Government of South Australia

Department of State Development

Department of State Development

Mineral Resources Division

Submission to the

Nuclear Fuel Cycle Royal Commission

In response to

Questions regarding lessons learnt from historical uranium extraction, milling and processing activities in South Australia

FINAL

6th October 2015

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Overview

The Nuclear Fuel Cycle Royal Commission (the Royal Commission) wrote to the Department of State Development (DSD) on the 12th August 2015 seeking information on the lessons learnt from historical uranium extraction, milling and processing practices in South Australia. The Royal Commission outlines an interest in understanding the lessons that may be drawn from the experiences during site rehabilitation work carried out at the former Port Pirie uranium treatment plant and the former Radium Hill mine.

This Submission sets out DSD's responses to the series of questions posed by the Royal Commission. DSD understands that the Environment Protection Authority (EPA) is also providing responses to a number of the questions referred to DSD. DSD and the EPA are responding independently to the Commission's questions in accordance with the responsibilities of each agency.

DSD has engaged Mr. Andrew Johnston (Southern Radiation Services Pty Ltd.) to assist it in responding to the questions raised in the letter. His input into the responses was specifically directed to providing answers to questions 5, 6 and 7 with some input to questions 8 & 9.

The Mineral Resources agency responsible for the regulation of mining within South Australia has undergone a number of department name changes over the years. References in this Submission to the Department of Mines, PIRSA, DMITRE and DSD all refer to Mineral Resources agency.

In addition to the responses to the questions posed by the Royal Commission an additional section has been included in the Submission which compares the current State regulatory framework with what was in place in South Australia in the 1950's and also with leading practice uranium mining jurisdiction in Canada. This comparison demonstrates that the current regulatory environment for the uranium mining industry has comprehensively evolved since the 1950's.

In response to the draft submission by DSD dated the 4th September 2015, the Royal Commission wrote to DSD with a series of questions in relation to the draft submission. The responses to these questions have been included in this submission and have been placed in the document in the section to which they relate as a question and response.

Activities resulting in environmental impacts

Q1a During the periods in which they were operating, what activities were undertaken at Port Pirie and Radium Hill that had an impact on the environment?

Activities Undertaken at the Former Radium Hill Uranium Mine *(Source of this information is from the 'Management Plan Phase 1 – preliminary Investigation 2004' by M McLeary)[1]*

The deposit was discovered in 1906 and mined intermittently over the years until significant interest was shown in the late 1940's with increased exploration to define the ore body.

The operations of the Radium Hill mine was part of an operation commissioned and operated by the South Australian Government to satisfy a contract signed by the Commonwealth and State Governments with the UK-USA Combined Development Agency for delivery of uranium over a seven year period.

Full scale mining operations commenced in November 1954 by the sinking of a main shaft (ultimately to 417 metres in depth) and continued until November 1961. Approximately 854,000 tonnes of ore was extracted and milled to produce 120,000 of concentrate for treatment at Port Pirie to produce approximately 850 tonnes of U_3O_8.

The ore was mined and transported underground to the shaft where it was lifted to the surface and transferred to a storage bin. From the bin the ore was crushed in a two stage crusher process to produce a product which was then ground in a ball mill to minus 0.0075m. Using spiral classifiers and flotation methods the ore was separated from the tailings to produce a uranium concentrate. The uranium concentrate was then thickened and filtered before being transported by rail in wagons to Port Pirie.

The tailings from the uranium concentration process were placed in a rectangular tailings impoundment adjacent to the Radium Hill ore treatment plant. The tailings impoundment comprised of two sections that were approximately 125m x 125m each covering a total area of approximately 4 hectares. At the time, these were normally built with very little preparation to the ground surface prior to construction of the tailings impoundment.

Waste rock extracted from the mine and heavy media rejects were largely placed in stockpiles adjacent to the mill and included the excess heavy media rejects not railed offsite for ballast or used in road construction.

The following impacts from these activities have been identified:

a. The waste rock stockpiles and dispersal of a quantity of tailings post-operations resulted in slightly elevated gamma dose rates and radon concentrations in the vicinity of the mine and tailings impoundment. There are elevated dose rates across the tailings impoundment itself. Subsequent surveys and assessment indicate the current state of the mine site does not represent a risk to the casual visitor, or to the environment.

b. The slightly elevated levels of radiation from the previous use of Radium Hill Mine waste rock and heavy metal rejects for railway ballast and road construction purposes do not present a risk.

c. Soil contamination in some isolated locations

Activities Undertaken at the Former Port Pirie Uranium Treatment Plant

(Source of this information is from the 'Management Plan Phase 1 – preliminary Investigation 2004' 'Port Pirie Uranium Treatment Plant' by M McLeary)[2]

The Port Pirie Uranium treatment Plant (PPUTP) was established in 1955 north of the City of Port Pirie. It was also part of the full scale operation commissioned and operated by the South Australian Government to satisfy a contract signed by the Commonwealth and State Governments with the UK-USA Combined Development Agency for delivery of uranium over a seven year period.

Ore concentrate arrived from Radium Hill by rail at the treatment plant and was converted into Yellowcake by an acid leach and ion exchange process.

In parallel to the uranium processing, a pilot plant was established to extract rare earths including scandium and other minerals. This ceased in 1962 and the plant was sold in 1968. The Rare Earth Corporation (REC) purchased the property and set up a monazite cracking venture to extract rare earths. A number of additional tailings dams were built and some modifications made to the existing plant, which had remained idle since 1962. A total of 1,500 tonnes of monazite was produced.

From approximately 1979 until 1986, the site was used for the recovery of lead from batteries and copper from electric cables.

From 1988 to 1991 SX Holdings constructed a rare earth plant on the site but did not proceed with treatment operations due to unfavorable economic conditions.

There is approximately 200,000 tonnes of tailings stored in clay lined tailings dams on the site. Approximately 75% of the tailings dam area is covered with granulated slag from the Port Pirie Smelter to control radon emanations and potential release of radioactive dust into the surrounding environment.

Site related activities identified as having a potential to impact on the environment have been the focus of the following post-operation assessment and environmental control measures.

a. A number of metals (among them uranium, thorium, lead) and rare earth elements which consistently exceeded the adopted media-specific health based investigation levels. Whilst the site would require further remediation before it could be used for uncontrolled purposes, there is no indication of significant off-site movement of contaminants.

b. The capping of the tailings dams and some areas of the plant with inert smelter slag has minimized any possible spread of contaminants through dusting, and reduced gamma dose rates and radon emissions.

Q1b How were these activities planned?

The activities at both Radium Hill and the Port Pirie Treatment works appear to have been planned in a workmanlike and professional manner in accordance with the best practice at the time by the South Australian Government. The anecdotal evidence suggests that the mine was properly set out and planned, ore processing methods appropriately tested and construction and operations well managed to ensure the contractual obligations for the supply of uranium product were met.

The Port Pirie Treatment Plant site appears to have been chosen due to proximity to rail transport, port facilities, a sulphuric acid supply, and a reliable water source.

In reviewing several lists of over 2,000 departmental documents relating to the operations at the time, the focus of the operations would appear to have been on the technical aspects of the operation, the best techniques to process the ore and the practical administration of a significant mining and processing operation rather than incorporating environmental management principles.

Some documents refer to issues relating to the health of employees including possible hazards in uranium mining, and the potential radiological impact of mining on the workers at the mine but do not have any reference to the radiological impact on the environment.

No consideration appears to have been given to the closure aspects of the operations at the project planning stage or during the operational stage. The planning of the decommissioning of the mine and treatment plant appears to have taken place as a separate exercise after production operations ceased.

Site Management during Operations

Q2a How was the environmental impact on each of these activities managed during operations in Practical terms? In answering this question, please identify each activity and the environmental impact attributed to it.

From the titles of the relevant departmental documents dating from the early 1950's and 1960's no reference appears to have been made to environmental aspects of the operations at Radium Hill and Port Pirie Treatment Works. There are no references to 'Environmental Impacts' in the document titles from the period. The emphasis evident in the historical documents was on meeting the contractual obligation to produce uranium for the British and American governments.

