UraniumSA

Appendix 3

Draft Radiation Management Plan

Retention Lease Proposal

On

Mineral Claim 4280

for a

Uranium In-situ Recovery Field Trial

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Mullaquana Project
Uranium In-situ Recovery Field Trial

Draft Radiation Management Plan

Prepared for

UraniumSA Limited

by

On Site Technology Pty Ltd

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1 Introduction

This draft Radiation Management Plan (RMP) has been prepared to document the radiological protection procedures to be implemented during theIn-situ Recovery Field Trail (ISR-FT) proposed for the Mullaquana uranium project. The ISR-FT will be undertaken by UraniumSA Limited at their Mullaquana Retention Lease located approximately 20 km south west of Whyalla, South Australia.

The RMP has been prepared to address the regulatory requirements of the South Australian Radiation Protection and Control Act (1982)[1] and the Code of Practice for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing (2005)[2].

2 Location of Operation

The Mullaquana deposit is located approximately 20 km south west of Whyalla. The trial will be conducted within the Retention Lease Area (see Figure 1).

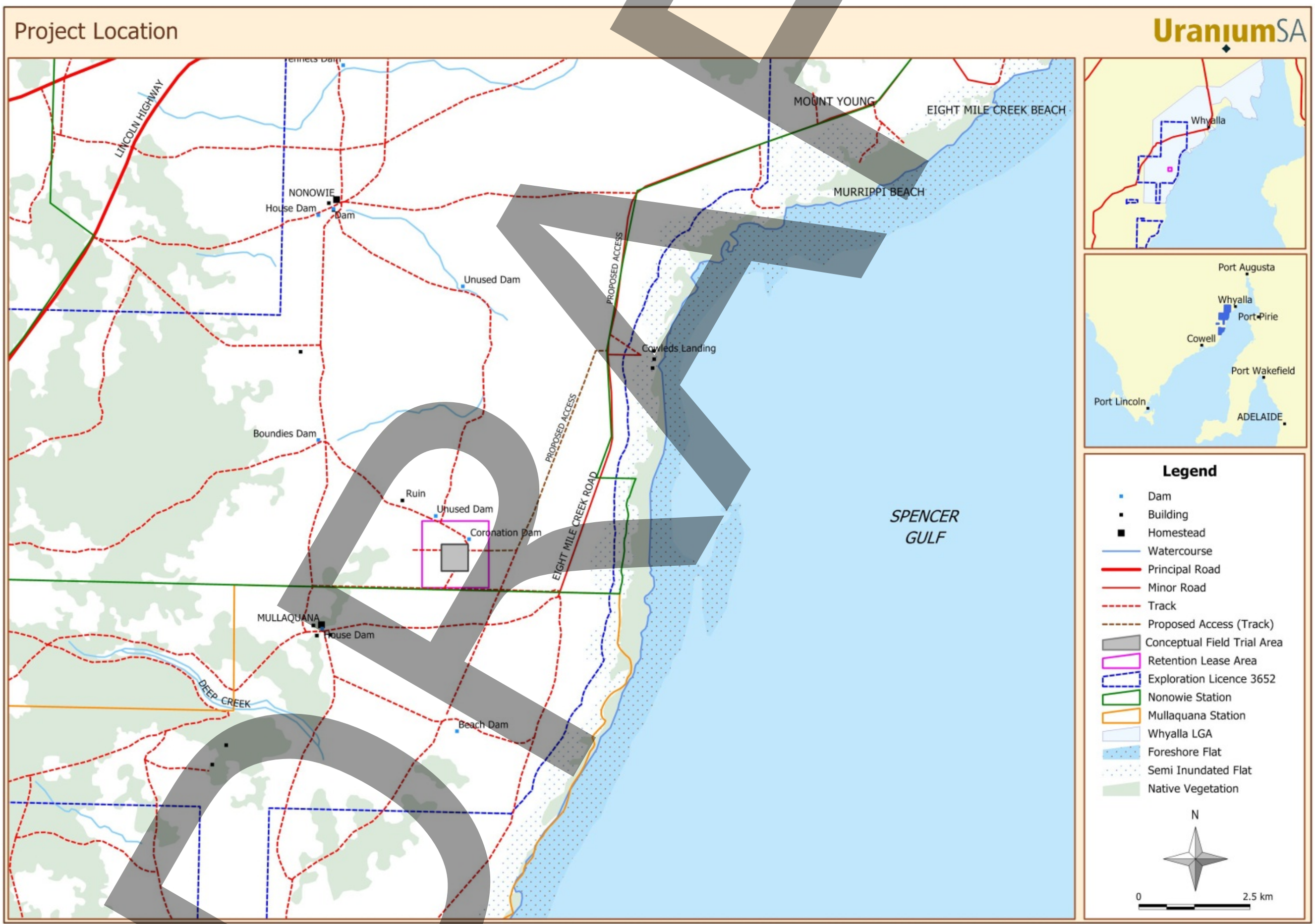

Figure 1: Project Location

The project is located on pastoral land primarily used for sheep grazing. The two properties covered by the exploration lease are the Nonowie and Mullaquana stations.However the trial will be undertaken wholly on land owned by UraniumSA between the Nonowie and Mullaquana stations.The land was previously part of the Nonowie station. The ISR-FT area is located in a coastal plain with the sparsely inhabited coast of Spencer Gulf to the east and low hills (running in a north south direction) to the west.

There are a number of seasonal drainage creeks that run from the west to the east across the exploration area but, other than stock watering dams there are no permanent surface water features.

Groundwater is located within the mineralised zone between 50 and 70 m below the surface. This groundwater is hyper saline (33,000 to 52,000 mg/l TDS) and contains radionuclides (primarily Ra^{226}). Outside the context of In Situ Recovery (ISR) uranium mining there is no identified current or potential future use of this groundwater.

Sensitive receptors have been identified at three locations;

1. The coastal hamlet of Cowleds Landing approximately 5.1 km to the north east, which has one or two permanently occupied residences and several sporadically occupied residences.
2. The Mullaquana Homestead located approximately 2.4 km south west from the retention lease boundary, which has two permanent residents and a varying number of short term contractors employed on a seasonal basis (for example during shearing season).
3. The Nonowie Homestead 7.5 km north north west, which has a permanent resident and also one of which is used byUraniumSA as an exploration camp while they are on site.

