RUM JUNGLE PROJECT

A report on the uranium mining and treatment industry established by the Commonwealth Government at Rum Jungle, and its contribution to the development of the Northern Territory of Australia.

AUSTRALIAN ATOMIC ENERGY COMMISSION
1963

Foreword

This booklet records the establishment by the Commonwealth Government of a uranium mining and treatment industry at Rum Jungle—a profitable and highly important development in the Northern Territory.

Rum Jungle was the first substantial industrial enterprise to be established in the tropical northern part of Australia. It has set a very high standard of housing and community amenities which has influenced, and will continue to influence, all new mining ventures in Australia. Above all, it has been proved beyond doubt that Australian management and Australian workers can operate successfully and efficiently in the tropical climate of the Northern Territory.

The Australian Atomic Energy Commission has been responsible for the Project since its formation and has determined the mining and treatment policies followed.

Initial exploration and development work was carried out by the Bureau of Mineral Resources. Later, management of the enterprise was undertaken by Territory Enterprises Pty. Ltd. (a subsidiary of Conzinc Riotinto of Australia Ltd.). The success of the Project in such a remote and undeveloped area owes much to the skilful management of this Company.

In view of the great importance of the Rum Jungle Project to the development of the Northern Territory, the Commonwealth Government agreed to reinvest its profits and keep the plant in operation after the completion of the Combined Development Agency contract early this year, even if this meant stockpiling the output until the uranium market situation improved. A large quantity of uranium oxide, produced at highly competitive cost, is currently held in store at Rum Jungle. Should this material remain in stockpile for some years, it would still be competitive in price even after bearing interest charges.

W. H. SPOONER,

Minister for National Development.

RESULTS OF RUM JUNGLE C.D.A. CONTRACT

On January 6, 1963, the ten-year contract for the supply of uranium from Rum Jungle to the United States and Great Britain was brought to a successful conclusion. It resulted in the delivery of 3,249,483 lbs. of uranium oxide to the Combined Development Agency (C.D.A.—the joint Anglo-American uranium procurement agency) and in a profit to the Commonwealth of £3.38 million.

The total capital advanced to the Project over the contract period was £6.70 million. The Commonwealth contributed £1.25 million of this total. The amount of £5.2 million, contributed by the C.D.A. by way of advances, was repaid progressively from the proceeds of sales of uranium oxide during the contract period.

The selling price of the uranium oxide under the contract was calculated by means of a cost-plus type formula containing an incentive factor which had the effect of reducing the profit as the cost of production increased.

In addition to the production of uranium concentrates, copper concentrates containing 12,981 tons of copper were produced. These were sold in Japan and Australia and the proceeds credited against the cost of producing uranium in accordance with the contract.