The operations appear to have been worked in accordance with the best practice of the day (and probably exceeded the norm). However 'environmental impact' was not a specific item considered in the manner that we consider it today.

The evidence available would suggest that the environmental impacts identified would have been managed in the following manner:

Radium Hill

a. The tailings and the potential spreading once they dried.

The tailings 'dam' wall was largely constructed from the tailings themselves and there is some evidence of 44 gallon drums being used as an initial edge barrier to contain the tailings. While the dam was in use over the life of the mine, the tailings were moist this did not present any dusting problems. However when the mining and processing ceased, no attempt was made to protect the integrity of the dam from ongoing erosion. Once the tailings had dried out, a quantity of tailings was dispersed through wind erosion and occasional water erosion spread the tailings in the area immediately surrounding the tailing impoundment. (If this tailings facility was operated today, the walls of the tailing facility would be engineered and rock lined to provide long term stability and when completed the top of the tailings would be sheeted with an inert but stable cover material to provide long term stability and containment.

b. The use of waste rock and heavy media rejects for ballast and road construction purposes.

There was use of the heavy media rejects, rubble and other waste rock as ballast on the Port Pirie – Broken Hill line when it was standardized by the Commonwealth Railways in the mid 1960's. The Highways and Local Government Department also purchased mill tailings from 1957 onwards to use in constructing and upgrading road.

While the slightly elevated level of radiation from this material does not present a risk to the public, the practice is not now undertaken. New uranium mines have separate quarries to supply inert road base and other construction materials.

Port Pirie Treatment Plant

a. Non-radioactive wastes are the key environmental risk within the plant area

A number of metals (among them uranium, thorium, lead) and rare earth elements which consistently exceeded the adopted media-specific health based investigation levels have a potential impact on the environment.

These materials are the product of the treatment of uranium ore and the impact of the associated lead smelter adjacent to the former treatment plant.

b. Radioactive wastes are the key environmental risk chiefly contained in the tailing dams.

The key waste products at the Port Pirie Treatment Plant are the tailings that remain from the processing of the uranium concentrate and in part from the processing of rare earths. The location of these tailings on tidal mud flats failed to consider the potential risks to the marine environment. The tailings dam walls appear to be constructed of clay and the base is also of clay to control the seepage of contaminants into the environment. The potential for flooding by a king tide remains and may in the future increase if sea levels rise.

Q3 What was the state of regulation with respect to those activities and how was their regulation managed and enforced?

The following extract from a paper by Bernard O'Neil entitled "National heroes, not national villains: South Australia and the atomic age' provides an insight to the approach that government took to establish and operate the activities at the sites.

> *'Uranium's special status was enshrined in legislation. In November 1945 the state took control of the mining, treatment and use of radioactive minerals and vested ownership of these minerals in the Crown. Uranium or thorium discoveries had to be reported to the Minister of Mines. No person was allowed to possess, use, sell or dispose of radioactive ores without a licence. Minister McEwin justified the decision on the grounds that the growing use of uranium for military purposes and its suitability for peaceful purposes meant that the government should retain control over it for the production of energy.*
>
> *State legislation authorizing uranium mining at Radium Hill followed a High Court decision that a statutory authority and parliamentary funding were necessary. The Uranium Mining Act 1949 empowered the Minister of Mines to open and work mines for the mining and treatment of uranium ore, to store, use, sell or dispose of any uranium by-products and to acquire any property, compulsorily by purchase, and construct any works and buildings for that purpose. But the minister could not sell or dispose of uranium without first consulting the Prime Minister.*

In 1951 amendments to the Uranium Mining Act exempted the opening and working of uranium mines and treatment plants from public scrutiny. A further amendment in 1954 empowered the minister to employ staff for uranium work as required and outside the provisions of the Public Service Act: public servants seconded to uranium projects were also excluded from that Act.'

Site Management during Decommissioning

Q4a At the time activities ceased, how were these sites decommissioned?

No evidence of any planning for the decommissioning of either site prior to closure has been found.

Radium Hill

When mining ceased it would appear that the mine gate was simply closed the next day. Over time various items of equipment were sold and most of the plant at Radium Hill was demolished and/or sold and removed. Only three large concrete ore bins remain along with foundations from the mine.

Waste rock and heavy media rejects were used to backfill the shafts and any openings in the mine and this is still used for that purpose today where there is subsidence. Some of the heavy media tailings, rubble and other waste were used as ballast on the Port Pirie – Broken Hill railway line when it was standardized by the Commonwealth Railways in the mid 1960's. Other uses of this material included its use in the constructing and upgrading of roads.

The buildings from the township of Radium Hill were sold and removed with one exception.

The tailing dams were initially left as constructed. As these tailing dried out they were subject to wind and water erosion resulting in a spread of the tailings over the adjacent land.

Port Pirie

At the Port Pirie Treatment plant uranium extraction ceased in 1962. The associated pilot plant to extract rare earths including scandium and other minerals also ceased. This pilot plant was later sold in 1968. Little seems to have been done with the main plant in this period.

The Rare Earth Corporation (REC) purchased the property and set up a monazite cracking venture to extract rare earths in the 1960's and added a number of additional tailings dams were built and some modifications made to the existing plant which had remained idle since 1962. A total of 1,500 tonnes of monazite was processed.

From approximately 1979 until 1986 the site was used for the recovery of lead from batteries and copper from electric cables by a local contractor.

The site was fenced in 1978 and the remaining equipment removed in the 1990's. From 1988 to 1991 SX Holdings intended to establish a rare earth plant on the site but the project did not eventuate. In 2004 the last structures were demolished and largely removed from the site by DSD as part of a risk reduction program.

Q4b How was the decommissioning of those sites managed? In answering this question, please provide details with respect to each period of operation at the sites.

The initial decommissioning would appear to be fairly adhoc with various items of equipment being sold and removed from the sites. There appears to be little assessment of any radiological risks with such equipment.

From the 1980's there has been an increased monitoring and study of the environmental impacts of the mining and processing activities. These studies and monitoring activities were undertaken by the Mining Regulation branch of DSD (and it predecessors) and the EPA.

At Radium Hill the tailings were effectively covered by DSD to prevent further erosion and dispersal of tailings.

At Port Pirie the site was fenced to prevent un-authorised entry. The tailings were covered with granulated slag from the Port Pirie smelter to prevent erosion and to provide a high level of protection for the public from the spread of contaminants through dusting and from gamma and radon emissions. Some rehabilitation work was also undertaken to re-vegetate parts of the former tailing dams. DSD also undertook additional demolition of the remaining buildings at the Port Pirie treatment works in 2004. Some steel from the demolition remains on the site due to radiological contamination as there is no designated disposal site in South Australia or an approved means of recycling such materials.

Extensive studies have been made in the period from 2004 to 2010 to understand and identify any environmental impacts at the sites to inform the development of an ongoing management plan. No immediate risks to the environment or the public were identified at either site.

Current activities are confined to ongoing monitoring of the sites.

Additional Questions raised by the Royal Commission

Response to Question 4b

The draft report states on page 11 that there has been increased monitoring of the environmental impacts of the mining and processing activities since the 1980's. The Commission would appreciate further explanation of the specific ways in which monitoring has been increased during this period:

1. Has that increase occurred in terms of frequency, sophistication of measuring techniques or the inclusion of additional environmental impacts to consider based on developments in knowledge?

Radium Hill

Monitoring at the Radium Hill mine site commenced in the mid 1960's on a six monthly basis but was confined to checking for any subsidence and undertaking any rectifications required.

Monitoring of the site was increased in the 1980's when the tailing facility was gazette as a low level radioactive repository and consignments of low level radioactive material were moved and buried in the facility. This monitoring was increased to quarterly and became more extensive covering the

integrity of the whole site including subsidence, erosion of the cover on the tailing facility, signage and any other matters considered to required attention.

With the closure of the repository in 1998 monitoring was reduced until the period of more intensive study from 2004 to 2010 when addition monitoring was undertaken to acquire knowledge and understand the risks associated with the site. This included radiation measurements and radon monitoring as part of the radiological assessments and site characterization work carried out by AECOM.