3 Description of Operation

It is proposed that the ISR-FT will be located within the bounds of the Blackbush Deposit which contains a 12,700 tonne eU3O8 JORC inferred resource which is located some 3.5 km from the coast of Spencer Gulf, covering an area of about 2.2 km^2. Mineralisation is located within an unconsolidated channel sand sequence positioned approximately 50 m below the surface and is overlain by 40 m of impervious clays and marls. Regionally over 300 drill holes have been drilled into the area including nearly 50 hydrogeological monitoring and pump test bores.

The retention lease area (RL area) is wholly contained within the Nonowie Pastoral lease(Figure 1). UraniumSA has recently entered into a contract to purchase the southern portion (8,200 ha) of Nonowie Station which extends from the Lincoln Highway to the coast and wholly contains the RL area. It is expected to settle on this contract by August 2011.

The RL area is 225 ha in total, but activities will be restricted to 5, 50 m x 50 m well array pads, a 200 m x 200 m processing and storage area, and connecting pipe work and tracks. It is estimated that about 5 ha of the RL area will be disturbed.

The purpose of the trial is to determine/confirm and/or investigate:

- Field and product recovery rates,
- Dissolving solution (lixiviant) performance and well field chemistry,
- Well-field flow rates and well array configuration,
- Water balance and other design criteria,
- Water disposal options,
- Recovery of uranium from hyper saline solutions via chelating ion exchange resins,
- Ion exchange resin loading, washing and elution,
- Uranium precipitation,
- Closure criteria,
- Environmental impacts, and
- Preliminary operating costs for financial analysis.

UraniumSA's objective is that, prior to conducting the trial it will have determined in the laboratory, the optimum metallurgical conditions for the trial's successful completion. Current testing indicates that conventional acid based solutions with oxidants will provide the optimum recovery results. Further tests indicate that a new generation of chelating ion exchange resin will be used to recover the uranium from solution and following the stripping of that resin a uranium based yellowcake precipitate will be produced. It will be necessary to remove calcium from the solution circuit to avoid its deposition within the mineralised zones.

The trial will comprise of up to 5 in-situ recovery (ISR) well arrays utilising a single well house and supporting uranium recovery infrastructure. Over the period of the trial it is estimated that about 11.5 tonnes of uranium metal equivalent will be produced in the form of yellowcake. This will **not be for sale** and it will be stored in a secure manner, at no risk to the public and in accordance with the *Nuclear Non-Proliferation (Safeguards) Act 1987* as administered through the Australian Safeguards and Non-Proliferation Office).

Groundwater associated with the mineralisation is more saline than sea water and has a high calcium content which could reach saturation as calcium is leached from the ore during normal uranium leaching. To reduce the initial calcium levels it is planned that pore volume flushing (PVF) pre-conditioning will be required as part of the program, (PVF is the displacement of high salinity/calcium waters through the introduction of lower salinity water). Alongside of this, a calcium control process will be undertaken via an increase to the normal raffinate bleed stream. Contingencies for calcium removal are also included. UraniumSA is considering two PVF options, those of sea water and Whyalla effluent water, both which will involve the trucking of water from the source to the site.

In support of the trial UraniumSA will need to provide underlying infrastructure. This will include, an access track in to the lease area from the Eight Mile Creek coastal road, power supply using generator sets, office and laboratory, septic services, workshop and storage areas, and a secure compound for uranium product storage. Conceptual layouts for the trial infrastructure are provided as Figures 5 and 6.

UraniumSA understands it will be required to establish an on-site low level radiation waste repository as part of its radiation waste management plan. Current estimates are that up to 2 tonnes of low level waste residues will be produced and drummed in addition there will be piping, contaminated soil and personal protection equipment to be placed in this repository. UraniumSA understands the state's requirement for management of this waste on site but UraniumSA is requesting that for the duration of the trial it be stored on the surface pending resolution of the long term future of the project and further consideration of the optimum location for disposal.

Security will be a key consideration in establishing the site and UraniumSA is proposing a multiple perimeters approach to security. As it will be the owner of the land it will be able to secure an extended perimeter fence matching its land boundary. The entire trial area will then be fenced and within that area storage and processing areas will be secured. Yellowcake will be secured in accordance with the *Nuclear Non-Proliferation (Safeguards) Act 1987* as administered through ASNO. UraniumSA will have the area under surveillance and staffed 24 x 7 for the duration of the trial.

It is proposed to dispose of surplus fluids in accordance with the "In-Situ Recovery Uranium Mining Best Practice Guide – Groundwaters, Residues and Radiation Protection" (Commonwealth of Australia, 2010).The approach to disposal will be by re-injection into the confined hyper-saline formation. UraniumSA has proposed a comprehensive monitoring regime based on existing best practice.

4 Access to Appropriate Technical Expertise

UraniumSA has engaged On Site Technology Pty Ltd to provide technical expertise and support for the radiological aspects of the ISR-FT. On Site Technology Pty Ltd has been involved in the provision of radiological services to the mining, government and industrial sectors for 13 years and Mr John Waters, On Site Technology's principle consultant has over 30 years experience in radiation protection in the Commonwealth and State regulatory framework. Support will include;

1. Provision of technical backup for the UraniumSA Radiation Safety Officer (RSO) who will be located on site;
2. Provision of advice on monitoring equipment, programs and data interpretation;
3. In co-operation with the RSO, undertake background, environmental and occupational monitoring;
4. Acting as Assistant Radiation Safety Officer;
5. Assistance in preparation of reports and documentation; and
6. Provision of radiological analytical services as required.

With respect to non radiological issues UraniumSA has employed or retained through consultancy agreements a wide range of technical personnel with considerable experience in all aspects of the proposed project.

This depth of expertise is demonstrated in the project'sorganisational structure shown in Figure 2.