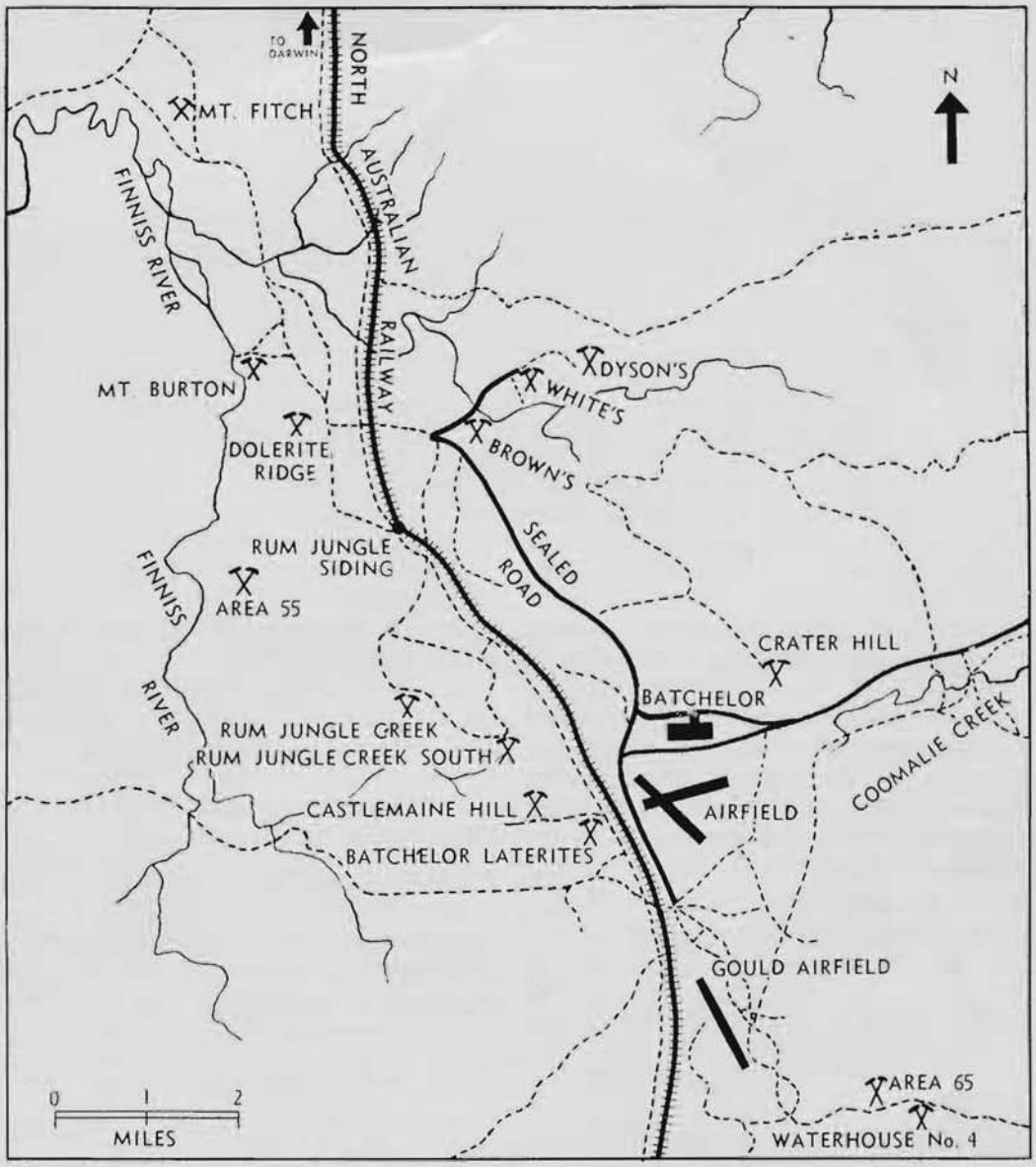
The Project earned total revenue of £21 million, of which approximately £19 million was earned from revenue sources outside Australia. Total capital and operating expenditure up to January 6, 1963, was £19.6 million, of which £17.5 million was applicable to the C.D.A. contract. The greater part of the total expenditure was spent in the Northern Territory. For example, disbursements made by Territory Enterprises Pty. Ltd. (T.E.P.) in 1961 were as follows:—

Payments to residents of the Northern Territory and to creditors in the N.T. but with headquarters interstate	£415,000
Payments to Government departments in the N.T.	15,000
Wages and salaries	650,000
	£1,080,000

Rum Jungle Project

The Rum Jungle Project is the biggest single industrial enterprise in the Northern Territory and is estimated to be responsible, directly and indirectly, for somewhere between one-quarter and one-third of the total economic activity of the northern part of the Territory. It has thus been a most important factor in the development of this area.

Facilities of the Rum Jungle Project comprise plant for the treatment of uranium and



The Rum Jungle area, about 60 miles south of Darwin, Northern Territory of Australia. Map area is approximately that of the Hundred of Goyder.

copper ores, and the model township of Batchelor, situated about five miles away.

Some 600 people live in Batchelor. There are 98 modern, furnished, two and three-bedroom, all-electric homes for families, and single quarters for approximately 340 people. Amenities include a mess designed for about 600 persons, a school attended by more than 100 children, three churches, a community store, swimming pool, sports oval, bowling green, tennis courts and a cinema. Labour turnover, high in the early construction period, is now satisfactorily low, due in part, no doubt, to the high living standards available.