Currently monitoring is undertaken on a more limited basis twice per year covering subsidence, some water level measurements, some radiological measurements, signage and the integrity of the tailings cover.

Port Pirie

In the 1960's and 1970's little if any formal monitoring was undertaken at the Port Pirie Treatment plant site.

Significant monitoring of the Port Pirie site occurred in the 1980's as a result of a king tide event that inundated the tailing's dam that had been constructed by the Rare Earth Corporation. These dams were lower than the dams constructed for the uranium treatment which were not flooded.

Monitoring occurred on a very regular basis in the 1980's during the period when some rehabilitation work was being undertaken and slag was being dumped from the smelter works over sections of the tailings.

A radiation monitoring program commenced in this period by the Health Commission to determine the effectiveness of the slag cover and the optimum depth of cover.

In the 1990's SX Holdings became actively involved at the site and during this period a caretaker was on the site to monitor these activities. Random monitoring for radiation was undertaken through this period to monitor the effectiveness of the slag.

As with Radium Hill a more intense period of monitoring occurred in the period from 2004 to 2010 as part of the radiological assessments and site characterization work carried out by AECOM.

Monitoring continues on a more limited basis since that period to confirm the site security and general state of the site.

In relation to the decommissioning activities that were carried out at both sites:

2. When were those activities undertaken?

Radium Hill

Knowledge of the decommissioning activities is unclear as there are few if any records on this process. The site was decommissioned following closure in 1961 resulting in the sale and removal of the processing equipment, the sale and removal of the houses from the township and the filling in of shafts and voids with waste rock and other materials left over from the mining and processing operation.

In 1981 there was a further clean-up at the Radium Hill site with the tailings storage facility covered with soil to control dispersion of tailings through erosion by both wind and water. The tailings impound was gazette as a low level radioactive waste repository. Low level waste was transferred to this repository until the late 1990's mainly from the AMDEL laboratories.

Since that time ongoing maintenance has been undertaken largely to cover the voids that occasionally occur due to subsidence of material around the openings. Waste rock is used for this purpose.

Port Pirie

At the Port Pirie Treatment Plant treatment work ceased in 1962. The site was sold and then used by third parties to process rare earths in the 1960's, to recover lead from batteries, and it was proposed to establish a rare earths plant by SX holding in the early 1990's which did not eventuate.

The site was fenced in 1978 and what remained of the original plant and equipment was removed in the early 1990's. In 2004 the remaining sheds, water tower and other structures were demolished.

Environmental Implications

Q5 What is the legacy of environmental consequences that now exist by reason of the way these sites were planned, operated and decommissioned? In addressing this question, please address the following issues (in addition to others that might have arisen):

a. Difficulties in managing tailings and other waste

b. Complexities concerning disposal of radioactive waste materials.

c. Risk of radiation dispersal through water, dust or animals.

d. Understanding of the nature of contaminants or pollutants present at the sites.

e. Impact of the sites on local communities

Radium Hill – Existing Wastes

A variety of waste materials were left on site at closure of the Radium Hill operations in 1961 [1]. These included low-level radioactive tailings, piles of low ore grade waste rock, the remains of concrete ore hoppers and the crusher house, concrete building foundations, and other miscellaneous non-radioactive wastes.

Tailings

The main legacy issues with the tailings impoundment at Radium Hill are associated with the lack of a properly engineered long-term containment of the above ground storage facility when originally constructed, and the lack of a suitable protective cover at the time of decommissioning in 1961. By the late 1970s, the tailings impoundment was found to be partly eroded with some tailings dispersed in the immediate vicinity by wind and rainfall run-off.

A site cleanup was undertaken in early 1981, and this included covering the tailings impoundment with soil. (Rock armoring of the walls and cap was not considered a viable option). The soil covering has been largely stable since that time but requires monitoring and occasional remedial work where rainfall run-off from sections of the walls creates gullying.

The tailings impoundment was gazetted as a low level radioactive waste repository in 1981 and used to contain contaminated soil from the cleanup of the AMDEL site in Thebarton and small quantities of pipes and other waste from early work conducted at the proposed Honeymoon uranium mine site. The repository was closed in 1998 and those materials remain buried in the capped tailings dam.

Waste Rock

At closure, small piles of waste rock were left stockpiled around the old workings at Radium Hill. The waste rock was consolidated into several larger stockpiles during the clean-up of the early 1980s.

Miscellaneous mine wastes

Soil contamination by heavy metals in some locations was identified during the detailed surveys conducted for DSD to 2009. The heavy metals exceed ecological screening levels but represent a low risk to people under current or foreseeable site usage.

The use of waste rock and heavy media rejects for the purpose of road making materials has left areas with slightly elevated gamma radiation background levels. It is believed that waste rock originating from the mine was also used as ballast along sections of the Broken Hill railway line. Neither use of the waste rock represents a risk as the observed gamma dose rates are very low and the probability of extended exposure is negligible.

Management of existing wastes

At Radium Hill, the complexities in managing the remaining wastes primarily revolve around ensuring the continued structural integrity of the tailings/waste repository impoundment. DSD conducts an ongoing inspection and maintenance program at the site to ensure for example, no erosion of the existing containment or dispersion of surface waste rock stockpiles.

The existing stockpiles pose no immediate risk in terms of safety but do have elevated radiation levels. There are no difficulties in managing the waste rock. They are used to backfill the mine openings should subsidence occur. It should be noted that the ore body itself reaches the surface in the vicinity of the former mine. For this reason, further risk reduction by extensive surface clean-up of existing waste rock stockpiles and contaminated soils may be counterproductive, as areas of the near surface ore-body could be exposed.

Port Pirie Uranium Treatment Plant Wastes

Subsequent to the cessation of mining operations in 1961 and decommissioning of the uranium processing plant in 1962, the Rare Earth Corporation occupied the site from 1969 – 1972. There have been other minor uses of the site since then [2].

Environmental and radiological surveys conducted across the former Port Pirie Uranium Treatment Plant over the past 30 years, have identified the main environmental hazards currently remaining at the site. These include uranium and thorium process tailings, scrap steel, contaminated concrete building footings and some localized areas of contaminated soils.

Tailings

The 6 uranium tailings dams had a total area of 22 ha and were located on a section of tidal mudflats to the west of the plant. The dams were constructed in a reasonably 'contained' manner utilising a largely impervious layer of clay below the dams and clay cored dam walls. Dams 1, 5 and 6 were used as process liquor evaporation ponds and dams 2-4 and part of dam 5 contained uranium tailings. The dams, containing around 200,000t of material, were left uncovered at the decommissioning stage.

The Rare Earth Corporation constructed 4 additional small tailings dams (1.2ha) to the north of the plant, which were eventually consolidated into a single dam. It is noteworthy that a king tide and severe weather conditions in 1981 caused an overtopping of the northern wall of the REC dams, requiring immediate repairs.

These dams were unfenced until 1978, and remained uncovered until the early 1980s when smelter slag from the adjacent lead smelter began to be used as a cover to reduce potential dusting and radon release from the surface.

Residual Infrastructure

The absence of decommissioning plans resulted in an ad-hoc demolition process to remove the infrastructure from the site over time as circumstances required. A major clean-up of the plant area occurred in 1989-90 in anticipation of the commencement of processing activities by the SX Corporation. Contaminated soils and some light building materials were placed into tailings dams 5 & 6, and covered.

Following a later survey by DSD and the EPA, most of the remaining structures were demolished. Uncontaminated wastes were removed from the site with some materials remaining on the basis of elevated radioactive readings. These include surface contaminated steel, and concrete drains and building footings.

Miscellaneous wastes

Over the years, the site had been used as a battery breaking business and Dam 1 was also used as a disposal site for asbestos. Battery casings were placed into the dams and

eventually covered with smelter slag. Assorted drums of residues were removed from the remains of the former laboratories, placed in Dam 5 and covered.

Dams 1, 5 and 6 remain partly uncovered. With the exception of a part of dam 5, these dams did not contain uranium process tailings. They were used for the disposal and evaporation of process liquids, and so may represent both a chemical and radiological exposure hazard.

