2 ENVIRONMENTAL ASSESSMENTS OF URANIUM MINES

2.1 Supervision process

The processes used by the Supervising Scientist to supervise uranium mining operations in the Alligator Rivers Region may be broadly categorised as participating in Northern Territory regulatory processes and audit and inspection. The outcomes of these activities are considered by the Supervising Scientist together with environmental monitoring data and other information to draw conclusions regarding the effectiveness of environmental management at uranium mining sites.

2.1.1 Minesite Technical Committees

Minesite Technical Committees (MTCs) have been established for Ranger, Jabiluka and Nabarlek. The MTC meetings provide an effective forum for stakeholders, including the Supervising Scientist, to discuss technical environmental management issues, especially in connection with the assessment of applications and reports submitted by mining companies for approval under Northern Territory legislation. Each MTC is made up of representatives from the Northern Territory Department of Primary Industry, Fisheries and Mines (DPIFM) which provides the Chair, the Office of the Supervising Scientist (***oss***), the Northern Land Council (NLC) and the relevant mining company. A representative from the Gundjeihmi Aboriginal Corporation is invited to attend each meting. Other organisations or experts may be co-opted from time to time as required to assist MTC members. The summary record of each MTC meeting held in 2005–06 was provided to the Environment Centre of the Northern Territory for information.

2.1.2 Audits and inspections

The Supervising Scientist, in consultation with the applicable MTCs, has developed and implemented a programme of inspections and environmental audits at Ranger Mine, Jabiluka Project Area and Nabarlek Mine.

The Routine Periodic Inspections (RPI) take place monthly at Ranger, being the only operating minesite in the region, and quarterly at Jabiluka, currently in long-term care and maintenance. The RPIs are intended to provide a snapshot of environmental management as well as an opportunity for the inspection team to discuss environmental management issues with staff on site. These discussions may include any unplanned events or reportable incidents and any associated follow-up actions. The inspection team is made up of representatives from ***oss***, DPIFM and the NLC.

The abandoned minesites at South Alligator Valley are also routinely inspected twice a year.

The environmental audits are conducted by a team of qualified audit staff from ***oss***, DPIFM and the NLC and are undertaken in general accordance with ISO Standard 19011:2003

(*Guidelines for quality and/or environmental management systems auditing*) and are consistent with current best practice in environmental assessments.

The annual environmental audit of Ranger and Jabiluka occurs in April or May to assess each site under end-of-wet season conditions. The final audit report is tabled at the following meeting of the Alligator Rivers Region Advisory Committee (ARRAC). A follow-up review of the audits is undertaken in November each year. The Nabarlek programme is slightly different in that an inspection is carried out early in the dry season and the annual environmental audit is conducted in November.

The audit outcomes are described later in this Annual Report.

2.1.3 Assessment of reports, plans and applications

The general Authorisations for the Ranger mine and the Jabiluka project are issued under the Northern Territory *Mining Management Act 2001* and are essentially the same as those operating under the previous *Uranium Mining (Environment Control) Act 1979.* The Act provides for alterations to the Authorisation to be issued by the Northern Territory Government. The Authorisations require that ERA seeks approval for certain activities from the Northern Territory regulatory authority, through DPIFM, who then grants approval or not after ***oss*** and the NLC have assessed the proposal and provided comment. This is the primary mechanism whereby the Supervising Scientist participates in the regulatory processes of the Northern Territory Government.

The main reports and plans assessed by the Supervising Scientist during 2005–06 included:

- Ranger Amended Plan of Rehabilitation No. 31;
- Ranger Mine Water Management System Operation Manual;
- Ranger Mine and Jabiluka Project Annual Environmental Reports;
- Ranger Mine and Jabiluka Project Wet Season Reports
- Ranger Mine Annual Tailings Dam Inspection Report;
- Ranger Mine and Jabiluka Radiation Protection Monitoring Programme Quarterly and Annual Reports;
- Jabiluka Mine Development Project Plan of Rehabilitation No. 9;
- ERA monthly environmental monitoring data and quarterly reports submitted in accordance with the Authorisations;
- Applications by the mining companies for amendments to their Authorisations;
- Ranger Mine – Draft Closure Model First Pass

2.2 Ranger

2.2.1 Developments

Mining and milling of uranium ore at Ranger continued throughout 2005–06, with further development of the orebody in Pit 3.