The first members of the Australian Atomic Energy Commission were nominated in November, 1952, and immediately became responsible for the Rum Jungle Project. The

Commission has now offered to make the facilities of Batchelor available to private persons who wish to settle there. This will be done through the Northern Territory Administration which will, when sufficient demand becomes apparent, proclaim for private development an area adjoining the present township.

A vigorous programme of exploration for further economic orebodies in the area has been carried out since the inception of the Project. This has resulted in the discovery of Rum Jungle Creek South, Brown's, and phosphate mineralisation.

In view of the important contribution being made by Rum Jungle to the development of the Northern Territory, and in anticipation of the demands which are likely to arise in the future for uranium to fuel nuclear power stations, the Commonwealth Government decided in 1961 to authorise the Commission to mine the Rum Jungle Creek South orebody so that operations could continue after completion of the C.D.A. contract. Rum Jungle Creek South, which has now been mined out and the ore stockpiled, contained 650,000 tons of uranium ore grading 9.6 lbs. U_3O_8 per ton. It was larger than the two original orebodies—White's and Dyson's—together, and of higher grade.

Sufficient ore is now available for treatment operations to continue at the present rate until about 1971. Current production is being stockpiled pending suitable market opportunities.

Other Ore Bodies

Brown's lead deposit is a large body of low-grade lead mineralisation. Although not an economic proposition at the present time, there is no doubt that it will be worked eventually. When brought into production, it will be a mining and treatment enterprise on a much larger scale than present operations at Rum Jungle.

The exploration programme for uranium in the vicinity of Rum Jungle also resulted in the first discovery of phosphate mineralisation on the Australian mainland. Although these particular deposits may prove to be uneconomic, they have opened up completely new possibilities in the search for phosphate resources in Australia.

A copper prospect near White's mine is currently being drilled by Conzinc Riotinto of Australia Ltd. (C.R.A.) which holds title to it.

A major programme of exploration for uranium and other base metal deposits is continuing with Commonwealth funds. The Commonwealth Government is also encouraging exploration for, and development of, copper and uranium prospects in the general area within economical transport distance of the Rum Jungle treatment plant by offering to purchase and treat such ores at Rum Jungle. This is an extension of the previous arrangement whereby Rum Jungle was the official Commonwealth buying station for uranium ores during the C.D.A. contract period.

HISTORY AND DESCRIPTION OF RUM JUNGLE

Early History

The first record of mineral discoveries in the Rum Jungle area, about 40 miles south of Darwin, was in 1869 when a surveyor named Wood made reference in a report to the presence of a green slaty mineral, probably torbernite, in association with malachite, at a site which 84 years later became White's mine.

After this the area was prospected by many fossickers, including Chinese, and in 1907 copper was reported one mile west of Wood's discovery, the area becoming known as the Rum Jungle Copper Mine. Some shaft sinking and minor exploratory development were done, but the results were not encouraging and the workings were abandoned.

The name "Rum Jungle", according to local legend, derives from the pioneering days of the 1880's, when the title was given to a nearby creek which was the scene of a battle, between outward-bound and parched homeward-bound bullockies, for the possession of a cargo of rum kegs.

Discovery of Uranium

Although a few isolated occurrences of uranium minerals had been known for many years, the search for uranium in Australia did not begin in earnest until after the Second World War.

To encourage the search for, and exploration of, new deposits, the Commonwealth Government offered a number of incentives including tax-free rewards, guaranteed purchase prices for uranium ores and taxation concessions. The discovery of White's uranium deposit at Rum Jungle was a direct result of these incentives.