Contaminated soils remain in the plant area. Detailed site investigations conducted for DSD have identified residual chromium and lead in soils in some areas, and some isolated and discrete areas of hydrocarbon contamination.

Management of Existing Wastes

The permanent disposal of any acidic uranium tailings requires careful examination of exposure pathways to ensure high levels of containment over extremely long time periods.

At Port Pirie, the smelter slag cover currently in place over the tailings and a portion of the plant area provides a high level of protection for the public from the spread of contaminants through dusting and from gamma and radon emissions and other contaminants.

DSD assessments to date indicate the primary environmental risks are associated with the potential mobilization of radioactive contaminants in the dams through structural failure or erosion of the dam walls, or through overtopping of the dams themselves due to storm surges or sea level rise in the longer term.

A plan is currently being developed by DSD to monitor and manage the radiological and non-radiological risks at this site.

A significant complexity at the Port Pirie site is the lack of a suitable disposal method or disposal facility in South Australia for the lightly contaminated steel and other materials remaining on the site. The surface contamination levels on these materials exceed radiation 'site release' limits (based on the national Code for the Safe Transport of Radioactive Material.

Until there is an approved removal/disposal pathway, these low level contaminated materials must remain on the site.

Environmental Consequences – Radium Hill & Port Pirie

DSD has conducted extensive air, soil and groundwater testing in and around the Radium Hill site and the Port Pirie plant over the 2004 – 2010 period. The nature and extent of the radiological and non-radiological contaminants is now well understood. All of this work (see references) has been documented and provided to the EPA under the conditions of the RPC Act licenses applying to the sites.

The studies undertaken by DSD indicate that the risk of radiation dispersal through water, dust or animals does exist for both sites, but these studies have also shown that it is not a significant or substantial risk while the sites remain in their current state. These issues are discussed below.

Radium Hill

The primary environmental hazard associated with the existing Radium Hill site is the potential for mobilisation of the wastes contained within the tailings impoundment due to structural failure, erosion/scouring, or seepage from within the tailings/waste dam [12].

Ongoing surveillance of the site and routine maintenance is required to ensure the continued structural integrity of the soil cap on the tailings impoundment/waste repository.

The waste rock stockpiles and dispersal of a quantity of tailings post-operations resulted in slightly elevated gamma dose rates and radon concentrations in the vicinity of the mine and tailings impoundment. There are elevated dose rates across the tailings impoundment itself. Subsequent surveys and assessment indicate the current state of the mine site does not represent a risk to the casual visitor, or to the environment.

No risk has been identified in relation to the use of waste rock on roads and railway lines, but it is a practice that is not now undertaken. The slightly elevated levels of radiation do not present a risk to the small number of visitors to the site each year.

There was a minor hazard identified associated with residual chemicals (chromium, cobalt and lead) found in very localized areas on the site, but assessments indicate these again, represent a low risk to people at current occupancy rates, and to the environment.

Risk assessments have been conducted by DSD based on a number of exposure scenarios, some of which assume an increase in human activities on the site in its current state. The risk assessments are based on possible future site usage (grazing/pastoral, short term visitors, temporary dwellers, industrial uses). The assessments concluded that the estimated exposures would be below current limit (1mSv/y), other than for potential future temporary dwellers or industrial workers, in which case the limit may be exceeded.

There does not appear to be any ongoing impact on the use of the land at Radium Hill, which is currently used for pastoral activities. These activities continue across the area, unaffected by the existence of the former mine.

Port Pirie

At Port Pirie, the capping of the tailings dams and some areas of the plant with inert smelter slag has minimized any possible spread of contaminants through dusting, and reduced gamma dose rates and radon emissions. The porous slag cover does not prevent seepage of rainwater to the tailings underneath. Some of this water is drained to the evaporation ponds at either end of the tailings dams, with the possibility of some water being available for seepage through the base of the dams.

The evidence for contamination of groundwater due to the presence of the tailings dams is mixed. There is some groundwater monitoring data indicating a gradual increase in the concentrations of heavy metals (cobalt and manganese) in the aquifer immediately below the tailings dams although, there is also evidence that the drainage channel to the north of the dams may be a source of heavy metals.

Overall, the available groundwater monitoring data to 2010, cannot exclude the possibility of site related contamination occurring. However this assessment must be viewed against a background also influenced by the nearby smelter. Evidence suggests that there is little migration of dissolved metals or other contamination into the lower aquifers.

The health of the aquatic system is generally good but subject to stress attributable to nutrient loading, temperature variation and potential localised metal impacts. The risk to terrestrial biota, birds and mammals is generally marginal.

The presence of chromium and lead contamination in some areas of the Port Pirie plant is attributed to both the operations of the uranium processing plant, and to a lesser extent, regional sources. As a result, the site would require further remediation before it could be used for uncontrolled purposes.

The Port Pirie plant is in the shadow of the lead smelter and in an area that has been cleared of housing to protect people from lead contamination. Risk assessments have been conducted by DSD based on a number of human exposure scenarios, some of which assume unauthorised human intrusion onto the site in its current state. There are moderate risks for adults and children in the unlikely event they access the tailings dams and plant areas for recreational purposes.

The former treatment plant and tailings dams are now securely fenced to prevent unauthorized access.

There is no indication of contaminants moving off site and the available evidence indicates that the plant and the partially covered tailings dams have no impact on the activities of the local community at this time.

Additional Questions raised by the Royal Commission

Response to Question 5

In relation to the management of existing wastes at Radium Hill, the draft report states on page 13 [*page 15 in this final submission*] that DSD conducts an ongoing inspection and maintenance program with respect to the tailings storage facility. The Commission would appreciate some further explanation of that program:

3. What aspects of the tailing storage facility are examined and how are they examined?

The principle monitoring activity is to check the condition of the soil cover over the tailings storage facility. A series of stakes are embedded in the side of the facility as reference points and these are measured to assess any additional erosion. The top of the facility is visually examined to assess if any erosion has occurred. The results indicate that the cover is secure and stable and little erosion has occurred. The vegetation on the top of the facility mimics the surrounding land forms.

Other activities which are included in the periodic monitoring activities are:

- *Ground wells are dipped*
- *Mine workings, including shafts are checked for subsidence at the surface.*
- *Safety Signs are checked.*

In the period from 2004 until 2010 additional inspections and monitoring was undertaken as part of the series of studies to fully characterize the site and to assess the environmental risks of the site. This monitoring included dust, groundwater and radioactive monitoring. Since that time ongoing inspections are carried out twice per year.

In summary the monitoring largely involves visually checking the site to ensure there are not additional safety concerns due to subsidence and that the integrity of the tailing facility is maintained. The program for monitoring will be reviewed as part of the development of a Radiation Management Plan.

4. What are the radiation levels recorded and the estimated dose that would be received by visitors and the extent to which that dose represents a risk to human health when compared to other common sources?

Radium Hill

*The AECOM report (Document No.:M4074230_RPT02_RH_rev02_31Aug09) entitled **Human Health Radiological Risk Assessment Radium Hill Former Uranium Mine**, provides an assessment of the radiological risks for various scenarios at Radium Hill.*

The table T12 provides a summary of the Gamma exposure doses for each of the scenarios. The doses are measured in µGy/hr. The Gray (Gy) is a unit used to measure a quantity called absorbed dose and it relates to the amount of energy absorbed. One Gray is equal to one joule of energy deposited in one kg of a material.

From table T12 the measured Radium Hill exposure are summarised as follows:

Site Average:	*0.67µGy/hr*
High Activity area:	*0.81 µGy/hr*
Hot Spot (Elevated Radiation):	*6.00 µGy/hr*
Background:	*0.67 µGy/hr*

Using this data, the report develops several scenarios, compares the potential exposure levels that a person may encounter at Radium Hill and then calculates the equivalent dose for a human being. This is measured in Sievert (Sv) and it is calculated by multiplying the absorbed dose (Gy) by a quality factor (Q) that is unique to the type of incident radiation to determine the equivalent dosage rate. Finally the calculated equivalent exposure doses are compared to the levels with the adopted internationally accepted member of the public dose rate of 1 mSv/yr. (It also compares the value for the occupational exposure limit for workers of 20mSv/yr).

