



Australian Government

**Department of Sustainability, Environment,
Water, Population and Communities
Supervising Scientist**

Alligator Rivers Region Technical Committee

Meeting 26

7 – 8 April 2011

Summary Record

**Alligator Rivers Region Technical Committee
Meeting 26, 7-8 April 2011
Agenda**

Wednesday 6 April 2011

Ranger uranium mine fieldtrip

Thursday 7 April 2011

1 Preliminary Session (Chair)

- 1.1 Welcome and Introductions
 - 1.1.1 New members
 - 1.1.2 Election of new Chairperson
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2 ARRTC25 Outcomes (Chair)

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3 Gap Analysis - *eriss*/ERA research against Key Knowledge Needs

4 Activity Updates (Members)

- 4.1 Uranium Equities Ltd (Nabarlek)
- 4.2 Department of Resources
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- 4.5 Parks Operations and Tourism Branch (South Alligator Valley)

5 Science underpinning regulatory decisions (DoR)

6 Research Activities

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 - 6.1.1 Status of 2010-11 *eriss* research against ARRTC 2008-10 KKNs
 - 6.1.2 Proposed *eriss* research program 2011-12

Friday 8 April 2011

6 Research Activities (*cont.*)

- 6.2 Energy Resources of Australia Pty Ltd
ERA research summary/Reports since ARRTC 25
 - 6.2.1 ERA overview and EIS update
 - 6.2.2 Trial landform Update
 - 6.2.3 Analogue site update
 - 6.2.4 Tailings Storage Facility TWG update
 - 6.2.5 Wetland Filter studies
- 6.3 Other stakeholder research activities
 - 6.3.1 Environment NGO Update

7 Other Business

- 7.1 SSD Publications since ARRTC 25
- 7.2 MTC Minutes

8 Next Meeting

9 Meeting Close

Attendance

Members

Dr Jenny Stauber	A/g Chair - Independent Scientific Member
Dr Simon Barry	Independent Scientific Member
Prof David Mulligan	Independent Scientific Member
Mr Andrew Johnston	Independent Scientific Member
Prof Colin Woodroffe	Independent Scientific Member
Dr Gavin Mudd	Environment NGO stakeholder member
Mr Alan Hughes	Supervising Scientist Division (SSD)
Mr Russell Ball	NT Department of Resources (DoR)
Ms Sharon Paulka	Uranium Equities Limited (UEL) – Thursday only
Dr Howard Smith	Northern Land Council (NLC) - from 2.00pm Thurs
Dr Peter Eaglen	Energy Resources of Australia Ltd (ERA) – Friday only
Ms Hilary Schofield	Per Parks Australia Division

Presenters/Observers

Mr Michael Welch	NT Department of Resources (DoR)
Mr Geoff Kyle	Gundjeihmi Aboriginal Corporation (GAC)
Dr Matt Daws	Energy Resources of Australia Ltd (ERA)
Ms Shelly Iles	Energy Resources of Australia Ltd (ERA)
Dr Ping Lu	Energy Resources of Australia Ltd (ERA)
Dr Peter Anderson	Energy Resources of Australia Ltd (ERA)
Mr Frank Harris	Energy Resources of Australia Ltd (ERA)
Mr Adam Thompson	Northern Land Council (NLC)
Dr David Jones	Environmental Research Institute of the Supervising Scientist
Dr Andreas Bollhöfer	Environmental Research Institute of the Supervising Scientist
Dr Chris Humphrey	Environmental Research Institute of the Supervising Scientist
Dr Renée Bartolo	Environmental Research Institute of the Supervising Scientist
Mr Mike Saynor	Environmental Research Institute of the Supervising Scientist
Dr Wayne Erskine	Environmental Research Institute of the Supervising Scientist
Dr Rick van Dam	Environmental Research Institute of the Supervising Scientist
Ms Kate Turner	Environmental Research Institute of the Supervising Scientist

SECRETARIAT

Mr Scott Parker	Office of the Supervising Scientist
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1 Preliminary Session (Chair)

1.1 Welcome and Introductions

The Acting Chair Dr Stauber welcomed attendees and on behalf of members thanked ERA for organising the fieldtrip to the Ranger mine on the previous day. Dr Stauber welcomed Mr Andrew Johnston and Prof David Mulligan (the new independent scientific members for radiation protection/health physics and minesite rehabilitation, respectively) to their first ARRTC meeting. She noted the appointment of the independent scientific members for freshwater ecology and hydrology/hydrogeology had been delayed as FASTS was still to provide nominations to Minister Burke.

Dr Stauber noted that the appointment of Dr Eaglen as the new ERA stakeholder member would be actioned at the same time as the two independent scientific members. Dr Stauber asked Ms Schofield if there has been any progress in nominating the Parks Australia representative. Ms Schofield indicated that the representative will be advised once the recruitment process for the position of Assistant Secretary, Parks Operations and Tourism Branch has been finalised.

Prof Woodroffe stated it was unfortunate that the new independent scientific member for hydrology/hydrogeology still hasn't been appointed as yet given the various important water-related issues that ARRTC needs to consider and form a view on. He stressed it was critical that the position be filled without further delay. Dr Stauber agreed that this area of expertise is one of the key positions on ARRTC. She indicated she was aware a number of potential candidates had been approached by FASTS but several did not have sufficient time available to take on the role. Dr Stauber also noted the process of appointing the new Chair of ARRTC was dependent on these appointments and suggested the process for this be discussed later this meeting.

Dr Stauber reminded members that the primary role of ARRTC is to review and advise the Minister on the quality and appropriateness of the science used in research and regulatory decision making in the ARR. Ms Iles asked if a start to the revision of the ARRTC Key Knowledge Needs would be made this meeting and agreed it was unfortunate that the appointment of the remaining two independent scientific members hadn't been finalised as yet as their expertise would be useful in this task. Prof Woodroffe asked if ARRTC would be receiving a report on the Heap Leach project and Ms Iles advised that this would be addressed as part of the presentation under agenda item 6.2.1.

1.2 Apologies and Observers

Dr Stauber noted apologies received from Dr Smith, Dr Eaglen and Ms Paulka for absences during the meeting. She also noted advice from Dr Mudd that he may need to be absent from the meeting for a short period prior to and/or following the lunch break in order to attend to other matters.

MEMBER	PERIOD OF ABSENCE
Dr Smith	0900 – 1400 Thursday 7 April 2011
Dr Eaglen	All day - Thursday 7 April 2011
Ms Paulka	All day – Friday 8 April 2011

1.3 Correspondence

The following correspondence was noted:

Outgoing - letter from the Chair to Minister Garrett forwarding the summary record of ARRTC25 and the outcomes of the gap analysis process finalised at that meeting

Incoming - response from Minister Garrett acknowledging receipt of ARRTC25 outcome report.

1.4 Conflict of Interest Declarations

Dr Stauber invited members to table any issues of potential conflict of interest. Ms Paulka advised that she is undertaking commercial work for both Energy Resources of Australia Ltd and Uranium Equities Ltd. Dr Stauber advised that staff in her Division are involved in commercial work CSIRO is undertaking for Energy Resources of Australia Ltd in relation to Pit#1 closure and that she is also working collaboratively with various *eriss* staff on the *Uranium in Sediments* project.

2 ARRTC25 Outcomes (Chair)

2.1 ARRTC25 - Summary Record

Dr Stauber asked for any comments or issues arising from the draft ARRTC25 minutes. She also asked if members believed the minutes were sufficiently detailed, especially in relation to the information presented under each agenda item. Dr Mudd advised that he had no problems with the current format as long as members can still access the presentations on the website. The ARRTC25 minutes were accepted and approved as read.

ARRTC26-1: The ARRTC25 minutes were approved without amendment.

Approved 29 November 2011

2.2 ARRTC25 - Business Arising

No.	Action/Outcomes	Resp.	Status/comments
ARRTC225A	ARRTC requested eriss to present at the next meeting results of further analysis of relationships between plant assemblages and soil characteristics as part of the process to inform selection of species for rehabilitation.	Dr Jones; Dr Humphrey	This work was delayed due to (i) decision to commit more resources to the G'town analogue area (with further veg surveys undertaken), and (ii) awaiting good imagery to derive DEM for that location. Both available now, with DEM being used to derive landform variables for modelling.

Dr Jones advised that this matter would be addressed in the eriss presentation later this meeting.

ARRTC23 2.6	ARRTC agreed to consider the draft Terms of Engagement for members and advise the Secretariat on their suitability out of session.	Secretariat	Outstanding. Process for addressing out of session.
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ARRTC26-2: Secretariat to recirculate revised ARRTC Terms of Appointment to members for comment and finalisation out-of-session.

ARRTC24 4.1	DRDPFR to provide out of session a copy of the report on the investigation in the seepage of the northwest wall.	Mr Ball	Outstanding. Mr Ball to resend to all members.
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Mr Ball advised that he was unsure which report this action referred to but suggested based on the previous minutes it may be efflorescence related.

ARRTC26-3: Mr Ball to identify the relevant report referred to in ARRTC24 4.1 and circulate to members out-of-session

ARRTC24 6.2	Earth Water Life Sciences to provide six-monthly updates on both the trial landform and the ecohydrology analogue site study.	Mr Puhlovich	Ongoing – presentation later this meeting by Dr Lu.
ARRTC25-1	Members to check the ARRTC24 minutes and provide comments/changes to Secretariat by 21 April 2010.	Members	Complete.
ARRTC25-2	Mr Evans to sign off on ARRTC 24 minutes.	Mr Evans	Complete.
ARRTC25-3	ARRTC requested that eriss prepare a short outline of existing climate change projections for the ARR and identify future needs for various aspects of the future work program, such as vegetation, ecology, geomorphology, groundwater recharge, etc. and outline how they are addressing	Dr Jones	Presentation this meeting by Dr Bartolo.

	<i>these needs.</i>		
ARRTC25-4	<i>Parks Australia Division to provide summary report documenting proposed monitoring plan and budget for the SAV rehabilitation works to ARRTC26.</i>	<i>Parks Australia Division</i>	<i>Presentation this meeting by Mr Balding.</i>

Dr Mudd suggested there may be good scientific value in ARRTC undertaking a fieldtrip to inspect the SAV rehabilitation site. Mr Hughes advised that this could be arranged if ARRTC believed this was warranted but noted it would be a long day. Dr Mudd acknowledged such a trip would be logistically difficult but still worthwhile. Mr Johnston indicated he would be interested in visiting the site but would like further background on the project. Dr Barry stated he thought a visit would be useful. Prof Woodroffe asked if ARRTC should also visit the Rum Jungle site. Dr Stauber noted visits to both sites could be arranged but ARRTC would need to consider the business case for such fieldtrips.

ARRTC25-5	<i>ERA and DoR to report back at ARRTC26 on progress in compilation of groundwater monitoring data, including radionuclides, from ERA, SSD and DOR sources.</i>	<i>Mr Puhlovich; Mr Ball David Jones</i>	<i>There was some discussion about the status of compiling a database that contained all historic and contemporary data from ERA, SSD and DOR. This is regarded as an essential component underpinning overall hydrogeological understanding of the site and the development of groundwater closure criteria. ERA provided water quality and bore log data to Bruce Ryan (SSD) in mid 2010 for incorporation into single database. Several meetings were held in 2010 and early 2011 to plan suitable format and protocol for updates, web based access, responsibilities and inclusion of ERA geology data (separate database) to enable aquifer properties to be assigned to each bore. ERA will continue advancing the production of an integrated database with alternative SSD representative now that Bruce Ryan has resigned. It was noted that URS used data supplied to the Tailings Storage Facility Technical Working Group to construct a database. However, it was not apparent if this database included all site bores or if it was focussed only on the footprint around the TSF. The suitability of this database should be assessed alongside that built by SSD for production of a consolidated database.</i>
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Ms Iles advised that ERA and SSD staff have met several times to discuss whether ERA and SSD could both access the combined ERA-SSD dataset collated by Mr Ryan and the possibility of combining the groundwater dataset with the existing ERA geological database. Dr Jones advised this differed from his recollection which was that ERA would take the lead in producing the integrated database, with SSD collating and providing its in-house data to expedite the process. He noted that SSD was not able to collate all of the data due to resource constraints. A particular issue that was identified was the apparent difficulty in supply of DOR groundwater data prior to 2000 owing to the different methods used to electronically store the data prior to that time. It was noted that resources continue to be problem for the project. Mr Hughes advised that SSD had recently lost the key staff member responsible for this work. Dr Jones noted that it was his understanding that the compilation of the SSD data had been completed prior to the departure of this staff

member. It was suggested that the recent compilation by URS Pty Ltd of groundwater data for the TSF working group may have overtaken the original plan. Dr Mudd advised he didn't think the URS project was using ERA data. Ms Iles advised that ERA has a new champion for the project (Mr Angus McCoy), who has built the geology database. She advised it was still to be decided whether ERA would use the URS database containing ERA data for the tailings dam area bores or the dataset built by Mr Ryan, which was not complete. Dr Jones noted this work is very strategically important.

Ms Iles noted that there are essentially a number of conceptual knowledge acquisition processes that have overlapped – the development of a database for groundwater pre mining and a global database that incorporates all data for the site. She suggested the priority should be to agree on a dataset that can be considered the reference dataset representing natural groundwater conditions to be used in interpreting groundwater changes and developing criteria. Dr Jones stated he thought the SSD side of this work had been completed and, based on a meeting held with EWLS about two years ago, that ERA had undertaken to take the lead in developing the global database integrating ERA, SSD and DOR data. He suggested that SSD and ERA resolve the matter out-of session. Dr Mudd asked that the matter be sorted out as soon as possible given the critical importance of groundwater post rehabilitation. He also noted that pre-mining data were almost non-existent as most groundwater monitoring commenced after development had begun. Ms Iles noted that developing improved understanding of groundwater issues is one of the ERA commitments in TSFWG process. It was agreed that ERA would provide an update on this work to the next meeting.