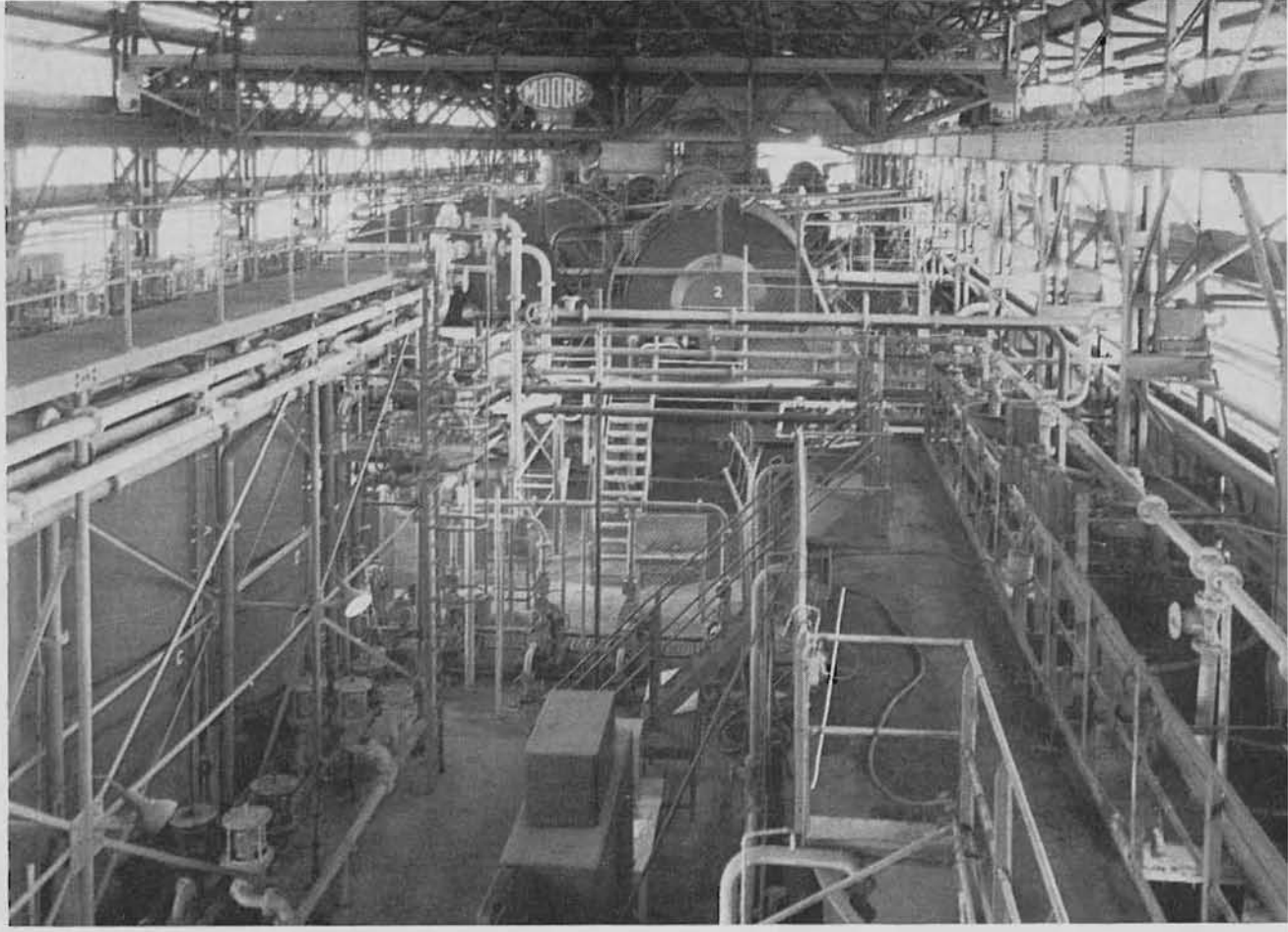
Late in 1949, Mr. J. M. White, a local prospector who had been aware for some time of the existence of distinctive and unfamiliar minerals in the Rum Jungle area, saw a Bureau of Mineral Resources (B.M.R.) pamphlet on radioactive minerals, which included coloured illustrations. He then reported the locality of the occurrence and his belief that the minerals were uraniferous.

