Sustainability aspects of the Beverley Uranium Mines

by Peter Woods MAusIMM(CP), Environment, Safety and Health Manager, Heathgate Resources Pty Ltd

Introduction

Heathgate Resources Pty Ltd (Heathgate) operates the technologically advanced in situ recovery (ISR) Beverley and Beverley North uranium mines, located about 550 km north of Adelaide, South Australia, on the arid plains between the northern Flinders Ranges and Lake Frome.

The original Beverley Uranium Mine has operated since 2000 under close environmental scrutiny (Jeuken *et al*, 2008; Märten *et al*, in press). Since the discovery (see Curtis, Brunt and Binks, 1990) and mining of the original Beverley uranium resources, additional uranium deposits have been found in the area and mining is extending over a larger area. In 2009 Heathgate's exploration group discovered the first of several new deposits to the north of Beverley. The Pepegoona and Pannikan deposits are the first ISR uranium satellite mines in Australia and form the nuclei of the Beverley North Project.

Sustainability of the Beverley operations is achieved through an environmental management strategy, developed in partnership with regulatory authorities. This strategy focuses on monitoring activities which are undertaken to ensure that the mine complies with regulatory requirements and has an acceptable impact on the environment. The 'social licence to operate' aspect is also important, and extends to relationships with our stakeholders, including the State and Federal governments, the local traditional owners and landholders, our employees and contractors and to the wider community beyond.

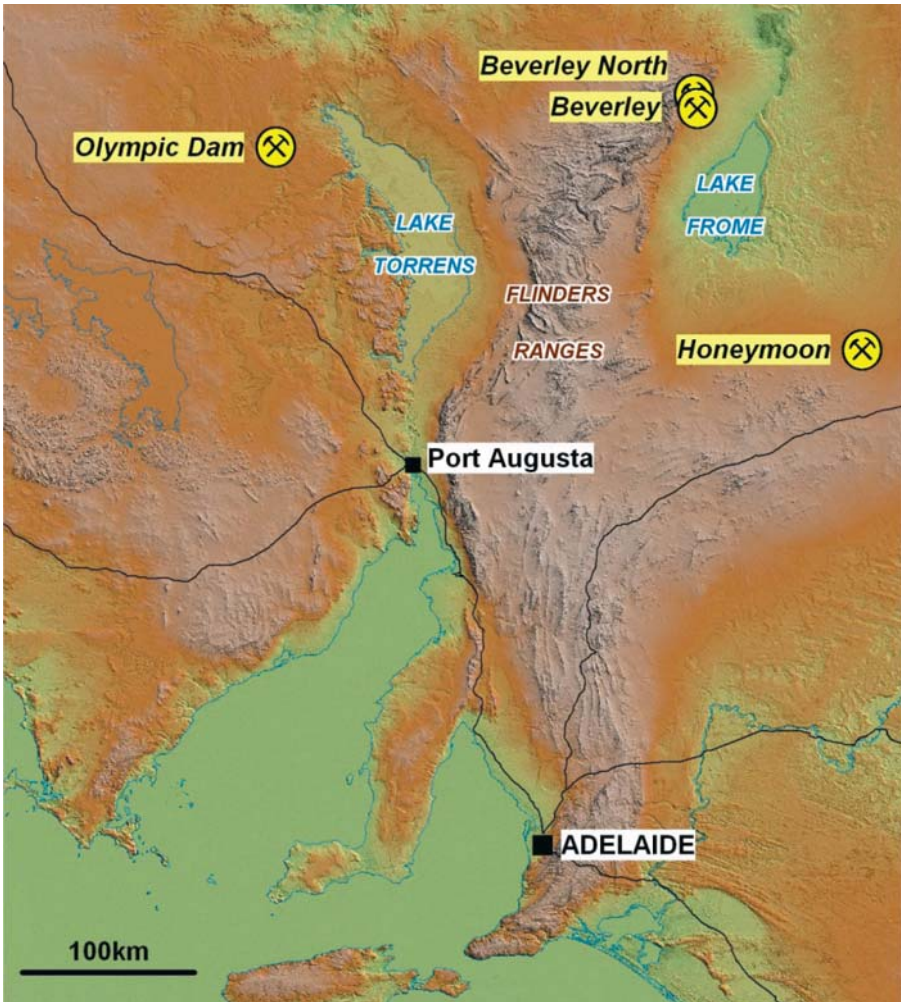

Figure 1. Location of Beverley Mines.

