

RUM JUNGLE Rehabilitation Project

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POWER AND WATER AUTHORITY

RUM JUNGLE Rehabilitation Project

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Darwin September 1988 The Rum Jungle Rehabilitation Project was a Commonwealth funded project managed by the Northern Territory Government. It was aimed at substantially reducing the adverse environmental effects of the mining and milling of uranium and other metals at Rum Jungle between 1952 and 1971. The Project's civil works were completed between 1982 and 1986, and an ongoing monitoring and preventative maintenance program has been conducted to August 1988.

The rehabilitation programme has been completed within the escalated budget of \$16.2 million (in 1982 values) and on time.

The monitoring programme, established as an integral part of the Project, has demonstrated the effectiveness of the rehabilitation measures implemented. It has provided positive evidence of reductions in the heavy metal burden being carried by the East Branch of the Finniss River, thus confirming a reduction in the pollution from the Rum Jungle mine site.

A Site Management Plan has been developed to help ensure the lasting integrity of the rehabilitation measures.

The Project is an example of the successful application of mine rehabilitation techniques, and of successful co-operation between the Commonwealth and Northern Territory Governments.

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ABSTRACT

CONTENTS

LIST OF TABLES

LIST OF FIGURES

- INTRODUCTION 1.
 - 1.1 Location
 - 1.2 History 1.3 Scope Of The Problem
- 2. REHABILITATION AGREEMENT AND PROJECT MANAGEMENT
 - 2.1 Rehabilitation Agreement
 - 2.2 Project Management
- 3. DESIGN CRITERIA AND WORKS COMPLETED
 - 3.1 Overburden Heaps
 - 3.2 Tailings Dam, Copper Heap Leach Pile And Dysons Open Cut
 - 3.3 Open Cut Pits
 - 3.4 Other Areas And Revegetation
- 4. PROJECT ACHIEVEMENTS AND THE ROLE OF MONITORING
 - 4.1 Achievements
 - 4.2 Monitoring
- 5. SITE MANAGEMENT PLAN
- 6. REFERENCES

LIST OF TABLES

1.2	Mining Sequence
3.1	Summary Of Overburden Heaps
3.3(a)	Open Cut Pits
3.3(b)	Comparison Of Pit Water Quality Before Treatment With Target Pit Water Quality
3.4	Details Of Revegetation Operations

LIST OF FIGURES

1.1	Locality Plan
1.2	Site Plan Prior To Rehabilitation
3.	Site Plan After Completion Of Rehabilitation
3.1(a)	Rehabilitation Of The Overburden Heaps
3.1(b)	Typical Cross Section Of Rehabilitated Heap
3.1(c)	Intermediate Overburden Heap Before And After Rehabilitation
3.2(a)	Tailings Dam Area Before And After Rehabilitation
3.2(b)	Dysons Open Cut Typical Cross Sections
3.2(c)	Copper Heap Leach Pile Area Before And After Rehabilitation
3.3(a)	Schematic Arrangement With The Water Treatment Plant
3.3(b)	Treatment Of Intermediate Open Cut
4.2(a)	Annual Copper Loads In The East Finniss River

4.2(b) Temperatures In Hole A (Whites Overburden Heap) At Various Depths With Time

The Rum Jungle Rehabilitation Project, a Commonwealth Government financed project managed by the Northern Territory Government, was aimed at reducing the environmental pollution that resulted from mining and processing activities at the abandoned Rum Jungle mine site.

This report summarises the Project and its results to August 1988, marking the termination of the rehabilitation Agreement (Section 2.1). The report updates an earlier document prepared by Allen in 1985 (Reference 1). For greater detail, the reader is referred to the two formal project reports:

- . <u>The Rum Jungle Rehabilitation Project. Final</u> <u>Project Report</u>; June 1986 (Reference 3)
- The Rum Jungle Rehabilitation Project. Monitoring, Maintenance And Management; August 1988 (Reference 6)

These in turn contain extensive reference lists of reports and papers on subjects in even greater detail.

1.1 Location

The site is located approximately 65 km south of Darwin, in the Top End of the Northern Territory (Figure 1.1). It straddles the East Branch of The Finniss River, an important tributary of the Finniss River.