The visitor scenario for a site visitor is on the basis of spending 8 days per year (24 hours per day) on the site. The exposure would be between 0.13mSv/yr (assuming the site average) to 1.24mSv/yr (assuming the total time was spent where there is elevated radiation). The dose rates with radon taken into account would increase this total exposure slightly but given it is an open area it is uncertain as to how much of an increase could be attributed to radon, but it is not significant. (Table T13 of Report).

Port Pirie

The AECOM report (Document No.:M4074230_RPT06Rev01_PPRad_31Aug09) entitled ***Human Health Radiological Risk Assessment Port Pirie Rare Earth Treatment Plant,*** *provides an assessment of the radiological risks for various scenarios at the Port Pirie Treatment plant site.*

In respect of the radiation levels recorded from table T4 of the above report the measured Gamma Exposure at Port Pirie can be summarised below:

Site Average:	*0.64µGy/hr*
Hot Spot (Elevated Radiation):	*5.11 µGy/hr to 27.1 µGy/hr*
Background:	*0.12 µGy/hr*

Assessing the equivalent dose rate for a human being using a RESRAD analysis table T2 of this report outlines the exposure levels on the basis of the scenarios contained in table T3. The occasional visitor/trespasser is assumed in the scenario to spend 52 days per year and 8 hours per day. Assuming the time is spent across the whole site then average exposure is approximately 0.32mSv/yr, but could be up to 12 mSv/yr if all the time was spent on a an area of elevated radiation which is considered unlikely.

Actual exposures to members of the public are being managed by controlling access to the site with security fencing and warning signs.

Comparison with natural and common artificial *sources*

The Australian Radiation Protection and Nuclear Safety Agency has published figures on the relative annual per capita dose rate to the Australian Population is exposed to from the various natural and artificial *radiation sources.*

*(*http://www.arpansa.gov.au/radiationprotection/Basics/understand.cfm)

The total dose rate from these natural and artificial *sources is estimated at 3.2mSv/year. The limit of 1mSv/year of radiation from these sources is additional radiation dosage but it is against a background of just over 3 mSv/year of natural radiation.*

Q6a Are any of those legacies uncertain by reason of a lack of information?

Q6b How are those issues being addressed?

While the available historical records from the operations at both Radium Hill and Port Pirie lack reference to environmental issues, the extensive studies that have been commissioned by DSD in recent years have largely addressed those information gaps.

Key data uncertainties that still remain are acknowledged in the scoping assessment for future controls that might be placed on these sites. In addition, the human and ecological risk analyses conducted to date acknowledge an element of uncertainty in projecting exposure scenarios into the future.

However, the benefit of the recent studies is that the main issues have been identified and uncertainties itemized and provide a basis for ongoing monitoring, and where necessary, appropriate remedial actions.

Management plans are now being prepared with a view to managing residual risks, consistent with the RPC Act licence conditions applying to both sites.

It is noted that Australia is a signatory to the Joint Convention on The Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. Article 12 of the Convention requires each Contracting Party to take the appropriate steps to review:

(i) the safety of any radioactive waste management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary, all reasonably practicable improvements are made to upgrade the safety of such a facility;

(ii) the results of past practices in order to determine whether any intervention is needed for reasons of radiation protection bearing in mind that the reduction in detriment resulting from the reduction in dose should be sufficient to justify the harm and the costs, including the social costs, of the intervention.

The requirements of the Convention inform the setting of RPC Act licence conditions applying to both Radium Hill and Port Pirie sites.

Lessons for contemporary Management and Regulation

Q7 Given the nature of the operations at these sites, to what extent can lessons be learned from the way these facilities were planned, operated, regulated and decommissioned?

It is important to understand that the regulation of all mining, including uranium mining, has evolved significantly over the past 50 years. Although acceptable at the time, the planning, operation and decommissioning of the Radium Hill and Port Pirie sites would not be acceptable in today's regulatory environment.

Some of the specific aspects in relation to the planning and operation of the Radium Hill mine and Port Pirie Treatment Plant that are different today are:

- *A proposal to locate a uranium processing plant and tailings dam adjacent to a large population centre and on tidal mud flats would be subject to a rigorous environmental impact assessment which would likely find that the proposed location was not appropriate.*
- *Tailings would be stored in a properly engineered containment structure and capped with an engineered cover upon completion of the mining operations.*
- *Prior to commencement of operations, a comprehensive mining and rehabilitation plan with outcomes and measurement criteria would need to be submitted and approved by the Regulator.*

In the discussion of regulatory frameworks below (see response to Question 10), the current requirements are shown in comparison with previous frameworks and international requirements.

One unanswered issue that has arisen from the work conducted at both sites is the need for a disposal pathway for radiologically contaminated steel and other materials. The practice at current mining operations is to bury such materials on the mine site in engineered repositories. In the case of Port Pirie, this is not a practical solution as it may limit any future usage of the site. It would be preferred to have a designated disposal site elsewhere in South Australia, or an approved means of recycling such materials (e.g. through a smelter).

Q8a Have these lessons already been embodied in contemporary environmental management and regulation?

The lessons learned from the Radium Hill mining and Port Pirie treatment plant are part of a an extensive regulatory framework that has been developed both here and overseas in response to the experiences in many countries.

The nature of mining operations has changed in relation to environmental management generally, and specifically in terms of any mine dealing with radioactive materials. The framework has evolved from international and national standards and continues to evolve to meet new and differing circumstances.

In the particular case of mining and processing radioactive minerals, the International Commission on Radiological Protection (ICRP) and the International Atomic Energy Agency (IAEA) provide standards codes and guidelines that inform those applying in Australia.

The next section of this document outlines the regulatory framework that currently exists for uranium mining in South Australia and compares this with the regulatory framework in the 1950's, and the framework in the significant uranium mining jurisdiction of Saskatchewan in Canada. Some of the key regulatory requirements now in place include:

- *Rehabilitation bonds are required for mining operations to ensure that sufficient money is available to Government to rehabilitate mines not rehabilitated by the mine owner.*
- *Programs for Environment Protection and Rehabilitation (PEPR) that set the standard for environmental management and mining rehabilitation need to be lodged and approved by DSD prior to any mining on a tenement. The PEPR has a very strong emphasis on the environmental outcomes that must be achieved and the criteria that is to be used to demonstrate that these outcomes have been achieved. Where radioactive minerals are mined and processed, a Radioactive Waste Management Plan is incorporated within the PEPR process.*
- *The PEPR includes closure outcomes and criteria for measuring those outcomes.*
- *The uranium mines file quarterly reports and regular meetings are held between government regulators and mine operators to review compliance status and discuss the operation.*
- *Uranium mines are required to report environmental and radiological incidents to DSD and EPA regulators.*

Q8b If so, to what extent?

As detailed above and contained in the next section on the Regulatory Framework

Q9 To what extent is information about these case studies available to be learned from by those who are currently planning or are engaged in environmental management?

The lessons from the Radium Hill mine and Port Pirie Treatment Works are part of a much broader learning experience from around the world which is now incorporated into the regulatory framework as outlined in the next section of this document titled, "A comparison of the regulatory frameworks for uranium mines."

Additional Question raised by the Royal Commission

Response to Question 9

The draft reports states on page 21 [*page 26 in this final submission*] that the lessons from the Radium Hill and Port Pirie sites are part of a broader learning experience from around the world and have been incorporated into the regulatory framework. However, the question seeks a response which relates to the public dissemination of information relating to those specific case studies.

5. Given what is now known about the environmental impacts at the Radium Hill and Port Pirie sites as a result of ongoing monitoring and reporting, how much of that knowledge is available to those who might be interested in establishing and operating mines or milling facilities? Could additional information be made available that would be beneficial in that regard?

The lessons learned from both Radium Hill and the Port Pirie Treatment Plant are part of the broader learning experience and knowledge that has been gained over many years in the operation and environmental management of all types of mines. This knowledge has been and continues to be incorporated into the South Australian, Australian and International regulatory frameworks and environmental standards and is available to mining proponents through websites administered by national and international jurisdictions.