Geologists sent to the area by the B.M.R. immediately on receipt of this report, confirmed the presence of uranium-bearing minerals. Prospecting and mining operations were begun by the B.M.R. early in 1950, as soon as the wet season had ended. Subsequent investigations led to the discovery of Dyson's, White's Extended, Brown's, Intermediate, and Mt. Fitch Prospects. In the following year, the White's South and Crater Prospects were also discovered. Several drill holes were put down, mainly on White's Prospect, but failed to intercept an orebody.

Despite many disappointments, the B.M.R. persevered with its investigations, and in December, 1951, found a high-grade orebody at White's. This early exploratory work by the B.M.R. included geological mapping, airborne scintillometer surveys, costeaning, diamond drilling and underground exploration.

The first shaft at Rum Jungle on White's discovery. The mine was converted later to an open cut.

White's open cut mine some years later showing the progressive deepening of the mine.



Uranium ore treatment plant at Rum Jungle. Left foreground shows ion exchange section. Right foreground, precipitation section with drum filters in the background.

Mr. White received the maximum reward of £25,000 for his discovery of uranium in the area.

C.D.A. Mission

In March, 1952, the United States Atomic Energy Commission sent a party of experts to Australia at the invitation of the Commonwealth and South Australian Governments. The party was accompanied by a representative of the United Kingdom Atomic Energy Authority. Discussions took place regarding a basis for development of the Rum Jungle and Radium Hill fields. Agreement was reached on broad principles and arrangements were made later for funds for both projects to be provided by the Combined Development Agency (C.D.A.)—the joint Anglo-American uranium purchasing organisation. In the case of Rum Jungle, the agreement with the C.D.A. was formally executed in January, 1953.

Territory Enterprises Pty. Ltd.

In August, 1952, the Commonwealth Government made arrangements with Consolidated Zinc Pty. Ltd. for the management of the Rum Jungle Project. A wholly-owned subsidiary company, Territory Enterprises Pty. Ltd., was formed by Consolidated Zinc Pty. Ltd. to handle these operations, and on January 1, 1953, Territory Enterprises Pty. Ltd. (T.E.P.) took over development of the uranium deposits within the Hundred of Goyder as agent for the Commonwealth Government.

There were many difficulties. Little was known about the characteristics of the various uranium ores and the best treatment methods. Rum Jungle was many hundreds of miles from

any industrial centre, and there were many technical and transport problems. For instance, it was necessary to manufacture sulphuric acid on the site for leaching the ore.

After completion of the construction of the treatment plant, the Project was officially opened on September 17, 1954, by the Prime Minister of Australia, the Rt. Hon. R. G. Menzies. Production of uranium oxide has been continuous since then.

Establishment of Commission

The first members of the Australian Atomic Energy Commission were nominated on November 27, 1952, and the Commission was formally established on April 17, 1953. Immediately on its formation, the Commission took over control of the Rum Jungle Project from the Department of Supply, and it has continued to be responsible for the Project.

The Commission has overall responsibility for Australia's programme of atomic energy research and development. Uranium exploration is carried out on behalf of the Commonwealth by the Bureau of Mineral Resources acting as agent for the Atomic Energy Commission. In addition, exploration in the Rum Jungle area is also carried out under contract by C.R.A. Exploration Pty. Ltd. on behalf of the Commission.

GEOLOGY AND MINERALISATION

The orebodies in the Rum Jungle area occur in sheared and faulted slates of Lower Proterozoic age. The primary uranium mineral is pitchblende. Secondary uranium minerals which occurred above the base of oxidation in White's and Dyson's deposits included torbernite, saleeite, autunite, sklodowskite, and uranium ochres. At Rum Jungle Creek South, where the top of the orebody is 100 feet below the surface, pitchblende is the only mineral present.

At White's, copper mineralisation was intimately associated with the uranium mineralisation. In addition, the uranium-copper orebody was overlain stratigraphically by a copper orebody which in turn was overlain by lead-cobalt-nickel mineralisation.