The Ranger mill produced 5184 t of uranium oxide (U_3O_8) during 2005–06 from 1 960 000 t of treated ore (Table 2.1). Production statistics for the milling of ore and the production of U_3O_8 at Ranger for the years 2001–2002 to 2005–06 are shown in Table 2.2.

TABLE 2.1 RANGER PRODUCTION ACTIVITY FOR 2005–2006 BY QUARTER

	1/07/2005 to 30/09/2005	1/10/2005 to 31/12/2005	1/01/2006 to 31/03/2006	1/04/2006 to 30/06/2006	Total
Production (drummed tonnes of U_3O_8)	1 590	1 606	1 392	596	5 184
Ore treated (‘000 tonnes)	567	508	555	330	1 960

TABLE 2.2 RANGER PRODUCTION ACTIVITY FOR 2001–2002 TO 2005–2006

	2001–2002	2002–2003	2003–2004	2004–2005	2005–2006
Production (drummed tonnes of U_3O_8)	3 815	5 312	4 666	5 544	5 184
Ore treated (‘000 tonnes)	1 429	2 153	1 880	2 231	1 960

On-site activities

Exploration

ERA is continuing to conduct exploration drilling near the eastern edge of Pit 3, and in other areas within the Ranger Project Area following interpretation of the results of airborne geophysical surveys conducted during 2005.

Water Treatment Plant

Construction of a Water Treatment Plant (WTP) began in April 2005 (Figure 2.1) and was completed in November 2005. The Water Treatment Plant was identified as the preferred treatment option during ERA’s investigations into reducing the water inventory, which has increased over the last few years. It is designed to treat both process and pond water prior to their release from site. Commissioning of pond water treatment was undertaken in December 2005 and 758.83 ML of pond water permeate has been released to Corridor Creek Wetland Filter up to the end of this reporting period. Commissioning of the process water circuit had not yet commenced at the time of writing and therefore no process water has been released during this reporting period. The commissioning of the WTP has been significantly behind schedule resulting in the pond and process water inventory not being reduced as much as planned. Site water management is discussed in more detail in Section 2.2.2.

Figure 2.1 Water Treatment Plant

Seepage barrier in Pit 1

The construction of a seepage limiting barrier in Pit 1 is now complete. ERA continues to monitor groundwater around the seepage barrier and within adjacent aquifers. This is a statutory requirement and reports are provided to stakeholders for comment and are discussed during RPIs and MTC meetings.

ERA is currently authorised to store tailings in Pit 1 to RL12 as an interim operational strategy. If the interim strategy is not proven to meet the requirements of the MTC for final containment, the Supervising Scientist has advised that tailings should be removed from Pit 1 to a scientifically justifiable level approved by the Supervising Authorities. It is expected that tailings will reach RL12 in Pit 1 during 2008. Tailings and waste management are discussed in more detail in Section 2.2.2.

Tailings Dam Lift

The approvals process for a lift of the walls of the Ranger Tailings Dam from RL43.5 to RL51.0 began in June 2006, with work commencing in July 2006.

2.2.2 On-site environmental management

Water management

Water management continues to be a critical component of environmental protection as well as being of importance to the smooth operations of the mine. During the 2005–06 wet season a number of operational issues, and 'wetter than usual' seasonal conditions (Figure 2.2) have resulted in the pond and process water inventory being significantly greater than forecast.