1.2 History

A uranium deposit was discovered by Mr J White in August 1949, at the site of what is now known as Whites Open Cut. Subsequent exploration defined Australia's first uranium mining field (Reference 1). In 1952,



Territory Enterprises, a subsidiary of Consolidated Zinc Pty Ltd (now CRA Limited) commenced mining and exploration at Rum Jungle on behalf of the Australian Government. Mining was initially by underground methods, followed in 1954 by the development of Whites Open Cut. Mining continued until 1969; the sequence is summarised in Table 1.2, and shown on a plan of the site as Figure 1.2.

PIT	MINES	ORE PRODUCED
Whites	1952 - 1958	Uranium/Copper/Lead*
Whites extended	1957 - 1958	Uranium
Dysons	1957 - 1958	Uranium
Rum Jungle South	1961 - 1963	Uranium
Mount Burton	1958 - 1958	Uranium
Mount Fitch	1969	NIL
Intermediate	1964 - 1965	Copper

TABLE 1.2 MINING SEQUENCE (from Reference 2)

*Lead ore was stockpiled, but not treated

The ore treatment plant was completed in 1954 and continued operation until 1971 when the plant was closed. Mining operation at Rum Jungle produced approximately 3500 tonnes of uranium oxide and 20000 tonnes of copper concentrate (Reference 2).

During the mining of Intermediate Open Cut lower grade copper ore was used to construct an experimental heap leach pile to recover the copper from the low grade ore by acid leaching. The experiment was unsuccessful, and on closure of the plant in 1971 it was estimated that approximately 12 000 tonnes of copper remained in the Copper Heap Leach Pile.

During 1977/78 initial attempts were made to clean up the treatment plant area.

Following a series of studies, the Rum Jungle Rehabilitation Project was established in 1982. By agreement between the Commonwealth and Northern Governments, Territory Territory the Northern Government was to implement the rehabilitation of the Jungle mine site under Commonwealth Rum funding arrangements. The Agreement established the objectives of the project, the strategy to be adopted, and a time frame for completion (Section 2.4).



1.3 Scope Of The Problem

The mining and treatment operations, and disposal of resultant waste products were carried out within the environmental guidelines applying two and three decades ago. These were significantly less onerous than current requirements, and allowed the disposal of mine waste to the environment. As a result, the operation left a legacy of continuing pollution which this Project aimed at alleviating.

It should be stressed that the pollution at Rum Jungle resulted mainly from the pyritic nature of the overburden and from the ore treatment processes and was not directly related to the uranium mined. It was more typical of copper mining where the presence of pyritic material is more common.

The principal sources of pollution (shown in Figure 1.2) were:

- The Copper Heap Leach Pile and four overburden heaps - Whites, Whites North, Intermediate and Dysons - were oxidising producing acid mine drainage, which was the most serious form of pollution of the surface water and groundwater systems.
- . Three open cut pits Whites, Intermediate and Dysons - were filled with wastes and acidic water, polluting the water environment and proving hazardous to public health.
 - The tailings dam, which was being eroded, had already contributed 150,000 tonnes of acidic wastes containing heavy metals and low levels of radioactivity to the river. It was aesthetically disasterous.

In addition, other areas of the mine site had been denuded of vegetation as a result of both mining activities and the continuing generation of pollution.

The overall environmental effects were the marked depletion of aquatic life in the East Branch of the Finniss River, the denuding of areas of vegetation, accelerated erosion, continuing pollution of surface water and groundwater systems, and the public health hazards associated with the tailings dam and open cut pits.

2.1 Rehabilitation Agreement

An Agreement was concluded between the Commonwealth and Northern Territory Governments (Reference 3) establishing the Project and incorporating the measures to be adopted. The Agreement provided for scheduled works to be undertaken over a period of four years (1982-86), together with a monitoring program for a further period of two years to mid 1988, with an all up cost to the Commonwealth Government of \$16.2 million (1982 values).

The objectives of the project included:

- Major reductions in the pollution load in water courses feeding the river, including reduction of the annual releases of copper, zinc and manganese by 70%, 70% and 56% respectively.
- Reduction in public health hazards and in particular reduction of radiation levels at the site at least to the standards set out in the Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores published by the Australian Government Publishing Service in 1980.
- Reduction of pollution in the water contained in Whites and Intermediate Open Cuts.
- Aesthetic improvements including revegetation.