ARRTC26-4: ERA to provide a report on progress in compilation of groundwater monitoring data, including radionuclides to ARRTC27.

Prof Woodroffe noted that SSD data on groundwater is provided in the *eriss* reports to ARRTC and asked what level of corporate memory ERA has on these issues. Ms Iles advised that ERA has an extensive library and key reports are also available electronically (last 10 yrs). She advised that ARRTC was free to request to see relevant ERA reports but noted that some of these remain commercial-in-confidence. Dr Barry asked what processes are in place to ensure these reports are available if required in 20 yrs time. Dr Mudd noted that SSD actually doesn't hold much operational groundwater data which are mainly held by ERA and DoR. He also noted that while URS collated available data reports for the TSF, data still needs to be collated for the entire site so a more complete and integrated knowledge base can be formed. He noted this would avoid previous issues such as what happened with the Mn leak where SSD research detected the leak before ERA operational monitoring. Ms Iles advised that ERA has a water chemistry database but that this is not linked to the groundwater database at this stage.

ARRTC25-6	<i>Members to review the conceptual framework, draft pathway submodels and narratives of the CPCM project and provide comments to Mr Parker.</i>	<i>Members</i>	<i>Project delayed due to staff changes and competing priorities.</i>
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There was general agreement that the conceptual pathway models should underpin SSD scientific knowledge management. Prof Woodroffe noted there have been several iterations of the models and agreed further review would be useful. Dr Jones advised the conceptual models and narratives will be published as a SSR so comments from ARRTC members are sought at this time to inform finalisation of the process. Prof Mulligan suggested that as the draft report had only been circulated prior to the meeting, members should have further time to review and provide any comments.

ARRTC26-5: ARRTC members to review the draft Conceptual Models report and provide comments to the Secretariat in two months.

ARRTC25-7	<i>Mr Parker to circulate draft SSR on conceptual framework, draft pathway submodels and narratives for review by members prior to ARRTC 26.</i>	<i>Mr Parker</i>	<i>Project delayed due to staff changes and competing priorities.</i>
ARRTC25-8	<i>Mr Puhlovich to provide a report to ARRTC26 on current monitoring data and management framework for water (specifically that relating to leachate from wall rock) emanating from the TSF footprint in the Gulungul Creek catchment.</i>	<i>Mr Puhlovich</i>	<i>This information is provided in weekly water quality report updates provided to the MTC. The most recent report will be provided to ARRTC at the time of the meeting. ERA has contracted a consultant to review historic data and reports relevant to Gulungul Creek water quality. It is planned that the outputs of this review will be available at ARRTC 27.</i>

Ms Iles noted that the weekly water quality report to the MTC includes sites around the TSF. She noted this information would be provided in a presentation to be given at this meeting. Dr Mudd suggested ARRTC should be looking at longer time series data as well, given the real issue is source terms getting into surface water systems. Dr Mudd suggested if the wet season data are presented then this would suffice and Ms Iles confirmed these data would be presented. Mr Hughes suggested there may be concerns over time in relation to the movement of contaminants into Gulungul Creek. He noted that previous research indicated that run off and shallow seepage from the TSF rock wall were the sources of these solutes reporting to the surface drainage lines. He also noted that ERA has recently installed interception sumps, which means water not of sufficient quality to be discharged to adjacent water courses will be able to be returned to the pond water system in the future. Mr Kyle noted that not all of the water currently being captured is able to be diverted to the pond water system and that GCT1 is still a potential source.

Mr Hughes stated his understanding was that all TSF runoff was currently being intercepted. Ms Iles advised that the current sumps were clay lined as part of the last TSF lift and this upgraded strategy has resulted in significant water quality improvement. Mr Kyle suggested it was too early to say that water quality has improved. Mr Johnston asked if the seepage was coming from the surface or shallow bores and Ms Iles advised that further information would be provided under the presentation on the findings of the TSF Working Group by Mr Puhlovich later this meeting and that a review of the time series data by an external consultant was about to commence and a report would be provided to ARRTC27. She further noted that the design of the surface water management system for the new TSF lift will incorporate more extensive collection points to manage leachate on the basis of water quality.

Ms Iles advised that ERA has taken over the monitoring of the shallow bores near the TSF from DoR and is investigating the possible causes of the fluctuating EC levels observed. She advised that the initial thinking was that this may be due to infiltration of higher EC leachate from the TSF walls rather than lateral seepage. Ms Iles advised the next report to be produced would combine the surface water results with the EC results. Dr Mudd asked why the surface water would have such high EC readings. Mr Welch noted the bores in question lie outside the footprint of the sump, and Ms Iles added that the shallow bores in question are in the drainage channel and are therefore subject to infiltration by surface water. Dr Mudd noted that as most of the areas surrounding the bores were sandy, rapid infiltration would be expected. Ms Iles advised there are two different reports being prepared: a report covering the continuous monitoring data for the shallow TSF bores and a report on the review of the catchment. She advised that the outcomes of the catchment review would hopefully be presented at the next ARRTC meeting.

ARRTC25-9	<i>Heap leach project to be included in ARRTC26 agenda with presentations from ERA, SSD, and NGO rep if required.</i>	<i>ERA/SSD/ Dr Mudd</i>	<i>Presentation later this meeting by Dr Anderson.</i>
ARRTC25-10	<i>Secretariat to alert members when the heap leach EIS is released.</i>	<i>Secretariat</i>	<i>Heap leach EIS has not been released yet.</i>

Ms Iles noted that the draft of the Heap Leach EIS has been submitted to the Commonwealth and NT governments for assessment against the EIS guidelines.

ARRTC25-11	<i>ERA to provide update on trial landform to ARRTC26.</i>	<i>Mr Puhlovich</i>	<i>Presentation later this meeting by Dr Daws</i>
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Approved 29 November 2011

3 Gap Analysis - *eriss*/ERA research against Key Knowledge Needs

Dr Stauber suggested that any gaps identified by the Contaminant Pathway Conceptual Pathways project be combined with those identified from the previous gap analysis of the current KKNs. She noted that data management was another potential gap. Dr Jones indicated that this issue was being strategically addressed in ERISS by the progressive implementation of corporate systems to manage the different types of data that are produced.

Dr Stauber suggested that members consider these and any other potential gaps that should be included in the next revision of the ARRTC Key Knowledge Needs document and asked if members had any issues with the proposed process. Mr Hughes suggested that ARRTC not get too bogged down in the detailed analysis of the gaps and instead consider whether the KKNs should be updated as and when needed rather than through the process of producing a document with a defined lifetime (e.g. KKNs for the next two years). Dr Stauber agreed that ARRTC should focus on addressing the current gaps before seeking to identify more. Dr Jones indicated that the key issue is the sequencing and resourcing of work required to address the KKNs. Dr Stauber noted that ARRTC has previously attempted to prioritise specific areas of work within the KKNs and Mr Hughes agreed that this approach was still useful. Dr Jones advised that work to address the current KKNs was still on track but clearly the KKNs related to knowledge gaps associated with the impending closure of Pit#1 in 2013 needed to be addressed soon.

Dr Mudd indicated he supported the KKNs being updated on a continuous basis particularly given the situation at Ranger is highly dynamic and that the various new operational developments being proposed all involve a range of new knowledge needs and uncertainties.

Dr Stauber asked members how the revision of the KKNs should be progressed. Prof Mulligan asked if there was scope to undertake progressive rehabilitation of the site and Mr Hughes advised that this would present a number of difficulties due to the small footprint and the need for various operational areas to continue functioning while the Pits are being rehabilitated. Dr Mudd advised the only option for progressive rehabilitation might be with Pit#1 which is being closed out during the operational phase. Ms Iles suggested that some of the land application areas could also present opportunities for progressive rehabilitation during the operational phase.

Prof Mulligan asked when fire effects on the trial landform will be looked at and Dr Lu advised that this work was scheduled to commence in 2012. Prof Mulligan asked if there was sufficient space available on the landform to have split treatment plots and Dr Lu advised that it was planned to put fire through the whole system. Prof Mulligan noted this meant that there would be no control plots or opportunities for doing different intensity and frequency treatments. Dr Lu advised that the small size of the landform limited the scope for having a number of treatments but suggested experience from previous work on effects of fire would be valuable. Prof Mulligan noted that burning the whole landform would only provide results for a single age class and suggested perhaps only burning half. Ms Iles advised that more work was needed to design the fire work program that would be implemented. Prof Woodroffe stated the site is a trial landform and he would be disappointed if the site was burned so soon. Dr Jones noted that the key issues in relation to fire effects are early resilience and fire frequency, and that there are significant data available from previous studies in Kakadu National Park that will be relevant and useful. Prof Mulligan noted that a good understanding of baseline fuel loads was important and Ms Iles advised that there are other sources of data and information on fire such as the NT Bushfire Council and the results of previous studies at Nabarlek and South Alligator Valley sites. Dr Lu noted the most important issue will be the high potential of destroying the native vegetation in the event that weeds are not effectively controlled on the landform.

Dr Stauber asked if there are any other issues with the KKNs that need to be addressed over the next 6 months. Prof Mulligan suggested gaps in databases were a key issue. Dr Jones agreed that data management is an important and intrinsic component of the KKNs, noting that he would provide a summary in his presentation of the work that is being done in ERISS to address this. Mr Hughes suggested that a definitive groundwater database for Ranger was definitely a key knowledge gap. Dr Jones added that development of a

comprehensive groundwater database has always been a critical knowledge issue, but that collaboration between stakeholders to produce such a database had lost momentum over the last couple of years.

ARRTC26-6: ARRTC agreed the 2008-10 ARRTC KKNs should be updated as and when required, including by out-of-session inputs.

4 Activity Updates

4.1 Uranium Equities Ltd (Nabarlek) (Ms Paulka)

Ms Paulka described UEL operations in the Alligator Rivers Region, which include Nabarlek (exploration and rehabilitation), the Headwaters project (exploration) and the West Arnhem JV (exploration with Cameco). She advised exploration at Nabarlek for 2011 would involve 52 holes involving 7800m of RC drilling following up on new potential targets. Dr Mudd noted that there was an announcement that something had been found at the old waste rock dump at Nabarlek and Ms Paulka advised that an anomalous area was found but subsequent drilling had not provided any significant results.

Ms Paulka advised the key outcomes for the reporting period were the completion of the rehabilitation of the Old Camp including the removal and burial of asbestos containing material and the planting of 5000 seedlings. She noted that weed spraying was almost completed for the year and burning was scheduled for May depending on weather conditions.

Dr Stauber asked if asbestos from the cleanup of the old village site was buried on the lease. Ms Paulka confirmed this was the case and that a marker has been installed. Dr Stauber asked to what depth the asbestos has been buried and Ms Paulka advised that the asbestos has been buried to 5m depth with a cover placed on top. Dr Mudd asked if the contractor was licensed and Ms Paulka confirmed this. Dr Stauber asked what monitoring was undertaken during the works and Ms Paulka advised that dust monitoring was conducted as per the regulations and the site had been inspected by a hygienist who issued a certificate. She noted that different certificates are required for different types of asbestos. Mr Johnston asked if asbestos was the only contaminant of concern at the site and Ms Paulka confirmed this. Ms Paulka advised that the final contour of the site looks good and that the contractor had also replaced the trunks of old trees felled by Cyclone Monica in situ. She noted that further revegetation was planned subject to control of weeds.

Mr Hughes asked if any work had been done at the rubbish tip and Ms Paulka advised that no work had been done but a "No Access" sign has been installed and UEL will probably get the contractor to close the site off to minimise any dust disturbance. Prof Woodroffe asked where the sand used as part of the sewerage works rehabilitation had been sourced from and Ms Paulka advised that the sand had been sourced from the site. Ms Paulka advised additional works to control erosion had been undertaken. Prof Woodroffe asked where the eroded material was being transported to. Ms Paulka advised that the gully erosion on the site was not significant but there was minor potential for it to increase. Mr Hughes advised the black soil plain upstream of the site on Coopers Creek limited the potential for further erosion.

Ms Paulka advised 5000 seedlings had been planted in February 2011 following re-contouring of the area and direct seeding with grasses was also carried out. The area had been ripped, and wetting crystals and fertiliser tablets dispersed by hand. She advised that the aim was to plant during the monsoon season but it was initially hot and dry before it rained. Ms Paulka advised replanting on the evaporation pond had used an island approach and there have been some issues with grazing by feral horses. Prof Mulligan asked if the areas revegetated were previously natural ground and Ms Paulka advised the areas were previously ponds which had been scraped and backfilled. Dr Mudd noted the ponds had retained significant amounts of radium so had to be scraped prior to being rehabilitated.

Ms Paulka advised weed management commenced in early October 2010 with a focus on Para Grass during the wet season and this early action had resulted in reduced weed density through the wet. She noted that Mission Grass density on the site is also slowly being reduced. Spraying had been conducted on the site four times so far this season and twice outside the fence, including in escarpment areas to prevent high

temperature fires damaging artworks. She advised there would probably be a large final weed control campaign later in April or probably early May.

