

ALLIGATOR RIVERS REGION TECHNICAL COMMITTEE

MEETING 22, 22 – 24 OCTOBER 2008

MEETING OUTCOMES

ATTENDANCE

MEMBERS

Mr Ray Evans - Independent Scientific Member (Chair)
Dr Carl Grant - Independent Scientific Member
Prof Peter Johnston – Independent Scientific Member
Dr Simon Barry – Independent Scientific Member
Dr Terry Hillman - Independent Scientific Member
Dr Jenny Stauber - Independent Scientific Member
Mr Alan Hughes – Supervising Scientist (Thurs and Fri only)
Mr Alan Puhlovich – Energy Resources of Australia Ltd
Ms Sharon Paulka – Uranium Equities Limited (member elect)

APOLOGIES

Mr Howard Smith - Northern Land Council
Mr Russell Ball – DRDPIFR
Ms Anne-Marie Delahunt – Parks Australia North
Dr Tony Milnes – Energy Resources of Australia Ltd

PRESENTERS/OBSERVERS

Mr Gary Martin – DRDPIFR
Mr Geoff Kyle - Gundjei'mi Aboriginal Corporation
Ms Shelly Iles - EWL Sciences Pty Ltd
Dr Ping Lu – EWL Sciences Pty Ltd
Dr Matt Daws – EWL Sciences Pty Ltd
Dr David Jones - Environmental Research Institute of the Supervising Scientist
Dr Andreas Bollhoefer - Environmental Research Institute of the Supervising Scientist
Dr Chris Humphrey - Environmental Research Institute of the Supervising Scientist
Dr Ken Evans - Environmental Research Institute of the Supervising Scientist
Dr Rick van Dam - Environmental Research Institute of the Supervising Scientist
Dr Renee Bartolo – Environmental Research Institute of the Supervising Scientist
Mr Bruce Ryan - Environmental Research Institute of the Supervising Scientist
Mr Mike Saynor - Environmental Research Institute of the Supervising Scientist
Ms Kate Turner - Environmental Research Institute of the Supervising Scientist
Ms Mel Houston – Environmental Research Institute of the Supervising Scientist
Mr Richard McAllister – Office of the Supervising Scientist
Mr Keith Tayler – Office of the Supervising Scientist
Ms Jenny Brazier – Office of the Supervising Scientist
Ms Ewa Madon - Office of the Supervising Scientist
Ms Michelle Bush - Office of the Supervising Scientist
Ms Jennene Marum – Office of the Supervising Scientist
Other Environmental Research Institute of the Supervising Scientist staff

SECRETARIAT

Mr Scott Parker – Office of the Supervising Scientist

Day 1 - Wednesday 22 October

1 Preliminary Session (Chair)

1.1 Welcome

The Chair formally opened the meeting and welcomed members and observers.

1.2 Apologies and Observers

The Chair noted apologies received from Mr Ball, Ms Delahunt, Dr Milnes, Mr Smith and Mr Hughes (for Wednesday only) and invited members and observers to introduce themselves. The Chair noted that as a result of the acquisition by Uranium Equities Limited (UEL) of the Nabarlek lease from Hanson Pty Ltd, Mr Ellsmore had resigned and Ms Sharon Paulka was attending the meeting as the UEL representative pending her formal appointment.

1.3 Correspondence

The Chair noted the following outgoing and incoming correspondence:

Outgoing

- Chair's letter of 12 June 2008 to Minister Garrett advising the outcomes of ARRTC21.

Incoming

- letter from Richard McAllister of 18 April 2008 on behalf of Minister Garrett responding to Chair's letter on ARRTC20 outcomes;
- letter from Minister Garrett of 28 August 2008 responding to Chair's letter on ARRTC21 outcomes; and
- letter from Minister Garrett of 20 October 2008 advising appointment of Prof Woodroffe to ARRTC.

The Chair noted Minister Garrett has indicated that he would support a relevant environment NGO having permanent observer status on ARRTC should this be requested in the future.

1.4 Conflict of Interest Declarations

The Chair called for any conflict of interest declarations. Dr Stauber advised that she wished to declare a possible conflict of interest in relation to a recent joint CSIRO-*eriss* project proposal to RioTinto dealing with the development of ecotox limits for uranium in sediments. Dr Stauber advised that the project proposal had been written 18 months ago and forwarded to *eriss* for possible collaboration. Dr Stauber advised that she had been trying to get ecotoxicity guidelines for uranium in sediments on the national research agenda for some time and that CSIRO is currently working on the development of a sediment quality guideline for Cu. She advised that in July 2007 she drafted a project proposal highlighting the lack of a national sediment quality guideline for uranium and had held discussions with a range of stakeholders outside of ARRTC (including EWL Sciences Pty Ltd staff whom no longer work for that organisation) and it was suggested that she include a paragraph in the proposal on Ranger.

Dr Stauber advised that she had held the draft proposal for some 12 months due to potential issues regarding confidentiality. Dr Stauber advised that, following the presentation by *eriss* staff on the outcomes of research on uranium in sediments at Ranger at SETAC in August 2008, she believed that this information was now in the public arena and, on this basis, she had presented the proposal to RioTinto. Dr Stauber stated that she had not had a chance to look at the report provided by EWL Sciences Pty Ltd on the sediments work requested at ARRTC21 until just prior to the ARRTC22 meeting, so it was not the source of the information contained in the proposal. Dr Stauber advised she was concerned that uranium toxicity in sediments was not a high priority on ERA's or *eriss*' research agenda, and she thought it would be possible to get RioTinto support for the project. Dr Stauber sought advice from ARRTC as to whether this constituted a conflict of interest.

Professor Johnston noted that he had previously declared a joint funding proposal to ARC he had developed with *eriss* staff and suggested that the fact that Dr Stauber's proposal involved *eriss* shouldn't in itself constitute a conflict of interest. The Chair suggested that if RioTinto funded the proposal prepared by CSIRO this could potentially raise some issues in terms of conflict of interest. Dr Jones agreed that there may be issues if some aspects of the proposal were based on unpublished work by ERA. Dr Jones advised that *eriss* faces this issue regularly in relation to the work it undertakes on behalf of ERA. He added that SSD has procedures in place to assess whether any proposed work may pose a conflict of interest.

The Chair advised that ERA representatives had raised concerns with him prior to the meeting that Dr Stauber's proposal may constitute a breach of confidentiality and conflict of interest. He noted that ERA had not raised their concerns directly with Dr Stauber. The Chair advised that a meeting would be convened the following day between the relevant parties to discuss the matter further¹. The Chair suggested that ARRTC was not in a position to form a view at this stage but would need to give the matter serious consideration following the proposed meeting. Dr Hillman agreed it is proper and important that the matter be reviewed given ERA's concerns regarding the potential conflict of interest.

The Chair noted the matter also raises the general issue of how information provided by stakeholder organisations to ARRTC members in presentations or reports should be treated, and whether ARRTC should require providers of such information to clearly identify information that is confidential. Dr Stauber reminded the meeting that she had previously raised the issue of confidentiality at ARRTC21.

2 ARRTC21 Outcomes (Chair)

2.1 ARRTC21 - Summary Record

ARRTC approved the Summary Record for ARRTC21 with no changes. The Chair asked whether the minutes from previous ARRTC meetings are publicly available via the ARRTC website. Mr Parker advised that he thought this was the case.

ARRTC22 Action/Outcome 2A

ARRTC approved the ARRTC21 meeting outcomes with no changes.

2.2 ARRTC21 - Business Arising

ARRTC reviewed the status of the following actions arising from ARRTC21.

ARRTC21 Action 4L – ARRTC agreed to carry forward the presentation on activities to integrate traditional knowledge into the regulatory process.

ARRTC21 Action 3E – the Chair noted that the prioritisation of the KKNs was undertaken internally by SSD and requested this item be carried forward so that ARRTC members could review and provide any comments.

ARRTC21 4D and E – Ms Iles advised that these actions were being addressed through the closure planning process and that ERA has determined that there is sufficient laterite available for the rehabilitated landform. Dr Grant noted that the issue ARRTC originally raised was the need to ensure that the final design cover mix for the landform is based on how much laterite is actually available at site. Dr Jones noted that a key issue was the proportion of clean (uncontaminated) material available versus the total material indicated to be available from mining records. He indicated that this could be assessed through drilling of the waste stockpiles.

Ms Iles advised that ERA was looking at the drilling results from a current low grade stockpile characterisation program for determining the potential resource available for extraction by heap leaching. Dr Grant indicated he assumed that the results of this quantity survey work would have been taken into account in the design of the demonstration landform. Ms Iles advised that the characterisation process will confirm the modelling assumptions in due course.

2.2.1 Environment NGO representation (ref Chair letter to Min Garrett on ARRTC21 outcomes)

The Chair advised that Minister Garrett had indicated in his response that he would support an environment NGO having observer status at ARRTC should this be requested in the future. Professor Johnston asked if any requests had been received to date and the Chair advised that no requests were outstanding.

2.2.2 ARRTC Confidentiality requirements (ref ARRTC22 Action 1A)

The Chair noted the issue of ARRTC confidentiality requirements had been raised by Dr Stauber at the last meeting and that further advice had been requested from the Secretariat on this issue. Mr Parker advised that members of ARRTC are subject to the same confidentiality arrangements that apply to members of other Australian Government advisory committees. He noted that, in general, these arrangements require that members protect all confidential information provided to them in the course of their work and to only use that information for the purposes for which it was provided for. Mr Parker noted that it is also standard practice that members of such bodies sign documents confirming their acceptance of the terms and

¹ The matter was subsequently resolved out of session to the mutual satisfaction of the relevant parties.

conditions of their appointment which may include deeds of non-disclosure and declarations of pecuniary interests. Mr Parker noted that the induction of ARRTC members in the past has been relatively informal and that members may not have signed non-disclosure agreements or terms of appointment. Mr Parker advised that the Department has a policy covering governance of committees and suggested that as a minimum the Committee should seek to comply with the key aspects of that policy. Mr Parker advised that he had drafted an ARRTC Terms of Appointment document based on the DEWHA policy and circulated it for member's consideration. A number of members advised that they have signed similar documents as part of their involvement with other government advisory committees.

Dr Grant expressed concern that imposing more formal confidentiality arrangements could hamper ARRTC's access to information from stakeholders and suggested that a case by case approach would be more useful. The Chair agreed that maintaining the free flow of information to ARRTC was important but noted most members were generally comfortable with the proposed requirements contained in the draft Terms of Appointment tabled by Mr Parker.

Ms Iles noted that ERA has previously provided ARRTC members with commercial-in-confidence information to assist them in their deliberations but given UEL and ERA are potential competitors, this may limit the level of commercially sensitive information ERA can provide ARRTC in the future. The Chair noted this is ultimately a matter for both ERA and UEL to determine but stressed the importance of ARRTC continuing to have access to all relevant information on the current and future operational activities of both ERA and UEL so that it can discharge its statutory responsibilities. Ms Iles suggested that UEL and ERA look at arrangements for handling the presentation and/or discussion of commercial-in-confidence information which could include either party agreeing to absent themselves for relevant agenda items. Ms Paulka agreed this was a sensible approach. ARRTC supported the proposed approach.

ARRTC22 Action/Outcome 2B

ARRTC noted that stakeholder members with commercial interests will agree between themselves whether they will absent themselves for agenda items involving presentation/discussion of commercial-in-confidence information – see also Action/Outcome 8A

3 Current Operations (Members)

3.1 Contextual statements by stakeholders

3.1.1 Energy Resources of Australia (Ranger & Jabiluka)

Ms Iles provided a presentation covering ERA developments at Ranger and Jabiluka. She advised that Dr Tony Milnes was now GM Environmental Strategy for ERA and Mr Alan Puhlovich was Principal Manager EWLS. She advised that radiation safety was still reporting through Ms Philipa Varris and that Mr Jody Clark is Manager – Water and Tailings in the Technical Projects group. Ms Iles presented ERA's 2008 indigenous employment figures and targets and advised that ERA has a target of 20% for 2008 and was currently at 18% with a total 91 employees, and was anticipating achieving 100 by November 2008. Mr Kyle asked how ERA defined "indigenous" in terms of the employment statistics and expressed some concerns about how indigenous employees are being defined and the accuracy of the indigenous employment statistics being reported by ERA. Ms Iles advised that the reported numbers of indigenous employees is based on those who identify themselves as being Aboriginal or Torres Strait Islander and includes people from local areas as well as interstate.

Ms Iles advised current operations included: preliminary earthworks for the Shell 50 extension of Pit#3; an expanding Western Stockpile; further drilling in the MLAA to explore mineralisation corresponding to the deeper south-eastern extension of Ore body #3; a focus on increasing the capacity for pond water treatment and commissioning process water treatment; wall raise on the tailings dam to RL54m underway; and utilisation of the new irrigation areas along Corridor Creek to dispose of pond water and keep Pit#3 dry for mining. Ms Iles advised that the laterite processing and radiometric sorting plants are currently being commissioned and that ERA is considering options for either an onsite acid plant or transporting acid to site.

