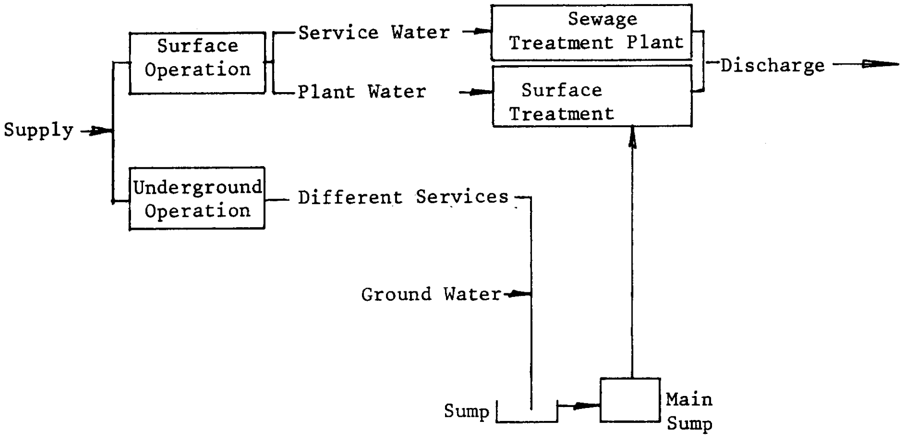



Figure 1 Schematic open circuit service water distribution

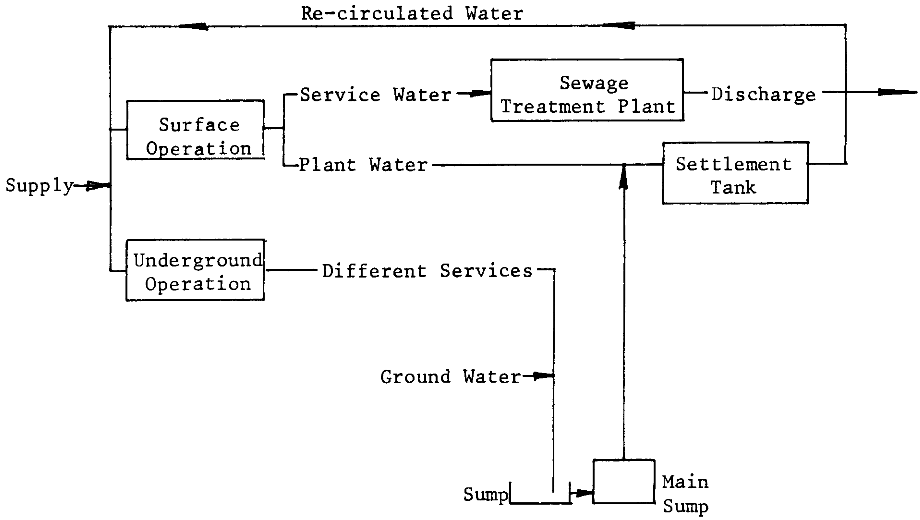



Figure 2 Schematic closed circuit service water distribution

acceptable manner. Figure 1 shows a schematic representation of an open circuit distribution and reticulation system.

### Closed Circuit

Closed circuit distribution is utilised where the water supply is scarce and expensive, and the mine water quality is such that it is amenable to economical treatment. Figure 2 shows a schematic closed circuit scheme in which water losses are made up by fresh water. In some cases, where mine water has a high saline content, fresh water is used for both replenishment and dilution purposes. In this situation some excess water will have to be discharged.

### Integrated Circuit

In hot deep mines circulation of chilled water may be required for refrigeration of the mine ventilation. In many cases the supply of chilled water for mine refrigeration is arranged in a closed circuit. However, economical advantage can be achieved by integrating mine service water distribution with the chilled water reticulation. These systems are at present used exclusively in South African mines and are described in detail by Van Der Walt and Whillier [1], Stephenson [2], Whillier [3] and Grosman [4].

## DESIGN CRITERIA FOR MINE WATER DISTRIBUTION SYSTEMS

### Water Quantity

In order to design a mine water distribution system it is necessary to have basic estimations of water requirements for the various mining operations. In addition to the total requirements for each operation, the peak demand, mean and demand distribution pattern per 24 hours have to be estimated. This information is important to plan guaranteed water supply at the point of usage and thereby facilitate continuity of production operations. A balance of quantity is essential to make up evaporation losses in mine atmosphere and moisture loss in coal.