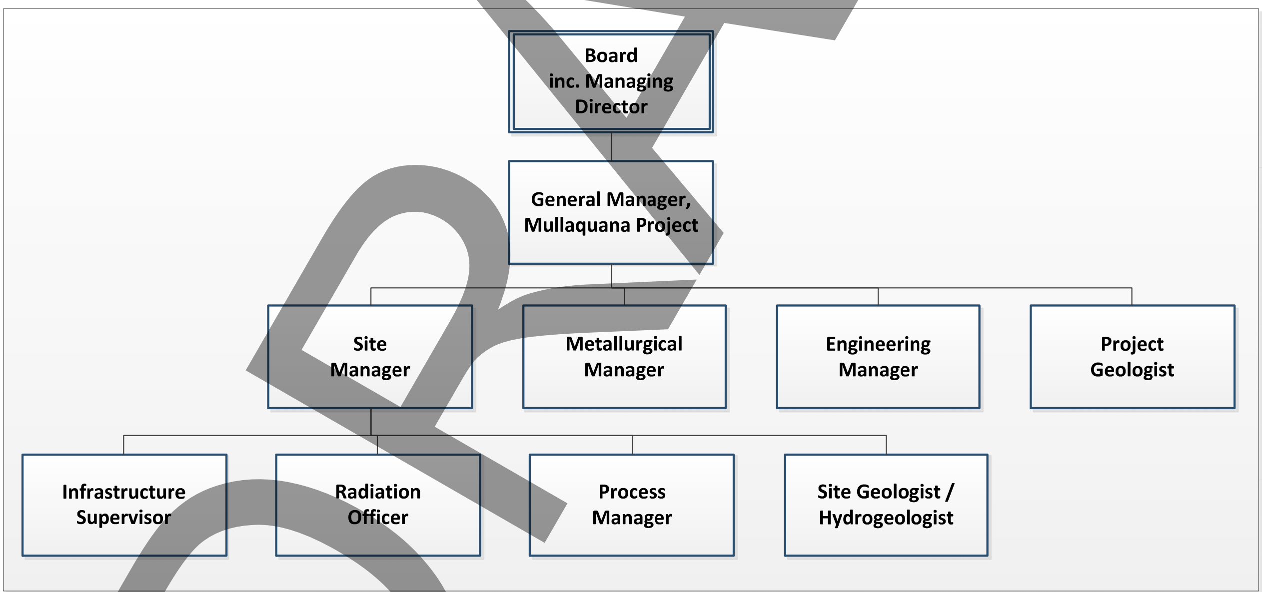

Figure 2: ISR-FT Project Organisational Structure

5 Occupational Monitoring Program

When assessing the occupational exposure criteria the total dose, that is the dose received from external gamma radiation and inhaled dust, radon and radon daughters will be considered.

For workers a total dose constraint of 20 mSv per year will be applied in line with the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) national standard[3]) and the requirements of the South Australian Radiation Protection and Control Act (1982). This constraint will be assessed on a quarterly basis with a 5mSv action limits. This will ensure that appropriate action can be taken well before the dose constraint is reached.

In practice it is anticipated that the actual occupational dose will be significantly less than the mandated 20 mSv per year. In accordance with the As Low as Reasonably Achievable (ALARA) principle and current industry best practice a target occupational dose of less than 4 mSv per year, to be assessed quarterly as a 1 mSv investigation limit. If the 1 mSv per quarter investigation limit is exceeded a review of the data will be undertaken including identification of the key contributors to the dose and a revision of work practices where required. This target will be reviewed on an annually based on the achieved occupational dose.

In practice, occupational dose will be controlled procedurally using a hierarchical approach as summarised in Table 1. A summary of the occupational monitoring program is provided in Table 2

Pathway	Primary Control	Secondary Control
Gamma Dose	Limit occupancy of high dose areas Relocation of high dose infrastructure	Shielding where practical Rotation of staff
Radon	Ventilation and extraction Limit occupancy of high dose areas	
Radon Daughters	Ventilation and extraction Limit occupancy of high dose areas	PPE, mask
Inhaled Dust	Housekeeping Limit occupancy of high dose areas	Dust suppression measures PPE, mask

Table 1: Occupational Dose Control Hierarchy

In general the secondary control measures will be implemented only in those cases where the primary control is either inadequate or impractical in controlling the dose.

Potential exposure pathways that have been considered for occupational exposure include:

5.1 Whole Body Exposure to Gamma Radiation

All employees working on the Mullaquana project participate in the ARPANSA Thermo Luminescent Dosimeters (TLD) monitoring program for the assessment of whole body exposure to gamma radiation. Results are reviewed on a quarterly basis. A three month change over period is considered adequate because the maximum annualised dose received by workers to date (that is, during the exploration program) has been 0.08 mSv[3]).

Although exposure to some workers (specifically the 6 or so involved in the trial) is expected to increase when compared to the exploration phase, the increase is expected to be low compared to the regulatory occupation limit of 20 mSv per year. This assumption is consistent with current practice in operating uranium and mineral sand mines operating in Australia.

Regular gamma surveys of the trial plant area and the selected use of direct reading dosimeters will be used to confirm that occupational dose rates are kept low in accordance with the ALARA principle. The use of these survey techniques will ensure that areas or processes involving dose rates above the average will be identified and can be addressed well in advance of the quarterly TLD review timeframe.

5.2 Inhalation of Dust Containing Radionuclides

The ISR process to be used for the trials is a wet process that does not inherently generate dust. The yellowcake product to be produced during the trials will be kept moist and not dried prior to storage in sealed drums. Consequently the potential for dust to be generated by the proposed operation is low under routine operating conditions. However, there is the potential for inadvertent dust generation from dried spilled material, unplanned events and handling of plant, equipment and product.

Occupational exposure to radionuclides in dust will be assessed by regular personal and positional monitoring of inhalable dust. Gross alpha activity will be determined on collected samples with potential inhaled dose calculated using International Commission on Radiological Protection (ICRP)documented dose conversion factors[4)].

5.3 Inhalation of Radon Gas and Radon Daughters

The ISR process to be used for the trial involves bringing large quantities of acidified ground water to the surface for processing. This will result in the release of a significant (but at this stage, unknown) proportion of the dissolved radon into the atmosphere within the plant area. The trials will be conducted in an open environment and it is anticipated that radon will be rapidly dispersed into the atmosphere.

Extraction and dispersal into the outside atmosphere will be used at key emission points in the process. This approach will ensure that “in plant” radon levels are kept low and there is limited time for build up of radon daughters in the plant area.

Occupational exposure to radon will be assessed by the use of a continuous radon monitor located within the plant area and grab samples at various locations around the plant.

The release of radon from the liquor could result in the build up of radon daughter products in or near the plant. Because the trials will be conducted in an open area rather than a confined space it is anticipated that radon will be rapidly dispersed. Therefore radon daughter products in the plant area should be dominated by background levels and mitigated by prevailing meteorological conditions.