DSD's web site www.minerals.statedevelopment.sa.gov.au/knowledge_centre contains many of these publications by way of Information sheets, Ministerial Determination and Regulatory Guidelines. DSD also provides advice directly to proponents on a project by project basis.

Ministerial Determination and Regulatory Guidelines set out specific guidance to the regulatory requirements for environmental assessment, operation, monitoring and compliance reporting for all classes of mining operations.

Examples of Ministerial Determinations that set out the requirements for establishing the environmental requirements for assessing and operating metalliferous and industrial mining operations include:

> ***MD005** Minimum information required to be provided in a program for environment protection and rehabilitation (PEPR) for a mineral lease.*

MD006 *Minimum information required to be provided in a mining proposal or management plan for a mineral lease (ML). Similar determinations have also be developed and used by industry for insitu recovery uranium mines to address specific risks associated with this class of operation including incorporating the requirements for radioactive waste management plans.*

The following Ministerial Determination is in preparation:
Minimum information required to be provided in a program for environment protection and rehabilitation (PEPR) for a mineral lease (ML) or retention lease (RL) and any associated miscellaneous purpose licence (MPL) for uranium to be mined using the insitu recovery (ISR) method.

While excluding uranium mining these Determinations are still the basis of most of the aspects of any mine including a mine producing radioactive materials.

The following Regulatory Guidelines have been published to assist the industry comply with legislative requirements and to provide advice on relevant environmental standards miners:

MG1 *Guidelines for miners: mining approval processes in South Australia*

MG2 *Preparation of a Mining Proposal or Mining Rehabilitation Program (MARP) (This is currently in revision)*

MG5 *Guidelines for miners: tailings and tailing storage facilities in South Australia*

Additionally under the Radiation Protection and Control Act (administered by the EPA), uranium mining operations must comply with the Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing (2005) (PDF 607k)

The Australian Government also required that new ISR Uranium mines have regard for the following:

Australia's in situ recovery uranium mining best practice guide

The development and review guidance and advisory information for industry is an ongoing responsibility of DSD. DSD's engagement with international uranium mining jurisdictions such as Saskatchewan and the US Nuclear Regulatory Commission has created important opportunities for sharing information to ensure that the South Australian uranium mining industry is informed about best practice environmental management and standards that have been developed as a result of the experience of uranium mining in these jurisdictions.

If a mining project is assessed as a major project under the Development Act an Environmental Impact Statement (EIS) is required to be submitted, consulted on, amended as appropriate and finally approved prior to any mining. This covers all environmental and radiological matters. An example of such a major project is the Olympic Dam expansion proposal in 2011 and the EIS can be read on the web site (www.bhpbulliton.com/society/regulatory).

Issues raised by Submissions to the Commission

Q10 Bearing in mind the issues raised by the answer to Question 5 above, how do the requirements for ongoing monitoring and remediation at the Radium Hill and Port Pirie sites differ from that which would be required at contemporary sites which will be decommissioned in the future?

One of the key lessons is that when a mine is decommissioned it should be left in a state that does not required significant ongoing monitoring, assessment or evaluation. This is the objective of the current regulatory regime and is part of the PEPR which must be approved prior to mining commencing.

The PEPR sets out the closure objectives and the criteria to assess whether the outcomes have been met. Bonds are in place to ensure that money is available in the event of a rehabilitation failure (eg company fails or the rehabilitation effort fails, etc.).

Examples of current requirements include:

- *For example some of the requirements now in place are that waste is buried below grade under the appropriate level of topsoil (typically 2 to 5 metres) rather than have an above ground waste facility. Such a site can be left with little danger of erosion.*
- *Another step is to ensure that a tailings dam has a rock or engineered side wall and a clay or membrane lining. When completed the tailings is covered with an engineered cover and shaped to achieve the desired outcome appropriate for the particular tailings material and environment. (Some need to remain saturated some dry). Such a structure can be securely left without the risk of erosion or ongoing environmental damage.*
- *Where a particular mine site requires construction materials for road making these would now be sourced from a separate site rather than use waste rock from the mine which may be contaminated.*
- *Where there are potential chemical reaction issues that may occur with tailings and/or waste rock such as acid and metalliferous drainage, geochemical studies are undertaken and the waste storage facilities are designed to manage geochemical hazards.*

The objective is to leave the site in a safe and stable form that does not have an ongoing impact on the environment and this is achieved by a solid regulatory framework and prior planning by mining companies backed up with the use of bonds to ensure the state does not have an ongoing liability.

A comparison of the regulatory frameworks for uranium mining

DSD has compiled a comparison table of the regulatory framework for uranium mines, with comparison between:

- South Australia Radium Hill and Port Pirie 1954-1962
- South Australia Current, and
- Saskatchewan, Canada (today being an internationally recognized uranium mining jurisdiction).

Since the 1950's regulatory practices and the understanding of environmental and radiological protection has significantly changed, particularly in developed countries. Following improved understandings since the commencement of post World War 2 uranium mining and processing practices, there has been a concerted international effort to ensure repeats of shortcoming from the many international examples, including Radium Hill and Port Pirie, are learnt from. This is where international organizations such as the ICRP and the IAEA have been chartered in developing international radiological standard for occupational and environmental radiological protection throughout the mine life cycle.

Today regulatory regimes in South Australia, Saskatchewan and many other jurisdictions are focused on protecting the environment and managing radiological exposures, whilst maximizing the return from the exploited resources. The 1950s South Australian regulatory regime focused on the economic and strategic opportunities uranium provided, with no environmental consideration and limited radiological considerations. This is not to say that operations weren't managed in a manner consistent with good practice of the days (i.e. tailings were contained in dams, encapsulated processing facilities were constructed). There is no evidence that uranium mining and processing of this period was any different to any other type of mining and processing standards of the day.

Assessment of mining projects have significantly changed since the 1950's where impact assessments did not occur and mine closure planning was minimal. Today's South Australian and Saskatchewan requirements focus on a complete impact assessment regime which includes environmental and radiological considerations through the entire mine life cycle. In addition there are numerous State/Province and Commonwealth/Federal legislative controls that apply which link to international, national and state/province standards. This includes clear expectations and requirements for closure, to ensure appropriate environmental and radiological protection is achieved and liabilities to the state/province are minimised. This is complemented by the requirement to have a rehabilitation bond system in case a site is abandoned.

Compliance and enforcement provisions, transparency and stakeholder engagement have significantly changed over the years. Statutory compliance and enforcement provisions, transparency or stakeholder engagement did not apply to the Radium Hill and Port Pirie sites as they do today, where numerous legislative provisions are available. Regular compliance reporting, inspections, incident report and engagement with regulators is considered standard practice when operating a uranium mine in South Australia or elsewhere in the developed

world. Transparency and stakeholder engagement are critical throughout the mine life cycle ensuring a trusted relationship is developed by the mine operator to gain a 'social licence to operate'.

Management of former mines remains an area of continual review for many jurisdictions around the world. Saskatchewan implemented a post surrender management initiative called the Institutional Control Program. South Australia is investigating mining lease release arrangements in other jurisdictions (including Saskatchewan), with a view to forming a clear, forward-looking policy for managing closure risks, responsibilities and funding of enduring maintenance requirements.

A Comparison of the Regulatory Frameworks for Uranium Mines

Regulatory Framework Component	Time and comparisons of regulatory provisions
Regulatory Approach	**South Australia Radium Hill and Port Pirie 1954-1962**: • Radium Hill and Port Pirie were South Australian government managed operations. The history and management of these operations is discussed elsewhere in this submission.
	South Australia Current: • Outcome based regulatory approach. That is aligned with the Council of Australian Governments Best Practice Regulation, A guideline for Ministerial Councils and National Standard Setting Bodies, October 2007 https://www.coag.gov.au/sites/default/files/coag_documents/COAG_best_practice_guide_2007.pdf • Department of State Development Mineral Resources (DSD) thought the *Mining Act 1971* is the lead mining regulator in South Australia (Note, DSD no longer conducts mining activities on behalf of the State of South Australian and is now solely the regulator). • DSD's framework for best practice regulation as discussed in https://sarigbasis.pir.sa.gov.au/WebtopEw/ws/samref/sarig1/image/DDD/BROCH005.pdf • Radiation Protection Guidance used in Australia are developed by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), based on guidance developed by the International Atomic Energy Agency (IAEA). • Uranium In-Situ best practice guideline developed by the Commonwealth promotes current best practice standards, including environmental protection. South Australia provided significant contributions towards this guideline document (http://www.ga.gov.au/corporate_data/70503/70503.pdf).