### Water Quality

The study of water quality is necessary for the following purposes:

- To ascertain if used water can be recirculated with or without treatment.
- To select a method of water treatment such as filtration, dilution or mixing, etc.
- To estimate the quantity of fresh water required for dilution or replenishment.
- To select a method or treatment before surface discharge.
- For selection of mine pumps and pipes with respect to attrition and corrosion problems.

Table 1 shows the typical analysis of water required for underground usage.

Table 1 Typical Analysis of Mine Water for Underground Usage

| Parameter | Raw Water Source Preferred | Raw Water Source Acceptable | Treated Water Preferred | Treated Water Acceptable |
|---|---|---|---|---|
| pH value, range | 6.0 - 9.0 | 5.5 - 9.5 | 6.0 - 9.0 | 5.5 - 9.5 |
| Suspended solids mg/ℓ | 25 | 50 | 10 | 25 |
| Ammonia, N mg/ℓ | 1.0 | 2.0 | 1.0 | 2.0 |
| Total Iron, Fe mg/ℓ | 0.3 | 1.0 | 0.3 | 1.0 |
| Total dissolved solids mg/ℓ | 2500 | 5000 | 2500 | 5000 |
| Total Coliforms No./100 mℓ | 5000 | 5000 | 0 | 0 |
| Faecal Coliforms No./100 mℓ | 2000 | 2000 | 0 | 0 |
| Free chlorine mg/ℓ | * | * | 0.1 - 1.0 | 0 - 1.0 |

* not specified

(after NCB [5])

Water Temperature

In hot deep mines a temperature balance of mine water is an important criteria in the design of a closed circuit distribution system, particularly at mines with a high ambient temperature, as the mine water has to be cooled as well as treated before recirculating underground.