All of the orebodies in the area contain pyrite in varying amounts and some of the mineralised slates are graphitic.

Ordinary surface geological methods have been of rather limited value in the Rum Jungle area due to the extensive soil cover and generally poor rock outcrop. Consequently, methods of exploration designed to detect concealed orebodies have been used extensively.

Radiometric surveys, both on the ground and in the air, delineated a number of radiometric anomalies which became the main locations for sub-surface testing by drilling.

The uranium orebody at White's was associated with base metal sulphides, and all the known orebodies are pyritic and graphitic. Because of this, geophysical and geochemical surveys, aimed at detecting these indicators of the possible presence of uranium mineralisation, have been undertaken over selected areas to supplement the radiometric work. Copper and lead anomalies have been outlined by geochemical testing over some known uraniferous areas and this work is being continued. Some areas of high conductivity have been outlined by electromagnetic surveys and are now being drilled.

Diamond drilling has been the main sub-surface exploration tool used to follow up promising preliminary results.

To June 30, 1963, some 600 diamond drill-holes had been completed, totalling over 140,000 ft. In addition, churn, rotary, blast-hole and wagon drilling have been used for a further 70,000 feet of sub-surface testing.

This exploration programme resulted in the discovery of the major uranium orebody at Rum Jungle Creek South. This deposit has now been mined and the stockpiled ore will be sufficient to supply the plant for the next seven years. In addition, the exploration programme was directly responsible for the discovery of

the large low-grade lead deposit known as Brown's, and the discovery of the first significant occurrence of phosphate mineralisation on the Australian mainland. Also, an interesting copper prospect, now being tested, was found while drilling for uranium.

It is apparent that the Rum Jungle area is quite highly mineralised, and there is no reason to assume that all economic orebodies in the area have been found. The current exploration programme will continue while worthwhile exploration targets remain to be investigated.

MINING AND TREATMENT OF ORE

Mining

Initially it was proposed to develop White's mine as a conventional underground operation. However, the exploratory development revealed the ground to be extremely incompetent and the mineralisation irregular. It was evident that an open cutting operation, despite the high overburden to ore ratio, would produce ore at a lower cost per ton and would permit better ore selection and, consequently, reduce treatment costs. The same argument applied to Dyson's and Rum Jungle Creek South orebodies.

Part of White's orebody was situated beneath the bed of the East Finniss River and the river had to be dammed above the mine and a diversion channel cut. When the last of the ore was extracted, the river was allowed to resume its original course and the open cut was filled with water. This provides storage for more than 800 million gallons of water for use in the treatment plant.

The open cutting of White's orebody allowed the recovery at no additional cost of 280,000 tons of copper ore assaying 2.9 per cent copper which lay stratigraphically above the uranium copper orebody, but which could not have been economically extracted by underground methods.

Open cutting of the orebodies was done by contractors using shovels and rear dump trucks as basic equipment. Except in the softest material, blasting of the rocks was necessary before excavation.

Continuous supervision of the working faces had to be maintained in order that uranium-bearing material could be selected for recovery. Selection was done with the aid of portable Geiger counters.

Extraction of White's and Dyson's orebodies (completed by November, 1958) involved the removal of approximately 6 million cubic yards of material and provided sufficient ore to satisfy the requirements of the Combined Development Agency contract.

