ABSTRACT

A detailed plan for the rehabilitation of the Mary Kathleen mining and processing site was developed prior to the closure of operations in late 1982.

The plan was based on three basic principles of: making all areas safe for public access; removing all structures which could deteriorate and become unsightly or unsafe with time; and encouraging natural revegetation on erosion resistant surfaces. The aim was to leave the site in a safe and satisfactory condition, consistent with future land use in the area, requiring no foreseeable ongoing maintenance and a minimum of precautionary monitoring. When the programme has been completed, the only constraint on future land use will be the need to control building construction in the tailings/evaporation, dumps and mine areas as a precaution against possible exposure to radon daughters.

A site-specific approach was adopted in developing the plan. Experience at other sites was evaluated but was adopted only if it was appropriate for Mary Kathleen. As a result of this approach a conceptual solution was established for each area within the site. Each solution was then used as the basis for detailed planning for rehabilitation of that area.

Appropriate radiation and water quality monitoring programmes were incorporated in the plan.
INTRODUCTION

History/Location

The Mary Kathleen uranium deposit was located in the Cloncurry mineral field in North West Queensland (Figure 1). It was discovered in 1954 and mined in two phases for a total of twelve years between 1958 and 1982. Operations ceased finally in October 1982 when the deposit was virtually exhausted and sufficient concentrates had been produced to satisfy contractual commitments.

A self contained township of 220 houses, market garden, shopping complex, sports facilities, etc., had been built to support a workforce of 450 and a population of 1000, some 8km from the mine site.

Climate

The climate is generally hot and dry with an average annual rainfall of 450mm, ranging from 250mm to 1000mm. Typical daily temperature ranges are 2 to 30 degrees C in winter and 15 to 44 degrees C in summer. The average annual evaporation rate is 2700mm, being at its highest in the early summer months and at its lowest in mid-winter. Rainfall is highly variable, falling mainly in summer, as localised storms or under the influence of the northern monsoons. Storm showers are usually very intense with a consequent fast runoff, producing swiftly flowing creeks for limited periods. There are no permanent water courses in the area.

Topography

Mary Kathleen lies, at a height of about 300m above sea level, in an elevated area of ranges and valleys of Pre-Cambrian origin. The ranges are a mixture of rounded and rugged hills having large areas without soil cover. Gorges and narrow winding valleys form a network of drainage channels from the hills, resulting in a quick runoff of water in the rainy seasons.

Hydrology

The catchment area surrounding the mine and treatment plant is underlain by a granite formation with a covering of dolomites, lavas, sedimentary rocks, schists, slates and calc-silicates in various areas. Weathering varies from 8m over granites to 18m over sheared and intruded
FIGURE 1 - LOCATION OF MARY KATHLEEN
rocks. Creek channels contain 2 to 5m of shallow alluvium, usually course angular sands and cobble gravels, which is not continuous but is broken up into small basins separated by bars of unweathered rock. Water is present in the alluvium and weathered granite at depths ranging from 6 to 21m, depending upon the seasonal rainfall and the time of the year. Aquifer flow is vertically downward through the weathered material and horizontally along fresh rock surfaces to zones of higher permeability in lower level creek beds. Groundwater flows are therefore concentrated underground in creek bed alluvium unless prevented by rock bars. The presence of the rock bars in the creek below the evaporation ponds at Mary Kathleen greatly assists the interception and control of groundwater flow.

Description of Operations

The orebody outcropped on the side of a hill and was mined by open cut methods. The total material removed from the mine was about 31 million tonnes, (7 million tonnes of ore). The remaining waste rock was deposited in neighbouring valleys and on the slopes of adjacent hills close to the mine. The ore was processed in the treatment plant using acid leaching and solvent extraction. The washed solids and unneutralised acidic effluent were pumped as a slurry to the effluent disposal area, which was located in a small, well-drained valley some 1.5km from the plant site, at the head of the Cameron Creek system (Figure 2).

The tailings retention area was formed by constructing a rolled earthfill and granitic waste rock wall across a narrow section of the valley. The hills, forming the sides of the valley, provided the area side walls, whilst some secondary embankments were constructed, where necessary, from mine waste rockfill and covered with a synthetic membrane placed against the inside wall. The main embankment is classified as stable with increasing stability due to the increasing shear strength of the foundation as the water content of the tailings falls. Intermediate embankments constructed inside the area divided it into three sections, thus enabling the final slope on the tailings surface to be kept to about 1 in 200 to minimise erosion.