2.2 Project Management

Under the Agreement, the Northern Territory Government successfully implemented the rehabilitation works. For the period 1982 to 1986, a project team was established and operated, first from the Department of Transport and Works and later from the Department of Mines and Energy. The project team was, as far as practical, self sufficient, containing its own administrative and technical staff. It drew on the resources of various Northern Territory Government departments and consultant organisations for expertise, advice and monitoring services. Various elements of the rehabilitation work were carried out by contract. Supervision was either direct by the project team or, in the case of the Water Treatment Plant, by a consultant (Mining and Process Engineering Services).

The project team was disbanded in mid 1986 following completion of the works. Project management for the two year monitoring/maintenance program was provided by Water Resources staff in the Power And Water Authority.

Three committees were involved in the oversight and inter-governmental co-ordination of various aspects of the project: Liaison Committee, Monitoring Committee, and Technical Committee (Reference 3).

3. DESIGN CRITERIA AND WORKS COMPLETED

Rehabilitation works completed (scope shown in Figure 3) include:

- Removal of Whites North Overburden Heap to Whites Overburden Heap.
- Reshaping of Whites, Intermediate and Dysons Overburden Heaps, construction of low permeability cover systems, construction of drainage, vegetation of the covers (Section 3.1).
- Burial in Dysons Open Cut of tailings and affected subsoils (from Tailings Dam), together with the Copper Heap Leach Pile and associated subsoils. Cover of the land fill, construction of drainage, vegetation of the cover (Section 3.2). Rehabilitation of the Tailings Dam and Copper Heap Leach Pile areas.
- Construction of a water treatment plant to treat polluted water in Whites and Intermediate Open Cuts. After completion of treatment, the East Branch of the Finniss River was rediverted through the open cuts (Section 3.3).
- Clean up and/or revegetation of other areas including the Treatment Plant and Stockpile areas, borrow pits and haul roads, the Acid Dam, and the Sweetwater Dam (Section 3.4).

3.1 Overburden Heaps

Each of the overburden heaps contains varying amounts of pyritic ore and various zones within the heaps had been shown to be subject to pyritic oxidation. Briefly, sulphides contained in the pyritic ore oxidised to form sulphuric acid, which further oxidised the sulphides and liberated heavy metals. In the uncompacted overburden heaps, infiltrating rain water provided both a medium for the process and a transport mechanism for carrying the products of the oxidation process to the environment. Oxygen infiltrating the heaps supported the reaction which was catalysed by bacteriologic action (Figure 3.1a).





WASTE ROCK IN THE WASTE ROCK HEAPS CONTAINS ABOUT 5% PYRITE. AN IRON SULPHIDE MINERAL. PYRITE REACTS WITH AIR AND WATER TO FORM A SULPHURIC ACID SOLUTION WHICH ALSO CONTAINS HIGH LEVELS OF IRON, COPPER, ZINC, COBALT AND NICKEL. THIS PROCESS IS GREATLY ACCELERATED BY BACTERIA WHICH EXIST IN THE RUM JUNGLE OVERBURDEN HEAPS.

POLLUTED WATER CAN EMERGE FROM THE WASTE ROCK HEAPS EITHER AS SURFACE SEEPAGE, IN SHALLOW GROUNDWATER, OR WATER CAN PERCOLATE THROUGH FRACTURES IN THE UNDERLYING ROCK AND ENTER DEEP GROUNDWATER. FISH KILLS MAY OCCUR WHEN THIS WATER DRAINS INTO THE FINNISS RIVER.

SOLUTION - RESHAPING, CAPPING WITH COMPACTED CLAY AND REVEGETATION

WASTE ROCK DUMPS AT RUM JUNGLE WERE RESHAPED TO GIVE GENTLE SLOPES AND CONTOURED DRAINAGE CHANNELS. A COMPACTED CLAY CAPPING WAS PLACED OVER THE RESHAPED DUMPS, PREVENTING AIR AND WATER ENTERING THE DUMPS. PRODUCTION OF SULPHURIC ACID IS REDUCED AND WATER QUALITY IN THE FINNISS RIVER WILL IMPROVE.