Occupational exposure to radon daughters will also be assessed by undertaking regular spot checks for radon daughter products using the Rolle Single Gross Alpha Measurement Procedure (SGAMP)[5]. Results will be recorded in nJ/m^3 Potential Alpha Energy Concentration (PAEC) and converted to dose using conversion factors documented in the Western Australia Radiation Dose Assessment

Guideline[6]). Monitoring will be more intense at the start of the trial and be reviewed so that the locations and frequency of sampling reflects the significance of the radon daughter contribution to total occupational dose.

5.4 Contact with Surface Contaminated Items

Potential occupational exposure due to contact will contaminated items will be controlled by procedural methods including personal hygiene and the use of personal protection equipment.

Formal assessment of occupational dose due to skin contact with contaminated items will not be undertaken. However, regular surveys for surface alpha contamination will be undertaken to ensure that surface contamination levels are within acceptable limits.

The surface contamination limits are based on a target of 0.4 Bq/cm^2 alpha activity which is the SA-EPA criteria for unrestricted release of equipment from uranium mines[7]) and an action limit of 1 Bq/cm^2 which is the ARPANSA surface contamination limit (for alpha emitting nuclides in the U^{238} decay chain) for laboratories[8].

Certain pieces of plant and equipment may become contaminated with short lived radon daughter products due to a process called “plate out”. This contamination will be monitored by measurement of surface alpha activity. Control of occupational exposure from this pathway will be controlled by the use of delay (i.e. holding times) and Personal Protection Equipment (PPE) (gloves). Any surface activity due to “plate out” of radon daughters will decay to background levels within a few hours.

5.5 Ingestion and Wound Contamination

Potential dose from ingestion and wound contamination will not be formally assessed but will be controlled procedurally using standard operating procedures to ensure use of PPE, appropriate personal hygiene and first aid.

Inadvertent ingestion of radionuclides (and non radioactive chemicals and reagents) will be controlled by implementation of operating procedures that;

1. Prohibit eating and smoking in work areas
2. Limit drinking in work areas to the prevention of dehydration
3. Ensure strict adherence to good personal hygiene practices (for example washing hands and face before meal or smoke breaks)
4. Mandate use of PPE such as gloves in designated areas
5. Prohibit the wearing of contaminated PPE in crib rooms and office areas

Point 2 is of significance because in typically arid areas (such as the Whyalla environs) the occupational and health risk from dehydration is significantly greater than from inadvertent ingestion of the low level radioactive materials typically encountered in the ISR uranium mining environment. The implementation of measures noted in point 3 can ensure an appropriate balance of the two risks.

Contamination of wounds will be controlled by implementation of operating procedures that ensure:

1. Surface contamination of plant and equipment is minimised
2. Appropriate PPE is worn at all times
3. Pre existing cuts and abrasions are appropriately covered and protected
4. Occupational cuts and abrasions are appropriately cleaned and treated
5. Work reassignment is implemented in cases where an existing wound could become contaminated.

Item	Parameter	Method	Scope	Frequency	Criteria	Note
1	Gamma Dose	ARPANSA TLD	All Workers	4 per year	5 mSv per quarter limit <1 mSv per quarter target	
2	Gamma Dose	Dose Rate Survey	Infrastructure	Once per week	Consistent with item 1	Review after 4 weeks
3	Gamma Dose	Direct Reading Dosimeter	Targeted Workers	As indicated by item 2	Consistent with item 1	Ongoing review
4	Inhaled Dust	AS 3460, alpha count	Targeted Workers	5 per week	Consistent with item 1	Ongoing review based on observation and results
			Targeted Locations	5 per week	Consistent with item 1 based on occupancy	Ongoing review based on observation and results
5	Radon	Continuous Monitor (1 hour average)	in Plant	Continuous	1000 Bq/m^3 24 hour average limit <200 Bq/m^3 24 hour average target	
6	Radon	Grab Samples (Lucas Cell or 2 Filter)	Targeted Locations	1 per day	Consistent with item 5	Ongoing review based on observation and results
7	Radon	Track Etch	5 Targeted Locations	4 per year	Consistent with item 5	
8	Radon Daughters	Rolle SGAMP	Plant Area	3 per day	Consistent with item 1	Review after first week

Item	Parameter	Method	Scope	Frequency	Criteria	Note
9	Surface Contamination	100 cm^2, 1 minute alpha count	Various Infrastructure	1 survey per week	1 Bq/cm^2 for operational plant 0.4 Bq/cm^2 for all other items	Review after 1 month
10	Surface Contamination	100 cm^2, 1 minute alpha count	Potentially Contaminated Items Leaving Site	As required	0.4 Bq/cm^2	
11	Surface Contamination	100 cm^2, 1 minute alpha count	Any item requiring maintenance	As required	0.4 Bq/cm^2	

Table 2: Occupational Monitoring Program

6 Environmental Monitoring Program

The radiological impact of the proposed trials on the environment will be monitored by the program summarised in Table 3 (for atmospheric impacts) and Table 4 (for other impacts). Results will be compared to the baseline radiological survey undertaken prior to commencement of the trials[9)].

Monitoring will include the operational area (effectively the Retention Lease) identified sensitive receptors and reference locations.

The meteorological conditions during the baseline survey were uncharacteristically wet for the area,therefore reference locations were selected to match the general topographical and land use conditions of the retention lease. Reference locations have been selected to the north and south of the operational area. These locations will provide comparative results so that variations in radiological conditions that are due to seasonal or meteorological effects rather than operational impacts can be readily identified.

Notional monitoring locations are provided in Figure 3 and are described as follows:

Locations 1, 2, 3 and 4 represent the corners of the retention lease area. Dust deposition gauges and passive radon monitors will be deployed at these locations. These will effectively monitor the environmental impact at the retention lease perimeter. Other measurements to be undertaken at these locations will depend on operational conditions and observation of impacts and could include radon daughter levels, radon grab samples and low volume and optical particulate monitoring.

Location 5 represents the ISR-FT plant area and will be the focus of the occupational monitoring program described above. Environmental monitoring at this location will include the high volume air sampler collecting Total Suspended Particulate (located in this area because of power requirements). Some occupational data (for example radon and radon daughter levels) will be included in the environmental assessment of impacts.

Locations 6, 7 and 8 represent the identified sensitive receptors at Cowleds Landing, Mullaquana homestead and Nonowie homestead respectively. Dust deposition gauges and passive radon monitors will be deployed at these locations. These will effectively monitor the environmental impact on the sensitive receptors. Other measurements to be undertaken at these locations will depend on operational conditions and observation of impacts and could include radon daughter levels, radon grab samples. Low volume and optical particulate monitoring will be undertaken on a rotational basis or in response to concerns or complaints from the sensitive receptors.

