Special Problems of Management GENERAL REPORT

By A. BOWDEN

Principal Hydrogeologist,
Australian Groundwater Consultants Pty. Ltd.
6/456 High Street,
PRAHRAN VIC 3181.

The three papers reviewed here consider different problems of mine management. Comparison of two of the papers demonstrates a marked contrast between the old and the new, in terms of mine management and impacts. The third paper discusses post-mining rehabilitation.

The paper "The impact of a derelict base metal mine on the aquatic environment", by Brooks and McIveen contrasts strongly with the paper "Narbarlek Uranium Mine design, construction, operation monitoring and decommissioning of the water management system" by McLoughlin, Grounds and Weatherhead.

Brooks and McIveen detail the contamination emanating today from the Conrad Mine in New South Wales which was mainly operated for 15 years at the turn of the century and later for 7 years in the 1950's. The mine was apparently developed over the years on an intermittent, ad hoc basis with no regard to contamination management, resulting in significant contamination persisting through time. This type of mining development is the antithesis to the type of planned mining and management operation which was carried out in Arnhem Land at Narbalek, and which apparently resulted in no uncontrolled contaminant release and successful decommissioning of the mine.

The base metal Contrad Mine is located in an isolated valley beside a creek which eventually drains into Copeton Dam storage 3.5 km downstream of the mine. Surface and underground workings are extensive and three main mine waste dumps occur at the site. The dumps present a poor aesthetic image and are generally unstable. Trace metal and acid pollution are derived from discharge of water from underground openings, leachate from the dumps and erosion of dumps by runoff.

Sampling upstream of the mine, at the mine, and at various distances downstream from the mine clearly demonstrate contamination emanating from the mine site of arsenic, copper, iron, lead, zinc, sulphate, salinity, and acidity. Examination of the variation in contaminant concentration indicated that arsenic, lead, iron and silver were readily taken up by sediments within 2 km of the mine, and that acidity, copper and zinc persisted in the creek water. The effect of acid contamination on the Copeton Dam is negligible due to its high buffering capacity.

A considerable amount of environmental data has clearly been collected during this study and some scope possibly exists for further assessment of the capacity of the environment in general to absorb or attenuate contamination from mines and mine wastes.

The study has clearly demonstrated that contamination from the mine is currently occurring, which is really only the starting point with respect to the future. Evaluation should be carried out to determine acceptable levels of contamination, whether the current contamination levels are acceptable and if not, then a programme must be formulated to reduce the contamination to those levels. With regard to the Conrad Mine the following contentious questions must soon be addressed:-

i Who should determine acceptable levels of contamination?
ii Who should formulate and carry out the rehabilitation programme?
iii Who is potentially responsible for the contamination?
iv Who should pay for the rehabilitation?

The paper by McLoughlin, Grounds and Weatherhead describes the water management system used at the Narbalek uranium mine, monitoring aspects, the results of the management programme and the decommissioning plans. The paper demonstrates that proper waste water management practices and mine planning can limit contaminant release to the environment to controlled, acceptable levels, even for the reputed high risk uranium mines.

The Narbalek orebody was small and was completely mined out and stockpiled during 1979. Development occurred under strict approval guidelines and water management was a major concern. Currenlty operations and processing are almost complete.

One of the main considerations of the water management system was to achieve total containment of contaminated water and subsequent evaporative disposal in a monsoonal climate where average rainfall results in a nett water storage gain in the system of 200 ML/an. The process water requirement was 226 ML/an. The water management system also aimed to separate the waters into various ponds, depending on the degree of contamination, and treatment to control pH and radium levels was carried out to improve the evaporation pond water quality. The evaporation ponds were properly designed and constructed in terms of maximum water depth, selection of inherently low permeability sites, compaction of pond floors, and maintainance of moist floor conditions during construction. Tailings disposal into the pit was sub-aqueous to control dust and radon emissions.

The monitoring programme was developed as part of the water management strategy to collect baseline data, and to allow continuous performance review of the water management system. Monitorin was carried out of the groundwater, production bores, climatic parameters, water ponds, treatment applied and surface water. Results of the monitoring programme indicate that seepage rates and quality from the ponds were approximately as predicted. The pond water quality was also much as predicted, being ammonium sulphate water with high levels of nitrate and manganese. Heavy metals and uranium concentrations were low.