Liquor from the tailings pulp accumulated in the lower section of the area and was decanted over a reinforced concrete weir structure, cut through solid rock, into the evaporation ponds. The ponds were formed immediately below the tailings retention area by the diversion of a water course from a section of the valley and the construction of a series of rolled earth embankments.
FIGURE 2 - AREA LOCATION MAP
enclosing an area of 60 hectares and producing a pond capacity of about 2.5 million cubic metres.

Seepage Control

The tailings disposal system was designed to confine all liquid wastes and therefore it was necessary to intercept any seepage and dispose of it in a satisfactory manner. Piezometers, boreholes and pumps were installed on seepage paths downstream of the ponds to monitor the water table and seepage flows, collect the seepage water and return it, via a collection pond, to the mine and treatment plant for operational use. Pumps were also installed in the creek bed downstream of the area to transfer groundwater trapped in the aquifer, close to the rock bar, to the collection pond.

REGULATORY OBLIGATIONS

At the time the mining leases were granted, in 1954, and also at the subsequent renewal in 1975, environmental management requirements or special conditions, if any, attached by the State Government to leases in general usually related to measures required to be taken to prevent the release of impure or mineralised water.

However, MKU Limited, in keeping with the Company's philosophy to operate in accordance with current legislation submitted an Environment Impact Statement in 1975, although the lease conditions did not require such compliance. The EIS covered all aspects of the development from the operational stage through to decommissioning and rehabilitation.

Similarly MKU Limited undertook to operate in accordance with the various Codes of Practice for mining and milling and transport of radioactive ores, although legislation had not been enacted within the state to incorporate these codes.

REHABILITATION PLAN DEVELOPMENT

In 1982, following extensive studies of overseas operations and specific research at site, a Rehabilitation Plan for the closure of the Mary Kathleen operation was presented to Government.
The studies confirmed that site specific criteria for rehabilitation were required because of the variables in location, climate and land use. Such criteria, particularly for tailings storage, should be concerned with the maintenance of practical environmental and health levels which are also within accepted international standards. Increased emphasis was being placed on the effective containment of tailings and proper erosion control measures.

Key site factors which determined the approach to closure were:

- Climate - a hot/dry environment with short periods of tropical climate in most years. Annual evaporation rates about six times the average rainfall rates.

- Vegetation - extremely hardy plant varieties growing sparsely on hills and open country with local pockets of good grass, shrub and tree growth surrounding a few persistent water holes.

- Land Use - essentially confined to open range beef cattle raising, with limited recreational use for prospecting, gem collecting, picnicking, etc.

- Population - the major towns in the region were:
  - Mount Isa (pop. 27,000) 60km west
  - Cloncurry (pop. 2,500) 70km east
  - Mary Kathleen (pop. 1,000)
  The non-urban population density of the region is less than 0.01 persons per sq. km or less than 10 persons within a 20km radius.

- Soils - Alkaline soils with a high capacity to neutralise acid leachate and bind heavy metals.

The basic principles used to develop the Rehabilitation Plans were:

- make all areas safe for public access, with regard to radiation and physical safety;

- remove all structures which could deteriorate and become unsightly or unsafe with time; and
encourage natural revegetation and erosion resistant surfaces.

The only long term future constraint on land use was the need to control building construction in the tailings/evaporation, stockpiles and mine areas, as a precaution against possible long term exposure to radon daughters. This is not seen as a regionally significant loss of land use opportunities.

The Closure Plan also incorporated an environmental monitoring programme which continued on from the existing operational monitoring programme. The main variables being monitored are radon, radon daughters, gamma radiation and a range of water quality parameters in both surface and subsurface waters. The rehabilitation monitoring programme is designed to assess the effectiveness of specific rehabilitation measures and to predict the long term environmental status of the site.

REHABILITATION PLAN

The Rehabilitation Plan incorporates detailed integrated rehabilitation proposals for each area of the operation. It is based upon the aforementioned principles and the overall objective of returning the mine site and associated areas to a safe and useful condition which is consistent with future land use in the area and requires no foreseeable ongoing maintenance and a minimum of precautionary monitoring.

In pursuing this objective particular attention has been given to measures for the control of:

- water quality
- erosion
- radioactivity
- radon emanation

The area has supported activities associated with the exploration, development and operation of a mine, treatment plant and support facilities for a period of thirty years. Therefore it is inevitable that some evidence of these would remain whatever the extent of any rehabilitation programme. It is not intended to remove all traces of the operation as this would deny future generations the opportunity to visit and identify the site of an important phase of Australia's mining history. On the other hand, the Company and the Queensland Government are agreed that the area should not be left in a condition which would be open to criticism in terms of public safety or appearance.
Normal site and personnel health monitoring procedures have been carried out during the programme.