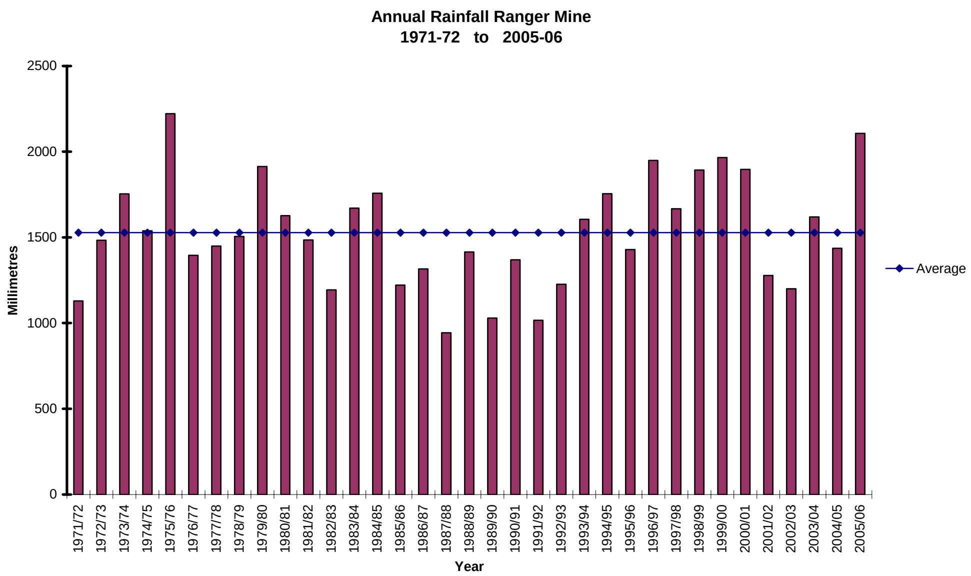

Figure 2.2 Annual rainfall Ranger mine 1971–72 to 2005–06

The major factors identified as contributing to the excess inventory include:

- the expansion of Pit 3 in 2004, resulting in larger catchment for rainfall and surface runoff,
- higher than expected seepage into Pit 3 which is thought to have expressed through the upper reaches of the North Wall in line with where Djalkmara Billabong used to be located,
- a delay in the commissioning of the Water Treatment Plant, and subsequent operational issues resulting in reduced treatment volumes during the second half of the wet season,
- a 'wetter than usual' wet season – approximating to a 1 in 33 year event, and
- the passing of Tropical Cyclone Monica over Jabiru in the early hours of 25 April 2006 resulting an intense rainfall event (≈ 100 mm in less than six hours) falling across the catchment late in the wet season.

Subsequently ERA has proposed a number of additional water management strategies in an effort to reduce the inventory prior to the 2006–07 wet season.

Under normal circumstances ERA disposes of excess water by:

- direct land application or land application following polishing through wetland filters,
- dust suppression on haul roads,
- passive evaporation from ponds, and
- utilisation within the process plant.

In order to increase the rate of disposal, ERA proposed a suite of management strategies including:

- ponding of Retention Pond 2 water on the Southern 2s stockpile surface to enhance evaporation of Retention Pond 2 water,
- an increased capacity of water carts for use in dust suppression,
- an increase in Retention Pond 2 Maximum Operating Level (MOL), and
- new Land Application Areas for irrigation of polished and unpolished pond water.

Process water system

Under the Commonwealth Environmental Requirements, water that is in direct contact with uranium ore during processing (process water) must be maintained within a closed system. It may only be released by evaporation or after treatment in a manner and to a quality approved by the Supervising Scientist. There were no releases of process water from the circuit during the reporting period.

Pond water system

The pond water system contains water that has been in contact with stockpiled mineralised material and operational areas of the site other than those contained within the process water system. This also includes water from Pit 3. The water is managed in accordance with the Water Management Systems Operation Manual. The manual describes a system whereby water is managed according to source and quality. The pond water system consists of Retention Pond 2, Retention Pond 3 and Pit 3. Water from Retention Pond 2 or Pit 3 may not be released without prior treatment through wetland filtration and/or irrigation. In recent years, management of the pond water system has changed from a proscribed regime based on catchment type to one in which water is managed according to water quality. As mentioned previously the pond water inventory is higher this year due to a number of factors and at the end of the reporting period was 2854 ML.

Methods of disposal of pond water

Ponding of Retention Pond 2 water on the Southern 2s stockpiles

Temporary pond water storage bunds were specially constructed on the Southern 2s stockpile to take advantage of enhanced evaporation and infiltration over the duration of the 2006 dry season (Figure 2.3).

The design of the system comprises bunds constructed from low grade material. These bunds are approximately 1 m in height and 5 m in width and extend the breadth (E–W) of the stockpile perpendicular to the slope. The bunds are spaced at approximately 1 m contour intervals and form a series of levees creating a network of terraced ponds. The geotechnical integrity of the stockpile is maintained by ensuring that the boundaries are at least 40 m from the edge in any direction.

Pond water is pumped directly from Retention Pond 2 and enters the stockpile upgradient of the most northerly bund. It then pools and cascades downslope over rock-lined spillways. The maximum depth of water can be 1 m (immediately behind the bund) and therefore the average water depth can be up to 0.5 m. Pumping stops when pond water is observed to first enter the lowest ponding area to avoid overtopping.