	International Uranium Mining Jurisdiction Saskatchewan, Canada: • 'Results based' regulatory approach. The application of this approach is similar to SA's outcome based regulatory approach. • Saskatchewan is an internationally recognised uranium mining jurisdiction and can be considered as an appropriate comparable jurisdiction to South Australia. • Saskatchewan Ministry of Environment is the lead regulator of mining in the Saskatchewan Province in conjunction with the Federal Canadian Nuclear Safety Commission.
Assessments of new uranium mining proposals (including provisions for radioactive waste management and mine closure)	**South Australia Radium Hill and Port Pirie 1954-1962**: • The South Australian *Uranium Mining Act 1949* (ceased), permitted uranium mining and processing in South Australia. • The Legislation allowed the acquisition of property, construction, mining, processing and use and sale of uranium product by the South Australian Minister of Mines. There was no environmental legislation that applied.
	South Australia Current: • Full environmental impact assessment at State and Commonwealth levels, through a Mining Lease Proposal (MLP), Environmental Impact Statement (EIS) or Public Environment Report (PER) (https://sarigbasis.pir.sa.gov.au/WebtopEw/ws/samref/sarig1/image/DDD/MRGMG1.pdf). Note, assessment bilateral between DSD and the Commonwealth has been implemented. DSD and the Environment Protection Authority (EPA) co-regulate radioactive waste at SA uranium mines. • DSD's impact assessments process adopts the Source, Pathway, Receptor model. • EPA leads on assessing occupational and environmental radiation impacts and Safework SA lead on all other worker safety matters. • Relevant legislation that applies to uranium mines in South Australia include: **South Australian**

(http://www.legislation.sa.gov.au/index.aspx)

- *Mining Act 1971*
- *Mining Regulations 2011*
- *Roxby Downs (Indenture Ratification) Act 1982*
- *Radiation Protection and Control Act 1982 (incorporating relevant ARPANSA codes)*
- *Radiation Protection and Control (Ionising Radiation) Regulations 2015*
- *Radiation Protection and Control (Transport of Radioactive Substances) Regulations 2003*
- *Work Health and Safety Act 2012*
- *Environment Protection Act 1993*

Australian Commonwealth Government
(https://www.comlaw.gov.au/)

- *Environment Protection and Biodiversity Conservation Act 1999*
- *Nuclear Non–Proliferation (Safeguards) Act 1987*
- *Australian Radiation Protection and Nuclear Safety Act 1998*
- Relevant Codes:
  - *Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing (2005)*
  - *Code of Practice for the Safe Transport of Radioactive Material (2014)*
  - *Radiation Protection Series 1 - Recommendations for Limiting Exposure to Ionising Radiation (1995)*
  - *National Standard for Limiting Occupational Exposure to Ionizing Radiation (republished 2002)*
  - *Code of practice for the near-surface disposal of radioactive waste in Australia (1992).* (http://www.arpansa.gov.au/publications/codes/index.cfm)

- DSD engages with stakeholders during the formal consultation process when an application is received. Uranium project proponents are expected to demonstrate that appropriate consultation with relevant stakeholders has occurred before an application is submitted to government. This is a critical step in the uranium industry establishing a 'social license to operate'.
- A proponent is expected to meet state, national and international standards for environmental and radiation protection (i.e. IAEA guidance documents, ARPANSA codes, ANZECC water quality guidelines, SA

	tailings guideline). • Numerous other State and Commonwealth approvals are required to complement uranium mining including Water Permits, Export Permits, License to Possess and Transport Plan endorsements. • Operational Plans including a Program for Environment Protection (PEPR)/Radioactive Waste Management Plan (RWMP), Environmental Protection & Management Program (EPMP) and Radiation Management Plan (RMP) are required prior to construction of an operation. These documents detail the specific environmental and radiological protection measures and monitoring programs that will be undertaken. PEPR/RWMP (Uranium In-Situ Recovery mines) and EPMP (Olympic Dam) documents are publically available through the DSD Minerals website (http://minerals.statedevelopment.sa.gov.au/mining/mines_and_quarries). • Focus on Management Systems, with Management System reviews required prior to construction, prior to commissioning and prior to operations to ensure the uranium miner has appropriate management systems and capabilities. This framework was recently utilized for the Four Mile uranium project, which successfully commenced operations in 2014. • Expectations for ongoing closure planning are expected to occur throughout the operational phase, with clear closure strategies defined for environmental and radiological aspects prior to entering the closure phase. This is a critical element of the mine life cycle and a key focus to ensuring liabilities to the State are minimised.
	International Uranium Mining Jurisdiction Saskatchewan, Canada: • Full impact assessment at Province and Federal levels, through an Environmental Impact Assessment. (http://environment.gov.sk.ca/Default.aspx?DN=219ece25-997c-42d2-90d3-ff97a2ccbf4e and http://nuclearsafety.gc.ca/eng/uranium/mines-and-mills/index.cfm#RegulatingUraniumMinesandMills) • Sufficient evidence of baseline environmental and radiological data to be provided as part of the Environmental Impact Assessment. • Use of national and international standards for environmental and radiation protection. • Operational Plans require Environmental Monitoring Programs to ensure environmental and radiological requirements are monitored and to confirm that Environmental Impact Assessment predictions are being met.

	• Expectations for ongoing studies associated with closure planning, with decommissioning plans updated every 5 years.
Compliance and Enforcement (including provisions for radioactive waste management and ensuring appropriate mine closure)	**South Australia Radium Hill and Port Pirie 1954-1962**: • Operations at Radium Hill and Port Pirie were carried out by the South Australian Government, and no statutory compliance and enforcement provisions for environmental and radiological aspects were adopted.
	South Australia Current: • DSD promotes being a fair but firm regulator in accordance with DSD legislative powers and Compliance & Enforcement policy. DSD has numerous tools under respective legislation to ensure legislative contraventions are addressed through either preventative, persuasive, compulsive and punitive legislative tools. • Quarterly inspections, to ensure environmental and radiological outcomes and other legislative requirements are being met. DSD and EPA jointly conduct inspection of uranium mines. • Quarterly environmental and radiological reporting for In-Situ Recovery Uranium mines. • 6 Monthly Environmental Consultative Committee Meetings between the uranium miner, State and Commonwealth regulators. • Publically available Annual Compliance Reports demonstrating performance against meeting environmental and radiological outcomes (http://minerals.statedevelopment.sa.gov.au/mining/mines_and_quarries). • Specific incident reporting protocol for uranium mines in South Australia. Which includes reportable incidents being made public http://minerals.statedevelopment.sa.gov.au/mining/applications_and_reporting/standard_criteria_and_procedures_for_reporting_uranium_incidents. South Australia is currently developing new uranium incident reporting criteria for consideration at a national level.