Ms Paulka advised work proposed for the dry season included producing a new weed map, development of a method for quantifying revegetation success, another burning program, further characterisation of the radiologically anomalous area (RAA) and design of the disposal site for material to be excavated from this area as part of the rehabilitation work.

Discussion

Prof Mulligan asked if the RAA was due to the poor construction of the rehabilitation works. Mr Hughes suggested the scrapings from the bottom of the evaporation ponds may have been placed into the top of the decline ramp leading into the pit at the end of the original site decommissioning works, or alternatively may have been inadvertently left in that position. Ms Paulka advised that the depth of the anomalous material still needs to be determined by auger drilling since the trenching that had been carried out was not able reach the base of the material. Dr Mudd commented that the radon flux at the RAA is still quite high. Ms Paulka noted the area affected is relatively small. Dr Bollhoefer asked if UEL is going to drill the site and Ms Paulka advised drilling was planned but that due to significant OH&S issues, a vehicle mounted auger would be used instead of an airblast drilling rig.

Mr Welch asked if UEL was planning to undertake work on site closure this year and Ms Paulka advised the proposed rehabilitation work this year as outlined in the report to the MTC would include development of suitable monitoring techniques and criteria for measuring rehabilitation success. Mr Welch stated it was good to see that this work is being done but emphasised the need to have appropriate criteria against which rehabilitation success can be measured. Ms Paulka suggested successional growth was probably one such criterion that would demonstrate sustainability but agreed this was subjective. She advised these issues, including fire management and weed control, would be resolved in planned discussions with DoR.

Prof Mulligan asked if UEL was the original operator of the mine site or was the rehabilitation work required to be done as a condition of the current lease. Ms Paulka advised UEL wasn't the original operator of the site, with the previous lease holders having sold the lease to UEL along with the liabilities. Ms Paulka advised the lease and attendant liabilities had been transferred with the purchase of the site but the lease itself was not able to be sold. Mr Hughes confirmed that the lease has never been returned to the NT Government. Dr Mudd advised that most of the rehabilitation work had been done between 1995 and 2000 but there was no work done on closure criteria. Ms Paulka advised the only applicable criteria were those in the settlement agreement. Although the work required and how it is to be done is set out in the Mining Management Plan, closure criteria have never been agreed and there are still gaps.

Dr Stauber asked if a certificate is issued once UEL has completed the rehabilitation and Mr Ball advised a Certificate of Closure is usually issued by the NT Government. Mr Thompson noted there are also rehabilitation issues related to groundwater on the site. Ms Paulka advised that a database is being collated and work has been done on identifying issues, the location of potential contaminant pathways and associated monitoring requirements. Mr Johnston asked what types of groundwater issues were involved and Dr Mudd advised that as in-pit storage of tailings was used at Nabarlek, there are concerns about potential groundwater contamination associated with fracture zones or fault lines. Mr Hughes advised that the ore body at Nabarlek was aligned along a geological structure with some instability. Since all of the surface sources of contamination have been removed, all areas on the site have improved with the exception of the Pit which has an associated groundwater contamination plume. Dr Mudd advised that groundwater contamination issues at Nabarlek haven't been extensively studied but it is known that there wasn't a plume in the past. Mr Johnston asked if the plume was discrete or contiguous and Mr Hughes advised the plume doesn't appear to be tailing off and is an ongoing issue requiring monitoring although contamination plumes from other sources such as stockpiles, water management ponds and irrigation on the site are attenuating.

Prof Mulligan asked if the Pit was being recharged and Dr Mudd advised that although the cover on the Pit was designed to shed water, some infiltration would be expected and there has been sufficient time for

groundwater rebound at depth to occur. Dr Stauber asked if SSD was currently monitoring the site. Mr Hughes advised that SSD wasn't, but UEL is doing some GW monitoring, and DoR is also undertaking check monitoring. Dr Jones suggested that given the length of time since decommissioning and the time series record available for a number of bores, that this site would provide a good opportunity for testing the capability of groundwater models. Such work would be potentially valuable in terms of the use of predictive models to aid closure and rehabilitation planning for the Ranger mine site. Dr Mudd agreed modelling work at Nabarlek would be highly relevant and valuable.

Mr Johnston asked if the groundwater plume was reaching the adjacent watercourse and Mr Hughes advised that it hadn't but that given the current rates of movement the front could traverse the distance in 20 to 30 years time, but there may be no coupling with surface water. Dr Jones noted that groundwater modelling at Nabarlek was a potential case study for the KKNs.

ARRTC26-7: ARRTC agreed SSD should consider developing a groundwater model for Nabarlek as a case study and this should be included in the ARRTC KKNs.

Prof Mulligan asked about the remaining infrastructure at the site and Ms Paulka advised the airstrip, although not currently licensed by CASA, was identified as a strategic airstrip for defence purposes and would be preserved.

4.2 Department of Resources (Mr Welch)

Mr Welch advised that in the NT there are currently 1147 applications for exploration licences (1048 last year), 1276 granted exploration licences (1149 last year) and 325 ALRA moratoriums (255 last year). He noted there were currently 63 exploration authorisations, one authorisation for care and maintenance (Jabiluka) and one authorisation to operate a mine (Ranger). Mr Welch advised that of the uranium mining and exploration tenements authorised under the NT Mining Management Act, there are currently seven authorised exploration operations on a number of tenements in the ARR including Uranium Equities Limited with two projects (Nabarlek, Headwaters), Cameco with four projects (Arnhem, King River, Tin Camp Creek & Myra/Kukuluk/Cadell) and Rio Tinto with one project (Arrla Bay).

Mr Welch noted that reports and applications received by the MTC during the reporting period included 11 reports (including 8 statutory) and 9 proposals for Ranger, 5 reports and one proposal for Jabiluka and a report and a proposal for Nabarlek. He noted that significant proposals for Ranger had included the construction of an additional 250 room camp completed in August 2010, the construction of the Ranger 3 Deeps decline and associated works (still being considered by the MTC), and the proposed final raise of the TSF crest to RL57m. Mr Welch advised a number of temporary approvals had been issued covering contingency process water storage in the TSF and Pit#1, storage of pond water treatment brine in RP2 and wet season operation of the water treatment plant which is still under consideration by the MTC.

Mr Welch advised the key findings from the recent review of water quality monitoring procedures used by ERA at Ranger included:

- previous groundwater sampling procedures didn't adequately describe bore purging requirements to ensure a representative sample is collected;
- field filtering and acidification is important to ensure that water chemistry of samples is preserved during storage and transport to the laboratory;
- the need to keep appropriate records of field equipment calibration to track performance; and
- the need to collect field and travel blanks for quality control.

Discussion

Dr Mudd asked how the proposed TSF crest raise would be included in the authorisation conditions given the operator doesn't currently have approval for the maximum operating level required to use the additional capacity. He also asked what DoR will do to ensure this is the final lift of the structure. Mr Ball advised that

DoR would amend the maximum operating level. Dr Barry queried if there are additional scientific implications of the proposed TSF raise, despite it having engineering and technical approval. Dr Mudd noted the proposed lift involves a range of overlapping scientific and operational issues.

Dr Mudd noted he was aware that a number of different levels had been put forward for the temporary RL in Pit #1 and asked if 15m RL was now settled as the maximum level. Mr Welch advised that 15m was the current level agreed by the MTC, with ERA seeking to raise the RL to 15.9m for contingency containment of process water. Mr Kyle noted that the clay seepage limiting barrier in Pit#1 ends at 15m and that ERA is seeking to raise the maximum operating level above this. Prof Woodroffe advised he was interested to hear the various issues and basis for concerns regarding the proposed process water management strategy. Mr Welch advised that the contingency in the event that current maximum operating levels are reached would be to pump to Pit#3.

Dr Stauber asked if audits of the water management system are carried out on a regular basis and Mr Welch advised that a regular program of audits were conducted at the mine site. He added if water quality issues were identified, more detailed reviews would be carried out and recommendations provided to the mine operator who would then be expected to provide a detailed response on how they intend addressing these. Dr Stauber asked if there would be follow up action and Mr Welch advised this would be part of check monitoring.

Ms Iles also noted that DoR would normally include any recommendations to the mine operator and resultant remedial actions in its report to ARRAC. Dr Jones noted there have previously been issues in relation to data presented to ARRAC by DoR and the mine operator. Mr Welch advised that DoR is always concerned to ensure that data presented to ARRAC by the mine operator and DoR are comparable. Mr Hughes noted for example the situation where DoR check monitoring data was stable but the mine operator's data was noisy. Dr Jones noted there are sometimes reasonable explanations, such as seasonal variability in water level, for differences in results between point measurements conducted at different times by the respective groups. Mr Welch noted that groundwater results were most susceptible to such variation. Dr Mudd advised it was imperative for data to be subject to proper quality assurance to ensure their validity and usefulness. Dr Stauber noted that data quality had appeared to improve in recent times.

Mr Kyle agreed with Mr Welch that the important issue is not necessarily the differences in absolute values of the data produced by different groups, but the consistency in time trends. He noted the example of pH readings of 3.7 and 3.94 reported for an upstream sample in different pages in the Jabiluka report and suggested the fact that no one questioned this was surprising. Mr Kyle advised he agreed there was no point worrying about having agreed absolute values between the mine operator and DoR but he was very concerned that samples taken on the same day and in the same place were different due to one sample being processed by in-field filtration (DoR) and the other (ERA) not. His view was that the mine operator should be doing in-field filtration and acidification. Mr Kyle stated it was unacceptable that the mine operator could be allowed to not do this on the basis it was too costly. Mr Ball advised that DoR was still discussing this matter with the mine operator through the MTC process. Ms Iles advised that ERA is currently looking at the data and will report back to MTC in due course.

4.3 Northern Land Council (Mr Thompson)

Mr Thompson advised that the NLC had nil to report this meeting.

4.4 Supervising Scientist Division (including monitoring) (Mr Hughes)

Mr Hughes noted that at the last meeting ARRTC was advised that SSD was in the process of transitioning from grab sampling to continuous monitoring based on the view that continuous monitoring is a more effective means of monitoring water quality in dynamically changing stream environments. He advised that starting with the 2010-11 wet season, continuous monitoring and automated grab sampling triggered by EC or turbidity events is now SSD's primary physico-chemical monitoring method. He noted that routine

biological monitoring using aquatic snails is continuing in both Magela and Gulungul Creeks. He also noted that ERA has also established a number of continuous monitoring sites along Magela Creek adjacent to the minesite, and that these will complement the existing monitoring programs conducted by ERA and SSD. Mr Hughes stated that these sites, taken in combination, contribute to increasing overall confidence that all events that occur are able to be captured, and the sources of these events will be able to be more reliably established.

Mr Hughes advised that SSD is now looking at determining the effect of pulse events on in-stream biota. He noted that previous work had focused on Mg as a contaminant of concern and this had led to the determination of the ecotoxicological relationship between concentrations of Mg and biological effects. Mr Hughes advised that SSD is now developing an assessment framework (based on pulse concentration and exposure duration) which more closely represents the actual situation in the system. Once validated, this approach will be presented to the MTC with the view to its ultimate use by the regulator. He noted that the use of continuous monitoring and the insights it has provided into system dynamics has led to significantly improved water management around the mine and has assisted in identifying pressure points and risk areas. Mr Hughes indicated an example of this was ERA's response to remediating deteriorating water quality in RP1, which involved the construction of a seepage interception trench around the base of the Western waste rock stockpile. Mr Hughes advised that SSD met its target through the 2010-11 wet season of making the continuous monitoring data publicly available on its website weekly in arrears.

Discussion

Dr Stauber asked if SSD was reporting both EC and turbidity data and Mr Hughes confirmed this. Prof Woodroffe asked if continuous monitoring means the peaks that were previously being missed are now being captured. Mr Hughes confirmed these events are now being detected. He noted that due to the size of the catchment, pulses of water go down the system in timeframes that are too short for grab sampling to detect, so continuous monitoring provides a better dynamic understanding of the movement of contaminants in Magela Creek. Mr Hughes noted, in particular, this understanding had resulted in ERA better managing the discharge of water from RP1.

Dr Barry asked if the availability of event based sampling measurements of other water quality parameters can be undertaken. Mr Hughes advised that continuous monitoring measures EC and turbidity, while event based grab samples allow other analyses (such as U) to be done if required. Dr Barry asked if there is overlap between the previous sampling system and the continuous monitoring and Mr Hughes advised that SSD has about 5 years of overlap. Dr Jones advised that continuous monitoring occurs on a 10 minute timescale so has generated a much larger dataset. Mr Hughes noted the most important issue is to determine the significance of these system pulses in terms of biological effects and advised this major work will be published as soon as it is completed. Prof Mulligan asked if the grab samples were taken on alarm levels. Mr Hughes advised event based sampling was initially activated when EC and turbidity levels reach a set trigger point, and continued for set increments of change thereafter.

4.5 Parks Operations and Tourism Branch (South Alligator Valley) (Ms Schofield)

Ms Schofield tabled a paper prepared by Mr Greg Balding and offered to take any questions on notice. Mr Hughes provided a brief overview of the operation and rehabilitation of former uranium mines in the South Alligator Valley.