At the end of the dry season, and before the first 100 mm of rainfall of the wet season, the surface of the stockpiles will be reinstated to shed surface runoff via the drop-down structure at the southern end.

Figure 2.3 Ponding on 2s stockpile

Passive release water

Rainfall runoff water discharges from the Ranger site during the wet season via Gulungul Creek, Corridor Creek and Coonjimba Creek with minor overland flow direct to Magela Creek. Retention Pond 1 (RP1) and the Corridor Creek wetlands act as sediment traps prior to outflow from the site. The Corridor Creek wetland filter receives runoff from specially prepared sheeted areas of low grade and waste rock stockpiles to minimise infiltration and excess water contribution to the Pond Water system. RP1 also receives some sheeted runoff from stockpiles and overflows via a constructed weir into Coonjimba Creek every wet season. Discharge over the RP1 weir occurred between 18 January 2006 and 29 May 2006.

Increase in RP2 Maximum Operating Levels

The dry season and wet season Maximum Operating Levels for Retention Pond 2 have been increased from RL19.25 m to RL19.80 m, and from RL18.75 m to RL19.00 m respectively to allow for additional storage capacity. In order to apply the new levels, ERA intends to construct a spillway on the northern wall of Retention Pond 2 which will provide suitable relief capacity for storm events so that overtopping of the dam does not occur and the integrity of the dam wall is maintained. The construction of the spillway will take approximately one month and will require water levels within Retention Pond 2 to be lower than the construction site. ERA determined that it was not practical to do this work in the short term as it would require the removal of water from Retention Pond 2 into Pit 3 impacting on the mining activities within Pit 3. Therefore as an interim measure, to take advantage of the additional storage immediately, a contingency is in place that makes use of an existing channel entering Retention Pond 2 from behind the workshop at the eastern end of Retention Pond 2. In the event of any unseasonal rain raising the water level within the pond to unacceptable levels above the Maximum Operating Level, ERA will cut a temporary spillway from this channel to Djalkmara sump through the old access road bund. Water would then flow through this temporary spillway to the Djalkmara sump and then into Pit 3, providing sufficient relief capacity to ensure the integrity of Retention Pond 2 is maintained.

Commissioning of new land application areas for application of pond water

ERA has been granted approval for the commissioning and operation of two new Land Application Areas to dispose of pond water during the 2006 dry season only. The larger of the two areas is situated on the former Jabiru East township and occupies approximately 52 ha (Jabiru East Land Application Area). The second site is an extension to the existing RP1LAA and is 24 ha (RP1LAAext). Both areas will be irrigated with unpolished Retention Pond 2 water under the same arrangements as the current Magela Land Application Area.

Stockpile sheeting

During the 2006 dry season the bunding to divert the first 200 mm of runoff from the Corridor Creek wetland filter into the pond water system was reinstated due to the use of the stockpiles in disposing of Retention Pond 2 water (as described above).

Wetland filters and land application areas

Two wetland filter systems operated during 2005–06. The Corridor Creek system and the Retention Pond 1 constructed wetland filter in the Retention Pond 1 catchment.

The Retention Pond 1 constructed wetland filter (RP1CWF) operated successfully throughout the 2006 dry season commencing on 23 May 2006 providing polished water for land application on the Retention Pond 1 and Djalkmara Land Application Areas. In addition RP1CWF supplied water for the suppression of dust on the temporary road constructed to haul laterite gravel material to the tailings dam.

Treated pond water from the Water Treatment Plant reports to the Corridor Creek Wetland Filter.

Land application commenced on 20 June 2005 for all application areas apart from the Magela Land Application Area which commenced the day after cease to flow was declared for Magela Creek. Land application continued until 17 November 2005. Both Djalkmara irrigation areas and the Retention Pond 1 irrigation area operated in rotating shifts of 8 hours over a 24-hour period. Supply to these areas is regulated by pumping from Cell 9 of the Retention Pond 1 wetland filter. Retention Pond 2 is irrigated directly on the Magela Land Application Area.