Mining method

Heathgate undertakes mining by the *in situ* recovery (ISR) process, a form of solution mining. This has been described in detail in the original EIS and recent Public Environment Reports and in several conference papers (eg Jeuken *et al*, 2008). ISR mines have many advantages when compared with traditional mines since they have:

- Minimal surface disturbance;
- No ore surface exposure;
- No waste rock dumps;
- No tailings dams; and
- Greatly reduced radiation exposure to workers and the community at large.

ISR mining removes economic mineralisation from the host ore without the physical removal of ore and overburden. It requires multiple close–spaced wells into the ore, pipelines to and from the wells and a surface processing plant, but does not require either underground mine workings or open cut pits, or waste rock dumps and tailings management facilities. The mine's location is shown in Figure 1 and the general arrangement of ISR facilities at Beverley and Beverley North are shown in Figures 2 and 3 respectively.

ISR mining is feasible where the geological and hydrological characteristics of the orebody are

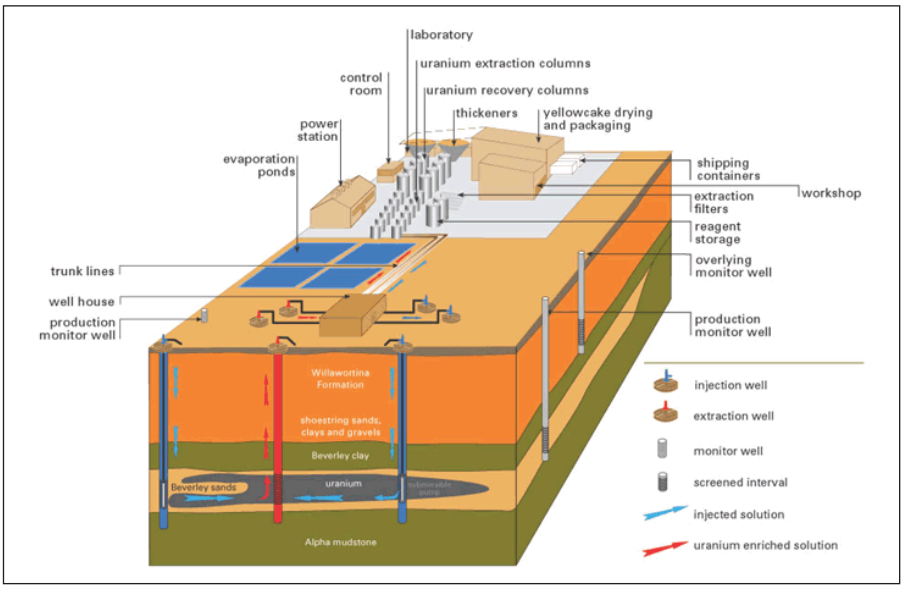

Figure 2. Schematic of mining at Beverley.

