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URANIUM MINING REMEDIATION IN AUSTRALIA'S NORTHERN TERRITORY

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INTRODUCTION AND HISTORY

Uranium was first identified in the Northern Territory (NT) in the late part of the nineteenth century [1]. However, it was only in the years immediately after World War Two that the mineral took strategic importance and exploration efforts really took off. The discovery of the Rum Jungle deposit by Jack White in 1949 is generally accepted as the start of the modern era of uranium mining in the NT [2]. Located about 75km south of Darwin the Rum Jungle mine operated from 1954 to 1971 and produced 3,530 t of uranium oxide and 22,000 t copper. A number of smaller mines in the vicinity also contributed to the development of the industry. However, when contracts were fulfilled or deposits worked out, little effort was put into remediation of the sites and many were simply abandoned. In some cases these legacy sites were relatively benign but others became sources of contamination; usually due to the development of acid and metalliferous drainage (AMD) arising from the sulphides in the remaining waste rock piles. Only in later years did legislation and public concern lead to action being taken. Some of those actions are described later in this paper.

THE SECOND MINING ROUND

After the "rush" of the 1950s the taste for uranium seemed to quieten down until the prospect of uranium as a fuel for nuclear power became firmly set in people's minds. In the later 1960s exploration returned to locations which had been successful previously. The NT was one of those areas, especially around the Pine Creek geosyncline. The results of the exploration effort in the Alligator Rivers Region (ARR) were the deposits at Ranger, Jabiluka, Nabarlek and Koongarra. But by the time the development proposals were being formulated a new paradigm had been established with respect to mining, environmental management and remediation. Society was no longer prepared to accept that mining, especially uranium mining, would be a one-time user of land in the NT.

The result was Australia's first environmental inquiry, the Ranger Uranium Environmental Inquiry (RUEI). This is perhaps better known as the Fox Inquiry after the Chairperson, Mr Justice Fox. The Inquiry produced two reports [3, 4] which decided that (a) Australia could become involved in nuclear fuel cycle activity by mining uranium, but that would be the limit of the involvement; and (b) that the four identified deposits in the ARR would be able to proceed to development, subject to the process of environmental impact assessment required under recently promulgated laws.

Only two of the four identified uranium resources have been developed to date, Nabarlek and Ranger [5]; both sites are subject to strict environmental regulation set down in the Environmental requirements from the Commonwealth Government (ER). Koongarra has been returned, unworked, at the request of the Aboriginal Traditional Owners of the land to become a part of the surrounding world heritage listed Kakadu National Park. Jabiluka was investigated and an EIS submitted but the site been put back into long term care and maintenance with the disturbed areas now in an advanced state of remediation following the removal of all infrastructure and the backfilling of the underground development trial workings [6].

MODERN REMEDIATION

Small scale operations from the 1960s in the South Alligator Valley had been simply abandoned when production quotas were filled. About 13 mines and three processing sites produced approximately 850 tonnes

of uranium oxide in this programme [7]. The sites were left un-remediated until the area was designated to be included in Stage 3 of the Kakadu National Park, at which time a series of hazard reduction works (HRW) were undertaken to improve public safety both physically and radiologically [8]. As part of a longer term lease agreement with the Aboriginal Traditional Owners in 1999 a programme was begun to undertake the planning and implementation of the various mining and processing sites in the valley [9]. This programme was begun eventually in 2007 and completed in 2008 with the various small containments built under the earlier HRW programme being opened up and the contents relocated to a central customised central containment built to modern standards. The containment was instrumented and monitoring is ongoing. Various reports have been made regarding the success of this project and presented at international meetings [10, 11].

The Nabarlek mine operated between 1979 and 1988; mining of the relatively high grade ore was undertaken in one dry season and the stockpile was processed over the following ten years at a production rate of about 1000t of U₃O₈ annually [12]. From the outset the mine had a plan of remediation and a fund to cover the cost of the works was guaranteed. After about a year or so the mine employed a decommissioning engineer whose main task was to ensure the plan was kept up to date and every opportunity for progressive remediation was taken up. One of the environmental requirements (ER) for uranium mines in the ARR was that all mill tailings had to be returned to the mined out pits at the end of the mine life. In the case of Nabarlek the ore body was excavated entirely in 1979 and then processed over the following ten years with tailings being returned directly to the pit. In 1989 the mine was mothballed in case another ore body could be found. However, this was not the case and the mine was decommissioned and remediated in 1995 with the final work of seeding the site being completed before the onset of the wet season in December 1995. Since then the site has continued to revegetate with varying degrees of intervention from successive lease holders. Some exploration activity has been based at the site and in the surrounding areas since that time although the minesite has been allowed to continue to remediate. Revegetation has been moderately successful despite severe damage from a tropical cyclone in 2006 [12].