Locations 9, 10, 11, 12, 13 and 14 are dams that will be used for the assessment of impacts on surface water. Surface water, soil and flora samples will be collected and analysed as detailed in Table 4.

Locations 9 and 14 are considered reference locations and are sufficiently distant from the retention lease area to provide ongoing data on typical baseline variations so that natural long term or seasonal variations in the measured parameters can be distinguished from those impacts resulting from the ISR-FT.

Location 12 (Coronation dam) is within the retention lease and adjacent to the proposed ISR-FL plant area. This dam and the soil and flora near it are expected to provide the first indication of any environmental impact resulting from the proposed ISR-FT.

Locations 10, 11 and 13 (particularly 10 and 13) represent potential impacts on the Nonowie and Mullaquana homesteads.

The exact locations for monitoring points are subject to variation resulting from operational, security or access conditions. For example location 6 is depicted within property controlled by UraniumSA to minimise the impact of vandalism or interference, however, subject to the identification of a co-operative resident at Cowleds Landing, this location could be moved to Cowleds Landing thus providing a more representative assessment of impact on that sensitive receptor.

The environmental monitoring program includes the use of low volume dust samplers and laser particle counter (Dust Trak) on a rotational basis.

The low volume samplers will be deployed at all locations on a rotational basis. It is envisaged that these will primarily be used at sensitive receptors (where dust impacts will have most impact and within the retention lease area (where potential dust generating activity will be most prevalent). However, depending on meteorological and operational conditions they can be used at any location.

The laser particle counter will log particulate matter (PM_{10}) dust levels at one minute intervals. This unit can be deployed very quickly or can be used in survey mode to provide a dust survey over a wider area. Although this unit will be used to collect a wide range of occupational and environmental dust data the primary function is to provide a rapid response to dust complaints from sensitive receptors or other members of the public. The unit can be located and be operational at the source of a complaint within a short time frame.

Figure 3: Environmental Monitoring Locations

Item	Parameter	Method	Scope	Frequency	Criteria	Note
1	Dust Deposition	AS3580.10.1 ICP-MS uranium thorium	5 on RL Boundary 3 sensitive receptors 3 control locations	Monthly	Operational and sensitive receptors consistent with controls	Review after 3 months
2	Dust TSP	AS2724.3 Alpha Activity ICP-MS uranium thorium	Plant Area Mullaquana	Monthly	Consistent with 1msv per year dose	
3	PM_{10} dust	Dustrak	1 unit deployed on a rotational basis	Continuous	Informative only	
4	Dust	Low Volume Sampler alpha activity	3 units deployed on a rotational basis	Weekly	Consistent with 1msv per year dose	Deploy based on observation
5	Radon	Grab Samples (Lucas Cell or 2 Filter)	RL boundary, sensitive receptors and control locations on rotational basis	1 per day	Consistent with baseline variation	Review after 1 month
6	Radon	Track etch	5 on RL Boundary 3 sensitive receptors 3 control locations	Continuous, change quarterly	Consistent with baseline variation	
7	Radon	Ausplume Model	Region	Quarterly	Consistent with baseline variation	Assessment outside RL boundary only

Item	Parameter	Method	Scope	Frequency	Criteria	Note
8	Radon daughters	Rolle SGAMP	RL boundary, sensitive receptors and control locations on rotational basis	1 per day	Consistent with baseline variation	Review after 1 month

Table 3: Environmental Monitoring Program (Atmospheric Impacts)

Item	Parameter	Method	Scope	Frequency	Criteria	Note
9	Surface Waters	Uranium Thorium Pb^{210} and Ra^{226}	6 dams	Quarterly	Consistent with baseline variation	Review after 1 year
10	Soil	Uranium Thorium Pb^{210} and Ra^{226}	6 co-located with dams	Annually	Pre operational baseline	
11	Flora	Uranium Thorium Pb^{210} and Ra^{226}	6 co-located with dams	Annually	Pre operational baseline	
12	Groundwater	U Th Ra^{226} pH EC Sulphate	All monitoring bores	Quarterly	Consistent with baseline variation	
13	Groundwater	pH EC sulphate	Overlying and Lateral Monitoring Wells	As per Groundwater Management Plan	As per Groundwater Management Plan	Review after each trial
14	Soil	Gamma Survey uranium thorium Pb^{210} and Ra^{226}	Well pattern	Before and after each trial	Consistent with baseline variation	

Table 4: Environmental Monitoring Program (Other Impacts)

7 Operational Monitoring Program

A number of operational parameters of the circulating lixiviant will be monitored during the trials. These will include:

1. pH
2. uranium
3. calcium
4. sulphate
5. free acid
6. iron
7. suspended solids
8. chloride
9. process flow rates

Other important process variables will be monitored as required for process plant control.

This monitoring program is not specifically related to radiological impacts although it may provide additional information that will compliment the information gathered by the RMP.

8 Provision of Equipment, Staff, Facilities and Operational Procedures

Equipment used for the evaluation, measurement and assessment of radiological impacts during the trial will be provided by UraniumSA. The equipment will be either, owned and maintained by UraniumSA, or hired or provided by sub contractors.

Documented operating procedures, work instructions and maintenance and calibration procedures will be provided in accordance with Uranium SA documentation policy prior to the commencement of any work.

9 Induction and Training

All personnel and contractors working on the trial will undergo a standard induction that will include background and project specific information on radiological conditions and hazards.

The radiological induction will be provided through a power point presentation to be given by the RSO and an information booklet.

Relevant personnel will be trained in the use of all radiological monitoring equipment prior to commencement of the trial.

This induction and training will be backed up by the on-site presence of the Radiation Safety Officer and off site access (via telephone and email) to radiological expertise through On Site Technology Pty Ltd.

10 Record Keeping and Reporting

All monitoring results and dose records will be documented and recorded in accordance with Uranium SA policies.

Information related to individual dose records will be maintained in confidence by the RSO. Summary information broken down into work function and exposure pathways will be recorded and made available for review by Uranium SA management and consultants.

11 Incidents, Accidents and Emergencies

The terms “Radiation Incident”, “Radiation Accident” and “Radiation Emergency” have regulated definitions under the Radiation Protection and Control Act (1982).