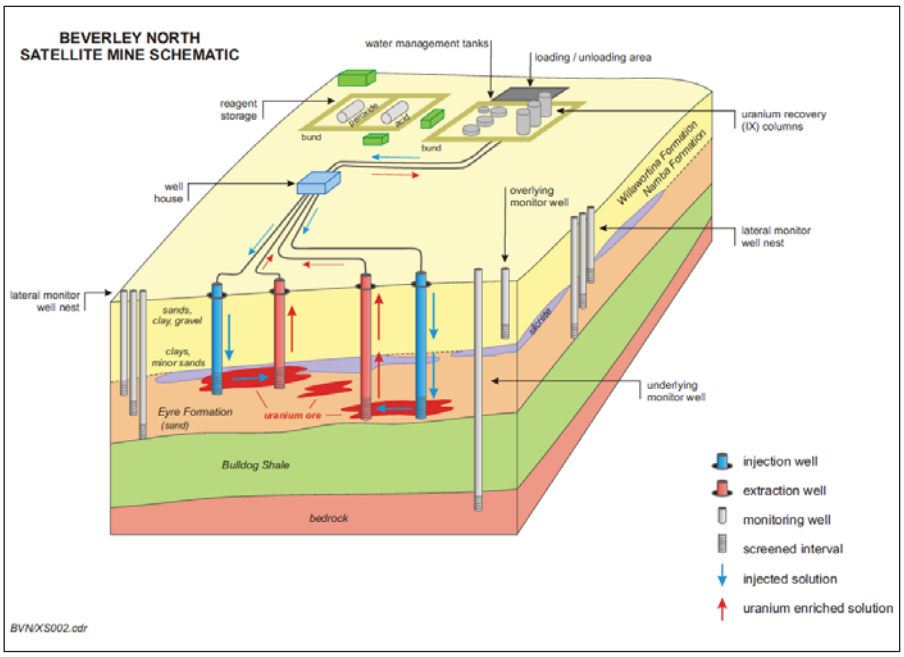

Figure 3. Schematic of satellite mining at Beverley North.

favourable. This is the case with the Beverley and Beverley North uranium deposits, where the uranium is easily mobilised. The mineralised zone occurs in highly permeable sediments that are confined by largely impermeable strata above and below the ore body and the mineralised zone is saturated with groundwater.

In the ISR process, natural groundwater from the mineralised zone requires the addition of oxidising and complexing reagents. Oxidising reagents are commonly oxygen or hydrogen peroxide, though other alternatives may be used. Complexing reagents may be acidic or alkaline. Our present operations are an acidic leach, using dilute sulfuric acid with added hydrogen peroxide.

The mining solution (lixiviant) is passed via multiple injection wells into a permeable orebody where it mobilises the uranium contained in the ore. In this process, some of the reagents are consumed. The resulting uranium–rich solution is pumped back to the surface via multiple extraction wells to a uranium processing plant; either the main plant at Beverley or a smaller satellite plant at Beverley North.

At the Beverley processing plant, uranium is stripped from the solution onto resin beads and held for later precipitation, drying and packaging. At Beverley North uranium–loaded resin is trucked to the main plant at Beverley; at Beverley the whole process takes place in the main plant. The barren mining solution is refortified to replace used reagents and recycled back to the injection wells. Within any given area, this cycle continues until the uranium remaining in the ore is depleted to uneconomic levels. Typically mining solution is circulated 50 to 100 times through a given patch of mined ore.

The design and operation of the wellfield controls the flow of mining solution through the mineralisation. Operations are generally limited to only parts of wellfields at any one time, although the whole of each wellfield will eventually be mined during the life of the mine.

Injection and extraction wells are closely spaced, at present between 12 – 40 m apart. Within the active mining area at Beverley North, the volume of solutions extracted is slightly more than the volume injected. This ‘bleed’ ensures a slight continuous inflow from the surrounding formation into the active mining area and minimises leakage of mining solutions away from the active mining area (excursions). At Beverley, ‘bleed’ is small and an essentially neutral water balance is maintained due to the very limited extent of the ore–bearing aquifer material at that location, and its lack of connection to regional groundwater systems.

Water is reused wherever possible. In the end, a small volume of saline water cannot be reused. This is disposed of to the mining aquifer at Beverley, which is an isolated sand body not connected to the flowing regional groundwater systems. Originally considered by some to be controversial, because of

the effective isolation of this saline water, the injection of waste water into the mined–out aquifer at Beverley has been confirmed as best practice by government reviews (CSIRO Land and Water, 2004; Geoscience Australian and Chief Scientist as quoted by the Minister for the Environment, Heritage and the Arts when announcing the approval of the Beverley extension, 2008_1.)