The salinity of the ponds increased with time due to evaporative concentration and treatment was occasionally required to control acidity.

During operations at the site the average annual rainfall was 25% greater than the design figure causing an accumulation of 1,250 ML at the end of the 1984-85 wet season, which was within the available storage capacity. Controlled spray irrigation disposal onto disturbed areas and natural forest areas was used, with apparently very low tree losses caused by waterlogging and salt stress. Currently, approximately 100 ML of water remains, which is considered the minimum necessary to operate the plant.

Decommissioning will involve placement of contaminated water into the pit, disposal in the pit of the clay pond bases and any contaminated materials, and capping, topsoiling and revegetation of the pit surface.

Currently it appears that the high levels of water management and planning practiced at the Narbalek Uranium Mine have resulted in negligible contamination. The longer term environmental impact has yet to be determined and widespread interest will be shown in how long it takes before the mine operator can walk away from the project with impunity.

Revegetation and mine waste rehabilitation is the subject of the paper by Greenwood and Netchaef. The paper focusses on the specific problem of rehabilitation from mine dumps, and in the control of contamination by turbid runoff and polluted leachates. One of the principal aims of mine dump rehabilition should therefore be to reduce contaminated runoff and infiltration.

One method which is considered by Greenwood and Netchaef to have a potentially profound effect on the hydrology of the mine dumps is to establish a suitable vegetation cover which can act to bind the dump surfaces and also to dewater the dump.

Revegetation of the mine dumps is generally carried out for aesthetic purposes, and the hydraulic effectiveness of the vegetation is normally seen as being small. Greenwood and Netchaef cite the developement of instrumentation for measuring vegetative interception and transpiration as the factor which will allow progress to be made towards successfully using vegetation to rehabilitate mine dumps.

Two examples are cited in order to demonstrate the hydrological potential of vegetation and the CSIRO should be given the opportunity, by the mining industry, to carry out research into rehabilitation of mine dumps by vegetation.

The first example is from a plantation established for 6 years in the Darling Ranges, Western Australia, and evaporation from trees was measured at 6 to 7 times greater than evaporation from the surrounding pasture area and 3 to 4 times greater than annual rainfall. The reasons for the high rates were:-

i vigorous growth,
ii the "clothes-line" effect, and
iii groundwater storage depletion.

The above example demonstrates that under optimum conditions vegetation is able to dispose of large volumes of water. However, rehabilitation, in the context of the paper, is concerned with long term reduction of nett infiltration, and under such circumstances the vegetative growth will not be vigorous, the vegetation will be close planted (the "clothes-line" effect will be substantially reduced) and water will be limiting by design of the dumps or will become limiting, which is the object of the exercise.

It is further claimed that in some circumstances eucalypts can discharge nearly twice pan evaporation, the inference being that these discharges may be achievable from mine dumps. Pan evaporation is controlled largely by solar radiation and to a smaller extent by aerodynamic factors and has traditionally been regarded as the maximum potential evaporation from a site where water is not limiting. How then can transpiration exceed the evaporative power of the forces which drive it?

The second example considers evaporation from a jarrah forest and from eucalyptus plantations in a rehabilitated bauxite mine pit at Dwellingup, Western Australia. The understory evaporation from the jarrah forest was measured at 52% of the annual rainfall, and evaporation from the eucalyptus plantations was estimated to be greater than annual rainfall.

The authors have demonstrated in their paper that vegetation has considerable potential in management of mine dump hydrology but may have overstated the potential long term evaporative power of vegetation in order to stem the tide of current disillusion. There is a considerable risk with this approach that unless their sought after research project is extremely successful, disillusionment will be even greater.

Mine dump rehabilitation studies are necessary and should aim to:

i minimize leachate production by increasing uncontaminated surface runoff and reducing infiltration by engineering design,
ii use vegetation to stabilze the dump surface, increase interception and dispose of excess infiltration.

Such studies should be carried out in close association using a multidisciplinary approach.

The authors are calling for a study site, perhaps the Conrad Mine would be a good place to start.