Discussion

Prof Woodroffe noted the progress from the presentation provided last meeting. Dr Jones advised that SSD has also undertaken verification surveys of the rehabilitation works at various sites. Mr Johnston noted the rehabilitation works were a significant project. Mr Hughes advised the project had involved the burial of the contaminated material under 2m of clay with an earth cover which was consistent with the conditions imposed by ARPANSA. Prof Mulligan asked if data from the monitoring undertaken by Parks was being reviewed by SSD. Mr Hughes advised that SSD had offered to review the monitoring data from the site and

Parks had accepted. Dr Jones noted that access to the sampling sites is subject to seasonal weather conditions. Prof Mulligan noted the various issues associated with interpreting data gathered from point sources. Prof Woodroffe asked if there is any way of systematically monitoring erosion at the site and Mr Hughes advised that the “as built” report from the contractor (which is still to be provided) should provide a basis for determining this. He noted that the contractor had undertaken laser levelling of the site which should assist in reducing the potential for erosion that was noted during the first wet season after construction. Dr Jones noted that the monitoring of the containment site did not involve the same level of sophistication as that applied to the trial landform at Ranger. Mr Hughes advised that SSD concerns were primarily limited to ensuring the integrity of containment. Dr Jones advised that he understood a budget of \$129K had been allocated by Parks for monitoring but wasn't sure if this was over five years. Dr Stauber asked if ARRTC was satisfied with the plan presented by Parks. Further details on the monitoring budget and proposed data analyses were requested.

ARRTC26-8: ARRTC requested that Parks Australia Division provide further details on the monitoring budget and data analyses proposed for the SAV rehabilitation site.

5 Science underpinning regulatory decisions (Mr Ball)

This agenda item was moved to Friday 0830.

6 Research Activities

6.1 Supervising Scientist Division

6.1.1/6.1.2 Major *eriss* projects - status and future - Dr David Jones, *eriss*

Dr Jones advised that the key outcomes of the 2009-10 work program were documented in the Annual Research Summary circulated to ARRTC members in January 2011. The production of this summary was brought forward to provide time for briefing of existing and new committee members in advance of ARRTC26, given the second ARRTC meeting in 2010 was not held. Dr Jones noted that the SSD research program for 2011-12 will mainly involve continuing these existing projects. Dr Jones then presented highlights under selected KKNs.

2010-11 wet season - Dr Jones noted the 2010-11 wet season was the 3rd wettest year since 1970 with 2240 mm rainfall recorded to April 1 (average = 1560 mm). He noted the most significant event involved 190 mm rainfall in two hours at Ranger in February due to a local storm over the minesite. Dr Jones advised that all existing and newly installed equipment/infrastructure performed well and SSD had met its target of public reporting of data. Prof Woodroffe asked how the rainfall event (190mm overnight) compared with previous intense rainfall events. Dr Jones advised there had been a previous event of 700mm over 48 hours in 2007. Dr Erskine noted that an event of 850mm had previously been recorded at Jabiru and that these are historically very notable events.

Continuous monitoring of EC – Dr Jones advised that continuous monitoring is providing an improved understanding of the full dynamics of the system. Dr Barry asked if the pulses were typically hours or days in duration and Dr Jones advised most events are of relatively short duration of up to a number of hours.

In-situ toxicity testing using freshwater snails – Dr Jones described the in situ toxicity program involving deployment of aquatic snails over a 4 day (chronic exposure) period upstream and downstream of the mine. This involves determining the upstream-downstream difference in numbers of eggs laid. Twenty years of time series data are available for Magela Creek, with the method having been deployed in Gulungul Creek over only the past two wet seasons. Dr Jones presented snail data for Magela and Gulungul Creeks for the previous and current wet seasons and noted that, for 2009-10 and 2010-11, higher downstream egg production was observed in Magela Creek. Dr Jones also noted there was no correlation with main mine constituents so this could possibly be the result of increased settling of organic detritus (snail food) in the test

containers. ERISS is currently quantifying the mass of settled detritus in the upstream and downstream snail capsules.

Dr Stauber asked if the use of snails was new in Gulungul Creek. Dr Jones advised that this was the case, with the deployment being initiated in response to the likely increased level of activity in the Gulungul Creek catchment, coupled with the increased levels of solutes in leachate from waste rock used for the tailings dam wall raises. Prof Mulligan asked if the new Heap Leach project, if approved, would be effectively monitored by the existing Magela Creek monitoring sites. Dr Jones advised that ERA was proposing to upgrade its monitoring activity in the Georgetown Creek catchment so this would address the onsite aspect. SSD's site would continue to monitor for any inputs that exited the site and reached Magela Creek. Prof Woodroffe asked if the current proposed Heap Leach site location requires monitoring points in Corridor Creek and Mr Hughes noted that monitoring sites are already in place in Corridor Creek. Ms Iles advised that additional monitoring sites are located in Georgetown Creek which are currently collecting baseline data and are proposed to be part of the monitoring network for the Heap Leach facility.

Dr Jones advised that two auto samplers have been installed on the Magela downstream pontoon, specifically to be able to separately focus on solute and turbidity pulses since EC and turbidity tend to behave differently. Prof Woodroffe asked if different results were recorded by the two different types of samplers and Dr Jones confirmed this. Mr Hughes advised that non-mine turbidity events are recorded but that most solute events were mine related.

Dr Stauber asked about the situation in Gulungul Creek with respect to higher downstream numbers of eggs being laid by snails, and Dr Jones advised that the same effect was being observed as in Magela Creek. Dr Humphrey advised that there was still no result on the possible reasons for this. Dr Jones advised one possible reason may be the sources of additional nutrients from billabongs. Dr Stauber commented the 2009-10 SSD report stated the opposite – that egg production was greater upstream. Dr Jones noted that, whilst this was generally true for previous data shown in the SSD Research Summary, the most recent results shown in his presentation were for the 2010-11 wet season only. Prof Mulligan asked if controlled laboratory ecotox studies on the effects on snail egg production had been carried out. Dr Jones confirmed this but noted that no specific studies had been done on the effects of an exogenous food supply (e.g. settled detritus). Dr Humphrey advised that snail stream data going back to 1992 show good conformance through time.

Mg pulse toxicity (KKN124) – Dr Jones advised this work aimed to determine the toxicological significance of pulse exceedances of the Mg guideline value (inferred from EC), to provide the basis for developing a new assessment framework to be applied to the continuous monitoring data. In this context he noted that one of the outstanding issues was developing guidance for determining the conditions under which a number of closely spaced pulses could be considered to be a chronic exposure regime for the purposes of applying the most appropriate guideline value. Dr Jones presented the IC 10 values for a range species for Mg pulse exposure durations, ranging from 4 h to 24h, showing that the IC10 values generally increased steeply for exposure durations of less than 24h. For the water flea, the life cycle stage at which the pulse occurs is an important consideration when determining the sensitivity of this species. Dr Jones noted that none of the EC pulse events recorded over the past five years would have resulted in biological impacts, based on the results from the pulse exposure testwork.

Dr Jones noted that there are some remaining experimental difficulties with the *Chlorella* assay and that these need to be resolved before the pulse exposure testwork for that species can be completed. Dr Stauber asked if dialysis (to separate the algal cells from the exposure medium) had been considered. Dr van Dam indicated it had been tested but had proved to be too slow.

Dr Erskine asked if any of the species were dissolved oxygen (DO) sensitive and Dr van Dam advised that ultimately this would depend on DO tolerance of the test species being looked at, noting that all SSD laboratory toxicity testing is done under well oxygenated conditions. Dr Jones commented if looking at metal toxicity then low DO conditions, if they occurred concurrently, would be an additional stressor. He added

that lower DO could be an issue for some of the billabong environments, but not for Magela and Gulungul Creeks, which remain well oxygenated through the wet season and recessional flow periods.

Dr Jones advised that the continuation of the Mg pulse exposure project in 2011-12 would include completing the remaining core program of testwork and any additional tests as required, and the development of a pulse-exposure based assessment framework for discussion with stakeholders.

Sediment toxicity of uranium (KKN124)

Uranium has a high affinity for organic matter and will accumulate in sediments. In this context Dr Jones noted that there is very little ecotoxicological data available on sediment uranium toxicity and there are no national or international guideline values for uranium in sediment. In particular, there are no sediment uranium trigger values for Magela Creek and regional billabongs. Gulungul Billabong was selected as the study site for this work given that its sediments contain low levels of U consistent with the regional background for billabongs. In contrast, Georgetown Billabong contains higher than regional baseline levels of uranium, and hence could be considered to be compromised from the point of view of carrying out this type of toxicity testing work.

Dr Jones advised the preparation of sediment material for first pilot deployment (2009-10 wet season) involved the sieving out of organic material, a long period of equilibration of the spiked sediment prior to deployment, and the “baking” in the sun of the deployed sediment containers for a period of about 2 weeks before the billabong wetted up. A very low abundance of macro-invertebrates was recorded in the material retrieved at the end of the wet season. It was proposed that this may have been due to the drying out of the sediment to a mud brick like condition before the water level rose. Mr Hughes suggested that it might also have been affected by sampling timing as well. In this context Dr Humphrey noted that the wet season was not average. Lower levels of dissolved oxygen could have also been a possible influence but this was discounted by the lack of correlation between lower DO levels and benthic macroinvertebrate abundance and diversity for SSD’s control billabongs in the ARR.

Dr Jones presented an ordination plot that summarised the results from the bacterial metagenomics classification. The results showed a separation of the high uranium treatment from the controls and from the lower uranium treatments. Dr Mudd noted that the sulfate-only treatment also appeared to be reporting as a separate cluster. Dr van Dam advised the high uranium treatment also had high-associated sulfate and Dr Jones added that one problem with sulfate is that it can be reduced to sulfide under anoxic conditions with resultant toxic effects to biota. Dr Stauber suggested the abundance title in the graph was somewhat misleading and noted it really should refer to community structure. Dr Jones noted that amongst the types of bacteria, *geothrix* particularly stands out as being highly abundant in the high uranium treatment. He added that *geothrix* has been previously associated with higher metal environments and this aspect warrants closer attention.

Dr Jones advised that the sediment preparation method used for the second pilot run through the 2010-11 wet season was much less disruptive to the structure of the collected sediment material, than the method used for the first pilot. The coarser organic matter was not sieved out and the U spiking was done by infiltrating uranium solution through the sediment contained in its deployment container, followed by gentle physical mixing of the material to ensure even distribution of U through the bulk of the material. Dr Jones noted the advantage of this method of spiking is that the entrained sulfate was able to be largely washed out of the sediment by rinsing with water, thus removing the complication of elevated sulfate as an additional variable in the sediment system.

Ms Iles asked if the uranium was absorbed onto the surface of the sediments. Dr Harford noted that subsamples taken from the spiked material were analysed for horizontal and vertical distribution which showed only slight vertical stratification. Dr Mudd asked what the pH of the mixing solution was and Dr

Harford advised that it was about 5. Dr Harford noted that selected subsamples of material from the controls and spiked treatments had been sent to CSIRO for detailed chemical analysis¹.

Ranger Trial Landform design (KKN221) – Dr Jones described the scope of work for the project and noted its importance for providing data to conduct a risk assessment of the site post decommissioning and for informing the development of design criteria for the final landform. He also described the monitoring instrumentation installed on the four SSD erosion plots and presented examples of the continuous data being recorded, including the 190 mm rainfall event that occurred during the 10/11 wet season. Prof Woodroffe suggested that as load is decreasing there is logic in also reducing the intensity of monitoring. Dr Jones noted that any reduction in monitoring effort will be contingent on a close assessment of the results from the analysis of the two wet seasons' data that have so far been collected.

Landform evolution modelling – Dr Jones provided background on the CAESAR (Cellular Automaton Evolutionary Slope and River) model. This is a cellular landscape and river reach evolution model developed by Prof Tom Coulthard, Uni of Hull, UK with the original purpose of examining the effects of environmental change on river evolution and movement of contaminated river sediments.

Dr Jones advised the model is being used to predict evolution of erosion through time and to simulate effects of extreme rainfall events. He noted the model was modified in 2009-10 to allow different surface treatment types to be modelled, and further modified in 2010 to use rainfall recorded at 10-minute intervals. The model is being applied to the 30m x 30m erosion plots on the trial landform, with the predictions of the model being compared with the continuously measured flow and turbidity (suspended sediment) record.

Dr Jones advised a digital elevation model of the trial landform had been generated from a Terrestrial Laser Scan conducted in 2010. He noted that 25 scans at 2cm resolution had provided an almost photographic resolution image. However, this had to be downscaled to 20cm resolution to enable reasonable time runs for the model. Two sets of simulations were carried out using the full data set from Plot 2. The first was for the 10/11 rain year using measured rainfall as input. The second was a hypothetical 20 year simulation that repeated the 10/11 rainfall sequence 20 times

Prof Woodroffe commented that modelled versus field measured bedload cumulative yield results are based on the same rainfall events and asked how the model was configured to derive bedload. Dr Jones advised that the only input data required by the model are particle size distribution, rainfall and the surface DEM. The particles are “moved” by the erosive power of the runoff water, with larger (heavier) particles reporting as bedload to the collection basin and lighter (<64 µm material) reporting as the suspended sediment fraction that exits the system. Prof Mulligan asked what the particle size distribution was given the rocky nature of the site and whether the model assumes equal distribution of different size particulates. Dr Jones noted that the model used the actual measured particle size distribution produced as an average from several subsamples collected from across the surface of the different treatments.

Dr Jones presented a graph showing predicted time series erosion rates over a 20 yr period, noting that the time series simulation he showed was illustrative only and did not include the effects of vegetation establishment, or any evaluation of the potential effects of extremes rainfall regimes. It is the intent to compare real and modelled data through time as successive wet seasons pass. This will provide the basis for enhancing the capability of the model to account for the evolution of both physical and biophysical properties.