REHABILITATION OF THE OVERBURDEN HEAPS

Acid mine drainage carrying the products of the oxidation processes entered the environment via both the groundwater system and surface water runoff from the heaps.

Areas and volumes of the overburden heaps are summarised in Table 3.1.

HEAP VOLUME OF OVERBURDEN AREA (cubic metres) (hectare

TABLE 3.	1 \$	SUMMARY	OF	OVERBURDEN	HEAPS
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	(cubic metres)	(hectares)
Whites	4,000,000	26.4
Intermediate	800,000	7
Dysons	1,200,000	8.5
Whites North	170,000	4

The general design approach to the rehabilitation of the overburden heaps involved the management of the water budget of the heap, limiting infiltration of rainfall and reducing both the rate of oxidation of the pyrites and the transport of the resultant pollutants to the environment, as shown in Figure 3.1 (a).

The rehabilitation of Whites and Intermediate Overburden Heaps included:

- Reshaping each overburden heap to create a stable landform with minimum grades.
- Constructing a three layer cover system on the reshaped heap, the layers being: i) a low permeability sealing zone, ii) a moisture retention zone, iii) an erosion protection zone.
 - Constructing drainage on the heap.
- Vegetation of the resultant landform.

Figure 3.1(b) shows details of a typical cross section of a rehabilitated heap. Figure 3.1(c) shows the change in plan view to Intermediate Overburden Heap as a result of rehabilitation works.

The rehabilitation of Whites North Overburden Heap was different to the above. Because of its relatively small size this heap was relocated to the toe zone of Whites Overburden Heap as part of the rehabilitation of that heap. The remaining surface was covered and revegetated.



Figure 3.1(b) TYPICAL CROSS SECTION OF REHABILITATED HEAP

Fig. 3.1(c)

INTERMEDIATE OVERBURDEN HEAP BEFORE AND AFTER REHABILITATION

SCALE 1: SOOD (Appros.) CONTOUR DRAINS ----



BEFORE



0.1

Because Dysons Overburden Heap was only a relatively small source of acid mine drainage, to maximise cost effectiveness only the top surface was reshaped, covered, drained and revegetated. The batters of the heap were not altered. Subsequent monitoring has shown the success of these measures.

3.2 <u>Tailings Dam, Copper Heap Leach Pile And Dysons</u> Open Cut

From 1954 to 1961, unneutralised tailings from the uranium treatment plant were discharged to the Tailings Dam. In addition to containing the daughter products of the uranium decay series, the Tailings Dam contained significant concentrations of heavy metals and acids. The Tailings Dam was also visually the most significantly affected area.

Tailings from the dam had, over the years, been transported by supernatant liquor during the dam construction phase and subsequently by the combined effects of rainfall, runoff and groundwater to both the East Branch of the Finniss River and to the Finniss River. Wind also spread the tailings.

Rehabilitation of the Tailings Dam included removal of the tailings together with affected subsoils, and their placement within Dysons Open Cut. The remainder of Dysons Open Cut was then filled with the material from the Copper Heap Leach Pile, sealed and vegetated.

After removal of the tailings and subsoil, the entire area of the Tailings Dam was covered with topsoil, drainage was constructed on the surface and the area was revegetated (Figure 3.2(a)).

The Copper Heap Leach Pile, constructed during the mining of Intermediate Open Cut from the low grade copper ore, was an experiment aimed at extracting the copper from the low grade ore by acid leaching. The extraction process also involved the use of open launders and ponds. The experiment was unsuccessful, and a considerable amount of copper remaining in the pile had been slowly released to the environment by both chemical and biological oxidation. In addition, the original impervious base of the heap and ponds had broken down, thus saturating the area with acid mine drainage.

Rehabilitation of the Copper Heap Leach Pile included the removal of the pile together with launders, ponds and the worst affected subsoils. Placing these materials in Dysons Open Cut above the tailings from the Tailings Dam served the dual purpose of providing a suitable confinement for the heap leach material as well as an adequate capping for the tailings in the open cut.



BEFORE



AFTER

BOALE 1 = 10 000 (Approx.)