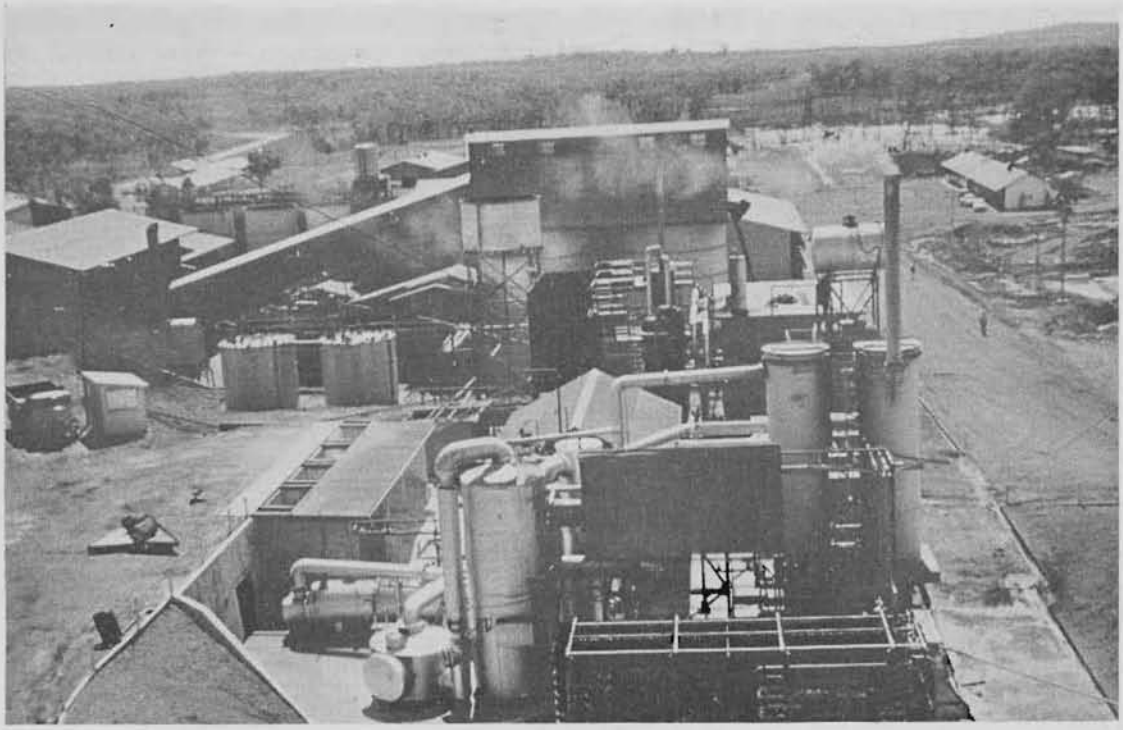
The Rum Jungle Creek South excavation, begun in April, 1961, was done under contract by Davis Contractors Pty. Ltd. and was completed in August, 1963. In this case the overburden was heavily leached and incompetent and was suitable for ripping and scraper-loading. In the mineralised zones some blasting was necessary.

Treatment of Ore

The Rum Jungle treatment plant produces a high-grade uranium chemical concentrate which consists mainly of magnesium diuranate.

The process consists of crushing and grinding of the ore, followed by dissolution of the uranium in sulphuric acid, separation of a pure uranium solution, and then precipitation of the concentrate.

Crushing and grinding are carried out with the conventional equipment used in treatment of any metallic ore. The finely ground ore is agitated with dilute sulphuric acid, and the uranium, as well as various impurities, goes into solution. Suspended material is removed from the solution by counter-current decantation and the uranium transferred into an organic solvent in a solvent extraction circuit. The uranium is then transferred back from the organic solvent to water and precipitated by the addition of magnesia. Undesirable impurities are removed during the solvent extraction stage of the process.



A general view of the Rum Jungle treatment plant showing the sulphuric acid manufacturing plant in the foreground.

View across Rum Jungle Creek South open cut showing the west wall, July, 1962. The excavation at this stage was 100 feet deep. When excavation was completed at 220 feet, about 600,000 tons of ore had been removed.

Originally the plant used a combined filtration and counter-current decantation circuit for producing a clear uranium solution, but Dyson's ore proved too difficult to filter and hence the flow sheet was changed to four-stage counter-current decantation. Extraction of uranium from the pregnant solution was originally accomplished by ion exchange, but a solvent extraction circuit was installed in 1962 to improve the purity of the product.