Dr Jones advised work during 2011-12 would include collation and analysis of continuous and grab sample field monitoring data from 2009-10 and 2010-11, a rerun of the CAESAR model to compare observed with predicted erosion rates, evaluation of the effect of evolution of self armouring and initial development of trees over part of landform, and calculation of solute export loads. He noted that the lack of a non-vegetated

¹ Postscript - The deployed sediment containers were retrieved on 11/4/2011 and subsamples dispatched for chemical characterisation and for bacterial and microinvertebrate genomic analysis. The macroinvertebrate analysis will be done internally by SSD. It is anticipated that the findings from the second pilot will be able to be reported at ARRTC 27.

control area could be regarded as an issue, but was not an aspect of the conduct of the landform trial that SSD could control. In this context it should be noted that the failure of the direct seeding establishment method has effectively provided two years or so of a surface treatment with essentially no vegetation coverage, and this will provide opportunity for comparison with the vegetated tubestock area.

Dr Jones advised that the model could be used to test various possible permutations of landform design parameters and, in particular, to test the effect of extreme rainfall events. This aspect will be especially important during the first 5 or so years when the exposed landform surface will be most vulnerable to erosion. Prof Woodroffe noted the presentation showed the spatial pattern of erosion and asked how CAESAR generates spatial projections of erosion. Dr Jones advised the each cell in the model moves particles to the lowest point, and that the model tracks the evolution of the topography in each cell. Dr Mudd asked if model has been applied to Nabarlek. Dr Jones advised that the Tin Camp Creek catchment had been looked at as an analogue to Ranger, and that the results of field measurements had been compared with the predictions from the Siberia and CAESAR models. Dr Mudd noted there is 16 years of data from Nabarlek so it seems a good opportunity to run the model for another location to further test its capability. However, Mr Hughes advised he didn't think a sufficiently detailed DEM was available for Nabarlek and Dr Jones added that we didn't have the erosion measurements. Dr Bartolo advised a coarse DEM would have to be used and Mr Hughes suggested subsidence at Nabarlek would also present a problem. Dr Jones suggested over the 0-10yr timeframe the amount of surface subsidence would be an important factor for the backfilled pits at Ranger given that they are much deeper than the pit at Nabarlek. Dr Barry suggested it would be good to use the site as an analogue but stressed the importance of model parameterisation. Prof Woodroffe suggested it would be good if the model could be used at Nabarlek and noted that while the Siberia model lacks the detail produced by event driven ones, it can still provide useful data.

ARRTC26-9: ARRTC proposed that SSD consider applying the CAESAR model to Nabarlek using available data

Prof Woodroffe asked if it was possible to generate DEMs for Pit#1 and see how the model behaves. Dr Jones advised that discussions to date had emphasised the need for a DEM with an appropriate resolution, and ERA had undertaken to provide such a model before simulations using CAESAR could be started. Prof Woodroffe asked if the learnings from the landform modelling were going to be incorporated into the final Landform design. Ms Iles advised that ERA will provide proposed final landform designs to SSD to model. Dr Jones advised SSD has only been provided low spatial resolution DEMs to date which didn't enable engineered erosion control measures to be introduced into the model at the required degree of spatial resolution. Until an appropriate DEM is provided SSD will not start modelling the proposed landform for the capped Pit#1. Dr Lu advised ERA will meet with SSD to discuss.

Water quality criteria for closure – Dr Jones outlined the status of current work on developing surface water closure criteria. He noted provisional surface water closure criteria for U and Mg have been derived from 1995, 1996 and 2006 macroinvertebrate sampling in Georgetown Billabong but finalisation of this work has been delayed pending the identification of the reasons for the lower benthic biodiversity in this billabong compared with reference waterbodies. Dr Jones advised that full macroinvertebrate resampling of impacted and control waterbodies will be undertaken during the 2011 recessional flow period, with the analysis of the data to be completed in 11/12. The trigger for doing this work is that the antecedent dry season water quality in Georgetown billabong was poorer than in 1995, 1996 or 2006. This provides the opportunity to extend the exposure data set and provide an additional data point to underpin the derivation of water quality closure criteria for potentially mine-impacted natural waterbodies on the lease.

KKN2.5 Ecosystem Establishment (as per ARRTC25 action) – Dr Jones advised the objectives of this joint work with ERA are to characterise plant communities from suitable natural analogue sites to assist in selection of species for revegetation of the Ranger mine final landform and develop suitable revegetation success measures. This work will also assist in determining the conditions required to support the vegetation and which types of vegetation are best suited to the rehabilitated landform. Dr Jones noted there are a number of potential analogue sites across ARR. He advised that to date no relationship has been found

between soil chemistry and spatial distribution of vegetation, with soil water availability and position in landscape being the most important determining factor in distinguishing between the three main plant communities that have been identified. Dr Jones advised the geographical focus of this part of the work will be narrowed down to areas closer to Ranger, given that, based on a broader regional analysis, the same three vegetation community types have been shown to exist locally. Work to be undertaken in 2011-12 includes modelling to determine the environmental requirements of dominant species and communities, assessing the reliability of earlier terrain analysis modelling used to derive landform design criteria, and assisting ERA to select long-term monitoring sites that represent the three key woodland community types identified in the region.

Prof Woodroffe noted the approach CSIRO had used for identifying land units is similar and Dr Jones mentioned that a terrain landscape functional analysis has been done for some sites. Prof Mulligan noted the integration of other factors like aspect, slope etc would all feed into water availability. Dr Mudd noted that the Georgetown analogue area will be impacted by the heap leach facility if this project proceeds. Dr Jones agreed and noted SSD was currently looking at other possible sites, as well as maximising information capture from the Georgetown area before the disturbance from construction of the heap leach project. Dr Mudd asked if any work on modelling evapo-transpiration would be done and Dr Lu advised that information about this topic would be presented later this meeting.

Pre-mining radiological condition (KKN2.2.5) – Dr Jones advised the aim of this project was to ground-truth pre-mining (1976) airborne gamma survey data at an undisturbed natural analogue (Anomaly 2) for Ranger to enable extrapolation to pre-mining radiological conditions for the Ranger lease as a whole. Dr Jones advised the work to be completed in 2011-12 would include determining the pre mining radiological conditions (γ dose rates; U (Ra) [Bq/kg] and Rn exhalation), predict radionuclide uptake in bushfoods and determine pre mining doses for various occupancy scenarios and geomorphic features on the site.

Dr Bollhoefer noted original ground surveys had been carried out, but that they were focused on the ore bodies and did not provide coverage for the broader areas of the lease. Mr Johnston advised that the SA Government carried out tests in SA comparing measured gamma to direct measurements on soil samples and the gamma was found to be much lower than actual soil radiation. He noted the samples were carried out in very sandy soils and Dr Bollhoefer noted the study area was also sandy clay and rocky outcrops. Mr Johnston asked if tests had been done to compare measured data given that usually it is the bismuth activity which is measured. Dr Bollhoefer advised SSD has tested the soil and compared the data. Mr Hughes advised that SSD had assumed any disequilibrium was due to the time the soil has been sitting there.

ARRTC26-10: ARRTC requested that SSD provide a report on the results of the pre-mining radiological condition project to next meeting.

Bioaccumulation of radionuclides in bush foods (KKN2.2.5) – Dr Jones advised the aim of this work was to develop a dose assessment model for radiation exposure of humans through consumption of aquatic and terrestrial foodstuffs. He noted that use of SSD's concentration ratio (CR) and ingestion dose database (BRUCE) will enable concentrations of radionuclides to be inferred if the concentrations of radionuclides in soil are known at a particular location. These concentration data can then be combined with knowledge of diet to estimate radiological dose from the ingestion pathway. Dr Jones advised that *eriss* has developed a comprehensive database, containing almost 2000 entries, using historical data. He noted this work has gained recent impetus due to increasing international interest especially in relation to radiation dosage to non-human targets.

Dr Mudd asked about migratory birds and Dr Jones advised it was more difficult to sample birds than animals like the kangaroo, which are often obtained as road kill victims. Dr Jones advised more than 2000 data points exist in the database which enables flesh activity concentrations to be calculated with maximum and minimum range values. Dr Mudd noted a range of animals can be modelled. The topic of averaging data for wider range foraging animals was raised, with one possible solution being to use spatially averaged soils data obtained from airborne radiometric surveys. Dr Jones noted it was obviously easier for vegetation,

which is fixed in location. Dr Jones advised the work program for 2010-11 will be database development and for 2011-12 will include finalising the ingestion dose front end, the whole body CR calculations in the database, and publishing the CRs in *Radiation Environment Biophysics* and contributing data to the *Wildlife Transfer Database*.

KKN 2.7.1 ERA of the rehab and post rehab phases – Dr Jones advised that there is a lack of accurately geospatially referenced and spectrally-corrected high resolution satellite data for the Alligator Rivers Region, in particular the Magela Creek Catchment and floodplain area which is required for inundation, habitat type and ground cover mapping. He advised that SSD was the first major customer to use the new WorldView- 2 satellite which is part of the DigitalGlobe constellation. Dr Jones advised the satellite provides spectral coverage over 8 bands at high spatial resolution. Prof Mulligan asked if SSD has obtained past imagery and Dr Bartolo advised SSD has obtained GeoEye images from 2009 and high resolution Quickbird images previously. However, the ground control for these images and spectral correction was not optimal. Dr Jones advised the key outputs from this work will include characterisation and mapping of vegetation analogue communities across the Magela Catchment, extraction of vegetation biophysical parameters from the imagery to test as landscape monitoring metrics, the first vegetation map of the Magela Floodplain and inundation mapping. It was noted that these outputs would be of value to Parks and would also feed into collaborative work with the National Environmental Research Program (NERP) and Northern Australia Water Futures Assessment (NAWFA) program. Prof Woodroffe asked if SSD was going to map all of the stages of both current rainfall inundation scenarios as well as possible inundation as a result of climate change induced sea level rise. Dr Bartolo confirmed that this would be the case. Prof Woodroffe queried if wet seasons involve lots of variability of wetting up and vegetation distribution and Dr Bartolo advised there is a high degree of variability and stated that through the Tropical Rivers and Coastal Knowledge (TRaCK) inundation mapping project, they had used Foley's precipitation deficit index, (which is the standardised monthly mean annual precipitation over a specified lag period relative to the long-term mean annual precipitation) to identify years of maximum and minimum rainfall for the Daly River catchment. Previous studies in northern Australia found that 3 years is a significant lag period and this figure was used in that project.

New ERISS program group – Dr Jones advised that the former Hydrological and Geomorphic Processes (HGP) group has been reconstituted as the Physico-chemical Processes (PCP) group in order to integrate water quality monitoring with the hydrologic stream and landform geomorphic research functions. He noted that the group, led by Dr Wayne Erskine, would also maintain all of SSD's continuous monitoring time series data.

Knowledge Management Projects - Dr Jones advised the implementation of the new point source database (Envirosys) was expected to be completed by early in 2011-12. He also noted that the upgraded electronic document records management system would be implemented by September 2011 and that the Divisions IT refresh was scheduled for late May 2011.

Dr Stauber thanked Dr Jones for his presentation and noted that it was a highlight of the meeting.

ARRTC26-11: ARRTC commended Dr Jones on his presentation on the SSD current and proposed research programs.

Climate Change presentation Action from ARRTC25 (Dr Bartolo)

As requested by ARRTC at last meeting, Dr Bartolo provided a presentation on climate change projections for the Alligator Rivers Region. Dr Bartolo advised the most recent projections were contained in the CSIRO technical report *Climate Change in Australia* (2007). Dr Bartolo advised the projections were based on the consensus output from 23 models (but not for all projections) and six emission scenarios. She noted that the change scenarios were presented for 2030, 2050, and 2070 relative to 1990 (baseline is actually 1980-1999, but often referred to as 1990). Dr Bartolo commented that the northern monsoonal tropics already have high natural variability that will be superimposed on any future climate change effects.

Dr Bartolo presented a summary of the projections for the Alligator Rivers Region which included higher temperatures with increased frequency of hot spells, potentially a small increase in rainfall (however, it is not possible to make definitive statements on the direction of change due to the uncertainty within the modelling), more frequent extreme rainfall events, increased evaporation, a likely increase in intense cyclones but a possible decrease in the total number, and sea level rises of up to one metre (18-59cm) by 2100. Dr Bartolo outlined the implications of these projected changes in terms of the KKNs and future work requirements.

Dr Stauber asked if the predicted cyclone frequency was counterintuitive and Dr Bartolo advised that this is related to the ENSO and local sea surface temperatures. Prof Woodroffe noted that because of the existing climate variability, by and large the modelling is not picking up the combined effects of ENSO and La Niña. Dr Mudd advised he has a PhD student currently looking at groundwater responses to periods of El Niño influence. He noted that at the moment a lot of climate change science understands possible implications for El Niño, while it is clear from the record that extreme events do occur. He suggested that climate variability will govern where things will go and, at a decadal scale, ENSO and PDO are important things to watch.

Prof Woodroffe advised he was surprised there hasn't been more focused work in the region to develop a more detailed climate change prediction, noting that CSIRO has been doing work to produce locally downscaled predictions for various organisations around Australia. Dr Barry noted this work is expensive to do and is inherently unpredictable, but he has seen analysis predictions of various extremes. Dr Smith noted that work looking at potential effects on northern Australia was being done by the Department of Climate Change.

ARRTC26-12: ARRTC requested that Parks Australia Division provide a copy to the committee of the Climate Change Report released by the Department of Climate Change which examined potential impacts on KNP.