The site specific concept was incorporated in the plan and the following actions were proposed to achieve the aims of the plan:

- leave the mine pit in a stable condition, inaccessible to cattle and vehicles and containing about 50m of water;
- contour, rip and sow, with local seeds, the waste dumps;
- removal all equipment and structures from the treatment plant area;
- decontaminate and revegetate the plant area;
- dry out the evaporation ponds, remove the evaporite and contaminated soil to the tailings storage area, contour and cover the area and revegetate;
- cover the tailings with 0.5m of soil/clay and 1m of waste rock;
- control drainage to channel surface run-off away from the evaporation ponds/tailings area;
- recover groundwater containing salts from boreholes around the tailings/evaporation ponds area and store it in the mine;
- monitor environmental and health aspects until appropriate conditions are achieved; and
- demolish the town should a continuing viable use not be identified.
REHABILITATION PROGRESS

Mine

The mine has been left in a safe and stable configuration. The entrances to the upper benches have been sealed off, however access to the lower levels is still required because the mine serves as a reservoir for saline groundwater pumped from the seepage collection boreholes surrounding the tailings/evaporation ponds area.

Good vegetation growth has developed on the higher level waste dumps, whilst initial growth has been observed on the surfaces of the other dumps.

Treatment Plant Area

The plant was decommissioned and decontaminated in late 1982/early 1983. Items which could not be cleaned satisfactorily were buried deep in the tailings area. The cleaned equipment was auctioned in April 1983 and removed from site throughout the remainder of the year. Some major concrete foundations and sealed roads remain in the area.

Contaminated soils from the area were removed and placed in the tailings area. The site was contoured, ripped and sown with seeds from local vegetation.

Evaporation Ponds

Disposal of the acidic liquor has been achieved by surface sprays, the use of infiltration trenches and the construction of internal bunds to produce extensive areas of shallow evaporation pans.

The precipitates formed as the liquor evaporated and the contaminated surface soils at the base of the ponds have been removed and placed in the tailings area. Depth of soil removal was determined by pm measurements.

A surface cover of waste rock or soil and waste rock is being placed over the base of the ponds. The design depth of the cover will provide adequate radiation attenuation and long term protection against erosion.
Tailings Disposal Area

The upper section, approximately sixty percent of the area, has been contoured and covered with an initial layer of 0.5m of soil and a final layer of one metre of waste rock.

The final quantity of acidic liquor, some 5,000 cubic metres, was stored in the lower section of the tailings area. Neutralisation of this liquor and precipitation of heavy metals was carried out by the addition of fine limestone.

The lower section will be covered in a similar manner to the upper section.

REHABILITATION MONITORING

Water Quality

The network of surface water locations and groundwater bores has been monitored for water quality since the commencement of the second operation. As rehabilitation work proceeded, a monitoring programme to assess the success of rehabilitation measures has been established.

The chemical parameters, location of boreholes and surface sampling sites have been selected to provide information on:

. change in groundwater levels with the lowering of the groundwater mound beneath the tailings dam and evaporation ponds;

. extent, rate of movement and composition of groundwater seepage from the evaporation ponds and tailings disposal area;

. change in surface water chemical composition as sources of surface contamination are removed;

. identification of locations where groundwater may resurface; and

. the likely future water quality downstream from the site and its potential uses.
Radiation

Radiation monitoring consists of ongoing surveys of working areas, final surveys of specific, rehabilitated locations and general area surveys. Both spot and time integrated measurement techniques are used. Specific sites are only considered rehabilitated when radiation parameters meet the required levels for general public safety or, as in the case of the pit, the design criteria proposed in the Closure Plan. The general environmental surveys, using integrated radon and gamma measurement techniques, cover the area of the tailings dam and evaporation ponds.

Radiation monitoring will continue for a period after rehabilitation of the tailings and evaporation area to confirm the success of the rehabilitation measures.

CONCLUSION

The approach taken to rehabilitation at Mary Kathleen has been based on achieving solutions which are specific for and relevant to the site and which also meet accepted international standards. The basic principles and concepts considered in the formulation of the Closure and Rehabilitation Plan will result in a situation which should achieve the stated objective to leave the site in a satisfactory and appropriately safe condition for future land use with no foreseeable ongoing maintenance and a minimum of precautionary monitoring.

All areas will be physically safe for public access and radiation and radon daughter levels will be within acceptable limits.

Completion of the Rehabilitation Programme according to the approved plan will enable the Company to satisfy the requirements concerning long-term integrity and safety of the area, prior to the relinquishment of the mining leases.