TAILINGS DAM AREA BEFORE AND AFTER REHABILITATION

Fig. 3.2(a)

To protect the heap leach material from the intrusion of water and thus prevent further oxidation, all placed material was thoroughly compacted and filter layers were constructed directly above the tailings (prior to placing the heap leach material) and on each side of the fill against the original open cut surface and directly beneath the cover system. Figure 3.2(b) shows typical detail. The resultant land form was then covered, drained and revegetated in a similar manner to the overburden heaps.

Once the copper heap leach material, subsoil and associated structures had been removed, a system of rubble drains was constructed and the area deep ripped to promote natural leaching of the soil. After leaving for a wet season, the area was covered and revegetated. The change to the area is shown in Figure 3.2 (c).

3.3 Open Cut Pits

Whites and Intermediate Open Cuts had become polluted as a result of acid mine drainage. They were both hazardous to public health and contributed significantly to the pollution of the river. Dysons Open Cut contained only a relatively small volume of water (see Table 3.3(a)).

TABLE 5.5(d) OFEN COL FILD (ALCEL DAVI 1975	TABLE	3.3(a)	OPEN	CUT	PITS	(after	DAVY	1975)
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PIT	ORIGINAL DEPTH (m)	ORIGINAL VOLUME (m ³)	UNFILLED VOLUME IN (m ³)	1982
Whites Open Cut	105.0	3,530,000	2,730,000	
Intermediate Open Cut	70.0	1,087,000	971,000	
Dysons Open Cut	45.7	917,000	450,000	

Following various studies of Whites Open Cut, the most economic solution was to utilise the natural stratification in the pit to separate the treated and untreated water. Heavy metals were removed by hydroxide precipitation followed by clarification and filtration, with the aim of rendering water to a standard whereby limited eye, nose and ear contact would be permissible. Table 3.3(b) compares initial and target water quality for the two open cut pits.





BEFORE



AFTER

SCALE 1 : 8000 (Approx.) CONTOUR DRAIN ---

COPPER HEAP LEACH PILE AREA BEFORE AND AFTER REHABILITATION The flow sheet for the water treatment plant is shown in Figure 3.3(a) and comprised:

- Raw water was pumped from the open cut via a pontoon mounted suction line with the depth from which the water was taken being controlled by a winch mounted on the pontoon.
 - Lime, which had previously been slurried with potable water, was mixed with the raw water in two neutralising tanks.
 - The neutralised water was transferred to a primary clarifier where overflow was returned to the open cut and underflow was transferred to the secondary clarifier.
 - Flocculant was added to the neutralised water prior to its entry to the primary clarifier to aid settlement.
 - Overflow from the secondary clarifier was transferred either as recirculating load or to the primary clarifier as overflow and underflow was transferred to the filter press feed surge tank.
 - Liquor was transferred from the filter feed surge tank to the filter press where the filtrate was returned to the primary clarifier overflow. The filter cake was transferred to a stockpile for disposal as landfill.



TABLE 3.3(b) COMPARISON OF PIT WATER QUALITY BEFORE TREATMENT WITH TARGET PIT WATER QUALITY

POLLUTANT	CONCENT		
	BEFORE	(see Note)	TARGET
	WHITES	INTERMEDIATE	BOTH
Copper	55	60	1.5
Iron	440	0.9	1.0
Manganese	230	53	1.0
Zinc	8	6.5	5.0
Chromium	0.55	0.08	0.1
Cadmium	0.21	0.04	0.1
Arsenic	0.45	0.003	0.05
Barium	< 0.002	< 0.002	1.0
Lead	0.5	0.038	1.1
Silver	0.11	0.130	0.1
Mercury	< 0.001	< 0.001	0.005
Selenium	< 0.005	< 0.005	0.001
Nickel	15	12	1.0
Cobalt	15	13.6	1.0
Radioactivity (pCi/L)	2363	865	5.0
рН	2.6	3.7	7.0
Calcium	445	200	1000
Sulphate	8400	2800	2000

NOTE: Chemical analysis of the water contained in the open cut pits was based on the chemical content of the water at 15 metres below the surface being selected as representative.

Whites Open Cut was treated to a depth of 22 m, after considering a number of factors (discussed in Reference 3).