Prof Woodroffe noted that the guidelines for the Heap Leach EIS included a requirement to consider possible climate change implications. Dr Mudd suggested that it's not the variability of climate per se that's the issue but the extreme events which have previously had a major impact on Ranger operations. Ms Iles noted the OPSIM modelling ERA does with the water balance on site includes the extreme event that occurred during 2007, and builds in the 120 yrs of rainfall data available from Jabiru and Oenpelli combined. The OPSIM model looks at sensitivities and produces a range of forecasting outcomes based on percentiles of occurrence. She added that the designer of the OPSIM model has also been doing some extreme event prediction work to feed into the Heap Leach EIS. Ms Iles noted the previous work done for Parks predicted salt water intrusion and Dr Bartolo advised she had gone through the report and the information presented is only high level and not detailed in terms of areas of inundation. She suggested that's why the work by Prof Woodroffe on the prehistory of floodplains is important and may be useful to assist in modelling what extreme events might look like.

Historical changes in annual rainfall across the Top End of NT – Dr Wayne Erskine

Dr Erskine provided a presentation on the results of a previous study of historical changes in annual rainfall across the Top End of the NT. He advised the study involved applying non-parametric statistics used in water resources assessment (Helsel & Hirsch 1992) to determine rainfall trends in the Top End. Dr Erskine advised the study also tested the hypothesis of Nichols & Lavery (1992) that rainfall has repeatedly switched between two different mean states over last 130 years, as first suggested by Carter (1990) & Mollah et al (1991). Dr Erskine advised there are 15 stations with between 68 & 136 years of rainfall record available. Of these he noted that Lavery et al (1992) found 3 stations in Top End suitable for climate change studies (Oenpelli, Pine Creek & Katherine) and that Lavery et al (1997) added 2 additional stations (Darwin Airport & Waruwi).

Dr Erskine advised that his analysis showed that annual rainfall oscillates between two different rainfall states (wetter and dryer) with the duration of each rainfall state being highly variable from sub-decadal to multi-decadal. He noted that all field measurements since 1994 - 1997 relate to a wet period and therefore

cannot be simply transferred to a dry period. He also noted the need to determine the influence of IOD, IPO, ENSO (SOI) and SAM.

Dr Erskine stated that water balance of mine sites must not be based on mean annual rainfall conditions which never occur and that the water balance of wet periods (current time period) is critical for mine management and must be used for design purposes. He suggested that ERA should look at decadal changes in mean rainfall conditions. Ms Iles noted that increased wetter periods are also being considered as part of the OPSIM modelling work ERA does with Water Solutions. She advised that each year the model is calibrated based on water used and evaporation rates and predicts how the mine water balance would respond if the previous rainfall records of past ~120 years are included. Interpretation of the results of model output takes this into consideration by using percentiles that reflect this rather than one that reflects the modelled minesite response to the average of the ~120 annual rainfall simulations. Ms Iles advised that ERA is seeking to incorporate more robust climate change analysis capability into the OPSIM model and has used this in determining the forecasts in the Heap Leach EIS. Ms Iles suggested that ERA staff meet with Dr Erskine to discuss the issues further.

Dr Erskine noted recent work by a PhD student shows that determining states can be found in the geological record of backwater plains, and that the zonal banding of carbonate deposits in caves may also correlate with changes in rainfall pattern. Prof Woodroffe noted it was stated in the MTC minutes that there was concern about using the estimated 1 in 1000+ event for 2007 as the basis for forward prediction. He noted that Dr Erskine has been talking about the rainfall record as a whole but suggested there is also a need to better understand the effects of extreme events (e.g. Cyclone Tracey and storms the size of Yasi). He suggested the main concern should be focused on really large events.

Dr Erskine noted that Dr Bartolo mentioned the KNP landscape symposium paper by Wasson & Bayliss. He indicated that personal communication with Bob Wasson confirmed this work is consistent with the findings presented today. Prof Mulligan commented that higher rainfall levels can result in increased runoff (e.g. 20% increase rainfall can result in 50% increase in runoff).

Dr Barry asked if the changes were detected across all stations and Dr Erskine advised that of the 31 stations analysed, the time of the change between the two states (i.e. wet and dry periods) was different at every station. Dr Mudd asked if temperature data had also been looked at and Dr Erskine advised it hadn't but agreed it should be looked at in conjunction with evaporative response. Dr Jones noted that for the OPSIM model of the tailings dam -which is essentially an open evaporative surface- the feedback effect between temperature and evaporation rate could be important. Dr Erskine noted that the available temperature records are a lot shorter than rainfall records. Prof Woodroffe noted that all climate change projections imply a greater intensity of rainfall and Prof Mulligan added that this will result in an increased percentage of runoff.

WATER MANAGEMENT ISSUES DISCUSSION

Dr Stauber noted the concerns of members regarding the current water management situation at the Ranger mine, and in particular the perception that the regulatory approach may not have been as proactive as required. Prof Woodroffe advised he was seriously concerned about the current water situation at Ranger. He noted the water level of the TSF was currently at 52.8m and the MTC minutes mention the establishment of an emergency management team should further rainfall occur. He advised that the current wet season shouldn't be seen as an extreme event, noting that climate variability is a real issue for this part of the world and a late season cyclone occurring at this time of the year is not necessarily a low probability. Prof Woodroffe advised, for these reasons, the current precarious state of water management at the mine is very concerning.

Dr Mudd noted that environment NGOs have been expressing concerns regarding the long term management of process water at Ranger for some time and in particular the fact that regulators appear to have been reactive, with approvals to increase onsite storage being provided to the operator when required rather than measures being imposed to force the operator to reduce the water inventory consistent with leading practice

principles. He further commented that, in his opinion, the current situation does not reflect world class regulatory practice despite the rhetoric. He noted that when he first started working with the Gundjeihmi Aboriginal Corporation (GAC) the process water treatment plant was just being constructed and this was supported by stakeholders at the time. However, the plant has never worked to design capacity and the process water inventory has continued to increase with the only option being to increase the TSF capacity, which has occurred.

Dr Stauber agreed the option to pump process water to Pit#3 which already contained 3 GL of pond water was not satisfactory as this would result in a substantial increase in the total process water inventory, without the commensurate capability to treat this water.

Mr Ball advised that it was incorrect to state that there was no expectation that the wet season maximum operating level would be exceeded, and in fact it was always expected that an extreme wet season might occur. Therefore the MOL for the TSF was adjusted accordingly. Dr Mudd noted the current tolerances would not take into account wave action associated with a cyclone and this was particularly unsettling given the proximity of the mine to an area of World Heritage value. Mr Ball advised that with 1m freeboard still remaining there was capacity (based on engineering advice) to accommodate wave action at the MOL of 53m. Dr Mudd suggested there was still significant uncertainty and debate about that. Dr Stauber noted that ARRTC did not want to stray into operational issues but needs to know that ERA has appropriate strategies planned for effectively dealing with the process water inventory over the longer term.

Dr Eaglen suggested that the prime focus of ARRTC should be on the science underpinning these decisions. He advised ERA supports full and open discussion with ARRTC on these issues. He noted that there have been various studies looking at variability of wet seasons over the past three decades and it is now fairly well accepted that over the past two decades wet seasons have been getting wetter. Dr Eaglen noted that in the past ERA has relied heavily on evaporative loss from the TSF for managing its process water inventory, and will continue to do so as part of its overall process water management strategy. However, he stated that ERA recognises the need to move towards large scale active process water treatment at a faster rate and this has been discussed in MTC meetings. He added that ERA is absolutely committed to this objective and would welcome ARRTC's advice.

Dr Eaglen noted that as part of this approach there is an urgent need to increase process water storage in order to ensure the surrounding environment (including KNP) remains protected, in advance of being able to implement active water treatment at the required rate. He advised raising the TSF to 57m is a key part of the proposed management approach. Dr Eaglen advised the TSF needs to be the right size for operational requirements but accepted that ERA has had some difficulty with getting process water treatment to sufficient capacity to progressively reduce the inventory.

Dr Eaglen advised that in relation to the perceived issues regarding impacts should the water level approach the MOL, the Australian National Committee on Large Dams (ANCOLD) guidelines, under which the dam is operated, take into account wave action. He advised that, on this basis he was comfortable with a level of 53m as the contingency point at which water will be pumped to Pit#3, even though this will significantly increase the process water inventory overall. Dr Eaglen noted however all options should be considered, and that current science supports a short term MOL of up to 15.9m in Pit#1, compared to its current MOL of 15m. Transfer of process water to Pit#1 avoids the consequences of discharging process water into Pit #3.

Dr Mudd advised he understood that the plan was to start pumping once water reached 52.8m and noted that a big rainfall event could dump a significant volume of water in a relatively short period of time. He noted the science underpinning the need for water treatment is still valid and the issue is that ERA has been dragging the chain. Mr Kyle advised that the ERA site manager agreed with GAC to start the pumps at 52.8m. He noted that raising the Pit#1 MOL above 15m is a problem because this will exceed the height of the seepage limiting barrier. Mr Kyle advised that in 2006-07 stakeholders approved relaxed controls for pond water management because ERA hadn't properly planned for an extreme wet season, and this was why work on the WTP really accelerated and the brine concentrator and covered evaporation projects were

proposed. Mr Kyle advised that due to two years of relatively dry wet seasons, ERA took its eye off the ball and the process water inventory has been increasing every year.

Dr Mudd advised one of the concerns regarding Pit#1 maximum RL of 12m for tailings deposition was that this was initially an interim plan and now it looks it could be like a longer term issue. He commented that the fact that ERA has been allowed to defer investment for process water treatment is unacceptable, noting further that that three months of lost production due to the shut down equates roughly to \$150m so the situation is also hurting ERA financially. He suggested ARRTC should request ERA to place a much greater priority on risk management.

In response to the points raised by Dr Mudd, Dr Eaglen advised the TSF 53m level will be treated as the maximum level before water will be removed, and that there has been no mention of using RP2 for storage of untreated process water. He noted the brine concentrator pilot work would be occurring in Melbourne over the next 18 months and a proposal was being presented to the ERA Board next week. Dr Eaglen also advised that the process water inventory had actually peaked a few years ago and had slightly decreased since then.

Prof Woodroffe advised he had some concerns regarding the current water management situation and also the content of the MTC minutes. In particular the statements that, as the 1 in 1000 yr rainfall could not be calculated, that it would be replaced with the maximum value from the current rainfall record. He noted also the MTC minutes state that 190mm of rainfall fell in six hours during the 2010-11 wet season which conflicts with statements by *eriss* that the rainfall fell in two hours. He advised these are issues that should increase the level of concern of all members. He noted the main issues of relevance to ARRTC relate to the science of extreme events and the quality of the science informing the management of the current situation.

Dr Stauber suggested that she could include words in the letter to the Minister on the outcomes of ARRTC26 expressing ARRTC's concerns regarding current status of water management at Ranger. She suggested ARRTC could also request a presentation from ERA on the longer term water management options and associated environmental and other risks, and the science required to appropriately address those risks. Dr Barry queried if the issue for ARRTC is that the risks associated with the current level of water in the TSF and the effects of extreme rainfall events haven't been properly or adequately calculated or is it to do with having a better scientific understanding of the risks associated with these types of events.

Prof Woodroffe noted that ARRTC is not fully aware of the science that has informed the regulatory decisions related to this issue. He advised he was also interested to know what science *eriss* has that may be relevant to the situation. Prof Woodroffe stressed the importance of appointing an independent scientific member with expertise in hydrogeology to ARRTC as soon as possible. He noted he was pleased to see the recent appointment of Dr Erskine to head the Physico-Chemical Processes Group in *eriss* but suggested the scope of the work of this group should extend beyond landform design and implications for erosional stability per se, and consider implications of extreme weather events such as cyclones. He noted that previous studies by Professor Jonathan Nott indicate there is evidence in the landscape of much larger magnitude events occurring than have been witnessed in recent times and therefore improving scientific knowledge in this area should be a high priority. Prof Woodroffe suggested it may also be appropriate to approach Geoscience Australia to investigate the cyclone history deposits on the coasts. He also presumed sources of information on cyclone history had been used in designing the final landform.

Mr Hughes thanked Prof Woodroffe for his comments and indicated this was the kind of frank expert advice SSD was looking for from ARRTC. He suggested that the relevant KKNs are probably a little vague in this area. Prof Mulligan asked if, reflecting on the role of ARRTC, whether there has been a failure in the science that allowed the site to get into the current situation. Dr Mudd suggested the main reasons why the current situation has arisen is that the water treatment plant has never worked as designed, and that over the ensuing nine years, ERA has failed to invest in appropriate and effective process water treatment and the regulator has failed to require the mine operator to remedy this situation.

ARRTC26-13: ARRTC requested that ERA provide a presentation to next meeting on water management including the risk context, threats to the environment and a written report on the science that has underpinned decisions and addressing likelihood and consequences of a range of scenarios.

Dr Eaglen agreed that ERA could have done more but argued the issue is more related to delays in decision making rather than any problems with the science per se. Mr Kyle suggested part of the problem stems from poor mine management and cited the example that in relation to the trial covered evaporation facilities, two units were installed and operated efficiently and effectively. He advised that his understanding was that Ranger engineers had then made a change to the design which decreased its efficiency and, as a result, during subsequent testing the units failed to achieve the required level of performance.