Ms Iles advised that this dry season was different to previous years in that ensuring water supplies for onsite for construction, exploration, dust suppression and process into the late dry season, rather than disposal of excess water, was the driver for dry season water management. She advised that at the start of the season ERA had used a borrow pit as temporary storage for pond water in early 2008 to allow access to the bottom of the pit and had ceased land application on 11 June 2008. She also advised that the WTP had been shut down from 14 June 2008 in response to OPSIM water balance model forecasts which predicted there will be

about 400 ML water in the inventory at wet season start, if no further land application or treatment takes place.

The Chair asked what borrow pit had been used for water storage and Ms Iles advised that this was the footprint of the proposed RP1 (2) wetland filter. Dr Jones noted that RP1 (2) was never commissioned owing to the area being poorly sealed and subject to leakage. Ms Iles advised that compacted laterite had been placed on the bed of the RP1 (2) footprint so that it could be used as a water storage. Ms Iles advised that ERA is currently preparing for the wet season and has approval to remove the ferric floc front end for pond water treatment. She advised that the WTP had been turned off but was ready to be switched on as soon as it was needed for pond water treatment. Ms Iles advised that ERA is aiming to commence commissioning the front end of the process WTP shortly and that a technical working group is currently examining the best way to manage the waste sludge and brine.

Ms Iles advised that ERA had submitted an application to DRDPFR to raise the TSF dam wall to 54m, and that DRDPFR had subsequently sought advice from NRETAS on whether the application needed to be referred for assessment under the Environmental Assessment Act (NT). She noted NRETAS had advised the application did not require assessment under the Act but had sought clarification in relation to seepage potential. Ms Iles advised that ERA would submit a separate application for raising the MOL in the future which will include advice on impact of the higher water level on seepage potential as requested by NRETAS.

Ms Iles advised that ERA was continuing to implement a number of closure related projects and that the trial landform project was underway. She advised that evaluation of Pit#1 closure strategies was continuing with the Water Research Laboratory (University of NSW) looking at solute transport modelling and CSIRO Land and Water working on geochemical behaviour of tailings and conducting a research review and knowledge gap assessment for Pit#1 tailings and groundwater research. Ms Iles advised the MTC Closure Criteria Working Group had been established and work was continuing on draft Terms of Reference and the scheduling of meetings. She advised field investigation of Land Application Areas (LAA) prior to preparation of rehabilitation plans was continuing. The Chair asked if the Franz Kalf projects are going to be progressed by the Uni of NSW as part of their work. Ms Iles advised that these would be covered under the presentation on Pit#1 closure by Mr Puhlovich later in the meeting.

Ms Iles advised the Pre-Feasibility and Order of Magnitude Studies for a possible Ranger expansion investigated the optimum mining (open pit and underground) as well as the optimum mining rate together with an expanded mill. With the substantial amount of low grade ore already stockpiled on the surface, which will increase with mining of Pit Shell 50, Ms Iles indicated ERA is also investigating a low grade ore heap leach process which would work in parallel with radiometric sorting and milling to extract U_3O_8 from low grade ores.

Ms Iles advised that the Pre-Feasibility Study is currently being completed and recommendations will be reviewed by Rio Tinto and the ERA Board before a full Feasibility Study is initiated. Ms Iles also presented various Pit expansion scenarios and possible greenfield and brownfield sites for locating a low grade ore heap leach facility at Ranger. Ms Iles advised that the proposed expansion of Pit#3 and the development of a low grade ore leach facility will require some changes to infrastructure, potentially including a new acid plant and upgraded power supply system, changes to ERA's employee and contractor accommodation in Jabiru, and increased capacity for process water treatment. Ms Iles outlined the conceptual timeframe for expansion which would involve regulatory approvals and associated stakeholder consultations running from 2008, feasibility engineering studies continuing until late 2009/early 2010, ordering of long-lead items to start early 2010, detailed engineering studies being finalised in 2010, construction running through 2011/2012, and commissioning during 2012.

The Chair asked if deposition of tailings into Pit#1 would cease shortly and where tailings will be directed to if they are unable to be deposited in Pit#3. Ms Iles advised that the tailings would be directed to the TSF. The Chair indicated he thought the TSF raise was primarily for water storage purposes. Ms Iles indicated that the TSF raise was always proposed for both tailings disposal and water storage purposes. Dr Jones asked if there was a timetable for when the new options for process water treatment and management will be considered and implemented. Ms Iles advised that a range of options and alternative methodologies is currently being considered including research into enhanced evaporation. Ms Paulka noted that heap leaching would probably contribute to reducing water storage requirements due to higher levels of evaporation from the surfaces of the heaps. Ms Iles advised that the new OPSIM model currently being built will look at expansion scenarios in terms of water management and especially heap leach.

3.1.2 Uranium Equities Ltd (Nabarlek)

Ms Paulka provided the UEL stakeholder report covering UEL activities since acquiring the Nabarlek lease from Hanson Pty Ltd. She advised UEL has a joint venture with Cameco and there is potential for finding another high grade deposit. Ms Paulka advised that to acquire the lease, UEL had to post a rehabilitation bond of \$1.8m. She advised that UEL has met with the NLC and Traditional Owners and received permission to drill within an existing disturbed area within the fenced area after the MMP had been approved. All 2008 drilling has been completed and rig demobilisation is underway. She noted that heritage clearance for work outside the fence is being completed. Ms Paulka advised that UEL was doing a full assessment of rehabilitation needs and has employed a staff member with local area land management background and engaged Kakadu Native Plants to provide seedlings (2500) and assist in land management (weeds & fire). She advised UEL had established infrastructure and a camp to support rehabilitation activities.

Dr Grant indicated he was interested in the output of the work on rehabilitation needs and the proposed future directions, and asked if UEL had drawn on all of the existing research findings. Ms Paulka advised that probably 80% of available research had been reviewed together with the outcomes from the 2007 workshop and Traditional Owner meetings, and that all of this information would be included in the new rehabilitation plan. Dr Grant noted this and stressed that ARRTC's primary interest is in the proposed rehabilitation approach and underlying principles. Ms Paulka advised that the rehabilitation plan would probably be provided for ARRTC comment. Ms Paulka advised fire management was an ongoing concern given the current volume of fuel on site. However, UEL had not managed to burn the area as yet. Ms Paulka noted the main fuel sources were grasses and weeds. Dr Jones asked whether active weed control had commenced and Ms Paulka advised that this was yet to commence.

Ms Paulka advised UEL was looking at re-contouring of the WRD runoff pond and was aiming to have minimal erosion at this stage but will review at the end of the wet season. She advised UEL is looking to get on top of weeds and significant work has been done including poisoning of mahoganies and production of weed maps for the site using GPS mapped survey transects. UEL is planning to use these maps to develop a five year plan for targeted management of weeds. The Chair recalled that previously indigenous stakeholders had been very interested in protecting the mahoganies. Ms Paulka advised the mahoganies on site were essentially weeds so they were poisoned. Dr Grant asked about dispersal mechanisms and other factors that may have led to the current distribution of weeds. Dr Grant noted that there may be other indications from the mapping that should be looked at and possibly integrated into a future approach for weed control. Ms Paulka advised that UEL planned to integrate all of the available data to look for trends.

Ms Paulka advised that a survey of the old Nabarlek camp site had been completed. Samples had been collected and it was planned to create a licensed asbestos repository and permits would be sought by the next dry season. UEL is currently doing a survey of the old plant runoff area to determine if it is radiologically contaminated. It is planned to re-contour the site to improve drainage. The site is currently dominated by Para grass. Ms Paulka advised that the existing pads and concrete would be left at the site to provide a foundation for any future plant that may be installed. Dr Stauber asked how potential future mining would impact the rehabilitation area and would these activities overlap. Ms Paulka advised that most rehabilitation will involve management of weeds, and this will also be required should mining proceed.

Ms Paulka advised that another map of the radiologically anomalous area (RAA) had been completed which showed the area is 0.6Ha in size. The footprint is expanding owing to transport of erosion products. She advised UEL will undertake coring to determine depth of contamination and will then get an engineer's report on rehabilitation approach including guidelines for burial. Dr Grant suggested some minor earth works could be carried out to stabilise the surface. Ms Paulka advised that earth works have been held off due to potential OHS concerns. A dose assessment will be required. Ms Paulka noted the contamination hasn't spread off the lease but has expanded. Ms Paulka advised that surface and groundwater monitoring is continuing.

Ms Paulka noted that the revegetation seedlings had suffered a 64 percent mortality rate and didn't look as good as they did earlier. Dr Jones suggested the current high density of weeds may compromise rehabilitation and asked if UEL is looking to address the weed problem before rehabilitation. Ms Paulka advised that 2500 seedlings are under propagation and planning on planting is underway. She noted that at this stage black spear grass appears to not be the best selection as it holds ground well but doesn't allow canopy to propagate well. She advised that minimum seedling plantings were being done in areas where there is low weed density. Dr Grant noted that at last meeting there was a discussion about doing clump plantings as a means of getting some over-storey established. Ms Paulka advised that weeds are the main issue to be managed first and that next year the focus would shift to planting out the waste rock dump.

Prof Johnstone asked if the possible ore bodies at Nabarlek are expected to be small and high grade like original deposits. Ms Paulka advised that UEL is looking for the motherload that produced Nabarlek deposit

and also smaller isolated deposits that collectively may be economically viable to mine. She advised that UEL holds other exploration leases jointly with Cameco and the next find is likely to be a small high-grade deposit. The Chair noted that UEL is mainly interested in exploration at this stage and asked what will be the implications in terms of rehabilitation of the Nabarlek site if no deposits are found. Ms Paulka advised that UEL has set aside funding for the rehabilitation so this will continue probably over a 10 year timeframe. Dr Grant asked when the current lease expires and Ms Paulka replied that the current lease expires in March 2009. The Chair noted that ARRTC is more focused on mining rather than exploration activities within the region. Prof Johnstone suggested it would be valuable for ARRTC to get a briefing from DRDPIFR on the status and extent of uranium exploration activity within the region.

ARRTC22 Action/Outcome 3A

ARRTC agreed that briefing from DRDPIFR on the status of exploration activity in the Alligator Rivers

ARRTC22 Action/Outcome 3B

ARRTC agreed to modify the preamble to the KKNs to include exploration as a mining activity.

ARRTC22 Action/Outcome 3C

ARRTC agreed that version and change control facility be added to the KKN document to allow tracking of changes and better linking to project management.

Mr Kyle suggested there may be a range of research issues in relation to exploration and agreed that ARRTC should at least be aware of current exploration activities. Dr Grant indicated he thought that uranium exploration activities are covered under ARRTC's Terms of Reference.

3.1.3 Department of Regional Development, Primary Industry, Fisheries & Resources

Mr Martin presented the DRDPIFR stakeholder report. He noted there is no requirement for applicants for exploration licenses to specify specific target minerals so it is difficult to differentiate uranium exploration from general mining exploration. He noted there are currently 1012 exploration applications and 1244 have already been granted. Mr Martin advised that after a company has been issued with an exploration license they then have to apply for an authorisation at which time it can be determined whether they intend mining uranium or not. Mr Martin advised that there are currently 62 authorisations for uranium but only one operational authorisation which is for Ranger mine. He noted that the exploration license for the Angela project was issued on 10 October 2008 to Paladin and Cameco. Mr Martin advised that there are 32 exploration licences, 67 applications and 1 exploration moratorium currently in effect in the ARR. He noted that most current exploration activity in the NT is being undertaken by Cameco.

3.1.4 Northern Land Council

No stakeholder report was tabled by NLC. A paper by Mr Smith titled *"Using Traditional Ecological Knowledge to Develop Closure Criteria in Tropical Australia"* was circulated.

3.1.5 Supervising Scientist (including Monitoring)

Dr Jones advised that the past year has been one of consolidation for SSD after two extreme events in the previous two wet seasons. Firstly cyclone Monica in 05/06 and then the major flooding event in 06/07 which resulted in considerable damage to equipment. Dr Jones advised that the 2007-08 wet season had been unexceptional and this had allowed SSD to concentrate on rebuilding and further strategic development of the monitoring program. Dr Jones advised SSD has also worked with ERA/EWLS on developing the trial landform project. He noted SSD is currently facing a number of challenges with its internal data management and storage, and is undertaking a spatial data management review. Dr Jones advised that SSD is moving towards development of closure criteria. He noted that three years ago ERA had been focused on closure criteria but with the closure dates being pushed out some momentum had been lost. Dr Jones advised that SSD and ERA are now starting to look in more detail at issues such as surface and groundwater closure criteria.

