6. Water Supply

In a country as arid as Australia, mining and mineral processing operations will almost certainly require a regular supply of water. Therefore, identification, evaluation and maintenance of this supply will be critical to the continued operations. While this topic could demand a handbook of its own, some concepts will be introduced in this section.

6.1 *Surface Water*

This section examines sources of surface water supply around typical minesites.

6.1.1 CATCHMENT YIELD

When discussing the useful yield of surface water within a catchment it is important to realise that it can never be any greater than the facilities available for storing or continuously using water. This can include groundwater recharge, as discussed in the next section.

The balance of processes contributing to the final yield at a given storage facility can be represented as

Yield = Inflow - Outflow.

Inflow

The inflow into a storage may originate from any of the following sources.

Imported water: reservoirs, irrigation schemes or major supply pipelines are often the major source of water for minesites in Australia.

Recycled water: most minesites in areas of water scarcity are now recycling water from various stages of the mine process. This is discussed in the following section.

Direct rainfall: within shallow storages covering large surface areas, the amount of direct rainfall may be appreciable.

Rainfall runoff: the quantity and quality of rainfall runoff will be dependent on the catchment area soil type, topography and vegetation. A discussion on estimation of rainfall runoff is given in Fact Sheet No.2.

Groundwater seepage: during periods of rain, a percentage of the water will seep into the ground as infiltration. Some of this water will percolate into groundwater stores. However, on sloping sites or areas underlain by shallow rock, most water will flow through the soil profile to the bedrock and percolate out into a watercourse or cutting. This water will continue to flow long after rain has ceased.

Mine dewatering: surface and groundwater reserves that flow into mine workings are usually pumped out to a suitable storage. This aspect is covered in Sections 8 and 9.

Outflow

Outflows will result from any combination of the following.

Releases: resulting from:

- excess water overtopping storages and passing into the next catchment or off the lease;
- water drained from darns to allow for maintenance, to make room for expected inflows or as regulated to provide water for downstream ecosystems or users; or
- treated water which may be released after sufficient residence time to remove pollutants (eg. acidity, suspended solids, salinity).

Evaporation: the loss of water from reservoirs through evaporation is appreciable in many regions of Australia. Where water supply is a critical issue, it can be worthwhile attempting to reduce evaporation by the use of a deeper storage or various cover techniques. Evaporation is also often used as a disposal method for highly saline or otherwise polluted waters.

Water use: this will depend on the location of the storage, the quality of the water and the scarcity of water on the site. Other potential users of the water must also be considered. A number of ideas for recycling water are presented in Section 6.1.2.

Seepage: although seepage through the ground has been identified as an inflow it is also an outflow mechanism. Any dam is likely to lose some water through seepage into the groundwater unless the groundwater level is higher than the base of the dam. In earth darns (as most minesite dams are) seepage may also occur through the dam wall.

If considering the yield of a specific catchment, it will be necessary to obtain specific information on all the above processes relevant to that catchment. Historical records of inflows and outflows will provide invaluable information for the calculations.

The *water balance* method for identifying the inflows and outflows is a useful tool for understanding how the water supply for a minesite may be achieved by considering all the potentially contributing elements. The *water balance* allows the user to optimise parameter values for the most desirable outcome and to explore the probability boundaries when variations are introduced (refer also to Fact Sheet No.3 for probability information).

6.1.2 RECYCLING OF WATER

Most minesites promote the use of recycled water. Recycling often occurs when water is scarce, or the discharge of polluted waters could be a hazard to the surrounding environment. Even where water is freely available, it may be more cost-effective to recycle water.

It is usually a more environmentally sound practice to recycle lower quality water on a minesite rather than to discharge the water and use better quality water from clean supplies when it is not needed. Some examples of sources and uses of recycled water are given in Table 6.1.

6.2 *Groundwater*

6.2.1 SOURCES OF SUPPLY

There are two primary sources of groundwater supply; unconfined aquifers and confined aquifers. Perched water tables (see Fact Sheet No. 11) are a special form of unconfined aquifer. Unconfined aquifers may be used for water supply via the pumping of bores. Confined aquifers are generally under pressure and, in some cases, may not require pumping to extract water (eg. a flowing or artesian bore).

Individual groundwater resources tend to be compartmentalised by geology, but are rarely truly isolated. Despite some connection to other aquifers, an individual groundwater resource should be viewed as a finite body of water. Replenishment of groundwater (or recharge) is a vital component in assessing the long-term viability of a source of supply. Recharge may occur through rainfall infiltration, or from rivers and streams, or from artificial recharge (such as pumping of surface water into aquifers).

6.2.2 SECURITY OF SUPPLY

Security of supply may be breached if the sustainable yield is compromised when a bore is overpumped or drawdown is quick but recovery slow. The quality is compromised when pumping stresses lead to dissolution of salts from the soil matrix and excessive salinisation of the pumped water or development of flow paths from neighbouring contaminated aquifers.