Tailings and waste management

Tailings

Since August 1996, no process residue from the milling of ore has been deposited into the tailings dam with Pit 1 now the sole receptor. Over this time a total of 20 million tonnes of tailings have been deposited in Pit 1, which apart from 1.8 million tonnes of tailings dredged from the tailings dam, is derived directly from ore processing. Transfer of tailings into Pit 1 from the milling and processing of ore is currently by central sub-aqueous deposition.

The average density of process residue in Pit 1 at 30 June 2006 was 1.37 t/m^3, which meets the minimum target density of 1.2 t/m^3.

It is a condition of the Commonwealth Environmental Requirements that all tailings be returned to the pits prior to mine closure. The current approval for tailings above RL0 in Pit 1 is an interim operational strategy and ERA will have to undertake further research and investigative work to provide a final tailings containment solution to the Supervising Authorities for approval. If the interim strategy is not proven to meet the requirements of the MTC for final containment, the Supervising Scientist has advised that tailings should be removed from Pit 1 to a scientifically justifiable level approved by the Supervising Authorities. It is expected that tailings will reach RL12 in Pit 1 during 2008.

In March 2006 ERA lodged a draft application with the MTC for the storage of tailings in Pit 3. Comments on the draft were provided by stakeholders to ERA and follow up discussions were held during a workshop on 16 June 2006. ERA intends to address these comments and submit a final application in the near future.

Audit outcomes

2006 Environmental Audit

The Annual Environmental Audit on behalf of external stakeholders of Ranger Mine was undertaken from 16 May to 19 May 2006. The audit team was made up of personnel from the Office of the Supervising Scientist, the Department of Primary Industry, Fisheries and Mines, and the Northern Land Council. The subject of the audit was compliance with the Ranger Authorisation 0108-03.

The audit team were generally satisfied that Ranger Mine complied with the major components of the Authorisation. Of the 63 criteria assessed the audit findings are as follows:

- 1 requires urgent action;
- 3 require action in the form of a firm deadline;
- 3 were satisfactory but improvement is recommended; and
- 56 were satisfactory.

A new ranking system that better reflects the style of audit undertaken has been developed by ***oss*** and was in use this year for the first time. The system is similar to the system used in the past with respect to the scale of the aspect and action required. The difference is that the new system is based on encouraging continuous improvement in that recommendations for the level of action and action required are made, which gives the auditee direction in remediating a deficiency prior to the follow-up audit.

Minesite Technical Committee

The Ranger Minesite Technical Committee (MTC) met six times during 2005–06. Dates of meetings and significant issues discussed are shown in Table 2.3.

TABLE 2.3 RANGER MINESITE TECHNICAL COMMITTEE MEETINGS

Date	Significant additional agenda items
29 August	Pond and process water treatment programme update, RL0 application update, Stockpile runoff proposal, Review of Ranger Authorisation, Gulungul monitoring site location, Northern Stockpile extension, Vegetation surveys of irrigation areas, Review of the Retention Pond 1 wetland filter, Temporary ADU storage, Laterite processing.
07 October	As above plus Pit 1 update, The role of the MTC in Ranger closure planning and approvals.
18 November	Pond and process water treatment programme update, Pit 1 update, Status of the Mine Management Plan and approvals, Vegetation surveys of irrigation areas, Temporary ADU storage, Review of Ranger Authorisation, Geochemical properties of waste stockpiles, Mine Closure, Review of Ranger reserves and proposal for additional exploration drilling, Closeout recommendations from SSR184 and 185.
20 January	Pond and process water treatment programme update, Pit 1 update, Status of the Mining Management Plan and approval(s), Mine closure, Review of Ranger reserves and proposal for additional exploration drilling, Power line clearing to Magela Bore field
27 March	As above plus: Ranger Mine Draft Closure Model, Acid plant and EPBC Act referral, Laterite Plant, Pit 3 Tailings Deposition, Uranium Industry Framework update,
30 May	Pond and process water management, mine closure, exploration drilling, draft application for tailings deposition in Pit 3

Authorisations and Approvals

There were four applications assessed by ***oss*** during 2005–06 (see Table 2.4). All were approved by DPIFM after concerns raised by stakeholders were addressed. Changes to the Authorisation that required input from ***oss*** are listed in Table 2.4.