Copper was recovered from White's uranium-copper ore by flotation treatment of the tailings after uranium extraction to produce a flotation concentrate of grade approximately 20 per cent copper. During the acid leaching in the uranium circuit, some copper was taken into solution and this was recovered after the uranium had been stripped from the solution by passing the solution through launders containing scrap steel, to produce a cementation precipitate of grade approximately 70 per cent copper. Similarly, both a flotation concentrate and cementation precipitate were produced from the treatment of White's copper ore which was floated in an acid circuit.

No copper ore is being treated at the present time but it is hoped that further reserves will be found which will enable copper production to be resumed.

CONCENTRATES AVAILABILITY

High grade uranium chemical concentrates are presently available from the Rum Jungle plant at competitive prices. Actual price depends, of course, on quantity required and the period over which deliveries are to be made. Sales are subject to the Australian Commonwealth Government's international commitments with respect to safeguards. Purchasers will be required to accept International Atomic Energy Agency safeguards, or equivalent safeguards under a bilateral arrangement.

The swimming pool at Batchelor built for employees of the Rum Jungle Project.

Current production has a U_3O_8 content of about 90 per cent and all deleterious impurities are below accepted specification standards.

Persons interested in obtaining further information should write to the Australian Atomic Energy Commission, P.O. Box 41, Coogee, N.S.W., Australia.

FINANCIAL ACCOUNTS

In the following pages detailed financial accounts are presented. These include Trading Account, Profit and Loss Account, Appropriation Account and Balance Sheet as at January 6, 1963.

PRODUCTION STATISTICS

The following table gives details of ores mined and treated during the C.D.A. contract period.

	Tons
Total excavation from White's, Dyson's and Mt. Burton orebodies (Rum Jungle Creek South being outside the ambit of C.D.A. Contract). approx.	12,000,000
Uranium ore mined	531,263
Base metal ore mined	318,422
Ore purchased	9,865
Uranium ore treated	538,342
Base metal ore treated	309,724
Uranium oxide produced and sold to the C.D.A. (subject to minor adjustment on assays of final shipments).	1,624.7
Copper concentrates produced	
Flotation concentrates	40,453
Contained copper	8,317
Cementation concentrates	7,016
Contained copper	4,664
Total contained copper produced	12,981

The manager's residence showing how standing timber has been used at Batchelor to provide shade.

	£	£
Capital Advances		
Combined Development Agency		
Fixed capital	4,705,299	
Working capital	250,000	
Capital for stores	276,914	
	5,232,213	
Less: Repayment	5,232,213	
Commonwealth of Australia		
Expenditure prior to start-up	123,464	
Compensation to landowners	50,513	
Replacements, improvements and modifications to plant	989,000	
Revenue from sales of oxide prior to start-up date	91,580	1,254,557
Advance for exploration	210,000	
Less: Expenditure 1/7/61 to 6/1/63	198,318	
		11,682
Revenue Reserves and Surplus		
Accumulated profits as at 6/1/63		3,151,416
Provisions and Reserves		
Employees' annual leave provision	10,404	
Staff holiday concessions provision	8,230	
Vehicles, plant and equipment insurance reserve	105,764	
Long service leave provision	3,831	128,229
Current Liabilities		
Creditors and accrued charges	147,389	
Unclaimed wages	324	147,713
		£4,693,597

AT 6th JANUARY, 1963

	£	£	£
Fixed Assets			
Darwin		9,293	
Batchelor		1,114,004	
Rum Jungle		2,687,631	
		3,810,928	
Less: Provision for depreciation		3,810,928	—
Capitalized Development Costs		1,690,548	
Less: Provision for depreciation		1,690,548	—
Compensation to Landowners		50,513	
Less: Provision for depreciation		50,513	—
Current Assets			
Uranium ore (at cost) copper concentrate (at estimated value) and warehouse stocks (at cost)		1,930,580	
Debtors:			
Combined Development Agency and Commonwealth Treasury	2,390,543		
Sundry trade debtors	11,013		
		2,401,556	
Bank balances and cash in hand:			
T.E.P.—Darwin, Coogee, Melbourne	228,542		
A.A.E.C.—Sydney	128,480		
		357,022	
Payments in Advance		4,439	
			4,693,597
			£4,693,597