Ms Brazier advised that she had recently moved into the Supervision and Assessment Section and was responsible for some of the work previously undertaken by Ms Iles. She advised that 2007-08 had been an average wet season and that Ranger off site surface water monitoring had not identified any issues of concern. Ms Brazier advised that all routine water chemistry results had been below guideline values. In relation to continuous monitoring, Ms Brazier advised that SSD was moving from the research phase to routine monitoring so it was likely this data would be reported more often. Ms Brazier noted that ERA

commenced siphon water releases of water from RP1 into Magela creek during the recessional flow period in early April 2008. She advised that SSD had contacted ERA when a significant and sustained uptrend in EC had been observed, and that in response ERA ceased the discharge. This underlined the value of continuous monitoring in being able to detect changes in real time and react accordingly. Professor Johnston queried whether salts may be exported from the LAAs during rainfall events.

The Chair noted the continuous data being collected by SSD was very useful however queried whether SSD has the resources to analyse the data on an ongoing basis. Dr Jones indicated that the rationalisation of the grab sampling locations in Magela Creek and the phasing out of creekside monitoring that will occur from the 08/09 wet season onwards freed up resources to be able to concentrate on the continuous monitoring data.

Ms Brazier advised that biological monitoring had shown no adverse effect on biota during 2007-08 wet season.

Dr Jones noted that the SSD monitoring grab samples are being taken at MCUS where ERA currently undertakes grab samples. Dr Hillman asked if this was the area where there had been a problem previously with cross channel variation in solutes. Dr Jones advised that cross channel variation was a potential issue at the 009 monitoring point, where inputs from the mine side of the creek tend to be preferentially directed along the west bank. Downstream of 009 the channel of Magela Ck becomes braided. Dr Jones noted that since the west bank of the west channel, where the SSD pontoons are located, displays the strongest minesite signal (based on cross channel profiling work) that this location provides the most conservative measure of mine influence. Hence, SSD is proposing to run one pontoon, at the location of the former creekside stations, equipped with two sondes and duplicate *in situ* snail biological monitoring tanks.

Ms Brazier gave a presentation, using Mg as an example, showing the comparison between the grab sample data obtained from MCUS and 009 with the corresponding data obtained from the upstream and downstream creekside monitoring stations over the past 10 years. Based on analysis of the data for the key solutes that are measured. SSD has concluded that shifting the location of water quality grab sampling to the same location as the continuous monitoring equipment will not compromise the continuity of the data record from either the upstream or downstream locations. It was proposed that this be done starting with the 08/09 wet season.

The Chair asked members if they wished to comment on the proposed approach. Dr Grant advised he assumed that SSD has done more rigorous statistical analysis, beyond a visual comparison of the mean and percentile distributions of the data sets from the different locations to support this. Ms Brazier advised that further statistical analyses had not yet been undertaken, but that this would be undertaken and the results formally documented in an internal report. Dr Jones advised that, in any case, the west bank pontoon at 009 provide a "worst case" indication of mine site impacts. The Chair noted that the statutory compliance point will continue to be 009, and that ERA and DRDPIFR would continue to sample where they have previously. The Chair asked if SSD envisaged being able to use the continuous monitoring data in a regulatory context where SSD may advise ERA where sampling starts to show a potential problem. Mr McAllister advised that this has happened already and continuous monitoring provides the basis for detecting events as they happen. The Chair noted this and suggested that if SSD is planning to use the data in a regulatory context, the data will need to be supported by scientifically rigorous interpretation. Mr Tayler advised that SSD would not consider using the continuous monitoring as a regulatory tool until full validation of the methodology had been completed. Targeted cross channel profile measurements and flow gauging will be conducted during the 08/09 wet season to provide additional data about the influence of preferential flow pathways on the continuous measurements.

Dr Barry asked how continuous monitoring assists in answering some of the current research questions. Dr Jones responded that the monitoring provides SSD with the ability to observe system response in real time, and hence to better understand the hydrodynamic conditions under which higher concentration pulses are likely to occur in Magela Creek. Integrated over a wet season the continuous data enable a much more robust estimation of the loads of solutes, and the sequencing of loads, being exported from the site. The Chair asked if SSD has done the statistical tests to compare the data from continuous monitoring with the grab sample water quality data. Dr Jones noted that the distribution of concentration data obtained from the weekly grab sampling program does need to be compared with the continuous data (time base of 10 min) in the context of the trigger guideline framework that has been developed, and is currently approved under the Ranger authorisation, for assessment of the weekly grab sampling data. He also noted that the continuous monitoring has detected infrequent short duration (typically <4h) pulses of EC that, when converted to equivalent Mg concentrations, approach or exceed the provisional Mg trigger value. The current ectox-derived guidelines used for assessing the grab sample data apply to chronic rather than pulse exposure scenarios. The effect of pulse exposure is being specifically examined by a program of laboratory ecotox

testing to determine if these short pulses could be having an effect, beyond that which would be accounted for by the current trigger framework. This issue is of particular concern to SSD's indigenous stakeholders.

Ms Iles noted that the locations of the continuous monitoring equipment (being proposed as the new location for SSD's grab sampling program) are not the same as the compliance sampling points. Dr Jones noted there is a potential issue regarding the continuity of data between the two locations, but that the material presented by Ms Brazier had indicated that the locations were very similar in their water quality record over the past decade. Dr Barry noted the key issue is the continuity of the data record and suggested there shouldn't be any major issues with having some minor differences between the data. Dr Humphrey suggested that issue of small levels of change are trivial compared to the change in values that typically occur, as a result of changing flow conditions, over a 24 hr period. He noted for example results from samples collected at 0900 hrs tend to be systematically lower than those collected later in the day.

Ms Brazier advised SSD is proposing to have, from the 08/09 wet season onwards, just one pontoon (for both grab and continuous water quality measurement) on the west side of the channel, given that the west bank provides the most conservative indication of mine site inputs. This station would be equipped with two sondes and replicate *in situ* snail deployments. In support of this, Dr Humphrey noted that comprehensive statistical analysis of both creekside and *in situ* biological monitoring data for both the west and east side of the west channel had shown close to zero difference.

The Chair advised he had no problems with the shift in sampling sites but suggested SSD needed to demonstrate by more rigorous statistical analysis that the two sites are not significantly different. Dr Jones advised that this will be done (see Ms Brazier's comment above). Dr Barry advised he thought the aims and approach appeared sound but suggested further work be undertaken to summarise more clearly the results of the East/West bank comparison work.

ARRTC22 Action/Outcome 3D

ARRTC endorsed the aims of the integrated surface water monitoring program by SSD.

ARRTC22 Action/Outcome 3E

ARRTC requested that statistical analysis be undertaken of the various sample populations of grab sample water quality data to support the hypothesis that the populations at the previous and the new grab sampling locations are the same.

3.1.6 Parks Australia North (South Alligator Valley)

Mr Balding provided a presentation on the status of the rehabilitation works being carried out by Parks North in the South Alligator Valley. ARRTC noted the status of the project and requested an update on the project in 12 months time.

ARRTC22 Action/Outcome 3F

ARRTC requested an update on the SAV rehabilitation project be provided at ARRTC24.

4 Science underpinning regulatory decisions (DRDPIFR) (ref ARRTC21 Action 4K)

Mr Martin provided the DRDPIFR report on regulatory decisions since ARRTC21.

Ranger

Mr Martin advised that since ARRTC21, ERA had submitted a number of proposals to the Minesite Technical Committee which had been reviewed in consultation with stakeholders and approved through the MTC process. Mr Martin advised that none of the proposals required regulatory approval as they did not require a change to the Ranger Authorisation. He advised ERA proposals submitted to the MTC included:

- 3 March 2008: Proposal to construct, commission & operate an Osmoflo pond water treatment plant & dispose of treated pond water at Ranger Mine. This had been reviewed by the MTC.
- 28 April 2008: Notification of preparatory earthworks for a lift to the Ranger Tailings Dam to RL54m and the construction of the demonstration landform.
- 11 May 2008: Notification of reinstating the temporary accommodation camp for construction workers at Jabiru East.
- 15 May 2008: Continuation of exploration drilling of Ore Body #3 at Ranger Mine.

- 15 May 2008: Proposal to construct an additional wall raise (lift) on the Ranger Tailings Dam to RL+54m. This had been referred to NRETA which advised the TSF lift wasn't a referable item under the NT Environment Assessment Act but raising MOL would require a change to the authorisation.
- 10 September 2008: notification to construct a trial landform at Ranger Mine.

Jabiluka

Mr Martin advised that, since ARRTC21, the MTC had reviewed the status of the Jabiluka Environmental Requirements and agreed to sign off on four previously approved requirements. The Chair asked if a water professional was engaged as part of the project to close out the Jabiluka ERs. Mr Martin advised that ERA had engaged a water professional and a number of reports were done. Mr Kyle noted that a report had been done on changes to surface hydrology that would be associated with the construction and operation of a mill at Jabiluka. Mr Martin advised he thought there was always an understanding that should the Jabiluka project proceed, additional work would be required. Mr Kyle noted DRDPIFR had prepared a summary document of progress against each of the Jabiluka ERs as part of the negotiation of the long term care and management arrangements in 2005. Dr Jones noted these came out of the Jabiluka PER.

Nabarlek

Mr Martin noted that Hansen Landfill Services sold the Nabarlek Mining lease to Uranium Equities Limited (UEL) on 4 April 2008. He advised that following the change of ownership, Hansen was issued with a certificate of closure and the existing Authorisation 0137-01 was revoked, and that Authorisation 0435-01 was granted to UEL as the new owner and operator of the Nabarlek site. He advised UEL had submitted an amended Mining Management Plan (MMP) for the Nabarlek site which included the proposed drilling program for 2008-09 and an updated security calculation. The amended MMP and security were accepted by DRDPIFR on 8 September 2008. Prof Johnston asked if there are any current applications for new uranium mines in NT. Mr Martin advised that there is significant interest in exploration but currently no mine applications. He noted there are also 24 projects in moratorium that could turn into mines and at least one is uranium related.

Thursday 23 October 2008

5 Research Activities & Key Knowledge Needs

5.1 Supervising Scientist Division

Dr Jones provided a summary of *eriss* research on ARRTC Key Knowledge Needs 2007–08. He advised 2007-08 was an average hydrological year which had allowed *eriss* to progress research activity which had been previously delayed due to extreme weather events (cyclone in 05/06 and flood in 06/07 wet seasons) in the preceding two reporting periods. Dr Jones advised the key *eriss* work highlights for 2007-08 included:

- Data analysis to support relocation of grab sampling point for SSD's independent water quality program
- Solute load mass balances from continuous monitoring data
- Red (suspended sediment) waters aftermath of the 2006/07 flood
- Finalisation of comparison of *in situ* and creekside for snail biomonitoring
- Longitudinal sampling of mussels along Magela Ck and in Mudginberri Billabong (Ra and Pb isotopes)
- Pilot investigation of toxicity of Mn
- Analysis of soil physical and chemical data for the vegetation analogue study
- Assistance to Parks Australia for South Alligator Valley rehabilitation works

Dr Jones advised *eriss* had undertaken a range of collaborative work with ERA during the reporting period including:

- the assessment of radiological signatures of land application areas – especially the MLAA – and looking at the affected footprint including Bushtucker and soil organisms. Samples have been collected and currently being analysed;
- excavation of old trial rehabilitation areas as part of reclamation of material for the TSF wall lift and comparison with naturally vegetated area (landform trial footprint), looking at depth of tree root penetration and root biomass to provide key data for cover design; and
- work in relation to the revegetation trial landform including technical meetings to agree on physical design of landform and cover scenarios to be assessed, and input to the design of erosion assessment infrastructure and associated monitoring program.

Dr Jones advised that the footprint for the demonstration landform had been cleared and dumping of waste rock for the base has started. He noted SSD would undertake background radon emanation measurements

of the footprint area. The completion date for construction and planting of the trial landform was still unclear but not likely to be until end Jan 2009 at the earliest.

Dr Jones advised **eriss** would be providing ARRTC presentations under Aquatic Ecosystem Protection; Ecotoxicology; Environmental Radioactivity and Hydrologic and Geomorphic Processes themes.

Ranger – Current Operations – Monitoring - Dr Chris Humphrey

Dr Humphrey provided a presentation on the **eriss** stream monitoring program for Ranger. Dr Humphrey noted that details of SSD 2007-08 stream monitoring results and proposed changes to SSD monitoring in Magela Creek had already been presented by Ms Brazier, and that Dr Bollhoefer would report separately on the longitudinal assessment of bioaccumulation in mussels in Magela Creek.

Comparative Assessment of in-situ and creekside methods for toxicity monitoring

Dr Humphrey advised that snail egg production results for *in situ* (using two different feeding regimes) and creekside monitoring were carried out over the 2005-06, 2006-07 and 2007-08 wet seasons, and noted the 2006-07 wet season was interrupted by a flood event. Dr Humphrey advised that a three factor ANOVA was used to test for differences in upstream-downstream egg number difference values amongst the two *in situ* and creekside treatments and this showed no significant differences observed between the treatments. Dr Humphrey advised that *in-situ* toxicity monitoring provides an improved testing environment, exposes test organisms to greater creek flow-through, vastly reduces staff resources and reliance on maintenance-intensive infrastructure, and is portable. He noted that the success of once-only feeding regime will further reduce staff resource requirements for this test. Dr Humphrey advised that based on the findings of the validation program, the *in situ*, once-only feeding regime will be used for future toxicity monitoring.