The radioactive materials that will be encountered during the trial will be:

1. Yellowcake product (specific activity approximately 190 MBq/kg)
2. Process solutions (U estimated activity up to 5kBq/l and Ra^{226} estimated activity up to 0.06 kBq/l)
3. Contaminated equipment (activity unknown at this stage)
4. Radium containing scale (estimated maximum activity 250 kBq/kg)
5. Soil contaminated with spilled process liquor (estimated activity 2.5 kBq/kg, (not radioactive under the regulations)

Given the nature of the radioactive materials to be produced and handled during the trial it is difficult to formulate a scenario that would result in a “Radiation Emergency”. For example a “Radiation Emergency” would result in a dose rate equivalent to 80 mSv per year with exposure for a three month period. The occupational monitoring program discussed in section 5 would identify and rectify such excessive dose rates before the “Radiation Emergency” threshold was reached.

A “Radiation Accident” would require the dispersal (without regaining control) of more than 300 g of yellowcake or loss of more than (approximately) one thousand litres of extracted process solution.

While it is feasible that these quantities of material could be spilt it is unlikely that the material would not be recovered. Procedures outlined in Figure 4 will ensure that spilt radioactive materials will be recovered and disposed in accordance with the Radioactive Waste Management Plan.

A “Radiation Incident” is considered feasible for the proposed trial. The most plausible scenarios are:

1. Spillage of yellowcake (more than 330g)
2. Spillage of liquor (more than 1,000 litres)

The accidental or inadvertent ingestion of 33g of yellowcake or 100 litres of liquor (either of which would constitute a radiation incident) is not considered a plausible scenario.

The occurrence of any radiological incident, accident or emergency during the trial will be documented and reported in accordance with the requirements of:

- *Radiation Protection and Control Act 1982* (SA),
- *Environmental Protection Act 1993* (SA), and the
- *Occupational Health, Safety and Welfare Act 1986* (SA),

as appropriate for the specific occurrence.

In addition any incident will be documented and reported as required by PIRSA’s “Criteria and Procedures for Recording and Reporting Incidents at SA Uranium Mines”.

Unplanned events will be handled by a hierarchical approach that will be documented in accordance with Uranium SA policies. The management of non radiological unplanned events is detailed in other documents. The process outlined in Figure 4 will be followed for unplanned events involving radioactive materials.

Spillage of yellowcake is likely to be on a small scale (compared to liquid spills) and is more easily recovered because of the smaller volume and physical form of the material.

Spillage of concentrated uranium liquors (uranium retrieved from the recovery resin) if it did occur is likely to be within the plant itself and will be contained by bunding. Therefore this material will be recovered and added back into the process. Therefore the generation of waste from this material will be minimal.

A key part of the incident response process is the post response evaluation and review of the incident. This will involve an assessment of any radiological exposure to workers, members of the public or the environment and a review of procedures to avoid re-occurrence of the incident.

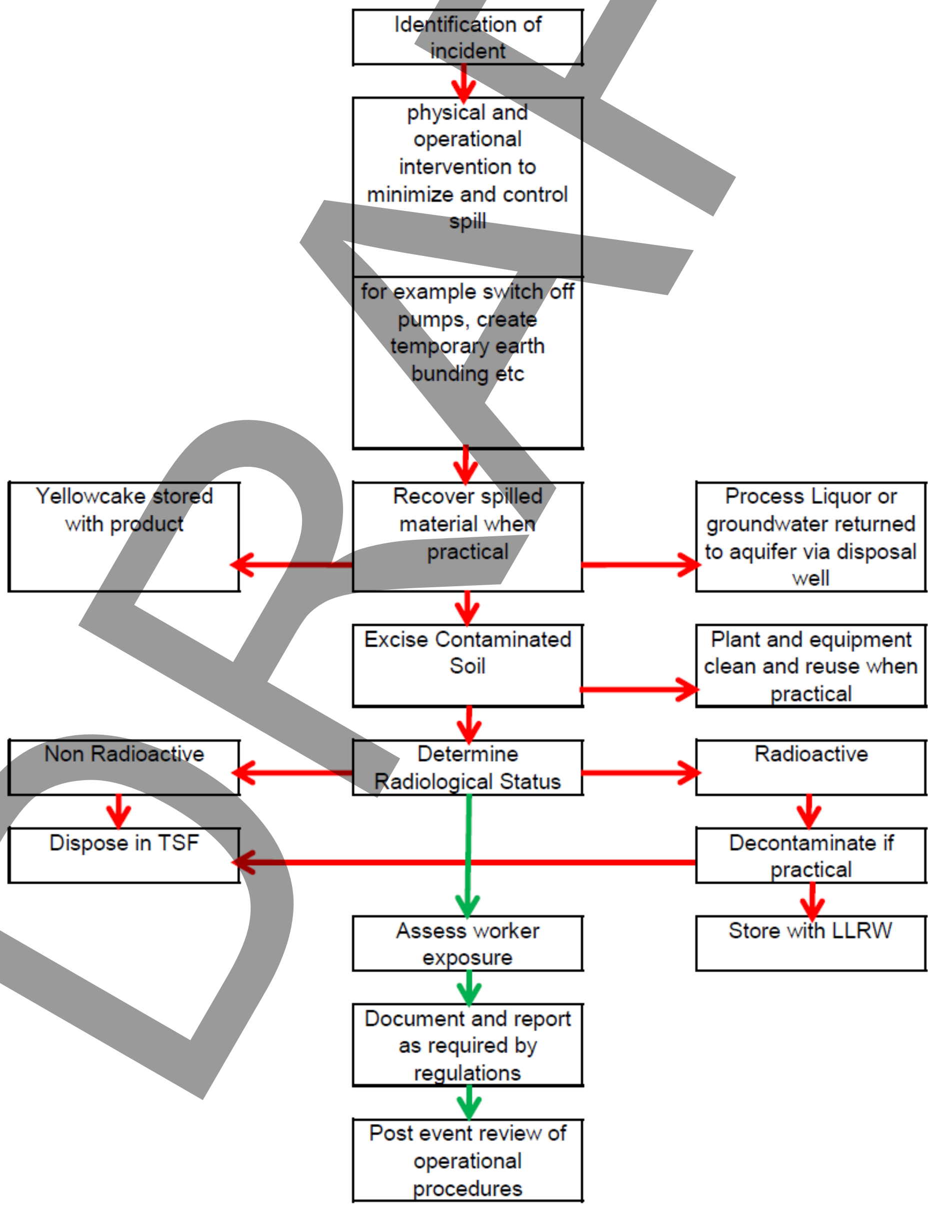

Figure 4: Incident Response Process

12 Radioactive Waste

The handling and disposal of radioactive waste is described in detail in the separate Radioactive Waste Management Plan (RWMP). In brief the RWMP can be summarised as follows:

All waste produced by the trial program will be classified according to criteria detailed in Tables 5 to 7. Any waste classified as radioactive based on the National Directory[10] exemption levels will be segregated, consolidated and securely stored within the Retention Lease until the trials have been completed.