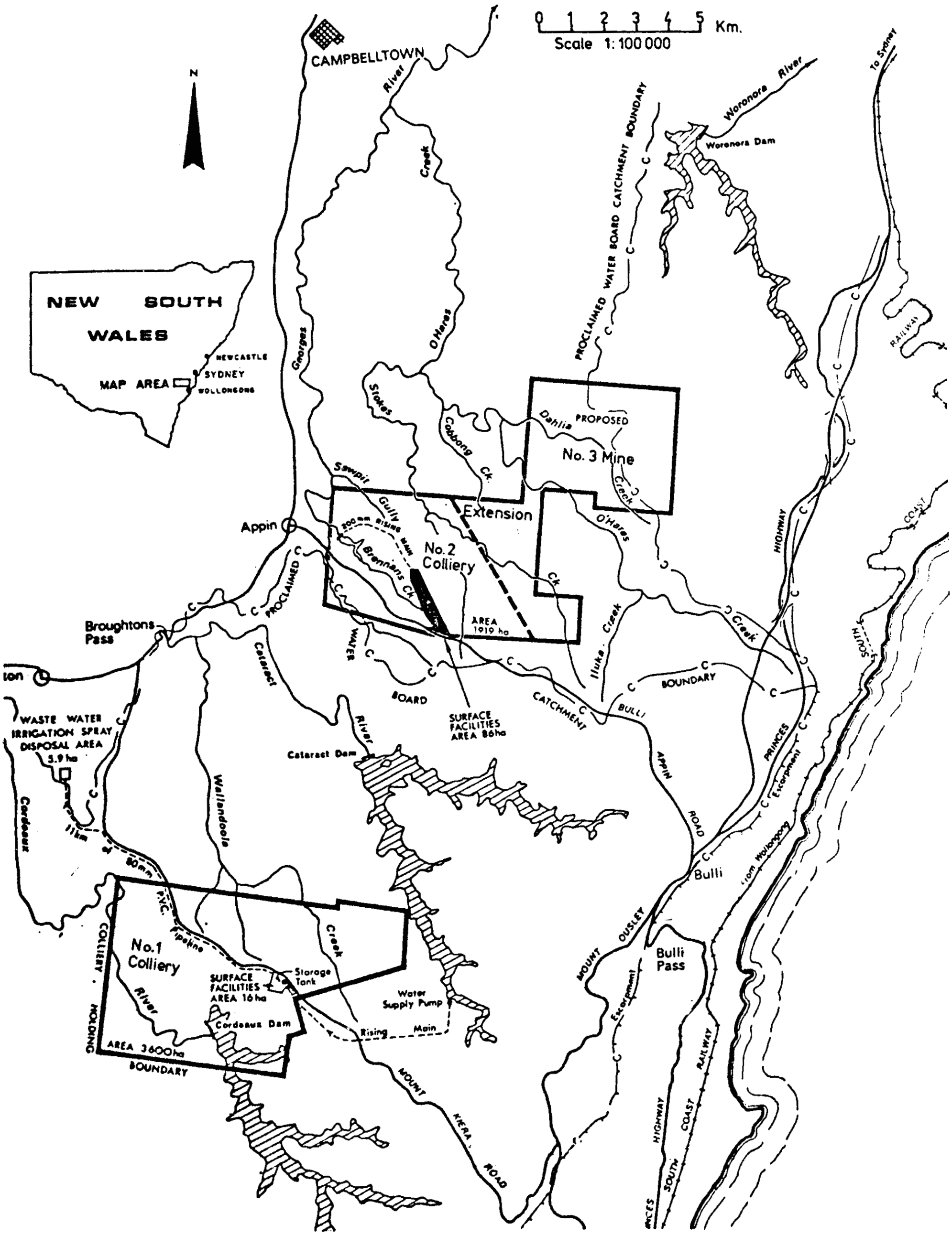
Mine Water Inflow

Estimation of quantity and quality of mine water inflow is necessary to design pumping requirements. Atkins and Singh [6], Bridgwood et al [7].

Pressure Gradients and Storage Sumps

Pipe layouts should be designed in such a way that the static water head should be utilised to overcome frictional losses. In multiseam or steep workings, waste water should be collected in a subsidiary sump in close proximity and pumped to the surface rather than being allowed to gravitate to lower parts of the mine. This will offer advantages of reducing pumping cost and preventing temperature and humidity increases in mine ventilation particularly in hot deep mines. In order to maintain continuity of supply a storage sump of fresh water should be designed into the system in individual mine levels.

Figure 3 Location plan of colliery holding boundaries



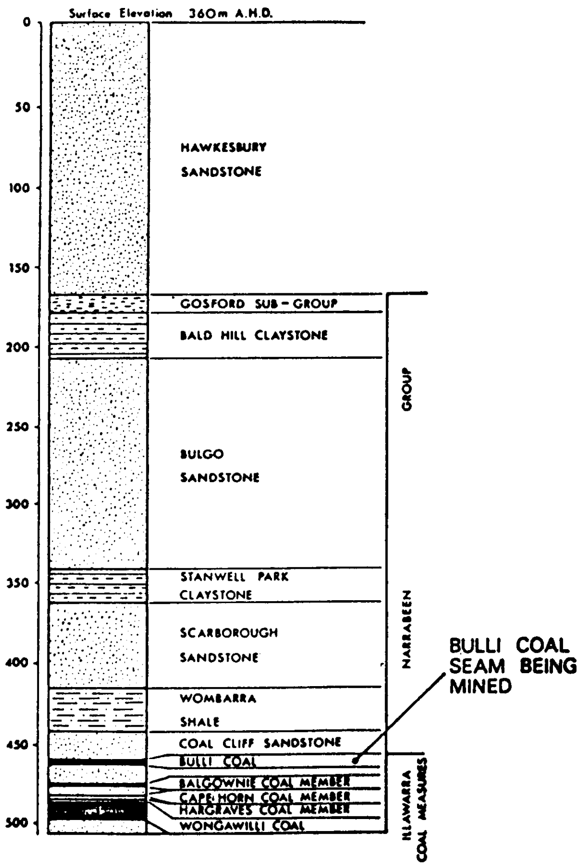



Figure 4 Typical geological section

# CASE HISTORIES REGARDING MINE SERVICE WATER DISTRIBUTION AND RETICULATION

## 1 Open Circuit Distribution

The colliery concerned (No. 1 in this study) is located in the New South Wales coalfield as shown by the location plan in Figure 3. The colliery at present works the Bulli seam approximately 3 m thick, some 430 m below the surface. It has an average output of 300,000 t/y from room and pillar working and it employs 142 people and utilises continuous miners. Figure 4 shows a typical geological section of the colliery.