Enhancements to statistical analysis of biological monitoring data

Dr Humphrey advised that the Student t-test was employed in the past to test for differences in the upstream-downstream difference values between two time periods (in particular, before and after an event or wet season of interest). He advised that a more powerful and efficient two-factor ANOVA, with Before/After (BA) and Season (nested within BA) as factors was now being used. He advised the results of applying the ANOVA to the 2007-08 wet season results had shown that upstream-downstream difference values for snail egg production data are not significantly different from difference values measured in previous wet seasons, and that no differences were observed among the difference values for particular wet seasons within the Before (pre-2008) and After periods. Dr Humphrey advised that toxicity monitoring results indicated no adverse effects on freshwater snails from inputs of Ranger minesite waters to Magela Creek during the 2007–08 wet season. Dr Humphrey also advised that MBACIP design and analysis for assessing Ranger mine-related change had indicated that there was no significant difference between the control and exposed streams in relation to the change in dissimilarity between the values from 2007 and from earlier years.

Deriving a catchment solute budget for Ranger using continuous monitoring data

Ms Turner presented key findings of her work on deriving a catchment solute budget for Ranger using continuous monitoring data. She advised that natural and mine derived point sources are contributing to the total solute load at the Magela Creek downstream site. She noted that solute load can be calculated using solute concentration and measured discharge and integrating over time and that greater time resolution provides more accurate load assessments. Ms Turner advised that diffuse sources are also contributing to total downstream load, but this was difficult to quantify due to complex solute interactions with soils and ground water. She noted that mine-derived solutes from irrigation of mine water onto LAAs are eventually flushed into Magela Creek and that the load of solutes applied to the LAAs in any given dry season can be calculated using the solute concentration in the source water and the irrigated volume. Ms Turner advised that a good relationship was found between EC and Mg at RP1 and at GC2 (ERA's continuous monitoring locations), and this builds on the good correlation between EC and Mg at each of SSD's continuous monitoring sites in Magela Creek.

Ms Turner noted that data at the downstream site in Magela Creek spans a greater range of concentrations than the upstream site due to input of mine waters. She advised that different relationships in Magela Creek upstream and downstream of the mine reflect the influence of mine waters on the major ion balance at the downstream site. Mg and Na are co-dominant major ions in Magela Creek upper catchment water while the mine waters are MgSO₄ dominated. Accordingly the EC-Mg relationship at the upstream site is different to that in RP1 and GC2 due to the presence of significant amounts of the monovalent ion – Na – which has a lower specific conductance than the divalent Mg. She noted that the slope of the downstream Magela EC-Mg relationship lay between that for the upstream site and the mine-site slopes for GC2 and RP1 - consistent with mixing of the different sources. Ms Turner advised that solute input from the mine occurs on the western side of Magela Creek and results show that the waters downstream of the mine site are poorly laterally mixed, with the west channel consistently showing higher EC than the eastern channel, with the latter being

more similar to background levels measured upstream at the mine. This is also the case under high flow conditions. Ms Turner advised that the depth profile and the EC gradient vary under different flow conditions in Magela Creek and that the uneven distribution of solutes has made it difficult to accurately estimate total loads transported by Magela Creek.

Ms Turner advised that Magela Creek Mg loads were calculated and the continuous EC record was used to predict time series Mg concentration and the discharge measured at G8210009 was used to derive loads. She noted that due to the EC gradient at the downstream site, the EC measured at the west station in the western channel is always higher than the EC measured at the east station in the same channel. This concentration gradient potentially causes the load at the downstream west channel to be overestimated, in the event that the west bank data alone are used. Ms Turner advised that the total downstream load is essentially the sum of all point and diffuse inputs, and the difference between the loads derived for upstream and downstream is essentially the contribution from the mine catchment. Ms Turner advised that the results indicate that there is 100% recovery of Mg load at the downstream site and all of the Mg input to Magela Creek from the point and diffuse sources are accounted for at the downstream west site. Ms Turner noted that the data for the 07/08 wet season were not included in the validation analysis because the data for GC2 and RP1 had not yet been supplied by ERA.

The Chair suggested that, if the objective is to determine the solute balance, there is a need to take account of groundwater underflow that doesn't get measured at 009 but he thought this would probably be small. Ms Turner advised the loads for point sources are fairly accurate measures but it is difficult to measure input from the LAAs so the upper limit for diffuse input of Mg was estimated based on Mg loads in the water being applied to the LAAs. Ms Turner noted this assumed the total amount of Mg applied to the LAAs runs into Magela Creek. She indicated there appears to be close to 100 percent recovery when the amount applied to the LAAs is added to the inputs from upstream in Magela Creek and the amounts passing GC2 and RP1 in the Corridor Creek and Coonjimba (RP1) Creek catchments, respectively. Ms Turner advised that based on this mass balance closure, overestimation of solute loads from the minesite is considered to be negligible. The Chair asked if the concentration of solute in the central and east channels at the downstream location of the continuous monitoring stations had been looked at to see if this supports the hypothesis. Ms Iles asked if 100 percent of solutes are passing through noting that the figures in work by Klessa et al are different. The Chair asked to what extent this work had been compared to the previous work on magnesium and sulfate done by Klessa et al. Dr Jones advised it is important to note that when Klessa did his work he only had weekly grab samples to use so there was substantial interpolation (weekly) of the measured EC values, whereas the current assessment used the continuous EC data.

Prof Johnston asked how reliable the data are and Dr Jones advised probably at the ten percent level. Prof Johnston asked if the flow characteristics of the three channels (west, central, and east) of Magela Creek at the location of the continuous monitoring stations were well understood. Dr Jones advised that the west channel in which the continuous monitoring stations were located was the dominant flow channel in low to medium flow. However, the distribution of flow needed to be better characterised under medium to high flow conditions. This would be done in the 08/09 wet season with measurements being made of flow through the three channels under a variety of flow conditions. Dr Jones added that the close agreement in mass balance obtained using the flow measured at GS009 coupled with the EC values measured continuously a few hundred metres downstream in the west channel was much better than he would have initially expected, given the gradient in EC from the west to the east bank in the west channel.

The Chair asked if grab samples had been taken from the eastern channel at 009 and Ms Turner advised they hadn't. The Chair asked if there are grab samples from 009c and whether flow concentration relationships can be looked at to see if the hypothesis is supported by the data. Mr Hughes suggested the variability is probably within the error margins. The Chair advised he thought this was good work and *eriss* was close to closing the balance equation. Dr Jones added that it appeared that the pontoon bearing the datasonde near the west bank side of the west channel was located at a position in the cross section where it recorded the effective flow weighted average of solutes across the cross section. It was intended to further investigate this hypothesis in the 08/09 wet season. The Chair asked if concentration gradient measurements would be carried out and Ms Turner advised they would. The Chair further advised that the propagation of errors in the loads attributed to each source be tracked to see how they accumulate and hence how this affects the confidence that can be placed in the total load estimates.

Ms Turner advised the correlation between the input of diffuse sources of Mg versus rainfall appears to be linear with a zero intercept corresponding to 250 mm of rainfall. This was consistent for the 05/06 and 06/07 wet seasons. This suggests that 250mm of rain is required before the soil moisture deficit is satisfied and there is input of Mg to Magela Creek via shallow groundwater flow. The Chair noted that the soil moisture deficit looks higher than expected which could suggest significant uptake/interception by vegetation of

infiltrating rainfall. Prof Johnston asked when creek flow begins and Ms Brazier advised usually in the second week of December. Prof Johnston asked if the data are suggesting that there is no input of Mg into Magela Creek for the first weeks of the wet season and Dr Jones noted the data were for diffuse inputs only. Prof Johnston suggested the graphs really should have error bars, incorporating propagation of errors for each of the solute sources. Dr Hillman asked if the errors are systematic and Ms Turner responded that the instruments used to measure are properly calibrated, with regular comparisons made between *in situ* and laboratory measurements of EC.

The Chair asked what solutes will be looked at once Mg has been resolved and suggested sulphate. It was agreed this was a good suggestion. The Chair suggested that once the solute budgets have been resolved it would be useful to start developing statements about how the system works and this should identify where further work is required.

Dr Jones advised that uranium was being looked at but there was a potential problem given the non-conservative nature of this solute. U binds strongly to suspended particulate matter so there is not a good correlation between EC and U, especially at the lower end of the EC range where it would be anticipated that there were only low inputs of U. The results from the auto sampler grab samples being collected at the higher end of the EC range would be assessed to see if there was a relationship between U and EC under these conditions.

KKN 2.2 Ecosystem Establishment – Dr Chris Humphrey

Developing water quality closure criteria for Ranger billabongs using macroinvertebrate community data

Dr Humphrey advised the aim of this work was to derive water quality criteria for closure that supports the current ecological condition of waterbodies using the ANZECC/ARMCANZ (2000) approach. He advised that macroinvertebrate sampling and analysis has been conducted in 1995, 1996 and 2006. It was noted that results of ordination of macroinvertebrate communities in waterbodies by habitat type in 2006 had shown that for macrophyte habitat, and macrophyte and benthic habitat combined, Georgetown macroinvertebrate communities are similar to those of reference waterbodies. Dr Humphrey noted similar results were derived in 1995 and 1996. However, when macroinvertebrate data for benthic habitat were analysed separately, there was greater interspersed of reference and exposed waterbodies, and Georgetown communities were more aligned with the impacted waterbodies.

Comparison of data on sediment uranium concentrations in GTB in 1978 and 2007 show that uranium concentrations in sediments of GTB have been higher than those of other natural billabongs of the region since before the start of mining. Dr Humphrey suggested that the higher pre-mining uranium levels in sediment (and mussels) from GTB was most likely due to natural erosional contributions from surface expression of ore body #1 located in the Georgetown Creek catchment. It was noted that an assessment of sediment uranium concentrations in GTB measured over time indicated there has been little change in sediment uranium concentration from before the start of mining until about 2002. However, the most recent sediment data obtained by SSD suggest there may have been an increase since then. Interpretation is complicated by the fact that the 2007 data came from edge of the billabong samples and that more organic-rich sediment from the edges may contain higher uranium concentrations than the billabong centre. It was noted that even if uranium concentrations in sediment may have increased over time, the current levels are still well below published toxicity guidance for U in sediments.

It was noted that the low benthic diversity in GTB could be due to the compacted, cracking clays characteristic of GTB sediments being unsuitable for macroinvertebrate residence, or leaf litter from the fringing Melaleuca trees affecting water quality (increased tannins, humic acids and decreased DO), rather than U levels. Dr Humphrey advised that work in the future would include further processing of historical samples, quantitatively comparing the different digest methods for U that have been used in the past to determine if this is a significant factor, resampling the sediment in GTB to determine if there is significant lateral variation, better characterisation of sediment physical properties, investigation into water quality impacts of leaf litter, and further analysis and modelling to better assess potential mine related impacts on benthic communities in GTB.

The Chair asked if sediment U concentration reflected U availability and Ms Turner advised that this depended on the digestion method being used. Dr Stauber advised that the most accepted current method for sediment bioavailability screening is cold 1M HCL extraction. Dr Jones noted that the fine fraction of sediment needs to be taken into account and that not standardising by grain size can affect the results. Dr Humphrey asked how data would be affected using this method and Dr Stauber advised that results are generally lower than strong acid extraction methods. Dr Stauber noted there is evidence in the literature that

some organisms may respond at 6mg/kg, so the range could be from 2 to as high as 2000 and suggested a more cautious approach. Dr Stauber advised that she doesn't have confidence in the effects data for U at the moment or in the guideline, and suggested caution in drawing conclusions from the data.

The Chair noted the benthic communities in GTB are similar to high EC billabongs but it is currently uncertain whether this is mine or habitat related. Dr Hillman asked if it is known what taxa are responsible for the observed difference as this may inform the type of extraction method used. Dr Humphrey advised that this is not known at this stage. Dr Hillman advised that the vector of impact is the key issue so until more is known about which macroinvertebrates are being impacted it is difficult to set closure criteria. He noted it is also important to understand the types of assemblages present in the natural condition as sites may be naturally depauperate. It was noted that the relationship varies across sites and Dr Humphrey noted that RP1, for example, has a high concentration of fine sediment but also has high macroinvertebrate biodiversity.