Although the current regulatory definition of radioactive material (defined in the Radiation Protection and Control Act) is higher than the National Directory exemption limit, the lower National Directory limit has been proposed to provide a conservative approach to the disposal of radioactive waste.

Segregation and storage of Low Level Radioactive Waste has been proposed because the ultimate disposal of the waste will be dependent on the results of the trial program. Two outcomes are possible:

1. The project is terminated or placed on hold due to an unsuccessful trial.
2. The project progresses to the mining phase

For outcome 1 the evaporation pond facility (which will not contain LLRW) used for the trial project will be closed in accordance with the requirements of the Minerals Regulatory Guide MG5[11] and the Mining Code[2].

There is currently no viable regulatory mechanism for the off-site disposal of LLRW[12] therefore the LLRW will be placed into a LLRW repository in accordance with the Mining Code and the Code of Practice for the Near Surface Disposal of Radioactive Waste in Australia[13].

In the event that the regulatory framework changes by the end of the trial project by the establishment of a national or state repository for LLRW then off-site disposal would be considered subject to regulatory approval.

For outcome 2 where the project will progress to the mining phase the trial waste storage facility will be either closed without containing any LLRW or expanded (subject to the Mining Lease Application process) to handle the ongoing wastes and LLRW produced by the mine. If the trial wastes storage facility is closed a new facility will be required for the mining phase and this would be operated (subject to the Mining Lease Application) as a LLRW repository.

Source	Waste Material	Disposal Method	Sorting Criteria
Laboratory waste	Spilled and Used Reagents	Segregation and storage, removal by licensed contractor (Violia or Transpacific)	Hazards index
	Surplus Samples	Return to aquifer via disposal well	
	PPE and Laboratory Consumables	Radioactive waste stored on site pending disposal Non radioactive waste removed as industrial waste by licensed contractor	National Directory exemption levels

Table 5: Low Level Radioactive Laboratory Waste

Source	Waste Material	Disposal Method	Sorting Criteria
Fuel or chemicals	Recovery when practical	Removal by licensed contractor (Violia or Transpacific)	
	Excise contaminated soil	Removal by licensed contractor (Violia or Transpacific)	Above SA-EPA waste fill criteria
		Dispose in tailings storage facility	Less than SA-EPA waste fill criteria
Yellowcake	Recovery when practical	Store with yellowcake product pending removal at trial completion	Visually clean yellowcake
	Excised contaminated soil	Store with radioactive waste pending trial completion	Uranium content above national directory exemption limit
		Dispose in tailings storage facility	Uranium content less than National Directory exemption limit
Leach or Process Liquors	Recovery when practical	Return to aquifer via disposal well	Visually free of settled solids
	excised contaminated soil	Store with radioactive waste pending trial completion	Activity greater than National Directory Exemption Limit
		Dispose in tailings storage facility	Activity less than National Directory Exemption Limit

Table 6: Low Level Radioactive Waste from Spillage

As detailed in Table 7 the two exceptions to this process will be:

1. Process liquors (including the calcium bleed) that are an integral part of the trial which will be returned to the aquifer via disposal wells in accordance with ISR best practice.
2. Radon (and daughters) which will be extracted and vented to the outside atmosphere for dispersal by wind.

Source	Waste Material	Disposal Method	Sorting Criteria
Plant Waste	PPE	Store with radioactive waste pending trial completion	Activity greater than National Directory Exemption Limit
		Non radioactive waste removed as industrial waste by licensed contractor	Activity less than National Directory Exemption Limit
	Consumables	Store with radioactive waste pending trial completion	Activity greater than National Directory Exemption Limit
		Non radioactive waste removed as industrial waste by licensed contractor	Activity less than National Directory Exemption Limit
	Equipment	Store with radioactive waste pending trial completion	Activity greater than National Directory Exemption Limit
		Non radioactive waste removed as industrial waste by licensed contractor	Activity less than National Directory Exemption Limit
	Calcium Scale	Store with radioactive waste pending trial completion	Activity greater than National Directory Exemption Limit
		Dispose in tailings storage facility	Activity less than National Directory Exemption Limit
	Radon and Radon Daughters	Extraction from plant area and atmospheric dispersal	As per monitoring program
	Process Liquors	Return to aquifer via disposal well	

Table 7: Low Level Radioactive Waste from the ISR-FT Plant

13 Yellowcake Handling and Storage

The ISR-FT will produce approximately 26 t of yellowcake that will be stored in lined 200 or 300l steel drums. The produced yellowcake will not be dry and is expected to contain approximately 35 % moisture. This will significantly reduce the occupational and environmental risk from product dust.

The potential for occupational exposure to the yellowcake product will primarily occur during the filtering and packaging processes. These processes will be undertaken in a controlled access area. All workers entering the area will be required to wear the following PPE;

1. Disposable overalls with hood (tyvek or similar)
2. Disposable latex or similar gloves
3. Disposable overshoes
4. A correctly fitted P2 dust mask
5. Safety Glasses or full face shield as appropriate

Drinking, smoking and eating will be prohibited in the filtration and packaging area and adjacent areas. Because of the risk of ingestion of yellowcake drinking to prevent dehydration will also be prohibited in the filtration and packaging area.

After sealing a drum of yellowcake the external surface will be inspected to confirm the absence of dirt, product or other contaminants. A wipe test of the lid, rim and upper external wall of the drum will be taken to confirm that the alpha activity is less than $1Bq/cm^2$. This confirmation will be made by either alpha counting or analysis of the wipe for uranium.

Once packaged and contained within a lined steel drum the yellowcake will be transferred to the storage area. Storage will be in a locked shipping container located in a secure area complying with the requirements of the *Nuclear Non-Proliferation (Safeguards) Act 1987* as administered through ASNO. Records of production and storage of yellowcake will be kept in accordance with ASNO requirements.