TABLE 2.4 RANGER AUTHORISATION CHANGES/APPROVALS

Date received	Issue
18 August 2005	Approval to change the programme of inspection of vegetation in irrigation areas
16 May 2006	Approval to use the southern 2s stockpile surface for storage of Retention Pond 2 water
23 May 2006	Approval for the extraction of gravel for the tailings dam wall lift
20 June 2006	Approval for the increase in Maximum Operating Level of Ranger’s Retention Pond 2

Incidents

Background to incident investigation

Since 2000 ERA has undertaken to provide stakeholders with a comprehensive list of environmental incidents reported at its Ranger and Jabiluka operations on a regular basis. The regular monthly environmental incident report is additional to reports made to meet the statutory requirements for incident reporting. This regime of reporting all recorded environmental incidents is undertaken voluntarily by ERA in response to concerns expressed by stakeholders about the establishment of suitable thresholds of incident severity for reporting.

Immediately upon receipt of notification of such incidents, ***OSS*** assesses the circumstances of the situation and a senior officer makes a decision on the appropriate level of response. Dependent on the assessment, this response will range from implementation of an immediate independent investigation such as occurred in March 2004 following a potable water contamination incident, through seeking further information from the mine operator before making such a decision. In those cases where immediate action is not considered to be required the situation is again reviewed on receipt of a formal incident investigation report from the operator.

Prior to each Routine Periodic Inspection (see Section 2.1.2) the inspection team reviews the previous month's incident reports and any open issues. Where incidents are considered to have any potential environmental significance or represent repetitions of a class of occurrences an onsite review is scheduled as a part of the routine inspection protocol.

OSS determined that no incidents that occurred during the reporting period were of a serious enough nature to warrant a separate independent investigation, however, the following incidents were followed up as part of the routine periodic inspections.

ADU spray in Precipitation Building

On 14 October 2005, ***OSS*** was notified that an incident had occurred in the Precipitation Building involving an operator being sprayed with ammonium diuranate (ADU). During the night the operator observed that a short section of the ADU line near the pump that pumps ADU from the product thickener to the calciner was bulging, indicating a blockage in the line. The operator went to shut the pump down, however, the line failed before he could complete the process resulting in him being sprayed with ADU. The operator took the appropriate action to wash himself off. ADU was also sprayed within the Precipitation Building.

The Precipitation Building was promptly cleaned up and the operator underwent 24 hour urine testing. On the basis of the urine monitoring results and the biokinetic model for uranium published by the International Commission on Radiation Protection, the committed effective dose to the operator as a result of ingestion of uranium was approximately 0.1 microSieverts (µSv). This dose is low compared with the typical 1500 to 2000 µSv that humans receive each year from natural background.

Tailings pipe rupture

On 11 November 2005 at approximately 10.00 am there was a failure of the tailings pipe adjacent to the tailings pumping station. The failure resulted in approximately 1 m^3 of tailings being sprayed onto and across the Corridor Road and into the adjacent bush. This area of bush is part of the clean catchment of Corridor Creek.

The incident was noticed immediately and the tailings circuit was shut down until repairs and clean up could be undertaken. The tailings were removed from the Corridor Road along with the approximately 600 m^2 of bush. The material was placed in the tailings repository.

Accidental irrigation of Magela Land Application Area

To manage the water level in Retention Pond 2, pumping from Retention Pond 2 to Pit 3 (using a pontoon pump) commenced at 8.00 pm on 21 January 2006. The water management system is designed to allow water to be transferred from Retention Pond 2 to Pit 3 and/or the Magela Land Application Area (MLAA). In this instance the valves were set in the appropriate position to send water only to Pit 3 and water was observed exiting the pipe into Pit 3 as expected.

The following day during a routine daily check at approximately 12:15 pm, a flow meter in the line that feeds the MLAA was observed to be turning. The valve that should have prevented flow in that line was observed to be closed as appropriate indicating that the valve had likely failed. At 12:30 pm a valve downstream of the failed valve was closed stopping flow to the MLAA. ERA management and stakeholders were notified immediately.

Meter readings indicated that 1531 cubic metres had been sent to the MLAA between 8.00 pm on 21 January 2006 and 12:30 pm on 22 January 2006. This equates to an irrigation rate of 0.026 m^3/s. Four zones (of approximately 20) in the MLAA received the water.