The water contained in Intermediate Open Cut was considerably different to that in Whites Open Cut. Intermediate water contained significantly less pollution, and was largely free from stratification. A more cost effective solution was to treat the water in situ by the direct addition of hydrated lime, encouraging heavy metals to precipitate and settle to the pit floor, and removal of the accumulated sludge (see Figure 3.3(b)).

Disposal of the filter cake was by burial in a borrow area (Reference 3).

After the water in the open cuts was treated, the East Branch of the Finniss River was redirected along its original channel through both pits. Use of a system of weirs as described in Reference 3 is helping to further improve water quality naturally in the pits with time, by mixing with and flushing of situ waters.

3.4 Other Areas And Revegetation

As well as the above problem areas, other large areas of the mine site were denuded of vegetation and subject to erosion. These included:

- (i) The Acid Dam (the upper reaches of the East Branch of the Finniss River) which had been used as part of the waste retention system for the uranium treatment plant. The impoundment area was flushed during rehabilitation, and is now supporting natural revegetation.
- (ii) Sweetwater Dam (Fitch Creek) which was affected by the outwash of acid mine drainage from Whites Overburden Heap. Natural revegetation is occurring slowly.
- (iii) Treatment Plant and Stockpile Areas. Much of this area has been covered, drains constructed, and revegetated.
- (iv) Borrow pits and haul roads were rehabilitated before completion of the project.

Revegetation of various areas of the site was carried out following the completion of final surfaces and the commencement of reliable wet season rains, usually in December. Table 3.4 summarises revegetation operations (from Reference 4), while more details are presented in Reference 3.

AERATION AND LIME ADDITION

TABLE 3.4 DETAILS OF REVEGETATION OPERATIONS

		SOWING RATE kg/ha
Most Common Introduced	Chloris gayana (Pioneer rhodes grass)*	5
Species Sown:	green couch)	2
	(Pensacola bahia grass) Brachiaria decumbens	3
	(Signal grass) Urochloa mozambicensis	4
	(Sabi grass)* Stylosanthes hamata	4
	(Verano stylo)* Stylosanthes guianensis	6
Sown on rock	(Graham stylo) Stylosanthes scabra	4
batters only	(Seca stylo) Macroptilium atropurpureum (Siratro)* *Denotes most successful spe	4 ecies.
Seeding Rates:	Shotgun mix at 18-30 kg/ha d Rate and species select individual site requirements	drill seeded. ed varied with
Most Common Colonising Species to Date:	Alysicarpus vaginalis (Alyce (Buffalo) clover) Brachiaria pubigera Chrysopogon spp Digitaria ciliaris (Summer grass) Heteropogon spp Pennisetum pedicellatum	
Native Trees:	SPECIES NAME	COMMON NAME
	Acacia auriculiformis A. holosercea A. Mountfordeae A. difficilis Eucalyptus miniata E. clavigera E. bleeseri E. papuana E. polycarpa Melaleuca viridiflora	Black wattle Wattle Wattle Wolly Butt Cabbage gum Ghost gum Paperbark
Fertiliser:	For pastures, NPK mix at 300 at sowing. Maintenance N+P kg/ha 1st year; NPK 2nd year	0-400 kg/ha at 100 c.
Mowing of Pastures:	2-3 times first year; (mulch retained on ground).	1-2 thereafter
151:TJV4		

Ryan (Reference 4) has reported that strong vigorous pastures developed in the first season. The pastures have repeatedly demonstrated their ability to recover well after dry season fires and after six months without rain.

Ryan has found that judicious timing of mowing and fertilising throughout and at the end of each wet season has enabled the dominant species to achieve three or four seed sets within one wet season, thereby greatly increasing the quality of organic matter and seed in the soil. Native species are gradually increasing.

4. PROJECT ACHIEVEMENTS AND THE ROLE OF MONITORING

4.1 Achievements

An environmental monitoring program was established as an integral part of the project. Results (in particular References 3 and 6) show that as an indicator of short term success the objectives as set out in the Agreement (Section 2.1) have been achieved. While pollution still exists, the effect is very small by comparison with that prior to rehabilitation. It is important to remember that the rehabilitation measures were never intended or expected to eliminate all of the pollution sources.

All the engineering works were completed within the time allowed and within budget. Visually the project has transformed the stark landscape to one of grasslands and vegetated wetlands.