Use of vegetation analogues to guide planning for rehabilitation of the Ranger mine site

Dr Humphrey advised this work was aimed at characterising plant communities from suitable natural analogue sites to (i) assist in selection of species for revegetation of the Ranger mine final landform, (ii) assist in developing performance measure targets against which the success of revegetation can be tracked by monitoring, and (iii) identify and quantify key environmental determinants (parent material, slope, effective soil depth etc) of the range of key vegetation community types. It was noted that some soil characterisation results for analogue sites had been acquired but not all the landscape variables used in Hollingsworth et al's (2007) study, and that while some environmental data for a small number of analogue hill sites was missing, this was unlikely to affect modelling. Dr Humphrey advised that potential or existing (and supporting plant growth) waste rock and/or laterite mixes from the Ranger site had been recently acquired for chemical analysis. Processing of samples has just commenced. It was noted that progress in data analysis and modelling since ARRTC 21 had been confined to an indicative assessment of the importance or otherwise of soil properties (per se) in determining local vegetation classification groups.

Dr Humphrey advised the rationale was to determine whether soil characteristics group/classify similarly to vegetation communities and seek relationships (if any) between local vegetation classification groups and associated soil properties, and through this, (i) develop an ordination 'envelope' of natural soils characteristics that may be used to assess similar data derived from mine substrates (waste rock, laterite mixes) (ii) add landscape variables (eg elevation, slope, relief, aspect) and re-analyse, and (iii) undertake plant-environment modelling that may usefully inform plant community/species suitability for the final landform. He advised that multivariate results indicate a high degree of independence of vegetation and underlying soil properties, especially for dominant woodland communities, and that while successful plant growth on the Ranger mine site was achieved on harsh and stony mine-derived substrates (including waste rock), assessment was still required of potential toxicity to plants arising from leachable MgSO₄ associated with some waste rock types. Dr Humphrey advised that the trial landform and continuing analogue study will inform species selection for final landform.

Dr Grant asked if tolerance curves for individual species have been looked at and Dr Humphrey advised that this had not been done as yet. The Chair asked if there is a soil map across all of the sites and if so had attributes been looked at to explain the greatest number of variances. The Chair also asked if multivariate analysis had been done between soil and vegetation. Dr Barry noted that if there are a number of soil attribute variables and only one is casual the others will be noise so it is important to identify which variables are determining factors. Dr Grant asked if ARRTC could be presented with the results of this work at the next meeting and suggested it would have been useful to have the this work repeated for the demonstration landform.

ARRTC22 Action/Outcome 5A

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.

Tree root penetration on natural and mine-derived substrates

Dr Humphrey advised that the preliminary findings from this project were that although tree roots had been observed to depths of 2.1 and 2.5 m in mine-derived and natural soils respectively, that the main rootball (>95% biomass) was contained in the top 0.7 m of soil profile. It is unclear how important the small percentage of roots that penetrate to greater depths are in terms of meeting tree's water requirements in the dry season. It was noted that the literature on the subject is somewhat contradictory. Tree root penetration on some Kakadu sites is only possible to a maximum of 1.4 m (to ferricrete) while water balance estimates indicate tree survival is not possible with root penetration to these (shallow) depths. Dr Humphrey advised that EWLS is measuring soil moisture profiles down to 6m on Georgetown analogue sites together with

whole-tree water use patterns. The findings from this work, coupled with the installation of moisture profile sensors on the trial landform may resolve this issue.

Seed biology research to optimise germination of local native species to support the rehabilitation of the Ranger mine site

Dr Humphrey advised that latest progress report for this project (below) had been provided to sponsors in October 2008 which included information on 24 listed priority species and 7 other potentially useful species for rehabilitation. The reference to the report is:

Sean Bellairs and Melina McDowell (2008) "Seed biology research to optimise germination of local native species to support the rehabilitation of the Ranger mine site. Annual progress report 2007/2008." Charles Darwin University, Darwin.

It was noted that ERA has advised project will continue to be funded until July 2011.

1.2.4 Ecotoxicology – Dr Rick van Dam

Chronic toxicity of uranium to larval *Mogurnda mogurnda*

Dr van Dam advised the dataset used to derive current uranium limit includes two fish toxicity estimates (NOECs) from short-term (~7 day) experiments and based on mortality (from Holdway 1992). He noted it is uncertain whether these are representative of chronic toxicity of uranium and the aims of this work were to develop a 28-d larval growth toxicity test to unambiguously assess chronic toxicity of uranium. He noted that results from the development and implementation of the first toxicity test had been presented to ARRTC20. He noted that based on a comparison of the results of the short and long term tests, the 28-d exposure results appear to not be markedly more sensitive than shorter-term exposures. He advised that future work would involve uranium speciation modelling and peer reviewed publication.

Effect of dissolved organic matter on bioavailability & toxicity of metals to tropical freshwater biota

Dr van Dam advised this project had been funded by ARC and aimed to quantify the relationship between DOC and the bioavailability and toxicity of U, Al and As to tropical freshwater biota, and develop predictive models that can be incorporated into Water Quality Guidelines. Dr van Dam advised the results of toxicity testing with *Mogurnda mogurnda* had shown a four and one half fold reduction in uranium toxicity from 0 to 20 mg/L DOC, versus a seven and seventeen fold reduction in uranium toxicity for *Hydra* and *Chlorella*, respectively. Dr van Dam advised future work would include comparison of uranium toxicity results using Swanee River fulvic acid (the international fulvic acid reference material) with those using DOC extracted from Magela catchment water, publishing a journal paper, using *Euglena gracilis* as a fourth test species, focusing on measurements of physical response that indicate mechanisms of toxicity and commencing similar experiments for Al and As.

Dr Stauber suggested it may be useful to replicate this work using a range of pH values as other work has shown that pH is a key variable influencing the effect of DOC on modulating metal toxicity. The Chair asked if pH was kept constant in the current work and Dr van Dam advised that the synthetic water used had been maintained at just over pH of 6. Dr Stauber asked if it was expected the mechanisms of toxicity would be the same for each species and on what basis were the species selected. Dr van Dam advised the species were selected based on the body of existing data that ERISS had for these species – and they were chosen to span a range of toxic response, while the *Euglena* was selected as it was a good organism for studying mechanisms of toxicity. Dr van Dam was uncertain of the sensitivity of this species to metals.

Preliminary assessment of the toxicity of manganese to three local freshwater species

Dr van Dam advised that this work arose out of earlier work that showed spikes in Mn in surface and groundwater since early 2000 in Bore MC20, GC2 and Coonjimba Billabong to levels approaching the ANZECC/ARMCANZ limits. He noted that higher value spikes tend to occur at the end of wet seasons when groundwater contribution is greatest.

The Chair indicated he wasn't sure that the Mn is groundwater related and suggested it was probably due to the mine site. Dr van Dam noted that the results weren't suggesting that the Mn isn't mine related but that it is probably mine impacted groundwater. Ms Iles noted that some late season results were from stagnant pools in the creek bed and did not compare well with results for water sampled from flowing channels at the same time, indicating groundwater and redox influences. Prof Johnston noted the records for bore MC20 show no readings up until 2004. Ms Iles advised that a Mn spike in that bore from a few years earlier was related to a reduction in water table levels following reduced application rates. The Chair asked if the increase in groundwater Mn was related to changes in redox potential. Dr Jones suggested it is probably a response to acid sulfate conditions developed as a result of the oxidation of sulfides initially produced by

sulfate (from RP2 water) reduction in the transiently flooded upper soil profile. Dr van Dam noted this tends to be a more localised area issue. The Chair asked if late season excursion of Mn occurs during recessional flow conditions then what is the potential for stratification of Mn in the water column. Dr Jones noted that Georgetown Billabong was stratified in relation to DO and that Mn concentrations do rise at times of near zero oxygen concentration

Dr van Dam advised the study used water from Ngarradj as this tends to be lower in pH, and hence Mn is likely to be more stable in solution under these conditions. At higher pH Mn²⁺ can oxidise and precipitate out, thus complicating interpretation of the results. He advised that the results show that the algal species is insensitive to Mn up to concentrations of 60 mg/l but there is a strong response above 1 g/l for the *Moinodaphnia* species. Dr van Dam advised that the Hydra species is even more sensitive to Mn and that further work is required as data for Magela Ck at 009 occasionally approach the *Hydra* IC10 value.

Magnesium Pulse Exposure Testwork

Dr van Dam advised that the first test of the pulse exposure study for Mg had been completed, using a cladoceran species. The results were broadly in line with expectations with generally an order of magnitude lower sensitivity for the short duration pulse compared with chronic exposure. However, the time of the pulse was critical for the cladoceran with a pulse before the onset of reproductive maturity having a much greater impact than a pulse after maturity. Dr van Dam advised that IC50 results suggest the onset of reproductive maturity is a critical point and a possible factor in response. He advised further work will be done using other species.

Dr Stauber noted that in relation to the pulse exposure work the literature indicates chronic exposure always gives the worst case in terms of effect so it was good to see consistent results. Dr Jones noted that *eriss* is currently having internal discussion about using a rolling 24 hour average exposure value derived from the continuous monitoring data stream.

Dr Andreas Bollhoefer - Radiological monitoring

KKN1.3.1 Surface & groundwater monitoring, chemical, biological, sediment and radiological monitoring - Bioaccumulation of radium and metals in mussels and fish

Dr Bollhoefer provided a presentation on the bioaccumulation of radium and metals in mussels and fish. He noted that the use of a new dredge has significantly improved mussel collection.

The levels of radium 226 in mussels from Bowerbird Billabong are much higher on an age basis than at other sampling locations and this indicates that Bowerbird is not a suitable control site. Dr Bollhoefer advised that the level of lead isotopes had also been measured and results show that the minesite is not contributing to the higher concentration of Ra and U in mussels in Mudginberri Billabong This is thought to be due to natural catchment influences.

Prof Johnstone asked if the work has been published and Dr Bollhoefer advised that it hasn't been published as yet but would be. The Chair suggested the conclusion above isn't strictly correct in that previous work has shown that catchment variability controls distribution and just because you can't show the mine is contributing doesn't mean it isn't. Prof Johnston asked if there is a clear link between the movement of lead from the mine and the movement of uranium and radium from the mine. Dr Bollhoefer advised that there is not a direct link but that previous work shows that lead is also bioaccumulating in mussels. Prof Johnston asked if this was a matter for concern.

KKN2.2.4 Radiation exposure pathways associated with ecosystem establishment

KKN4.2.1 Radiological assessment of rehabilitation success at Nabarlek

Dr Bollhoefer advised that the Aboriginal diet for Kakadu North had been updated based on results of a questionnaire that had been distributed to local Aboriginal people and information from local meat supplier on meat consumption at various communities. He advised the updated diet profile had been provided to local Aboriginal communities for comments. From this work ingestion dosages were calculated. Dr Bollhoefer advised that future work would include publishing work on uptake factors in Passiflora and testing the Ra isotope ratio method on other terrestrial plants, publishing concentration factors and dose assessment for Kakadu North (IR), incorporating results from the Anomaly 2 study and the ARC Linkage Application (RMIT, eriss, EWLS).

KKN5.2.1 Remediation of the remnants of past uranium mining activities in the SAV

Dr Bollhoefer advised work was aimed at determining the radiological conditions and volume of material to be removed at the Rockhole mine residue area, determining Slesbeck post rehabilitation radiological conditions, and monitor standing water levels and groundwater radionuclide activity concentrations in the El

Sherana bores. Dr Bollhoefer advised that Gamma surveys had been conducted at Rockhole residues, the planned containment site, Sleisbeck (post-rehab), and Palette mine. In addition, investigation trenches had been dug at the Rockhole tailings footprint. He advised that all groundwater monitoring bores at the planned containment had been equipped with working data sondes, maintenance and that data download was ongoing. At Rockhole residues, there was no evidence of dose rates $> 1 \mu\text{Gy/hr}$ (the proposed cleanup threshold) below 70 cm.

Dr Bollhoefer advised that based on the ground survey work, typical dose rates of $\sim 0.2 \mu\text{Gy}\cdot\text{hr}^{-1}$ have been achieved at Sleisbeck after rehabilitation. A threshold value of $1.25 \mu\text{Gy}\cdot\text{hr}^{-1} \pm 20\%$ had been proposed for rehabilitation at El Sherana, Palette Mine and Rockhole Residues, respectively. He advised that baseline data had been collected at El Sherana Airstrip and a groundwater model was being developed for the containment site. He advised future work would include publishing the results of the Sleisbeck (post rehab), Palette and El Sherana West pit surveys, review of SARV AGS data to contribute to updated dose model and longer term surveys after material placed in containment.

Prof Johnston asked how much clean cover (i.e. roughly 5 m?) would be placed on top of the shallow burial site at El Sherana and Dr Jones advised that the burial depth was roughly 5m and the cover thickness would be around 3-4 m. Dr Jones advised that the site meets all of the ARPANSA requirements for a containment. Prof Johnston asked if the cut off grade for the Rockhole tailings of $1.25 \mu\text{Gy}\cdot\text{hr}^{-1}$ (± 20 percent) effectively means the cut off will be 1 micrograys/h. Mr Hughes advised the threshold will probably be around $1 \mu\text{Gy}\cdot\text{hr}^{-1}$ and that the reason why the plus and minus were included was to avoid issues associated with having a single number that would be impossible to precisely measure, given the intrinsic precision of such measurements. Prof Johnston noted there is also the issue of the area to which the cleanup threshold will be applied. Dr Bollhoefer noted the key issue is that all mine-derived residual material needs to be removed to meet the rehabilitation commitment given to indigenous stakeholders, and that the cut off threshold would not be applied to natural soil in the area.