In contrast, at Beverley North where the uranium is located in a more regional aquifer, saline water disposal is not part of current approvals and additional measures for the protection of groundwater after mining must be undertaken (Heathgate 2010a, 2011; Kalka, Märten, and Woods, 2011).

Figure 4. Wellfield at Beverley (undisturbed desert at far left).

Regulation and reporting

The operations at Beverley are subject to stringent environmental regulations. The mines operate in accordance with the environmental standards and procedures initiated through a comprehensive environmental impact assessment process which incorporates input from State and Commonwealth governments as well as from the broader community through consultation. This process is ongoing as continual improvement is sought by all parties. As well as the original Beverley EIS (Heathgate, 1998), thorough reviews and updating of environmental and radiation protection aspects, and public consultation arrangements, were undertaken as part of the Public Environmental Report (PER) processes for the extension of mining at Beverley (Heathgate, 2007) and Beverley North (Heathgate, 2010a). At the same time, significant review and associated updates to its Radiation and Radioactive Waste Management Plans was undertaken (Kutty *et al*, 2010). The current Mining and Rehabilitation Programs (MARP) for the Beverley and Beverley North mines are public documents (Heathgate, 2008; 2011) and the South Australian Environment Protection Authority is expected to make the radiation plans public in the near future.

Beverley's annual environment report (since 2008 called the Mining and Rehabilitation Compliance Report (MARCR) to meet local regulator guidelines (PIRSA, 2007)) has been available to the public since mining commenced (eg, Heathgate, 2010b). The South Australian Environment Protection Authority is expected to make the radiation reports public in the near future.

Native title and indigenous relations

Heathgate enjoys a strong working relationship with the Adnyamathanha people, who are the traditional owners and Native Title holders for the area where Beverley is located. Mining agreements have been in place for the life of the mines.

A new Beverley mining agreement including Beverley North was approved by Heathgate and the Adnyamathanha community in May 2010. This ensures the continuance of royalty payments, community payments and employment opportunities for Adnyamathanha people. As a minimum Heathgate meets quarterly with the Adnyamathanha people, and several heritage clearances are undertaken in most years, depending on the level of exploration and development.

For the past few years Heathgate has met its target of 20 per cent indigenous employment at Beverley; this is a goal we will continue try to maintain in the future. At Beverley there is a visitor's centre that displays cultural information, photographs and facts about the Adnyamathanha people.

Ongoing public consultation and interaction

Heathgate's community engagement plans are part of the published MARPs (Heathgate, 2008; 2011) and were subject to review and approval by both state and commonwealth regulators. Formal meetings are held with state regulators on a quarterly basis and with combined state and commonwealth regulators twice a year, together with many informal meetings. Informal meetings are held with local stakeholders in addition to the Adnyamathanha people, notably neighbouring pastoralists and the nearby Arkaroola Wilderness Sanctuary.

Heathgate is also a regular participant in industry conferences (see reference list for a selection) and hosts many site visits each year from industry groups, miners and explorers from Australia and other countries, regulators from

Figure 5. Workers in a Beverley wellfield.

Figure 6. Progressive rehabilitation of former exploration camp site (in a naturally patchy landscape).

Australian states, the commonwealth and overseas, regional development boards and non–government organisations, including the Friends of the Earth.

Groundwater protection and monitoring

Sustainable operation of the mine includes maintaining acceptable impacts on the environment during operations and following mine closure. Because of the nature of mining, with low surface impact, much of the environmental protection effort is groundwater related. The mined aquifers at Beverley are recognised as having low environmental value. In their natural state they are brackish to salty and too radioactive for any potable, agricultural or environmental use, and also contain naturally high concentrations of fluoride.