The Project's achievements have been recognised in a number of quarters, notably by the Institution of Engineers Australia. The Northern Territory Division of the Institution awarded the Project a High Commendation for Engineering Excellence in 1986.

The above described success is qualified by two concerns:

- (i) The four wet seasons during and after rehabilitation (1984/85) have all been of below average rainfall and well below average runoff. As a result, the rehabilitation works have not been sufficiently stressed by an average or above average wet season to enable analysis of their long term behaviour.
- (ii) The environmental response to the rehabilitation of some elements on site has predictably been relatively slow. The longer term effects on groundwater hydrology, and water quality of the open cuts, for example cannot yet be quantified.

4.2 Monitoring

To date, the environmental monitoring program has been relatively extensive in coverage (both on and off the site) and intensive in application (relatively frequent measurements, either seasonal or event based). The aims of monitoring included:

- Establishing the extent to which the rehabilitation program achieved the project objectives.
- Establishing the effectiveness of various rehabilitation measures.
- Helping to detect problem areas or a change in trend.

The key elements of the program have included:

- (i) Surface water monitoring of the Finniss River and of the East Branch of the Finniss River, by the Power And Water Authority (PAWA). This has included monitoring rainfall, runoff, and river water quantity and quality at a number of gauge points. One of the results is shown in Figure 4.2(a); the decline with time of annual copper loads in the East Finniss River near its confluence with the Finniss River.
- (ii) Monitoring the behaviour of Whites and Intermediate Open Cuts by PAWA. This has entailed measurement of water quality and temperature profiles in both open cuts, and measurement of groundwater levels and quality in adjacent monitoring bores. Results quantify the effect of groundwater inflow during the dry season, and flushing with river water during each wet season.
- (iii)Monitoring the water balance and chemical activity of Whites and Intermediate Overburden Heaps by the Australian Nuclear Science and Technology Organisation (ANSTO).
 - Water balance studies include monitoring 83 groundwater bores (PAWA) and using that information in groundwater models calibrated with additional data from lysimeter plots on the heaps. Studies to show date rainfall that infiltration through the heaps has been reduced at least tenfold, from 50% or more to less than 5% (Reference 6).

Chemical activity studies include measurement of oxygen, moisture content and temperature within the heaps. Figure 4.2(b) for example,

ANNUAL COPPER LOADS IN EAST FINNISS RIVER

Fig. 4.2(a)

14

TEMPERATURES IN HOLE A (WHITES OVERBURDEN HEAP) AT VARIOUS DEPTHS WITH TIME

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(Rehabilitation was carried out between September 1983 and May 1984) shows an accelerated rate of temperature decrease since Whites Overburden Heap was covered, indicating that oxidation (the chemical process generating mobile pollutants) has stopped.

- (iv) Monitoring of radiation levels by the Radiation Safety Consultant during rehabilitation. Results were used to verify one of the Agreement objectives.
- (v) Monitoring aethetic and other improvements by P Ryan and the Conservation Commission. This has included surveys of vegetation, erosion hazard, drain stability, rock batter stability, soil fauna and trees growth on overburden heaps.

5. SITE MANAGEMENT PLAN

The program of rehabilitation works and monitoring as defined by the Agreement was completed in August 1988. However, to ensure the lasting integrity of the measures, it is necessary to properly manage the site and to carry out a low level of preventative maintenance.

The Monitoring Committee has developed a Site Management Plan (Reference 5) which it has recommended to, and requires the ongoing commitment of, the Commonwealth and Northern Territory Governments. Major elements of the Plan include:

- Declaring the site a Restricted Use Area as defined in Clause 20 of the Soil Conservation and Land Utilisation Act 1978.
- Having the site administered by the Conservation Commission of the NT.
 - Implementing various land uses and restrictions. Access will cater for supervised public access (including tour groups and school children), and researchers. Use may be subject to determination of the Finniss River Land Claim which covers the site.
- Monitoring agencies PAWA, ANSTO and CCNT carrying out defined but markedly reduced programs of monitoring.
- CCNT administering the defined small 'preventative' maintenance program.

The Plan calls for annual reviews of the monitoring and maintenance programs, with the view to further reductions, and possible phasing out of monitoring by 1993.

6. REFERENCES

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