The method of estimation of service water requirement on the surface is given in Table 2 and Table 3 indicates the underground requirements. It may be noted that in this particular colliery, surface water is mainly required for the bath house, workshop, sewage, vehicle and plant wash and as drinking water. At this colliery there is no coal preparation plant, coal stock piles or surface sprinklers and conveyors and bin are all covered.

The underground water requirements are mainly used for dust suppression in coal winning and coal clearance operations. There are two sources of water loss:

- Loss in absorption in coal = $\left\{ \text{water content of R.O.M.} - \text{inherent water content of coal} \right\} \times \text{annual output}$

  $= (5 - 1) \times 300{,}000 = 12 \text{ m}\ell/\text{y}$

- Loss in evaporation, which is difficult to quantify. However, water loss to ventilation can be estimated by difference as 4 mℓ/y.

Table 2 Surface Water Requirements

| Service Requirement | No. of Persons | Unit Consumption ℓ/d | Working Days per annum | Total Consumption Mℓ/y |
|---|---|---|---|---|
| Bath house, Workshop, Toilets | 140 | 214 | 212 | 6.4 |
| Vehicle - Plant Wash | - | 14151 | 212 | 3.0 |
| Drinking Water | 128 | 4 | 212 | 0.1 |
| Fire Fighting | - | - | 212 | Negligible |