Personal dust monitoring with assessment of filters by mass, alpha activity and uranium content will be undertakenduring all filtering and packaging operations. Uranium is both radio toxic and chemically toxic, the chemical toxicity is generally of more significance than the radio toxicity, therefore the action limit for atmospheric yellowcake dust in the filtration and packaging area will be based on the Worksafe Australia limit of $0.2 mg/m^3$ uranium. Alpha activity will be used to estimate the potential occupational radiation dose from inhalation for the assessment of occupational exposure and compliance with the ALARA principle.

At the completion of the ISR-FT the yellowcake will be transported to a licensed uranium producer for final processing incorporation into their product. This transport will be undertaken as a single campaign in accordance with the Code of Practice for the Safe Transport of Radioactive Materials and in compliance with Department of Transport and ASNO requirements.

It is envisaged that transport will be in the same container used for on site storage of the yellowcake during the ISR-FT.

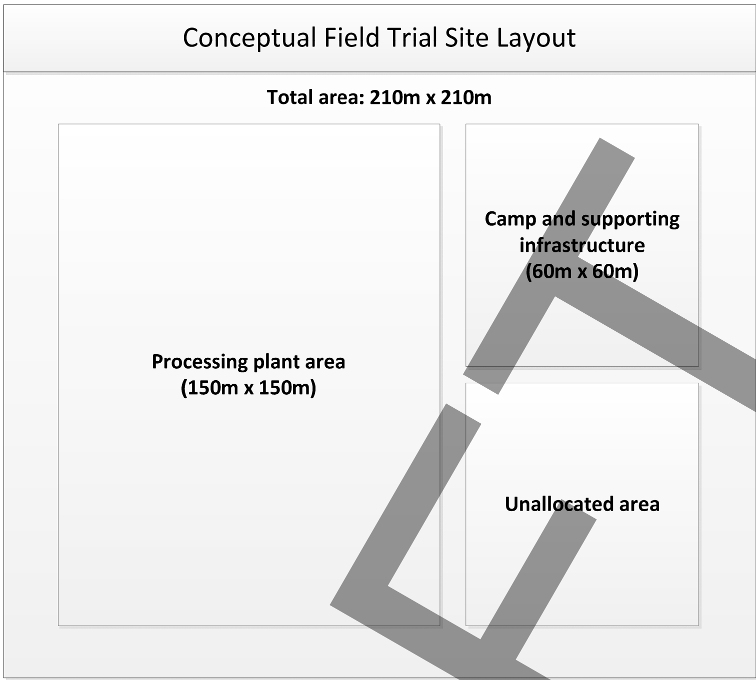

Figure 5: Conceptual Field Trial Layout

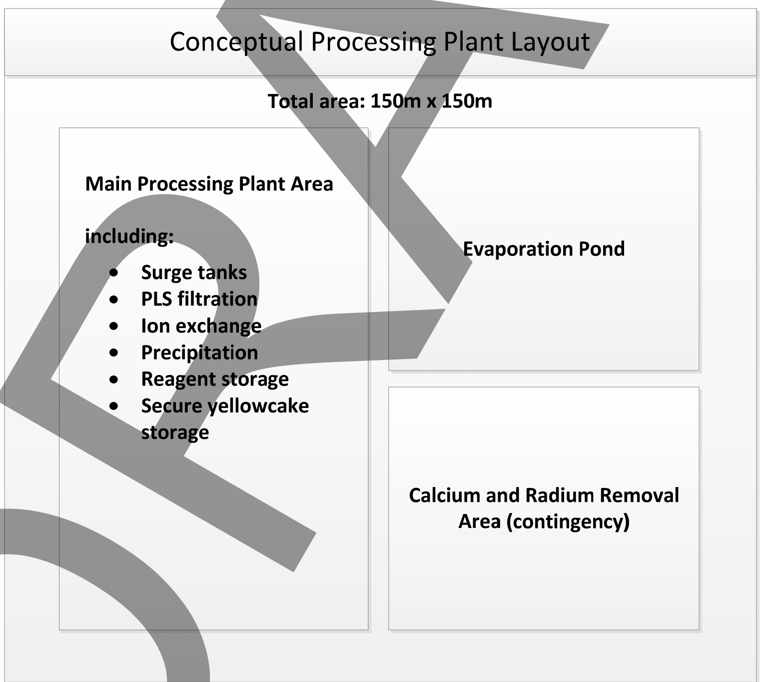

Figure 6: Conceptual Processing Plant Layout

14 Periodic Assessment and Review

This Radiation Management Plan will be reviewed on an annual basis in accordance with the Uranium SA document review policy. The review will be documented and involve stakeholders including:

- PIRSA
- SA-EPA
- Employees as appropriate
- Uranium SA management

In addition to an annual review the frequency and scope of various monitoring programs will be periodically reviewed as detailed in Tables 2 to 4. This will ensure that the various monitoring programs are implemented in a way that will allow the timely identification and rectification of any potentially unforeseen circumstances or areas of concern.

15 References

1 Radiation Protection and Control Act (1982) and Radiation Protection and Control (Ionising Radiation) Regulations 2000

South Australian Government

2 Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing

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3 ARPANSA dose reported to 27/3/2011

4 Dose Coefficients for Intakes of Radionuclides by Workers

ICRP Publication 68

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5 Radiation Protection in the Mining and Milling of Radioactive Ores

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Australian Radiation Laboratory document ARL/TR 043

January 1982

6 Approved Procedure for Dose Assessment

Department of Mines and Energy, Western Australia

Guideline RSG05, December 2007

7 Personal Communication Mr Andrew Johnston SA-EPA

8 Recommended limits on radioactive contamination on surfaces in laboratories

NH&MRC Radiation Health Series #38

June 1995

9 Baseline Radiation Survey, Mullaquana Project

On Site technology Pty Ltd report 10070

8th February 2011

10 National Directory for Radiation Protection
Radiation Protection Series Publication # 6
ARPANSA, August 2004

11 Guidelines for miners: tailings and tailings storage facilities in South Australia
PIRSA publication MG5
Version 1.4, September 2009

12 Communication with SA-EPA dated 29th April 2011
Reference MI/02/017

13 Code of Practice for the near-surface disposal of radioactive waste in Australia (1992)
Radiation Health Series No 35
NH&MRC, November 1992