Dr Eaglen advised the covered evaporators were operated as a pilot study under which the performance is tested under a range of conditions to address questions of the effectiveness of the evaporators under differing operating and design constraints. The decision not to pursue the covered evaporators was based on the results of the pilot study as well as some concerns regarding the impact footprint. He noted that none of the culverts purchased for the project were stored in Darwin; half of the culverts have been donated to the NT government to use as an artificial reef while the remainder are still at Ranger. Dr Mudd asked if the report requested from ERA (see ARRTC26-13 action above) could be presented at least two weeks prior to the next meeting to allow sufficient time for proper consideration.

6.2 Energy Resources of Australia Pty Ltd

6.2.1 Operational Update and EIS briefing – Dr Peter Eaglen

Dr Eaglen advised Ranger performance during 2010 was characterised by a strong safety record and ongoing environmental protection. He noted work had also progressed on a range of strategic projects. Dr Eaglen advised indigenous employment continued in a range of operational roles and ERA remains committed to community development. He noted plant production had been at record levels prior to the shutdown although the quality of ore had declined. Dr Eaglen noted the establishment of the TSF working Group and its report as a key achievement. Dr Eaglen outlined the reasons for the temporary shutdown of production and associated water management issues at Ranger. Dr Mudd asked if had been entirely ERA's decision to shut down production and Dr Eaglen advised it was, but that early and proactive discussions were held with the regulators in relation to this. Dr Eaglen noted that the current wet season is the 3rd highest on record but commented that similar magnitude wet seasons had occurred in recent history so a wet season like 10/11 is not unusual.

Dr Eaglen advised key project tasks for 2011 included closure-related studies focussed on larger areas of Pit#1, Pit#3, transfer of tailings from the TSF and LAA rehabilitation trials, pond water management being enhanced with additional pond water MFRO treatment capacity, process water management focusing on the pilot plant trial for the brine concentrator, and the Heap Leach facility and Ranger 3 Deeps projects. The current major projects for ERA are the exploration decline and the Heap Leach facility.

Dr Eaglen noted that the indicative production profile tapers off to 2021, adding that the heap leach would not result in an expansion in production terms. Dr Mudd suggested there appears to be a significant discrepancy in the stated volume of 140K tonnes of ore to be processed by 2021, and the capacity of the processing plant, and asked what will happen to the remaining stockpiles. Dr Eaglen noted that the proposed Heap Leach facility will not be using high grade ore.

Proposed Heap Leach Facility EIS – Dr Peter Anderson

Dr Anderson advised the primary goal of preparing the EIS was to ensure the protection of the environment and this was based on a range of studies on flora/fauna/groundwater/noise etc. He noted that heap leaching is a long established technology globally but with a somewhat chequered history for technical performance. He advised that ERA has studied existing Heap Leach facilities around the world to identify best practice and that this information had informed and been incorporated into the design of the proposed facility at Ranger. Dr Anderson advised the draft EIS had been provided to stakeholders in January 2011 and ERA is currently

considering feedback from the government regulators. Dr Anderson advised that the process also involved extensive ongoing consultation with relevant stakeholders. He noted the current design incorporates a range of technologies to prevent potential environmental impacts such as the use of a double liner to prevent contamination of soil and groundwater.

Dr Stauber asked how the proposed leak detection system works and Dr Anderson advised the system uses a network of under surface probes in the drainage system and under the liner which detect any leaks and enable any fugitive fluids to be intercepted and pumped back into the circuit. Dr Mudd noted that similar leak detection systems are used widely around the world and are generally effective. Dr Anderson advised another innovation was the proposal to use dynamic stacks which are removed once leached thereby avoiding slumping issues. Dr Jones noted however dynamic stacking involves increased movement of equipment over the leach pad and therefore a potential higher risk of damage to the liner. Dr Eaglen noted the level of the reclaimer can also be adjusted.

Dr Anderson advised the proposed project also incorporates water management infrastructure which has been designed to cope with extreme weather and rainfall events. For example, the surge pond has the capacity to store wet season rainfall plus a 1 in 100 year, 72 hour event. Mr Johnston asked about the composition of the water in the surge pond and Dr Anderson advised the water is classified as process water and will be acidic due to the solution used for the leaching process. Mr Johnston asked if the surge pond would be lined and Dr Anderson confirmed this.

ERA screened a brief video presentation on the Heap Leach proposal.

Dr Mudd suggested there is an apparent discrepancy between the throughput rates stated in the video and the rates stated in the EPBC referral of 10m tonnes.

Dr Stauber asked about the reasons for the selection of the final site over the others considered. Dr Anderson advised the first BPT workshop held in 2007 looked at 15 sites and assessed each of these against criteria and narrowed them down to 3 main sites. He noted that since then, ongoing studies and consultation with stakeholders regarding cultural heritage values had led to further refinement. He advised the formal process of site selection was based on assessments against a number of criteria and followed a complex decision making process using Australian standards of risk analysis. Mr Johnston asked if the workshops involved the regulators and Dr Eaglen advised the workshops were facilitated internally based on feedback from relevant stakeholders. Dr Stauber asked if the EIS covers all three sites. Dr Eaglen advised the EIS guidelines required a discussion of the site selection process.

Mr Johnston asked if precipitates forming in the system would ever be a problem with respect to creation of blockages. Dr Eaglen advised that tests had suggested precipitates to be of low risk but that any that formed would be able to be cleaned out of the channels in the liner support system and ponds as required. Dr Anderson advised the Heap Leach facility was anticipated to be net loser of process water through evaporation, and that tailings and heap leach residues would be co-disposed into Pit #3. Prof Mulligan asked about the timeframe for possible underground mining and Dr Eaglen advised this would be subject to the approvals process and the provisions of the *Atomic Energy Act 1953*. Mr Kyle advised that after June 2015, ERA was able to request an extension of the lease for another 20 years. Dr Eaglen advised at this stage Pit#3 was due to be exhausted by either the end of 2012 or early 2013, and that exploration is continuing on the lease.

6.2.2 Trial Landform Update – Dr Matt Daws

Dr Daws advised that ERA is required to undertake rehabilitation of the final landform including revegetation. However despite a number of prior trials it was yet to be shown that a waste rock and topsoil land surface constructed according to the current closure plan design could be rehabilitated to the standard required by the Environmental Requirements. He noted that ARRTC was a key driver in the process of getting the current demonstration landform initiated. The site which was selected for the trial will be integrated into the final landform. He advised the objective of the landform was to demonstrate ERA's

rehabilitation capability, trial various rehabilitation techniques, assess erosion rates, radiation doses and runoff water quality, and establish indicative trajectories for vegetation assemblages post closure.

Dr Daws advised the revegetation trial involves a number of different plots of waste rock only and plots consisting of waste rock mixed with laterite with different planting treatments using seeding, tube stock and irrigation. He noted seepage from the site was also being collected. Dr Daws advised that infiltration rates varied across the landform depending on the composition of the surface, and that use of laterite has resulted in water ponding in rip lines. However, ponding doesn't occur on the waste rock treatment which actually contains significant level of fines compared to natural analogue soils. Dr Mudd noted there was limited compaction on the site and Dr Daws added that the surface had been ripped prior to planting.

Dr Daws advised that irrigation on waste rock plots results in wetting up and water infiltrating through all of the profile. However on waste rock/laterite plots there was limited infiltration down the profile. He also noted that a significant number of species died from water logging on the waste rock plus laterite treatment, especially those planted in rip lines. None of the plants on the crests died. Dr Daws noted the mortality on waste rock/laterite plots was probably due to water-logging but generally the survival of tubestock was impressive, with and without irrigation. Dr Stauber asked where the water used for irrigation was sourced and Dr Daws advised the water was sourced from runoff, RP1 WLF (RP2 water) and high quality groundwater.

Dr Daws advised direct seeding was carried out in the dry season of 2009 and that this treatment was irrigated twice a day. He noted there was extremely high mortality with low survival but it was not clear why, as all seed used were viable. Prof Mulligan asked what seeding rate was used and Mr Daws advised a rate of 3.5kg/ha including all seeds. He noted there was an option to increase the seeding rate but this proved problematic.

Dr Daws advised growth was fastest on the waste rock/laterite plots but seeding produced smaller plants than tube stock so it appears tube stock are better able to deal with the conditions. He advised landscape functional analysis was conducted and all three indices for plots with waste rock and waste rock/laterite were lower than natural revegetation. Dr Daws advised that faunal colonisation is occurring on the landform with ants, spiders and feral dogs/dingos being observed. He noted there were also significant numbers of common rock rats which was probably due to the available habitat complexity and structure for rock dwelling fauna. Dr Daws advised fauna monitoring is ongoing.

Dr Daws advised that flows and water quality of runoff and seepage from the site was being monitored and this shows that the level of Mg is higher in seepage than runoff, and that there are much higher levels of uranium in some of the main drains than was measured in the runoff from the SSD erosion plots.

Discussion

Dr Jones noted the waste rock used to construct the bunds of the pilot RP1 wetland filter contained leachable uranium which resulted in the levels of uranium in water exiting the wetland being higher than the input. Likewise there is elevated uranium in leachate from the waste rock used to construct the walls of the TSF. Hence it is possible that the U being measured in the drains is leaching from the competent waste rock used to line them. Dr Mudd asked if the level of uranium in the rock had been measured as it looked like leaching rather than evapo-transpiration, and even with corrected data, elevated uranium levels were evident. Mr Hughes asked if a gamma survey of the plot had been undertaken to estimate the content of radionuclides including U.

Dr Daws advised future activities would include assessment of tube stock versus direct seeding, ongoing weed control (especially on laterite mixes), flora/fauna, and environmental monitoring, and a study of 'hydraulic behaviour and vegetation performance' (PhD study with CDU 2011-2013). Prof Mulligan noted the earlier slides showed an image of a landform which had a number of batters. Mr Daws advised that this was a conceptual figure only that didn't represent the design of the final landform. Prof Mulligan noted if using rock from the Pit it is not expected to produce fines, then what confidence is there that the final

landform will have a similar particle size distribution as that found for the trial. Mr Daws noted that the surface operation of earth moving equipment will also generate surface fines as part of the landform construction process. Prof Mulligan suggested given the lower survival attributed to water-logging a strategy of selective planting on the crest may be useful. Dr Barry asked what is expected to happen with infiltration in 10-20 years time. Mr Daws advised that it was expected that infiltration rates should increase as the organic matter content of the surface horizon increases. Prof Mulligan asked what density the key species are at and Mr Daws advised around 800 stems /ha but probably closer to between 450 and 800 stems /ha.

6.2.3 Ecohydrology at Analogue sites – Dr Ping Lu

Dr Lu advised that significant knowledge gaps exist for plant-soil water interactions and the hydrological behaviour of natural catchments around the Ranger lease. He noted the project aims to assess catchment hydrology and the soil-water storage required to support self-sustaining woodland on a rehabilitated mine site to inform the design of the final cover. Dr Lu advised the project involved measuring evapo-transpiration across a range of ecosystems in the Georgetown analogue area since the end of 2008, quantifying woodland water extraction from the soil profile down to 6 m depth and assessing hydrological behaviour and plant performance of the constructed trial landform.

Dr Lu described the various instrumentation installed at the analogue area sites which include sap flow and soil moisture probes, watertable detector, a weather station for the entire area and stream flow monitoring downstream of the catchment. Dr Lu noted that FDR (Frequency Domain Reflectometry) probes were used for soil moisture measurement in response to a question from Dr Mudd. Mr Johnston asked how plant sap flow was measured and Dr Lu advised the method was based on measuring the temperature difference between two probes inserted into the tree.

Dr Lu described the effects a hot fire that went through the sites 20 days after initial installation had on canopy dynamics and tree water use. There was immediate defoliation following the fire followed by re-sprouting by 20 days after, with the system fully recovered 6 months later. He noted that the fire also affected sap flux with tree water use shut down to almost zero immediately following the fire, and starting to recover within 20 days after the fire when trees started re-sprouting.

Long-term monitoring of inter-annual variation in eco-hydrology had shown that groundwater level at one of the sites located on top of the hill dropped below minus 10m. In relation to the presented leaf area index results Dr Lu advised there is a gap in the data due to no wet season access to the site. He noted leaf shed occurs for some species as groundwater recedes during the dry season and that the significant drop in leaf area index in 2009 was due to it being a particularly dry year.

Discussion

Prof Woodroffe noted the site was burned and Dr Lu advised the entire site was burned so the data presented are from the period post fire. Dr Mudd asked if position in the landscape was a factor influencing the reported results and Dr Lu advised the variation in vegetation was due to the different land types and moisture states. Dr Lu noted that tree water use and thus sap flow declines over the dry season then increases again at the commencement of the wet season. He added that the literature states that vegetation extracts water mainly from the top 2m of soil profile. However current data show significant extraction of water below 6m in the late dry season which has implications for the final landform design.

Dr Jones asked if the extraction was direct (i.e. through the roots) or capillary action and Dr Lu advised it was direct extraction. Prof Woodroffe asked if the trees dropped their leaves as the conditions become drier and Dr Lu confirmed that this occurs. Dr Lu presented the results of inter tree variation in sap flow and noted the behaviour varies between different species. Future work will include incorporating the findings into cover design and the revegetation strategy (e.g. species selection and planting densities for different location, plant water requirements and soil moisture holding capacity), prediction of impacts of extreme events and global changes effects on the compositions and structure changes of the vegetation, and comparison of ecosystem function along a chronosequence of the vegetation at the Georgetown Analogue sites, the 12-year-

old Heritage revegetation site and the trial landform. Dr Lu also advised that a new project had just been started by a PhD student from CDU.