The Rum Jungle uranium and copper mine operated from 1954 to 1971 [2] and produced 3,530t U₃O₈ and 20,222t Copper. The site was abandoned with little remediation apart from a token effort in 1976. Ongoing AMD production resulted in significant impacts in the Finnis River. As a result \$18.6M was spent on remediation between 1983 and 1986 and the program was hailed as best practice at the time. Sadly the works did not completely solve all the issues and by 2000 the situation was deteriorating. A series of investigations began in 2004 which eventually resulted in the NT and Commonwealth Governments entering into a National Partnership Agreement (NPA) in 2009 which was the beginning of a long term comprehensive program to characterise the site and develop new designs for its remediation.

Under the NPA and successive project agreements a wide variety of studies have been undertaken to obtain data which has facilitated a comprehensive characterisation of the site, assisted in improving the day-to-day management of the site and enabled development of an improved remediation plan for the site.

A major feature of the programme has been the extensive consultation with the Aboriginal Traditional Owners of the land and their inclusion in the process of determining final land form and land use objectives. The project has also provided business development opportunities for the land owners which has resulted in small business ventures being created and developed at the project, which have then gone on to compete successfully in the local market.

The final design data are currently being collected and contracts let to develop the final remediation plan; this includes preparation of an Environmental Impact Statement for assessment under NT and Commonwealth legislation. This work is due to be completed in 2019, with the production of costed designs for the final remediation program.

CURRENT ACTIVITY

The Ranger Uranium Mine, operated by Energy Resources of Australia Ltd (ERA), is, after 36 years, the longest producing uranium mine in Australia. Located about 250km east of Darwin, the mine is surrounded by, but not part of, Kakadu National Park. Operating since 1980 the mine has produced more than 125,000 tonnes of uranium oxide to date. ERA finished open pit mining in 2013 with the end of work in Pit 3. The previous pit, Pit 1, was backfilled with tailings between 1996 and 2004, in accordance with the ERs. In 2017 work started on completing the back filling Pit 1 using waste rock to commence construction of the final land form. Details of the final land form design are yet to be finally agreed with Aboriginal Traditional Owners but the requirement is that the area could be incorporated into Kakadu National Park if desired, without the need for any special management [11]. ERA is continuing to process ore from existing stockpiles on site. The present administrative arrangements require ERA to cease production and processing in January 2021 and to have completed remediation of the site by January 2026.

Since 2013 ERA has continued to implement progressive remediation works as and where it has been possible to do so, compatible with the last of the processing operations. When mining ended in Pit 3 work began immediately on preparing the void to be used as a disposal site for mill tailings. The main part of this programme was the placing of 33 M t of waste rock in the base of the pit to provide a level floor for deposition of tailings.

Since 2015 mill tailings have been deposited directly to this pit. As well as the tailings in Pit 1 ERA also has a tailings dam approximately one kilometre square containing nearly 23 M t of tailings. Since 2016 work has been underway transferring these tailings into Pit 3 using a custom built dredge. This operation is scheduled to last until 2021. At that time the excess process water will be disposed of through treatment and the tailings allowed to dry out and stabilised using prefabricated vertical drains. The final land form construction will then begin using waste rock with the final surfaces being made of material containing less than 0.02% uranium oxide, i.e. non-mineralised material. All this work is due to be completed in 2025 to allow planting to be completed by 2026, as required by the present administrative arrangements.

The Ranger site currently has a considerable inventory of process water which cannot be released from site. A brine concentrator, built in 2013, treats process water to produce 1.8GL of clean distillate per year, which is suitable for controlled release. The residual brines are to be injected into the void space in the back fill at the base of Pit 3. Other, less contaminated, waters on site are passed through conventional water treatment plants (reverse osmosis) and the permeate is released in accordance with the appropriate approvals. As the climate has marked wet and dry seasons, discharge of clean water is only permitted when creeks and rivers are running. During the dry season, when ephemeral rivers have ceased to flow, water may only be released through evaporation. ERA are introducing turbomisters during the dry season as a way of enhancing natural evaporation losses for treated water.

The progress of the remediation work is overseen by a Minesite Technical Committee (MTC) which comprises ERA, the NT DPIR, the Supervising Scientist and, to represent the Aboriginal traditional Owners, The Northern Land Council and the Gunhdjeimi Aboriginal Corporation. The Commonwealth Government Department of Industry, Innovation and Science attends meetings as an observer. ERA is producing a Mine Closure Plan as a document for publication to the community; standards and criteria for the remediation programme are developed in consultation with the MTC members and other interested parties as appropriate.

CONCLUSION

Uranium mine remediation in Australia's Northern Territory has come a long way from the days of simple abandonment that were the normal procedure only 50 years ago. Recent and current sites are being remediated in accordance with current leading practice and considerable attention is paid to consultation with stakeholders to ensure all concerns are understood and have the opportunity to be addressed. The efforts have not stopped there with a number of legacy uranium sites being cleaned up as well. There have been valuable lessons learned at every stage of this story and they are in turn being applied to the future work programmes for remediation of these and other mines in the region.

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Australia

Primary author: Mr WAGGITT, Peter (Department of Primary Industry and Resources of the Northern Territory)

Presenter: Mr WAGGITT, Peter (Department of Primary Industry and Resources of the Northern Territory)

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