Spectral Database

Dr Bollhoefer provided a presentation on work on developing SSD spectral database. He advised that a custom designed meta-database had been implemented and populated, and algorithms developed to assess suitability of spectra as "reference" for further processing. He noted the next steps would be to implement a processing tree to enable within and between species separability assessments using available public domain spectral analysis software (SAMS, SPECCHIO, and SPECPR). Dr Bollhoefer advised that future work would include incorporating spectral and metadata measurements of mineral assemblages e.g. magnesium sulfates, iron hydroxides, stockpiled and processed materials, and incorporating analogue soil sample spectra collected around the Ranger lease. .

Hydrological and Geomorphological processes – Dr Ken Evans - KKN 2.1.5

KKN 2.1.5 Geomorphic behaviour and evolution of the landform

Dr Evans advised that work is being undertaken in collaboration with Dr Greg Hancock from the University of Newcastle focused on validation of the SIBERIA model and assessment of impacts of extreme rainfall events on Tin Camp Creek (TCC) sub-catchment using CAESAR. TCC erosion simulation using a range of rainfall scenarios over a 1000-year simulated period indicated that annual sediment output starts high and then declines (Molierie et al (2002)) and that there is little difference between simulations in terms of erosion and deposition depths. Dr Evans advised that regional denudation rate was estimated to be in the range 0.01 to 0.04mm yr^{-1} (Cull et al., 1992; Erskine & Saynor, 2000). He advised that the modelling indicates that the extreme rainfall event at the end of the 2006/07 wet season did not have any significant effect on the erosional dynamics. Future work could include developing CAESAR's capability to incorporate spatial variability in surface material types and vegetation distribution, and testing various capping material types such as the laterite mix proposed for the Ranger vegetation trial plots.

KKN 2.1.7 Testing trial landforms- demonstration plot

Dr Evans advised that construction of the demonstration plot was underway adjacent to the North West corner of the tailings dam at Ranger. He advised that four erosion plots ($30 \text{ m} \times 30 \text{ m}$) will be constructed by jointly SSF and EWLS/ERA, and detailed the various monitoring instrumentation to be installed.

KKN 2.5.2 Off-site monitoring during and following rehabilitation post cyclone assessment

Dr Evans advised this work is assessing the significance of extreme events in the Alligator Rivers Region, in particular the impact of Cyclone Monica on the Gulungul Creek catchment, Ranger mine site and Nabarlek area. The work involved measuring a range of parameters on 5 plots on each land type including identifying the height, species, DBH and tree fall orientation of all trees $\geq 2 \text{ m}$ in height, and various soil parameters.

KKN 5.3.1 Landscape scale geomorphic processes in the ARR

Dr Evans advised the aim of this work was to define sediment sources and their effect on contemporary catchment erosion rates in the ARR. He noted that the highest annual rainfall at Jabiru in 2006/2007 was 2600 mm and that rainfall intensities exceeded 1:100 y storm event for durations between six and 72 hours. Dr Evans advised that during the extreme weather event a number of landslips occurred in Upper Magela Catchment which had mobilised approximately 80 000 tones of sediment potentially available for transport.

Landslips/ Red tide work

Dr Evans advised that SSD staff had observed a red pulse of sediment in Magela Creek on 24 January 2008. It is estimated the total area of the landslips was approximately 0.05% of the Magela Creek catchment upstream of G8210009. However, the downstream impact of this was a significant with approximately 40-50% of the fine sediment transport in Magela Creek coming from this source in the 2007/08 wet season. He advised that rainfall data was now being collected from a weather station located adjacent to the landslips, and that this would be analysed. . The Chair asked how often the rating curve for the channel cross section at GS009 was checked. Dr Jones advised the channel was re-rated annually and that SSD pays NTRETAS for this work as well as maintenance and downloading of the level measurement infrastructure.

ARRTC22 Action/Outcome 5B

ARRTC commended eriss on the high quality of the research and presentations to the meeting and noted members continue to be impressed with the quality of research across all eriss programs.

5.3 ERA research activities

Mr Puhlovich provided a presentation on the ERA research activities to October 2008. In response to ARRTC21 Action 4D, Mr Puhlovich advised that the results of the Ecological Risk Assessment work had been presented to the ERA Executive meeting in 2008. He noted also that ERA has been regular participant in meetings of the Kakadu BoM and that ERA continue to work positively with park management and look for opportunities to apply its expertise.

In relation ARRTC21 Action 4E, Mr Puhlovich advised that the total volume of laterite that would potentially be available for rehabilitation at end of mine life was 14.3 Mcu m. ERA was confident that sufficient laterite material would be available for closure.

Dr Grant suggested that given the estimated amounts of available laterite, it would be useful to have a mix of laterite depths as part of the landform trial. Dr Jones asked whether the additional 8 million cu m of laterite was clean or overlain by other material. Mr Puhlovich indicated he understood the material is being separated in stockpiling for future use onsite. Dr Jones noted that laterite can consist of material from 3m to 40 m deep in the weathering profile and can have a range of chemical properties. He suggested it may be useful to do some testing as part of the landform trial to see how final landform may be weathered/erosion and noted that different types of laterite each have difference uses.

Mr Puhlovich outlined the functions, membership and Terms of Reference of the Ranger Closure Criteria Working Group. He advised the timelines for developing the criteria had not yet been agreed between the stakeholders. Dr Jones suggested that that the surface and groundwater criteria were critical and would likely have long lead times. Mr Puhlovich advised that the Group has discussed the relationship of its work to the ARRTC Key Knowledge Needs and noted ARRTC interests in the process. Mr Martin noted the Group was currently resolving the various themes to be addressed. Dr Grant suggested the Group should look to develop some draft criteria as soon as possible and test these in the field. He noted that this was the approach used by Alcoa. Mr Puhlovich advised that ERA is looking at the Alcoa experience and process.

ARRTC22 Action/Outcome 5C

ARRTC requested ERA to provide a copy of the Terms of Reference for the Closure Criteria Working Group.

Pit#1 Closure Planning – Update

Mr Puhlovich provided an update on closure planning for Pit#1. He advised that ERA is trying to reduce the volume of water in Pit#1 through the use of pumping to maintain the water level below approved levels. He outlined the current studies which are taking account of work undertaken in 2004. Mr Puhlovich advised that work by the CSIRO is showing that the geochemical characteristics of Ranger tailings have changed over time and there has been a certain amount of self neutralisation of pH. He noted the potential benefits of installing a barrier between the capping surcharge and the tailings and integrity issues associated with surcharge materials coming into contact with supernatant fluids. He outlined other work underway on pore

fluid transport and the impact of low pH fluids, solute fate and transport modelling and updating the conceptual model.

The Chair advised he would be interested in seeing the report from the latest hydrogeological modelling work that was building on the earlier modelling work done by Franz Kalf. Mr Puhlovich advised the work was still at the data review stage. Mr Puhlovich advised that sulfate is being used as a conservative chemical species for this work. The Chair indicated that he noted that work by Klessa et al on the LAAs indicated that sulfate is less than conservative. Dr Jones noted that sulfate reduction is likely to be important in the near surface part of the soil profile. Mr Puhlovich advised that in this case he was referring to sulfate at depth and this was a different situation to the LAAs. The Chair noted the possibility there may also be sulfate reducing bacteria at depth. Dr Jones advised that this is the case in tailings that contain residual organic matter from the solvent extraction process.

Mr Puhlovich advised it is expected that there will be significant tailings consolidation which would create a stable surface for backfilling Pit#1 and landform shaping. The Chair asked if the water level in Pit#1 was higher enough for MBL to dewater and Mr Puhlovich advised that there is currently no gradient from the pit to surrounding groundwater as groundwater behind the barrier has risen faster than Kalf estimated. Therefore there is no avenue for flow out of the Pit. However, flow out of the pit could be driven by density given the highly saline nature of the tailings pore water.

The Chair asked if ERA has changed the frequency of monitoring around Pit#1 and Mr Puhlovich advised that ERA now has full telemetry around Pit#1 and would be alerted if EC goes above set limits. He added that water sampling of Pit#1 is done quarterly but ERA would increase frequency if this was shown to be necessary. Mr Puhlovich advised the timeline for closure was assuming a conclusion date of 2025 based on the current lease expiring on 1 January 2026. However this is always under review. Dr Jones noted that groundwater modelling is critical for the closure of Pit#1 and Mr Puhlovich advised modelling was expected to be completed by mid 2009, but may take longer.

Mr Puhlovich asked if ARRTC thought the new reporting format by EWLS was useful and the Chair advised the format was fine but perhaps more detail could be provided.

Mr Puhlovich provided a report on the results of the Long-Term Seepage Recovery Trial. He advised that although a number of modelling studies and reviews had been undertaken that ERA believes it was time to determine groundwater travel times based on results from actual pumping tests. Mr Puhlovich advised that if ERA has to clean up the plume under the tailings dam, it would be useful to test whether groundwater response behaviour is consistent with predictions based on modelling. He advised that based on the characterisation of seepage pathways, the data suggest groundwater flows to the N, S and W. He noted that a number of bores have been drilled but ERA doesn't use the peizo bore data. He noted that a number of faults were evident but it is not clear whether these are barriers to flow or flow pathways. Mr Puhlovich advised that ERA cored some holes around the base of the tailings dam in 2007 and the results to the North indicate highly weathered schist of TSF and the South West having deep clays.

Mr Hughes noted these results are consistent with general finding of more recent groundwater observations in the region and asked what information ERA used to target the locations of the core samples to be collected. Mr Puhlovich advised that ERA used mapped extension of faults, core observations of seepage at OB90 to the north and OB100/101 south to identify preferred seepage pathways. Mr Puhlovich advised that additional holes were drilled for permeability testing and tracer results but there were some difficulties due to elevated background concentrations of sulfate. He advised that results indicate that concentrations of manganese, uranium and ammonia (in addition to Nitrate/Nitrite) are effectively attenuated within 100 to 150 m of the TSF, and tracer testing shows there appears to be some ion exchange as sulfate drops off possibly due to interaction with chlorite minerals in the rock mass.

Mr Puhlovich advised the key results were that estimated rates of seepage are significantly less than that predicted by previous models, which predicted seepage to the north of 100-150m³/day, equal to 0.2 m³/day or 11% of total groundwater throughflow beneath the TSF. There is 50t of sulfate to the north of the TSF. However, the sulfate observed in groundwater down gradient is mainly due to wall rocks rather than seepage from the TSF and contamination is probably worst at the confluence of the two faults below the TSF. The Chair noted interpretation of the results depends on how seepage is defined noting that seepage may also be occurring vertically downwards underneath the TSF, but is not being considered in this analysis.

Ranger wetland and billabong sediments

Ms Iles provided a presentation on the findings of the Ranger wetland and billabong sediments work and proposed next steps. Ms Iles acknowledged Dr Paul Davey as co-author. The Chair noted that Dr Stauber

had declared a possible conflict of interest with this agenda item. Ms Iles advised that the draft report had been circulated to relevant ARRTC members on 31 May 2008 but to date ERA had not received any comments.

ARRTC22 Action/Outcome 5D

ERA requested ARRTC members to provide feedback on the draft sediment report circulated by EWL Science Pty Ltd in May 2008 by next meeting.

ARRTC22 Action/Outcome 5E

ARRTC agreed to discuss future directions in the Ranger sediment work at next meeting.

Ms Iles advised that water bodies on Ranger include tailings ponds (not an aspect of the sediment quality report), retention ponds, constructed wetlands, natural backflow billabongs and ephemeral creeks. She advised that water quality was the principal determinant of sediment quality within these systems. Ms Iles advised that prior to 2003 prescribed monitoring of sediments and research had been conducted using a range of methods resulting in greater than 20 years of baseline data.

Ms Iles advised that, due to variations in sampling and chemical analysis methodology, ERA had adopted a project sampling approach since 2003. She advised that the future approach would focus on a multi-evidence risk based approach to derive closure criteria and further research in to wetland efficiency and design. Ms Iles presented the outcomes of a review of historical monitoring data, previous work by Klessa & Spedding 2002 on uranium in sediments, a range of sediment studies conducted on Georgetown Billabong and work on RP1 and various constructed wetland filters by various authors.

Ms Iles advised that ERA is seeking to develop a better understanding of the distribution of uranium at the surface and its spatial variation as part of characterising the site and at looking at why the efficiency of wetland filters is declining. The Chair noted the original view was that there was sufficient organic material on the surface to deal with uranium. Dr Jones advised that a healthy wetland filter involves a very high level of biological activity so there is essentially a steady state between production of binding sites for uranium and the volume (load of uranium) entering the system. However, if the plant production declines then the efficiency of the wetland could decline. Ms Iles noted the occurrence of substantial benthic algal activity and suggested this may be blocking interaction with the bed of the wetland.