	International Uranium Mining Jurisdiction Saskatchewan, Canada: • Ministry of Environment and Federal Canadian Nuclear Safety Commission have a robust regulatory regime, with numerous legislative tools to ensure compliance with Province and Federal legislation. • 2 to 6 inspections per year per operation (depending on the risk profile of the operation) are conducted to ensure environmental and radiological standards are being met. • Where relevant Ministry of Environment and Federal Canadian Nuclear Safety Commission conduct joint inspections. • Uranium miners to provide quarterly Environmental Performance Reports to the Ministry of Environment and Federal Canadian Nuclear Safety Commission that demonstrate performance on meeting environmental and radiological approval limits or predicted impacts as defined in the Environmental Impact Assessment. • All uranium spills must be reported to the Saskatchewan Ministry of Environment http://www.saskspills.ca/about.asp
Rehabilitation Bonds	**South Australia Radium Hill and Port Pirie 1954-1962**: • As the operations were the responsibility of the South Australian Government there was no requirement for bonds.
	South Australia Current: • Rehabilitation bonds covering the estimated cost of rehabilitation prior to the commencement of mining operations. • Rehabilitation bonds for uranium mines are reviewed on an annual basis for operations regulated under the *Mining Act 1971.* Note, the Olympic Dam mine regulated under the *Roxby Downs (Indenture Ratification) Act 1982,* specifies rehabilitation liability obligation commitments the operator must meet. The South Australian government does not hold the bond for this operation. Provisions for a rehabilitation bond were introduced into the new

	Roxby Downs (Indenture Ratification)(Amendment of Indenture) Amendment Act 2011, which will come into effect once BHPB commences substantial operations relating to the expansion project.
	International Uranium Mining Jurisdiction Saskatchewan, Canada: • Requirements for rehabilitation bonds to be provided prior to the commencement of construction for the full cost of rehabilitation. • Rehabilitation bonds are reviewed every 5 years, with companies undertaking internal reviews annually.
Management of Former Uranium Mines	**South Australia Radium Hill and Port Pirie 1954-1962**: • The South Australian Government owned and operated the Radium Hill and Port Pirie sites and is therefore responsible for the ongoing management of the sites.
	South Australia Current: • There are no statutory arrangements for providing Government with a specific and ongoing funding stream for addressing liabilities associated with former mines or residual liabilities that could be realised subsequent to the surrender of current metal and uranium mines in South Australia. DSD is investigating mining lease release arrangements in other jurisdictions (including Saskatchewan), with a view to forming a clear, forward-looking policy for managing closure risks, responsibilities and funding of enduring maintenance requirements. Note that South Australia's Extractive Areas Rehabilitation Fund can address potential residual liabilities associated with quarries that have produced construction materials. This funding arrangement cannot be used to fund rehabilitation of former metal and uranium mines.
	International Uranium Mining Jurisdiction Saskatchewan, Canada: • In 2007 Saskatchewan implemented a post surrender management initiative called the Institutional Control Program. Subject to rehabilitation of a former mine meeting all environmental and radiological

	requirements, the mining tenement holder can apply to transfer responsibility for long term management and monitoring to the Provincial government. This responsibility transfer is accompanied by funding for ongoing maintenance, monitoring and any remediation resulting from unplanned failure events for at least 75 years. Further details see - http://www.economy.gov.sk.ca/Institutional_Control-Decommissioned_Mines/Mills
Transparency	**South Australia Radium Hill and Port Pirie 1954-1962**: • The South Australian *Uranium Mining Act 1949* (ceased) did not permit for transparency.
	South Australia Current: • DSD promotes transparency throughout the mine life cycle with all stakeholders, by ensuring all regulatory documents such as MLPs, PEPRs, EPMPs, Annual Compliance Reports, Reportable Uranium Incidents are all publically available via the DSD's Mineral Resources website. Further details see http://minerals.statedevelopment.sa.gov.au/mining/mines_and_quarries. • Several mine operators such as BHPB (operator of Olympic Dam) also have dedicated webpages on mine regulatory matters (http://www.bhpbilliton.com/society/regulatory). • DSD promotes the 'Social License to Operate' philosophy and encourages operators throughout the mines life to ensure ongoing engagement and transparency with stakeholders. • Uranium mines in South Australia permit members of the public including members of conservation groups to visit mining operations (i.e. Olympic Dam public tours, Beverley and Four Mile mine visits - by request). DSD strongly supports these transparency initiatives adopted by SA uranium mine operators.
	International Uranium Mining Jurisdiction Saskatchewan, Canada: • Ministry of Environment and Federal Canadian Nuclear Safety Commission support transparency, by providing access to certain regulatory information online, with all other information being available upon request

	(http://nuclearsafety.gc.ca/eng/uranium/mines-and-mills/index.cfm#RegulatingUraniumMinesandMills). • Companies such as Cameco Corporation provide significant information on their website including monitoring results from their uranium mines in Saskatchewan. This also supports their transparent stakeholder engagement initiative (http://www.cameco.com/northernsk/environment_safety/environmental_monitoring/).
Stakeholder Engagement	**South Australia Radium Hill and Port Pirie 1954-1962**: • No engagement occurred outside of the Radium Hill township. • There is no evidence of engagement with stakeholders external to the operations.
	South Australia Current: • Throughout the mine life cycle engagement by the uranium miner with all their stakeholders is expected. This includes development of a stakeholder engagement plans from the assessment to closure phases of a project. • DSD through the assessment phase of a project also further engages with stakeholders through statutory engagement processes. • Specific Native Tile Holders/Claimant engagement is also required through the life of a project, with agreements between Native Tile Holders/Claimants required before a Mining Tenement is issued. These also typically include commitments to ongoing engagement, protection of cultural heritage, indigenous employment opportunities and royalty benefits for Native Tile Holders/Claimants.
	International Uranium Mining Jurisdiction Saskatchewan, Canada: • Canadian uranium regulators focus greatly on stakeholder engagement due to the Duty to Consult with First Nation and Metis communities, throughout the life of a mining project. • Mine operators also has extensive programs relating to stakeholder engagement, environmental

	protection, reporting and partnering with local communities (http://www.cameco.com/northernsk/). • Saskatchewan government through the Ministry of Government Relations is focusing on maximising community benefits from uranium mining, through establishing best effort training, education, employment, business participation though agreements between the Saskatchewan government and the mine operator through Mining Lease Surface Agreements and Human Resource Development Agreements (http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/mineralsmetals/files/pdf/rmd-rrm/Mine%20Surface%20Lease%20Agreement.pdf). • Public engagement is further facilitated through the Northern Saskatchewan Environmental Quality Committee (NSEQC), which is a group comprised of community representatives, company representatives and government representatives, who discuss uranium mining activities, focus on environmental and radiation protection measures being employed, and the socio-economic benefits being gained. The committee meetings are open to the public (http://www.saskatchewan.ca/live/first-nations-citizens/first-nations-metis-and-northern-initiatives/northern-saskatchewan-environmental-quality-committee).

List of Documents

Ref #	Document Date	Document Title	Author/ Owner of the document	Purpose/Description	Location/Web Link
		About Radium Hill Mine Radium Hill activates and studies Radium Hill risk assessment and control scoping	Department of State Development	Short summary and history of mining and processing activities List of investigations and studies onsite 2006+ Short summary of 2006-2010 Radium Hill Risk Assessment and Remediation Scoping Project and link to report	http://minerals.dmitre.sa.gov.au/mines_and_developing_projects/former_mines/radium_hill_mine
1	**2004**	Radium Hill Uranium Mine and Low Level Radioactive Waste Repository Management Plan Phase 1 - Preliminary Investigation 2004. Report Book, 2004/9.	South Australian Department of Primary Industries and Resources (PIRSA).	This report provides a preliminary Characterisation and conceptual model of the site, and includes a consolidation of a considerable amount of site site-related information, and background data. Chapter 3 (the mine site) summarises the history of the mining and milling operations, including the site layout and waste management and disposal practices	http://minerals.dmitre.sa.gov.au/mines_and_developing_projects/former_mines/radium_hill_mine
		About Port Pirie treatment plant Port Pirie activates and studies Port Pirie risk assessment and control scoping	Department of State Development	Short summary and history of processing activities List of investigations and studies onsite 2006+ Short summary of 2006-2010 Port Pirie Risk Assessment and Remediation Scoping Project	http://minerals.dmitre.sa.gov.au/mines_and_developing_projects/former_mines/port_pirie_treatment_plant

				and link to report	
2	**2004**	Port Pirie Uranium Treatment Plant Management Plan Phase 1 - Preliminary Investigation 2004. *Report Book,* 2004/10	South Australian Department of Primary Industries and Resources (PIRSA).	This report provides a preliminary characterisation and conceptual model of the site, and includes a consolidation of a considerable amount of site site-related information, and background data. Chapter 3 (the treatment site) summarises the history of Port Pirie Uranium Treatment Plant operations, including site infrastructure, tailings disposal and impoundment and rare earth recovery from the tailings.	http://minerals.dmitre.sa.gov.au/mines_and_developing_projects/former_mines/port_pirie_treatment_plant