Figure 5 Diagrammatic reticulation layout of Colliery No. 1

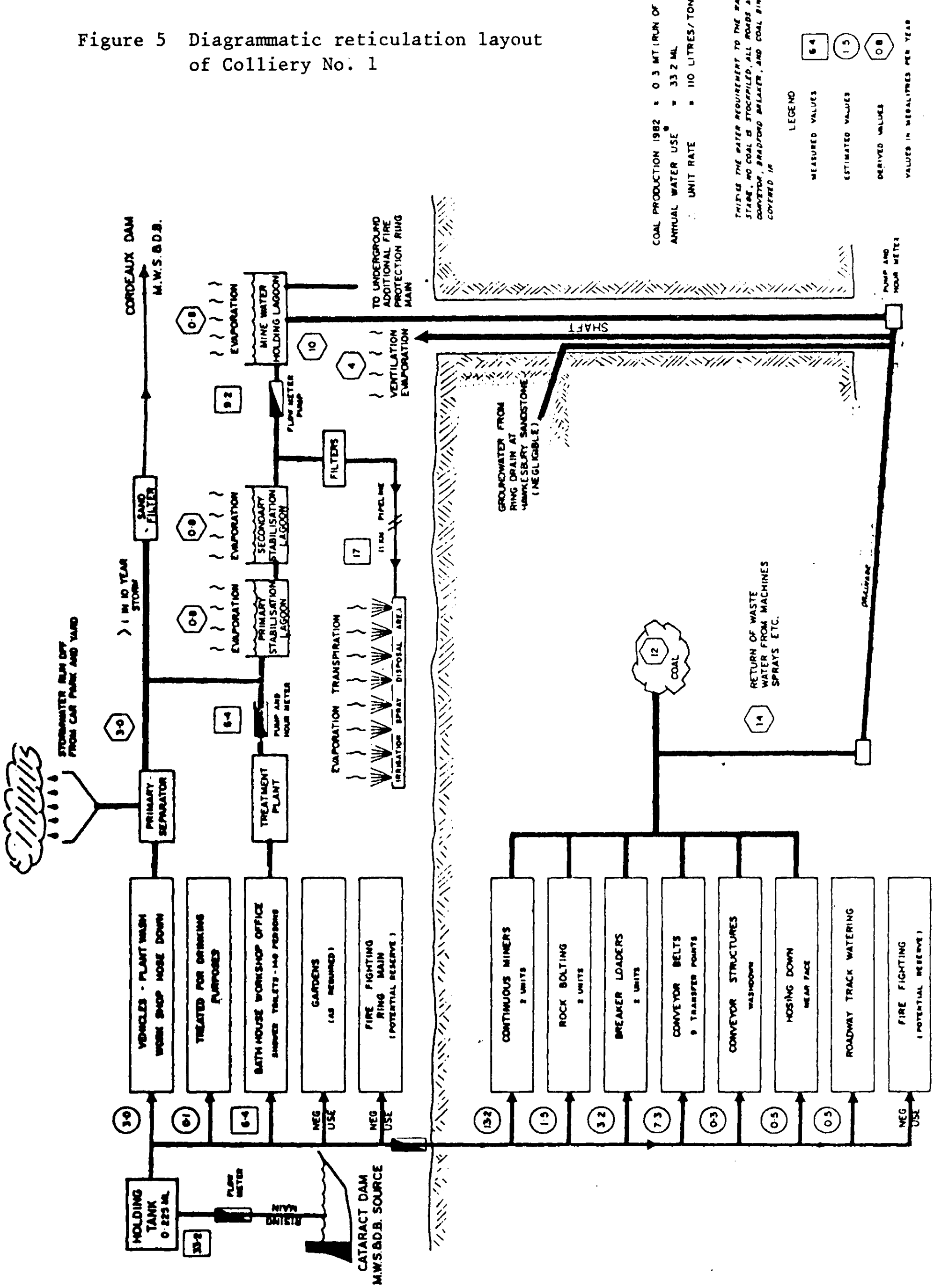


Table 3 Underground Water Requirements

| Service Requirement | No. of Units in Operation | Application | Units of Water | Total Consumption Mℓ/y |
|---|---|---|---|---|
| Continuous Miners | 2 | Cooling, Spray | 130 ℓ/m | 13.2 |
| - Hosing | - | Hosing | 5320 ℓ/wk | 0.5 |
| Rock bolting | 2 | Spray | 10 ℓ/m/bolt | 1.5 |
| Breaker loaders | 2 | Spray | 4.5 ℓ/m/spray | 3.2 |
| Shuttle Cars | 4 | - | No sprays | - |
| Conveyor Belts - Transfer points | 5 km | Spray | 6 sprays each at 9 transfer points | 7.3 |
| - Hosing | - | Spray | - | 0.3 |
| Track Watering | - | Spray | - | 0.5 |

Figure 5 shows the mine service water reticulation layout of the mine.

2 Closed Circuit Distribution

Colliery No. 2 is a good example of using a closed circuit mine service water distribution system. The location of the colliery is shown in Figure 3 and the geological cross section in Figure 4. The colliery was working the Bulli seam 460 m below the surface by long-wall system of mining and producing 2 Mt per year and employing 468 people. However, development headings were driven using continuous miners. Table 4 shows the estimates of service water requirements at the surface and Table 5 gives corresponding data for the underground workings. The water consumption for the mine for a one year period was 660 Mℓ/y.

It can be observed that 50 percent of service water is used at the surface mainly in the coal preparation plant, coal stock piles and road watering. It can be estimated that the loss of water in the Run of Mine (R.O.M.) coal is 76 Mℓ/y, mine water inflow 10 Mℓ/y and water loss in ventilation current is 59 Mℓ/y.

A diagrammatic representation of mine service water reticulation is outlined in Figure 6.