Mr Hughes suggested that the increase in uranium in GTB would be expected as there was also a rise in uranium in RP1 around that time. He noted there were fairly major changes in catchment management in terms of stockpile runoff, (that is the start of stockpile sheeting around 2001) so the result probably reflects the significant increase in levels of input into the upper catchments of Coojimba and Corridor Creeks since that time. Ms Iles advised that based on the distribution of uranium concentrations in the surface sediments and the increased extractability of uranium in the sediments compared to reference sites, the ecological risk associated with the sediments at GTB lowest on the site. The onsite water bodies can be ranked (from highest to lowest) as RP1 CWF > Corridor Creek CWF > RP1 > Georgetown Billabong.

She advised that ERA would be rehabilitating the wetland filters and planned to scrape and bury the material in Pit#3. Dr Jones suggested that sulfides also needed to be looked at in addition to uranium when assessing sediments, given their potential to oxidise and release an acidic and metal rich pulse. Dr Humphrey questioned the logic of the decision to cease routine sampling of the sediments in Georgetown billabong if increases were being observed. Ms Iles advised that ERA had submitted a paper to MTC on the reasons why the routine monitoring program was replaced with a project based program which included GTB. Dr Jones noted it was always intended that the monitoring would be replaced by research based assessments. Dr Hillman suggested there was a tendency in those monitoring reports to ascribe any issues with results to problems in methodologies without further investigation. He suggested the opportunity to review and mine the data a bit better should not be missed. There was agreement that the range of methods used historically make it difficult to statistically compare the data.

Dr Stauber noted that the limited exposure data and lack of pore water data makes sediment hot spots difficult to identify. Ms Iles advised that there are gaps in the data and ERA would continue to work cooperatively with *eriss* to address these. She suggested there is scope for macroinvertebrate benthic work to be integrated and applied to different sediment types as well.

Dr Jones noted that when the wetland filters were first constructed levels of metals, especially U, were low but this did build up substantially through time in the surface layers. He further suggested that high U levels could possibly have been one of the contributing factors retarding reestablishment of *Eleocharis* in the RP1

wetland following the extensive dieback that occurred around 2002. The Chair asked what the root zone looked like and if there is an order of magnitude change in toxicity deeper in the sediments. Dr Jones advised that after the *Eleocharis* died off the beds of the wetland cells were smothered by algae so it's difficult to determine whether the lack of subsequent recovery is due to smothering (ie exclusion of light) or toxicity of the sediments. Dr Hillman offered to provide the name of an expert in *Eleocharis* spp. Ms Iles suggested an approach could be to propagate *Eleocharis* in the laboratory and test the sediment toxicity hypothesis. She advised that ERA has some studies looking at macrophyte recruitment within wetland filters versus natural billabongs. Dr Stauber suggested it also may be useful to look at what uranium and other metals are present in algal mats which many macroinvertebrates feed on. Dr Hillman noted that usually blue-green algae produce a gelatinous coating for protection so anything feeding would probably ingest contaminants bound up in this.

The Chair asked what advice ERA wished to get from ARRTC and Ms Iles indicated that the discussion at this meeting was very helpful and ERA would revise the sediment report in response to comments to be provided and reissue as a final. Dr Stauber offered to provide written comments if ERA required. The Chair asked ARRTC members to provide any comments on the report and the recommendations for future work to ERA. Ms Iles advised ERA would also appreciate input on the proposed research direction which will be incorporated into a Masters programme that will be co-supervised by Dr David Parry from CDU.

Prof Johnston noted in the conclusion of the report it mentions potentially retaining parts of RP1 in a modified form following closure, and questioned the logic of this given the uncertainty regarding the long term use of the site. Mr Kyle noted that the 2007 plan of rehabilitation for Ranger states that RP1 will be scraped and that discussions are yet to be held about the fate of the embankment at RP1 and whether it will be used as a water storage. Mr Kyle noted this would be inconsistent with previous undertakings about not leaving any waterbodies behind there that weren't there previously. Ms Iles pointed out that RP1 is built on the former Coonjimba Creek line and that a water channel of some sort might form part of the final landform so the ecological risks of possibly retaining the sediment in these lines needs to be assessed.

ARRTC22 Action/Outcome 5F

ARRTC commended ERA on the quality of the science contained in the report and presentation provided by ERA on sediment work at Ranger and the considerable effort involved in providing this work in time for the meeting.

Characterisation of waste rock leachate generation at Ranger (Ms Iles) (ref ARRTC21 Action 4F)

Ms Iles provided a presentation on the results of a literature review and findings of key reports dealing with waste rock leachate generation at Ranger. She advised the current project will be undertaken in two separate phases. Phase I (the current phase) will involve determining limits on solute generation from stockpiles based on a review of existing knowledge and water quality data, while Phase II will involve development and validation of a conceptual model for solute generation from waste rock stockpiles at Ranger. Ms Iles advised there has been an extensive amount of work already completed and information is available on the measurement of both seepage and runoff rates/volumes and associated water quality implications. She noted that mechanisms for the generation of both runoff and seepage is well understood at Ranger and, while a predictive solute generation model exists, developments at Ranger provide an opportunity to further develop and validate this model providing the ability for longer term predictions. She noted that EWLS is currently undertaking a project within the closure program to undertake this work in late 2008 and 2009.

Mr Puhlovich agreed the forthcoming Pit#1 closure will be a good opportunity to test the release of solutes associated with both rock reclaim and the creation of a landform using the same design and construction techniques as will likely be applied to the final areas to be rehabilitated after ultimate decommissioning of the site. The Chair asked if there is potential to classify the solute runoff against the different rock grades and Ms Iles advised that ERA already places the different waste rock types (based on U content) into different dumps so this could be feasible to do. The Chair asked if the amount of solutes leached out depends on grade— i.e. Do 2's generate different runoff than 1's and 3's. For U, the answer is yes. Mr Puhlovich advised it was planned to cover the final landform using 1's grade rock so grade dependence might not be an issue.

Trial Landform - Strategy and methodology for revegetation and monitoring - Dr Ping Lu

Dr Lu provided a presentation on the strategy and methodology for revegetation and monitoring of the trial rehabilitated landform including consultations held to date, the current design of the trial landform, proposed supplementary watering for direct seeding area and the change in the scope since ARRTC 21. Dr Grant asked if the site would be ripped on the contour and Dr Lu confirmed this would be the case.

Dr Lu advised that the trial would involve a tubestock planted area comprising over and mid-storey species (understorey by direct seeding after 2-3 yrs) and a direct seeding area comprising over and mid-storey species by direct seeding (understorey by direct seeding after 2-3 yrs). He advised there would be both short term and long term treatments. Dr Lu outlined the revegetation practices to be used. The site would be ripped along the contour to a depth of approx 0.5m. Planting would occur during monsoon using tubestock and seeds supplied by Kakadu Native Plant Supplies. The plots would be fertilised using slow release Tropigro Monsoon Vine Pellets (1 per tubestock) and subject to fire and weed management. The cover treatments would be further divided into irrigated and non-irrigated areas. Dr Lu advised the "irrigated" plots would be subject to short term/minimum watering to supplement wet season rainfall (starting in January after seeding and ending about April). Dr Lu advised that plots would be monitored for a range of physical and biological parameters

Dr Grant noted the survey of root depth for trees growing on previous rehab areas and on natural terrain showed that trees are only shallow rooted anyway and therefore queried the value of having the 5m depth treatment. Dr Lu advised that some root systems have been observed down to greater than 2m depth and noted the likely importance of these to plant survival during the dry, notwithstanding that they only comprise a small fraction of the total root mass. The Chair advised he wasn't aware of any native species that wouldn't make use of available soil moisture. Dr Lu advised that if there is sufficient water available in the top 1 m of soil the root systems shouldn't have to go down to depth. Dr Stauber noted that in terms of the proposed experimental design it allowed only one replicate per treatment and asked if ERA would use pseudo replicate treatments to better understand the statistical implications of this. Dr Lu agreed.

Prof Johnston asked what time of year would the radon gas exhalation testing be carried out and Dr Bollhoefer advised three times a year. Dr Grant noted the sample spacing for soil chemistry should be intensive in the trial landform. The Chair asked if the top 10-15 cm would be tested and Dr Lu advised probably the top 15 cm where seeded. The Chair asked where the water collection sump would be located and Dr Lu referred members to the map of the demonstration landform. The Chair asked if the sump will be protected during the wet season to enable chemical sampling, free from the confounding effects of dilution by incident rainfall. Dr Lu advised this hadn't been planned for but was a good idea. Dr Grant asked if the ripping would mean that the water falling on the surface will drain straight down. The Chair suggested the water will percolate until it reaches the original ground surface and then follow the drainage slope. Mr Puhlovich advised that the design of the demonstration landform had been informed by previous experience from rock dumps on site.

The Chair asked if ERA would undertake a water balance (noting that bulk run off data are not being collected) or will ERA use the data from SSD's 30m by 30m plot and scale up to the whole area. Dr Evans queried whether it was necessary to know all of the seepage and suggested that the water balance could be closed based on estimate of total seepage. The Chair suggested that as most seepage will occur during the wet season, ERA should have a covered sump to enable water quality testing and consider doing a water balance. Mr Puhlovich advised that the demonstration landform is a high risk technical project.

Dr Humphrey asked what ERA will do if the vegetation trial fails and Dr Lu advised that ERA would reattempt. Dr Hillman noted in the document provided by ERA it seems to imply that only historical observations of analogue areas will be used to compare with vegetation development on the landform plots. He suggested ERA should establish parallel measurement plots in analogue areas so that the response of natural vegetation assemblages to the climate regime would provide a baseline against which to better assess what was happening on the trial landform.

Dr Lu advised ERA was planning to complete construction of the demonstration landform by mid December 2008 and commence installation of probes and planting by January 2009. Prof Johnston noted the vegetation shown on the photo of establishment on waste rock alone has no understorey and asked if the site shown in the slide had been weeded. Dr Lu advised that the lack of understorey was not uncommon on the top of plateaus in the ARR.

ARRTC22 Action/Outcome 5G
ARRTC endorsed the approach being taken by ERA for the demonstration landform site and commended ERA on progress made to date.

Friday 24 October

5.4 Other stakeholder research activities

No other stakeholder research activities were discussed.

6 Key Knowledge Needs: Next Steps (Chair)

The Chair suggested that ARRTC consider the next steps required in relation to the revised Key Knowledge Needs and decide what needs to be done, and by whom and by when. He suggested the key elements required were for ARRTC to (i) understand what work is currently being done under KKNs, (ii) assess whether the activity is meeting the KKNs or something more is required, and (iii) review and agree on gaps and priorities.

Dr Hillman queried how much work ARRTC could do in committee and the Chair asked whether ARRTC should do, SSD should do or whether there was a need to establish a subgroup to undertake the work. Mr Hughes suggested that SSD would populate a table with details on which projects are underway under each KKN. The Chair suggested the table just include current projects and that ARRTC will assume that the current KKNs have been informed by the previous projects. Mr Hughes suggested the gap analysis would need to take account of the previous projects as well. Dr Jones queried whether the EWLS projects should be included and Dr Hillman suggested ARRTC should ensure that all research effort is addressing the knowledge gaps.

Mr Puhlovich suggested that he work with Dr Jones to develop a single consolidated list of eriss and ERA projects under each of the KKNs. Dr Stauber asked if proposed projects should also be included and the Chair suggested these should be included if known. Dr Jones advised that eriss has both current and proposed research projects and asked when the work needed to be completed by. The Chair advised he would like to have the work completed and assessed so that ARRTC can consider at the next meeting. It was agreed to aim to have the work completed by the end of 2008 if possible. It was also agreed that only project titles would be listed under each KKN.

The Chair suggested setting priorities for the KKNs and Dr Jones advised that this had been done internally by SSD. The Chair noted there will be priorities in terms of the research as well as for ARRTC. Dr Jones noted that the priorities are driven primarily by operational timelines. The Chair suggested that a list of KKNs with current and proposed research projects (if known) be prepared with associated timeframes. Dr Stauber asked whether ARRTC should review and update the KKNs as operational status and timeframes change (eg. Nabarlek). The Chair agreed with the need to update contextual information but was concerned about changing the KKNs themselves. Dr Stauber suggested that ARRTC assess whether each KKN is still appropriate and queried whether ARRTC should do the gap analysis on the KKN as they are now or after they have been changed.

Mr Hughes suggested the only time the KKNs should be changed is when new KKNs are added or obsolete ones are removed. The Chair suggested the contextual statements be updated and then ARRTC assess whether this substantively changes the KKN. Mr Hughes suggested that the contextual information under each KKN could be changed without necessarily having to change the KKN itself. Prof Johnston suggested that issues with KKNs be discussed and recorded at the next meeting.