Confirmation of proper control of mining solution and waste water within the active regions of the mined aquifers is accomplished through regular groundwater monitoring using a comprehensive network of monitor wells completed in lateral extensions of the mined and adjacent aquifers. Additional monitoring is undertaken in underlying and overlying aquifers, although the risk to the underlying aquifers including, at Beverley, the Great Artesian Basin (GAB), has been assessed as not a credible risk (see CSIRO Land and Water, 2004 for the Beverley situation; they state '… there is considered to be no potential for mining–affected water from the Beverley project to enter the GAB', page 23). The GAB is not present at the location of the current Beverley North operations; there, fractured rock (bedrock) constitutes the underlying aquifer which is monitored.

Other environmental protection and monitoring

- Management plans and monitoring are undertaken of several other environmental and cultural aspects:
- Soils and creek sediments;
- Vegetation;
- Fauna;
- Surface water;
- Air quality;
- Heritage;
- Third party issues (infrastructure etc).

Since the PERs, programs have been based on a risk assessment approach (Woods et al, 2009; Heathgate; 2008, 2010a). Results of these programs, in common with groundwater monitoring, are reported on publically in the Annual Environmental Report/MARCR.

Observations of routine monitoring programs are sometimes of external interest, such as an extension of the known range of the Dusky Hopping Mouse (Waudby and How, 2008). The results of fauna and vegetation studies are also registered on the relevant government databases and are thus available to researchers and investigators world–wide. Heathgate also co–operates with other regional environmental studies such as the distribution of the Lake Eyre Dragon (Pedler and Neilly, 2010).

Post mining rehabilitation

Wellfields are rehabilitated through pressure grouting of old wells with sulphate resistant cement such that penetrations into the mined aquifer are effectively sealed to prevent migration of groundwater to overlying or underlying aquifers. On the surface, obsolete infrastructure such as wellhouses, wellheads and surface piping are recovered for re–use elsewhere in the mines or for disposal. The surface is rehabilitated, which may include re–spreading of soil and scarification, or the encouragement of volunteer vegetation which has been effective in many areas.

In the long term, the plant and other infrastructure that is not passed onto future responsible parties (eg water supply wells will be handed over to pastoral interests) will also be either relocated, such as the camp buildings, or demolished for appropriate recycling or disposal and the area returned to pastoral land use.

Some progressive rehabilitation has been undertaken to date (Woods *et*

al, 2010), but with the winding down of mining at the original Beverley deposits the focus on progressive rehabilitation will increase from 2011.

External reviews

Heathgate audits its environmental performance every year, with two internal audits and an external audit, later released publicly, every third year. These internal and triennial external audits are published with the annual environment report/MARCR.

An independent review of the environmental impact of ISR mining by the Commonwealth Scientific and Research Organisation (CSIRO) Land and Water in 2004 concluded that "ISR mining of uranium … is more cost effective and environmentally responsible than any suggested alternative techniques." and that Beverley " … has initiated and implemented world's best practice methods." (CSIRO, 2004).

Conclusion

Heathgate's Beverley operations introduced the ISR technique of uranium mining to Australia, and have continued to improve and adapt that low–impact technology to local conditions. Environmental expectations and requirements have always been high, and subject to ongoing review and updating to reflect changing regulator and stakeholder expectations. Similarly, the mine's relationship with the Adnyamathanha people has always been important and high profile. The company has developed a good working relationship with its regulators and neighbours and has received favourable technical reviews of its practices. These aspects have proved valuable in the recent expansions of operations and the company is now an experienced miner involved in its district and the broader mining industry. Heathgate's Beverley operations are frequently visited as an example of technical and regulatory best practice by regulators, miners and explorers from other states and countries. The thorough process for the Beverley extension, approved in 2008, was the basis for the later commonwealth best practice guidelines for ISR uranium mining (Commonwealth of Australia, 2010). The area around Beverley is considered one of the most prospective uranium exploration districts in Australia. In the medium to long term, mining is likely to be ongoing in the area. The processing plant, camp and airstrip at Beverley may be retained as a central facility for other deposits within economic distance, as is happening now with the Beverley North project. Safety, societal aspects and environmental and radiation protection and successful progressive rehabilitation will continue to be vital to ongoing mining enterprise in the district.

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