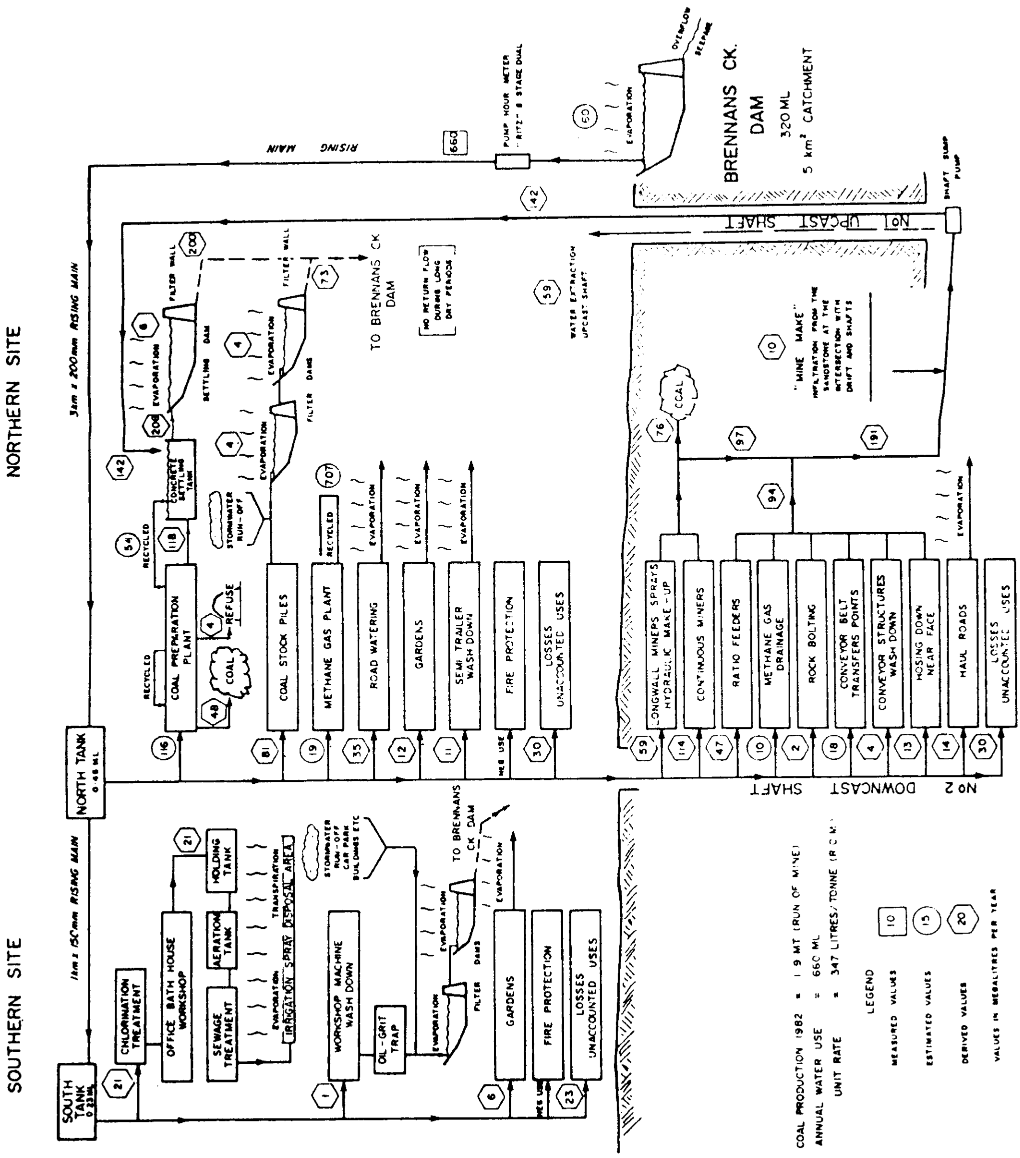



Figure 6 Diagrammatic reticulation layout of Colliery No. 2

Table 4 Surface Water Requirements

| Service Requirement | No. of Persons | Unit Consumption ℓ/d | Working Days per annum | Total Consumption Mℓ/y |
|---|---|---|---|---|
| Coal Preparation Plant | - | 524160 | 220 | 116 |
| Coal Stock Piles | - | 368181 | 220 | 81 |
| Road watering | - | 159091 | 220 | 35 |
| Bath house Workshop, Toilets | 468 | 200 | 220 | 21 |
| Methane Gas Plant | - | 52800 | 360 | 19 |
| Gardens | - | 81813 | 220 | 18 |
| Washdown | - | 59091 | 220 | 13 |
| Fire Fighting | - | - | 220 | Negligible |

Table 5 Underground Water Requirements

| Service Requirement | No. of Units in Operation | Application | Units of Water | Total Consumption Mℓ/y |
|---|---|---|---|---|
| Longwall Mining | 1 | Spray, hydraulic make up | shearer 272 ℓ/m hydraulic make up 833 ℓ/h | 59 |
| Longwall hosing | - | Spray | - | 13 |
| Continuous Miners | 5 | Cooling, Spray | 571 ℓ/m | 114 |
| Rock bolting | - | Spray | 32 ℓ/m/bolt | 10 |
| Breaker loaders | - | Spray | 23 ℓ/m/spray | 47 |
| Shuttle Cars | 10 | - | No. sprays | - |
| Conveyor Belts - Transfer points | 11 km | Spray | 3 sprays each at 10 transfer points | 18 |
| - Hosing | - | Spray | - | 4 |
| Track Watering | - | Spray | - | 14 |
| Methane Drainage | 3 | Spray | 16 ℓ/m | 10 |

## CONCLUSIONS

This study has indicated that the majority of mine service water is provided for dust suppression and fire fighting purposes. In coal mining, the use of refrigerated water supply is extremely rare. Service water is used at a colliery surface for bath house, workshops, coal preparation plants and dust control in tips and surface roadways. The paper outlines the mine service water distribution systems utilising open circuit as well as close circuit methods.

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