At the time of the release, Magela Creek was flowing at more than 169 m^3/s. Conservatively if that water discharged directly into Magela Creek, the dilution expected would be around 1 in 6500. Following the incident, water samples were taken from Retention Pond 2 and analysed indicating a uranium concentration of approximately 4400 µg/L. If this water had been directly discharged into Magela Creek it would result in a worst case concentration of approximately 0.7 µg/L assuming full mixing. This is well below the ecotoxicological limit of 6 µg/L for uranium concentrations in Magela Creek.

Both ERA and SSD sampled Magela Creek in the days following the incident and observed no unusual results, ie the results were within the range seen in previous years at that time of the year.

ERA undertook a formal investigation and provided stakeholders with a report outlining the root cause of the incident and proposed actions to prevent a similar incident in future.

Potential ingestion of contaminated dust in product packing room

On 27 February 2006, ***OSS*** was notified by ERA that an employee maintaining the hoppers in the product packing room noticed a metallic taste in his mouth and a 'cloud' around the room at approximately 10.30 am that day. The employee was wearing full Personal Protective Equipment, including an airstream helmet. As a precaution, a 24 hour urine sample was collected and analysed for uranium content. The result of the analysis of the 24 hour urine sample (first 24 hours) indicated that the urine contained 0.38 µg of uranium. Assuming that all of this came from an acute intake via inhalation on the 27th of February, the worker received a dose of approximately 80 microSieverts or 0.4% of the average annual dose received by the general public.

Investigations into the incident indicated that it was unlikely that the airstream helmet had failed. If an airstream helmet is not operating whilst being worn it quickly fogs up. The employee indicated that this had not occurred. The results of the urine analysis are also indicative of the levels of uranium expected from drinking potable water from the Brockman bore field.

2.2.3 Off-site environmental protection

Surface water quality

Under the Authorisation, ERA is required to monitor and report on water quality in Magela and Gulungul Creeks adjacent to the mine. Specific water quality objectives must be achieved in Magela Creek. These objectives were recently reviewed and updated by the ***oss***.

The Authorisation specifies the sites, the frequency of sampling and the analytes to be reported. Each week during the wet season, ERA reports the water quality at key sites at Ranger, including Magela and Gulungul Creeks, to the major stakeholders (the Supervising Scientist, DPIFM and NLC). A detailed interpretation of water quality across the site is provided at the end of each wet season in the ERA Ranger Annual Wet-season Report.

In addition to ERA's monitoring programme, the Supervising Scientist conducts an independent surface water monitoring programme that includes chemical and physical monitoring in Magela and Gulungul Creeks and biological monitoring of numerous water bodies in the region. Key results (including time-series charts of key variables of water quality) are reported on the Internet at www.deh.gov.au/ssd/monitoring/index.html. The highlights of the monitoring results are summarised below.

Chemical and physical monitoring of Magela Creek

The first water chemistry samples for the Supervising Scientist's surface water monitoring programme for the 2005–06 wet season were collected from Magela Creek on 6 December 2005, one day after flow was observed at the downstream statutory compliance point. Weekly sampling was conducted throughout the wet season, and continued until the creek ceased to flow, with the following exceptions: (i) following an accidental irrigation of the Magela Land Application Area with pond water on 21–22 January 2006, additional sampling of Magela Creek was undertaken on 23 January 2006; and (ii) in the last week of April 2006, sampling did not occur after Tropical Cyclone Monica passed over Jabiru on 25 April 2006 because sites were inaccessible. SSD collected its last sample on 24 August 2006 shortly before Magela Creek ceased flowing.

The values of all available indicators for the wet season, including the period immediately following the irrigation incident, have been within limits/guidelines[1] set by the Supervising

[1] Iles M 2004. Water quality objectives for Magela Creek – revised November 2004. Internal Report 489, December, Supervising Scientist, Darwin. Unpublished paper.

Scientist for the protection of the aquatic environment and are within the range seen in previous years.

The upstream and downstream key water quality data from both the SSD and ERA programmes are summarised in Table 2.5 while uranium concentrations from both the SSD and ERA routine and investigative monitoring (following the irrigation incident) are shown in Figure 2.4. There is good agreement between the datasets of both organisations.

Uranium, manganese, magnesium and sulfate median values from both datasets were higher downstream of the mine but the concentrations were very low and not of environmental concern. Uranium concentrations remained well below (<3% of) the limit (Figure 2.4). The low values are indicative of the pattern of improved water quality seen in the past four wet seasons, demonstrated in the uranium results of Figure 2.5.