TABLE 6.1: **Sources and Uses of Recycled Water**

Sources of Recyclable Water	***Uses for Recycled Water***
Dirty mine water: surface runoff from dirty areas, intercepted to remove suspended solids and/or other pollutants. *Clean mine water:* there will be some limitations on the amount of water which can be intercepted from undisturbed areas. This is to ensure that downstream users and ecosystems are not disadvantaged. *Process water:* most process plants or washeries will use large quantities of water which is often returned to a process water tank or dam, and then recycled back through the process. *Tailings liquor:* tailings are deposited with varying percentages of water to allow pumping, and to ensure proper deposition and drying. Excess water remaining after solids have settled can be recycled directly or after passing through a filter dam. *Washdown water:* vehicle and workshop washdown water should be passed through a settling pond and oil separator, after which it may be suitable for selected recycling. *"Grey" water:* wastewater from showers, hand basins, laundries and kitchens should be treated to remove solids and can then be recycled. Chemical dosing (eg. chlorine) may be necessary if people will come into contact with the recycled water. *Treated effluent:* package or site built treatment plants are used to treat sewage to acceptable levels after which it can be used for limited recycling applications. Treated industrial effluent from workshops may also be used for recycle water.	*Dust suppression:* dust control for haul roads, conveyor belts and transfer stations, loading facilities, dump hoppers, stockpiles (product and waste), construction sites and working faces does not require high quality water. Issues which may affect this are: • suspended solids, which may block pumping and spraying equipment; • viral and bacterial micro-organisms which, if present in fine aerosol mists, are easily ingested by workers; and • nutrient levels which can promote algal growth and block spray equipment. *Process water:* processes which involve crushing, washing and screening are suited to using recycled water. Co-disposal tailings will utilise recycled water. Typical quality issues are: • chemical make up of the water; and • suspended solids. *Irrigation:* rehabilitated areas, gardens and perhaps even neighbouring properties or stock may be a very efficient use of wastewater. Irrigation to rehabilitated areas may result in water dependant regrowth with shallow root systems which will struggle to survive if irrigation ceases. Water quality issues are: • chemical, salinity and pH extremes which may adversely affect plants and/or stock; • suspended solids (as for dust suppression); • viral and bacterial micro-organisms. *Wetlands maintenance:* during rainy periods there will usually be enough dilution and flushing to keep wetland systems healthy. However during dry periods there may be a build up of pollutants from mine dewatering or simply a shortage of water. Quality issues are similar to those for irrigation.

TABLE 6.1: **Sources and Uses of Recycled Water** (CONTINUED)

Sources of Recyclable Water	*Uses for Recycled Water*
Slurry transport water: at the end of a slurry pipeline, the slurry is dewatered, leaving large quantities of water. The location will often be environmentally sensitive, hence the water would require treatment to high standards before discharge; re-use may be a better option.	*Washdown water:* recycled "grey" water and treated wash down water can be used for washdown of mine equipment and workshop areas. Quality issues are: • build ups of oil or detergents; • viral and bacterial micro-organisms which if present in fine aerosol mists are easily ingested by workers. *Potable water:* in very arid and remote areas it may be viable to treat recycled water to very high levels and use it as a potable water source. Clean and dirty water runoff are obvious sources, but other sources can be used. All facets of water quality will obviously be vital if this is the intended use.

Sustainable yield is a significant parameter in water supply. It determines the maximum flow which may be extracted over the long term. This factor is determined by pump testing and analysis of drawdown. Borefields of two or more bores will incur some penalty in the sustainable yield of each bore because of interaction between the drawdown from each bore. More intensive analyses are required to identify the sustainable yields of borefields. The sustainable yield should be identified whenever bore water supply is considered. Expert advice should be sought before commissioning a bore drilling program.

The quality of water pumped out of a bore may depend on the rate of pumping exerted. The sustainable yield of a bore should be identified in conjunction with any deterioration in the quality of water being pumped. The likelihood of quality deterioration may increase with the rate of aquifer pumping. For example, in coastal locations seawater may migrate towards a bore which is pumped beyond its sustainable yield.

Constant monitoring of quantity and quality is an integral part of water supply evaluation and maintenance.

- **Quantities of pumped water** should be noted throughout the life of a bore. Flow totalisers are a convenient and cheap method of monitoring quantity. These show the total volume of water pumped. When monitored regularly and used together with a record of pump down time, adequate information on pump rates may be gathered.
- **Aquifer drawdown** should also be monitored on a regular basis. This may be done using adjacent observation bores and, where possible, within the pumping bores themselves.
- **Water quality monitoring** should be carried out regularly on representative samples pump from bores. Relevant water quality standards should be consulted, depending on the use of the supply. These may be for potable water, ablution water or process water. Site-specific process water requirements should be determined where the water is used for processing.

If a licence is required for the bore or borefield, conditions such as these are generally included on the permit. The information gathered usually has to be provided to the licensing authority on renewal of the permit.

The intensity of the monitoring program selected for water supply bores should reflect the importance placed upon the supply.