Dr Stauber noted the project is generating significant volumes of publishable data and is exciting research. Dr Mudd agreed the project was very important and the results will underpin so much of the rehabilitation work on the site in the future. Dr Erskine suggested adopting an engineering approach in relation to tree water use which could show sap flux density in mm per day and compare this with evaporation rates as a means for establishing the net water balance of the plant. Dr Lu advised this was planned to be done. Dr Erskine suggested the work be published in the ecohydrology journal and Dr Lu advised it was planned to publish results later in 2011. Prof Mulligan asked if Dr Lu had a feel for the proportion of mid-storey versus ground-storey in terms of evapo-transpiration. Dr Lu stated there is no ground level storey in place on the trial landform but further work is planned looking at evapo-transpiration in the under and mid-storey.

Prof Mulligan asked how much time was available before the site was impacted by the heap leach project and Dr Lu advised about two years. Dr Eaglen noted this timeframe would obviously depend on project approvals. Prof Mulligan commended Dr Lu on the work to date and agreed it was important. Prof Woodroffe noted the current demonstration landform is relatively flat and asked if further work was planned to see if more variable topography could introduce additional effects. Dr Lu noted previous work by Humphrey and Hollingsworth identified a link between topography and distribution with species on high well drained sites being more adapted to well drained soils.

6.2.4 TSF Work Group – independent review results and status – Mr Alan Puhlovich

Mr Puhlovich provided a presentation via phone on the results of an independent review of the hydrogeology in the vicinity of the TSF, and seepage issues focusing on the conceptual hydrogeological model and groundwater behaviour along preferential pathways. He advised that a key aim of the investigation was to review and revise the current conceptual hydrogeological model in the vicinity of the TSF with particular focus on preferential flow pathways, consider the dynamic nature of the hydrogeological conditions at the site and recommend areas of focus for future investigations. He also noted that revision of the conceptual hydrogeological model had required the integration of data of different types and sources to enable comparison and understanding of the links between groundwater chemistry and elevations, surface water conditions and potential source terms/receptors. Mr Puhlovich advised the key findings of the work were that:

- a three-aquifer system exists, with fracturing in weathered/fresh rocks hosting pathways for migration of seepage-affected groundwater away from the TSF and other sources, e.g. infiltration from walls and stockpiles, leakage from surface water;
- different to previous models, seepage from TSF occurs at increased depths than previously considered and that Mg and SO₄ (rather than Ra and Mn) are more appropriate indicators of seepage;
- following the change in groundwater monitoring strategy in 2003, there are insufficient monitoring data to effectively assess seepage mechanisms in the region of TSF, and seepage rates beneath TSF were unable to be determined but seepage velocities were estimated; and
- based on velocity estimates, the principal seepage pathway is to the north and SED2B and RP1 currently recharge the local groundwater system.

Mr Puhlovich advised key knowledge gaps include the current lateral/vertical groundwater quality along the perimeter of the TSF, the direction and concentrations of seepage affected groundwater to the north of the TSF, potential seepage to west and south-west of the TSF, the nature and volume of solute mass beneath the TSF floor, poor constraints relating to seepage away from the TSF and the type and extent of interactions between surface and groundwater. He outlined the future work required and noted other related research by CSIRO and a collaborative project involving ERA, Curtin University and the University of WA.

Discussion

Dr Stauber asked if there are any implications for surface water to the north of the TSF and is this complicated by other sources. Mr Puhlovich advised the TSF was constructed before the 2/3 stockpile and RP1WF were positioned. He advised there was clear evidence of groundwater movement prior to these structures but the stockpile probably expanded the zone of contamination to the east and west. Mr Puhlovich noted that while there is a need to better characterise seepage pathways which are heading down to the fractured rock aquifer at depth the review concluded that there was no expectation that this groundwater will contaminate surface water systems.

Dr Mudd asked about the sink caused by Pit#3 and the effect on shallow and fractured rock aquifers. Mr Puhlovich advised he was not sure if there is a link between Pit#3 and the area north of the TSF or if this was due to the bore not functioning properly. Dr Mudd asked if rare earth signatures were being looked at and Mr Puhlovich thought the work was focused on isotopes but wasn't sure. Dr Jones noted that using trace elements would be difficult. Dr Mudd added that this has been looked at previously and asked if there have been technological advances in the methodology. Mr Puhlovich noted the weight of evidence could identify the parameters that need to be monitored and that Mg and SO₄ are the key indicators. Dr Jones noted the sulfur isotope ratio for sulfate originating from sulfuric acid used in processing used to be very different to sulfate produced from weathering of waste rock. However, the more recent source of S used to produce acid had an isotope ratio much closer to waste rock, and thus afforded a less sensitive indicator of source. In this context Dr Mudd noted that most seepage in groundwater northwest of the TSF would be from an earlier time so perhaps the sulfur isotope method might still be useful.

Mr Welch asked what the timeframe for the research projects was and Mr Puhlovich advised the solute transport model was a significant piece of work and that calibration was expected to be done by the third quarter in 2011, with forward predictions for closure and rehabilitation due by early 2012. Mr Welch noted the results of this work will be important for the regulator in assessing the application to raise the TSF. Dr Eaglen advised that 3D modelling of the catchment is time consuming and costly. Dr Jones advised that SSD is concerned about Pit#1 closure and noted that until there is a model that can be used to predict the long range consequence of backfill of Pit#1, that it will be very difficult for ERA to convince stakeholders that its proposal for closure of the pit will be environmentally acceptable. Mr Puhlovich noted that while a whole of site transport model may not ever be developed due to the computing power required; looking at the three groundwater catchments across the site footprint there is no evidence of any cross interaction between the groundwater in these systems. Dr Jones advised this needs to be looked at independently and in parallel and Mr Puhlovich agreed this was a valid point. Mr Kyle recalled ARRTC recommended a number of meetings ago that 3D transport modelling be undertaken following the Aquaterra report and noted this hasn't been done as yet.

Dr Mudd asked if Pit#3 closure in 2012 would mean no further tailings would be going to the TSF. Dr Eaglen advised that there will still be tailings being generated post mining of Pit#3 but that these would be deposited in Pit#3 as soon as the base of the pit had been prepared to receive tailings.

6.2.5 Wetland Filter studies - Ms Iles (on behalf of Ms Valdron-Clark)

Ms Iles advised that a number of studies have been undertaken to investigate the possible causes of the declining performance of the RP1 constructed wetland filter (RP1WLF) at Ranger. She noted that RP1WLF had previously operated at 99% efficiency in relation to uranium removal but performance had declined annually since 2003. Dr Jones noted that in this context there has also been a massive increase in loads and an associated decrease in average retention times during that period. Ms Iles advised that calculating the efficiency of wetland filters was a complex task and depends on what factors are taken into account. She noted that different methods had been used over the years which made comparisons difficult and numbers had to be recalculated using a standardised approach. Ms Iles noted the current work is important as it will inform the design of any sentinel wetlands on the rehabilitated site from an ecological perspective. Dr Jones

noted that the proposed SSD sentinel wetland project will be important in this context and suggested that the forthcoming capping of Pit #1 may provide an opportunity to provide a field test for this.

Ms Iles discussed the various processes that operate within the wetland filter that assist in the attenuation of metals and detailed the operational history of the RP1WLF. She noted the dieback of *Eleocharis* and the subsequent partial recovery and the development of microbial mats and the shift from a closed vegetated assemblage to open water with floating algal mats. She also noted the associated step change in EC levels in 2001-02. Dr Jones noted that uranium levels also display a step change around that time. Ms Iles advised the structural changes including the dieback of emergents has influenced the current hydraulic conditions for the wetland.

Prof Woodroffe asked if the organic substrate is accumulating in these systems and Ms Iles confirmed this was the case. Ms Iles noted previous work on NT wetlands looking at EC effects on plant type suggests that the species of *Eleocharis* (*E. dulcis*) used at Ranger may perform better with shallower water depths. She further stated that pH is an important factor affecting uranium attenuation, noting in this context the increase in pH of RP2 feedwater in recent years as a result of higher carbonate content at the base of Pit#3 and increased alkalinity occurring with the WLF itself related to algal dominance. Ms Iles advised the key conclusions from this work are that the ability of RP1WLF to attenuate uranium has declined due to a number of factors including the die-back of *Eleocharis* due to ecological constraints, and the increased alkalinity and pH of RP2 water leading to an increased proportion of the dissolved U to be in form of the more weakly adsorbing uranium carbonate complex.

Discussion

Dr Stauber asked if it is practical to lower pH in the WLF and Ms Iles advised it would be possible but would probably require the use of acid. She added the primary purpose of the WLFs was to treat pond water to remove uranium prior to land application. She noted however there is still a need for an answer to the question about what caused the widespread dieback of *Eleocharis* given the proposed use of sentinel wetlands post rehabilitation. Ms Iles noted the need to prevent algal dominance in these systems means that the needs of macrophytes also need to be considered. Ms Iles noted that the cells of the WLF are uniform in depth so some variation in depth could be achieved by introduction of benches and trenches.

Prof Woodroffe noted anaerobic and aerobic issues in sediments had not been mentioned and Ms Iles advised that samples had been analysed in terms of sulfide levels and this shows there are some anaerobic zones and other aerobic iron oxide dominated areas. She noted that cell 9 contained deeper water so was more anoxic than others. Acid-base calculations had been done to determine acid formation potential of the sediments. Dr Jones noted he undertook work in 1997 looking at diurnal performance which showed that pH dropped at night and the water column became anoxic near to the sediments which is important in terms of uranium removal. In fact for this reason the removal of U occurred to a much greater extent at night. Ms Iles advised the report on this work would be available for ARRTC members.

ARRTC26-14: ARRTC commended ERA staff on the quality of their presentations and thanked ERA for providing the opportunity for ARRTC to visit Ranger.

6.3.1 Environment NGO update - Report on public seminar. Dr Gavin Mudd

Dr Mudd advised he attended a public workshop on Thursday evening organised by the Environment Centre NT. He noted that the workshop was attended by approximately 140 people and discussed a range of issues including the current problems with water management at Ranger. Dr Mudd advised that the Traditional Owner, Ms Yvonne Margarula, has restated her calls for Jabiluka to be incorporated into the Kakadu National Park. He noted that environmental non-government organisations were planning to campaign and raise public awareness of water management and proposed developments at Ranger this year. Dr Mudd noted that he had planned to provide a presentation on the Heap Leach this meeting but as the EIS has still not been released he suggested he provide the presentation at the next meeting. He also suggested that Dr Eaglen may wish to jointly present.

Dr Mudd advised he wasn't able to comment on the calls to incorporate Koongarra into the Park as he was not aware of the status of this. Mr Anderson asked if there were questions from the public regarding the proposed major projects at Ranger and Dr Mudd advised the biggest concerns included whether ERA will be able to commence rehabilitation in 2020, the transport of sulfuric acid through the Park and issues to do with the rehabilitation process. He added there was a clear focus on nuclear issues in light of the Japanese nuclear emergency. Mr Kyle noted that ERA had been invited to attend and speak at the workshop but had declined².

Dr Mudd advised he would be interested in seeing a number of publications on the ERISS list and will follow this up out-of-session. Dr Stauber noted the reason why the publications lists were on the agenda was to encourage publication for peer review and she commended SSD and ERA for continuing to publish the results of their respective research efforts. Dr Jones noted a number of documents were available from the ARRTC website including a protocol document describing SSD's toxicity testing setting out what is measured and why, and the underlying scientific basis for doing this work.

7 Other Business

Mr Hughes asked the new members if the amount of information provided prior to meeting was satisfactory. Prof Mulligan indicated he thought the information was somewhat voluminous and late in arriving. Mr Hughes asked members if missing a meeting caused any significant concerns and canvassed the option of having only one meeting a year. Dr Stauber advised she had found it problematic only having one meeting in 12 months. Dr Mudd suggested that given the importance of the current water management and other issues at Ranger, reducing the number of ARRTC meetings at this point would seem highly problematic in terms of providing transparency. Dr Barry suggested that holding fewer meetings would result in members losing context and being unable to keep on top of issues. Prof Woodroffe suggested the views of *eriss* staff about having fewer ARRTC meetings are probably as important.

Dr Stauber noted there are a number of tasks ARRTC will need to progress out-of-session including the revision of the KKNs and comments on the draft conceptual pollution pathways report. Prof Mulligan agreed it is important that ARRTC progress this work and asked if members need to communicate out-of-session. Dr Stauber requested that members communicate as required out-of-session and respond to requests from the Secretariat in a timely way if possible.

7.1 SSD Publications since ARRTC25

See publications listing on ARRTC members' website.

7.2 MTC Minutes

Dr Mudd advised he had serious concerns regarding the level of detail in the MTC minutes tabled by DoR which are essentially a list of decisions and actions with insufficient detail provided on the discussion surrounding each decision, or the scientific data and/or information on which these decisions were based.

8 Next Meeting

Dr Stauber advised the next ARRTC meeting would be held in Darwin in October or November and asked all members to notify the Secretariat of any dates they are not available around this time. Dr Stauber requested the Secretariat to circulate advice regarding the two independent scientific members once they have been appointed by Minister Burke.

ARRTC26-15: ARRTC requested the Secretariat to circulate details on the two new independent scientific members once they have been appointed by Minister.

² On 12 April 2011, Energy Resources of Australia Ltd advised that no such invitation had been received from either the Environment Centre NT or NLC and requested that the meeting record be annotated to reflect this.

9 Meeting Close

The meeting was closed at 1.00pm.

Approved 29 November 2011