ARRTC22 Action/Outcome 6A

ARRTC requested that EWLS and eriss prepare list of current and proposed research projects under each KKN and circulate to ARRTC members to assist them to identify potential gaps in coverage, and provide feedback to the ARRTC Secretariat for collation and discussion at next ARRTC meeting.

ARRTC22 Action/Outcome 6B

ARRTC agreed that the KKNs be made publicly available on the ARRTC website with a date and version number.

The Chair asked how the gap analysis should be done and suggested that ARRTC review out of session. Ms Paulka suggested there are probably a number of gaps in the current research and noted that the ICRP had recently changed its guidelines to require that dose assessment be undertaken on the environment as well as humans. She advised this means that future EISs will need to include assessment of impact of radiation on reference plants and animals and noted that the changes pose some significant issues for the uranium industry and the relevant regulatory authorities. Dr Stauber noted that the UK has compiled data on the effects of radiation various biota and this work was relatively advanced in Europe. Ms Paulka noted that ARPANSA is currently working on guidelines and Prof Johnston advised based on his discussions with Peter

Burns that ARPANSA is looking to develop regulatory guidelines for proponents since the process previously had been ad hoc. He indicated he would like to see how UEL approaches this issue.

Dr Jones advised that the effect of low level radiation on biota is potentially an important issue and that SSD has had some internal discussions on this. He noted that there is a risk that substantial investment could be made in research for relatively little return but that SSD could do specific work to assess radiological damage to organisms if ARRTC considered this to be of sufficient priority. Prof Johnston noted that there are bigger regulatory and research issues involved here which go beyond the protection of biota and the responsibilities of ARRTC. Prof Johnston suggested that ARRTC advise the Minister that stakeholders have raised a number of concerns in relation to the practicality of the IRCP decision, including the implications for the assessment and regulation of new uranium mine proposals and the need for industry guidance. Prof Johnston noted that the issue extends beyond the responsibilities of SSD.

Mr Hughes noted that it is now considered best practice to broaden the scope of radiation assessment to include non-human species and that this is a significant policy issue. The Chair noted there also may be research needs that ARRTC will need to consider in relation to the issue.

Ms Paulka noted that only EU data are available and this has implications for assessment of new uranium mines in Australia. Dr Bollhoefer noted the absence of data on native species means that assessments need to be done using data on European species (eg. Deer). Mr Hughes advised that the appropriate group doing EPBC Act assessment currently seeks advice from a range of expert sources. Prof Johnston suggested there is a need for guidance for industry in relation to the issue and Ms Paulka suggested that funding for this could be sought under the Uranium Industry Framework process. Prof Johnston suggested the issue is probably something ARPANSA needs to consider in the first instance. Mr Hughes noted this and advised it would be appropriate for ARRTC to raise with the Minister.

ARRTC22 Action/Outcome 6C

ARRTC agreed that the Chair, Prof Johnston and Mr Hughes will draft words for inclusion in Chair's letter to Minister on issues related to ICRP recommendations related to preparation of Environmental Impact Assessments for uranium mines.

7 Communication and Knowledge Management (ref ARRTC21 Action 3D)

Dr Jones provided a presentation on SSD communication and knowledge management activities. Dr Jones advised that SSD internal reports are not peer reviewed but are an important means of maintaining corporate memory and internal knowledge management. The Chair noted the value of SSD internal publications and asked what processes could be established to encourage SSD research staff to do more high level refereed science. Dr Jones noted in this context that the Supervising Scientist Series of reports is externally peer reviewed and provides a vehicle for publication of more comprehensive information than would be possible in a standard journal publication.

Dr Barry asked if there are specific areas where SSD is looking to publish. The Chair noted the issue is really about exposing SSD staff to a higher level of scientific rigour and suggested publishing in external peer reviewed journals is a good way of developing young scientists. Ms Paulka advised she thought SSD internet resources were excellent and that she found having access to reports and other information on the site very useful. Dr Jones noted that the web is increasingly becoming an important source of information and plays a key part in SSD communications. Prof Johnston suggested that there is a need for caution when using the internet as much of the information presented is not authoritative. Dr Stauber asked if SSD is tracking downloads from its website and Dr Jones advised that just information like the numbers of hits etc is recorded. Mr Kyle advised that he finds the SSD website excellent and very useful. Dr Jones advised that SSD is moving towards electronic document delivery which makes corrections to documents more timely and straightforward. Dr Jones outlined other SSD communication activities including attendance at festivals and other events, and the role of the SSD Aboriginal Communication Officer located at Jabiru Field Station.

Dr Jones advised that SSD has commissioned an internal spatial sciences data review which is looking at integrating point data holdings into the SSD Knowledge Management Framework. He noted this information will be important in the development of closure criteria. The Chair noted it is also important that data archives are forward compatible. Dr Jones noted this activity has implications in terms of having to refresh software and hardware.

Prof Johnston asked how much SSD data has been stored in the national archives and noted the importance of maintaining historical data in case it may be required in the future (eg. Maralinga). Dr Barry asked how SSD data is validated. Dr Jones advised that SSD data are internally reviewed. Dr Barry asked if SSD has

automated systems for alerts and alarms based on continuous monitoring data streams and Dr Jones advised there are alarms on data streams which are investigated if triggered. Dr Jones advised that each monitoring station has duplicated recording equipment as backup in case of primary equipment failure. The Chair asked what the data being collected are used for and Dr Jones advised that the monitoring data are currently primarily used to improve understanding of system behaviour. Mr Hughes added that data are also used for investigations.

Dr Barry asked if the data are routinely available for other users and Dr Jones advised this currently isn't the case. However, the data is supplied to relevant stakeholders in the event that it is required to inform management action.

The Chair suggested the key issues are (i) how to ensure maximum use is made of the data and science SSD generates, (ii) how to ensure that ERA (and increasingly other user eg. CDU) have access to appropriate SSD data and vice versa and (iii) how to facilitate improved exchange of information to ensure better research outcomes. Dr Jones advised that SSD has provided data to other users (eg. CERF-TRaCK) previously but tends to provide data on a case by case basis for specific purposes or projects. The Chair noted SSD can either make the data available and let other users access as required or be more proactive and provide data and research outcomes to those who require it. Dr Jones advised this is why SSD has an active communication approach through the internet and its publishing program. Mr Hughes noted SSD is not relying only on one mode of communication.

Mr Puhlovich advised that as Ranger closure approaches it is assumed that there will be various robust agreed integrated datasets being used by all stakeholders in relation to the key closure aspects. He noted this will avoid having to "reinvent the wheel" which still happens. Mr Puhlovich also noted the need to have access to previous research findings and suggested there will be more regular reporting back to ARRTC regarding knowledge and data requirements to support the closure process.

ARRTC22 Action/Outcome 7A
ARRTC noted that stakeholders appreciate and make extensive use of the data and information available on the SSD website.

Dr Jones noted there is an ongoing issue in relation to the updating of the SSD website. Prof Johnston asked if SSD has access to all of the grey literature in related fields and Dr Jones advised that SSD has reasonable access and that having a good library and librarian greatly assists this. Dr Stauber noted that it may be more difficult getting access to EWLS research outcomes due to potential commercial confidentiality issues. Mr Puhlovich advised this was more related to a lack of resources for publishing research findings and that ERA is looking to integrate measures into staff KPIs to improve the rate of external publishing and is making resources available to support this.

The Chair noted that having time and resources to cover publishing can be difficult in a commercial environment. Mr Puhlovich advised that EWLS now has five or six PhD staff in the office and is developing datasets that will enable more publishing in next few years, such as work by Dr Lu on fire response which is world class data that should be published. Mr Puhlovich suggested it is still more difficult for EWLS staff to publish than SSD staff. Prof Johnston asked what conferences do SSD staff currently attend and Dr Jones advised that a list of conference titles is available on the SSD website.

8 Other Business

The only other business raised was in relation to ARRTC confidentiality provisions and the wording on the proposed ARRTC Terms of Appointment document. It was agreed that the Secretariat would revise the draft Terms of Appointment document and circulate to members for approval and signature. Mr Puhlovich advised that ERA reports to ARRTC in future will be restricted to information that has been disclosed to the ASX. Mr Puhlovich suggested the ARRTC website be checked for an indemnity clause. The Chair advised he had checked the ARRTC website and confirmed that the minutes of all previous meetings are publicly available.

ARRTC22 Action/Outcome 8A
ARRTC agreed Secretariat will provide advice to next meeting on process for members to table commercial-in-confidence information in future meetings.

ARRTC22 Action/Outcome 8B
ARRTC agreed Secretariat will circulate draft Terms of Appointment to members for their approval and signature.

9 Next Meeting

ARRTC discussed the timing of the next meeting and agreed the meeting will be held in Darwin on 18, 19 and 20 March 2009 commencing at 2.30pm. ARRTC also agreed to undertake a fieldtrip as part of its October 2009 meeting.

ARRTC22 Action/Outcome 9A

ARRTC agreed the next meeting will be held in Darwin from 18 to 20 March 2009 commencing at 2.30pm.

ARRTC22 Action/Outcome 9B

ARRTC agreed to a possible fieldtrip as part of the ARRTC meeting in October 2009.

10 Meeting Close (1230pm)

ARRTC22 Actions and Outcomes

No.	Action/Outcome	Resp.	Status
2A	ARRTC approved the meeting outcomes from ARRTC21 with no change.	ARRTC	Done
2B	ARRTC noted that stakeholder members with commercial interests will agree between themselves whether they will absent themselves for agenda items involving presentation/discussion of commercial-in-confidence information – see also Action/Outcome 8A.	ERA, UEL	
3A	ARRTC agreed that briefing from DRDPIFR on the status of exploration activity in the Alligator Rivers Region be included as a standing agenda item for future meetings	DRDPIFR	
3B	ARRTC agreed to modify the preamble to the KKNs to include exploration as a mining activity	Secretariat	
3C	ARRTC agreed that version and change control facility be added to the KKN document to allow tracking of changes and better linking to project management	Secretariat	
3D	ARRTC endorsed the aims of the integrated surface water monitoring program by SSD.	Dr Jones	
3E	ARRTC requested that statistical analysis be undertaken of the various sample populations of grab sample water quality data to support the hypothesis that the populations at the previous and the new grab sampling locations are the same.	SSD	
3F	ARRTC requested an update on the SAV rehabilitation project be provided at ARRTC24.	PAN	
5A	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	
5B	ARRTC commended eriss on the high quality of the research and presentations to the meeting and noted members continue to be impressed with the quality of research across all eriss programs.	ARRTC	Done
5C	ARRTC requested ERA to provide a copy of the Terms of Reference for the Closure Criteria Working Group.	ERA- Mr Puhlovich	
5D	ERA requested ARRTC members to provide feedback on the draft sediment report circulated by EWL Science Pty Ltd in May 2008 by next meeting.	ARRTC members	
5E	ARRTC agreed to discuss future directions in the Ranger sediment work at next meeting	ARRTC	
5F	ARRTC commended ERA on the quality of the science contained in the report and presentation provided by ERA on sediment work at Ranger and the considerable effort involved in providing this work in time for the meeting.	ARRTC	Done
5G	ARRTC endorsed the approach being taken by ERA for the demonstration landform site and commended ERA on progress made to date.	ARRTC	Done
6A	ARRTC requested that EWLS and eriss prepare list of current and proposed research projects under each KKN and circulate to ARRTC members to assist them to identify potential gaps in coverage, and provide feedback to the ARRTC Secretariat for collation and discussion at next ARRTC meeting.	EWLS; Dr Jones; Secretariat	
6B	ARRTC agreed that the KKNs be made publicly available on the ARRTC website with a date and version number.	Secretariat	
6C	ARRTC agreed that the Chair, Prof Johnston and Mr Hughes will draft words for inclusion in Chair's letter to Minister on issues related to ICRP recommendations related to preparation of Environmental Impact Assessments for uranium mines.	Chair, Mr Hughes, Prof Johnston	Done
7A	ARRTC noted that stakeholders appreciate and make extensive use of the data and information available on the SSD website	ARRTC	Done
8A	ARRTC agreed Secretariat will provide advice to next meeting on process for members to table commercial-in-confidence information in future meetings.	Secretariat	
8B	ARRTC agreed Secretariat will circulate draft Terms of Appointment to members for their approval and signature.	Secretariat	
9A	ARRTC agreed the next meeting will be held in Darwin from 18 to 20 March 2009 commencing at 2.30pm.	Secretariat	
9B	ARRTC agreed to a possible fieldtrip as part of the ARRTC meeting in October 2009.	Secretariat	
OUTSTANDING ITEMS FROM ARRTC21			
3E	ARRTC agreed the ARRTC Secretariat would seek advice from SSD, EWLS and stakeholders on the prioritisation of the KKNs for short, medium and long term issues with supporting information, and to consider this at the next meeting.	Requested by Chair	Carried forward
4L	ARRTC agreed that Mr Smith would provide a presentation on activities to integrate Traditional Knowledge into the regulatory process at a future meeting	Mr Smith	Carried forward