Electrical conductivity (EC), whose guideline value provides a management tool for the control of magnesium and sulfate concentrations, was also slightly higher downstream but compared to the guideline value the difference was small. The manganese, pH, and turbidity medians are similar at both sites for each dataset.

The water quality objectives set to protect the aquatic ecosystems downstream of the mine were achieved during the 2004–05 wet season. Available biological monitoring data (described later in this section) also indicate that the environment remained protected throughout the season.

TABLE 2.5 SUMMARY OF MAGELA CREEK 2005–06 WET SEASON# WATER QUALITY UPSTREAM AND DOWNSTREAM OF RANGER

			Median		Range	
Parameter	Guideline or Limit*	Organisation	Upstream	Downstream	Upstream	Downstream
pH	5.0 – 6.9	SSD	6.4	6.4	5.6 – 6.8	5.9 – 6.8
		ERA	6.3	6.4	5.5 – 6.7	5.8 – 6.7
EC (µS/cm)	43	SSD	14	17	7.9 – 20	8.5 – 23
		ERA	12	15	4.8 – 20	6.9 – 23
Turbidity (NTU)	26	SSD	2.0	2.2	0.9 – 14	0.8 – 18
		ERA	2.	2.	1 – 11	1 – 14
Sulfate‡ (mg/L)	Limited by EC	SSD	0.2	0.7	0.1 – 0.4	0.3 – 3.4
		ERA	0.2	0.8	0.1 – 0.6	0.3 – 3.8
Magnesium‡ (mg/L)	Limited by EC	SSD	0.6	0.9	0.2 – 1.1	0.3 – 1.4
		ERA	0.5	0.8	0.1 – 0.9	0.2 – 1.2
Manganese‡ (µg/L)	26	SSD	4.4	4.9	2.2 – 13	2.1 – 16
		ERA	3.9	4.1	1.9 – 10	3.2 – 16
Uranium‡ (µg/L)	6	SSD	0.014	0.048	0.003 – 0.044	0.014 – 0.153
		ERA	0.018	0.064	0.006 – 0.060	0.014 – 0.145

ERA data taken from the ERA Weekly Water Quality Report 18 August 2006; ‡ dissolved (<0.45 µm); # SSD results from the last sampling event, 24 August, outstanding at time of report writing; * A compliance limit applies to uranium, management guidelines apply to all other parameters shown.

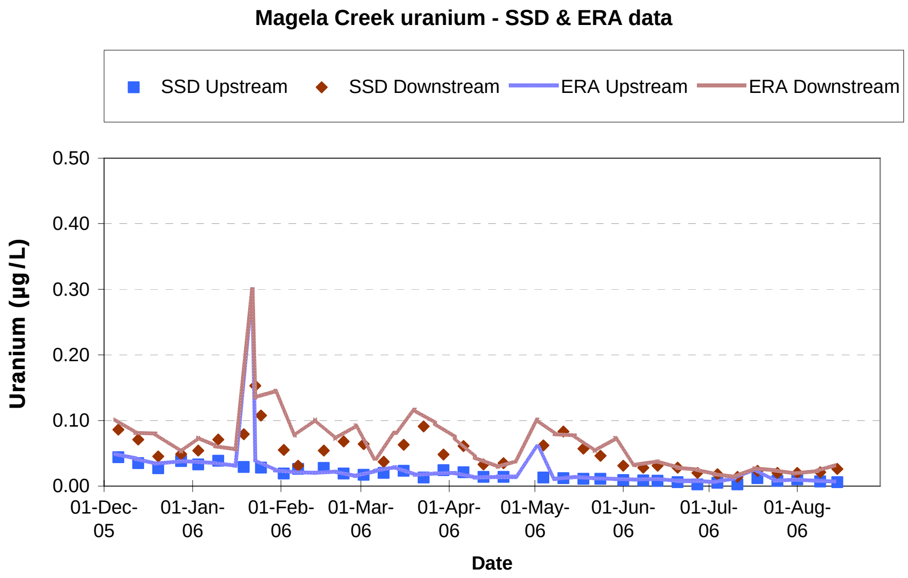

Figure 2.4 Uranium concentrations measured in Magela Creek by SSD and ERA during the 2005–06 wet season

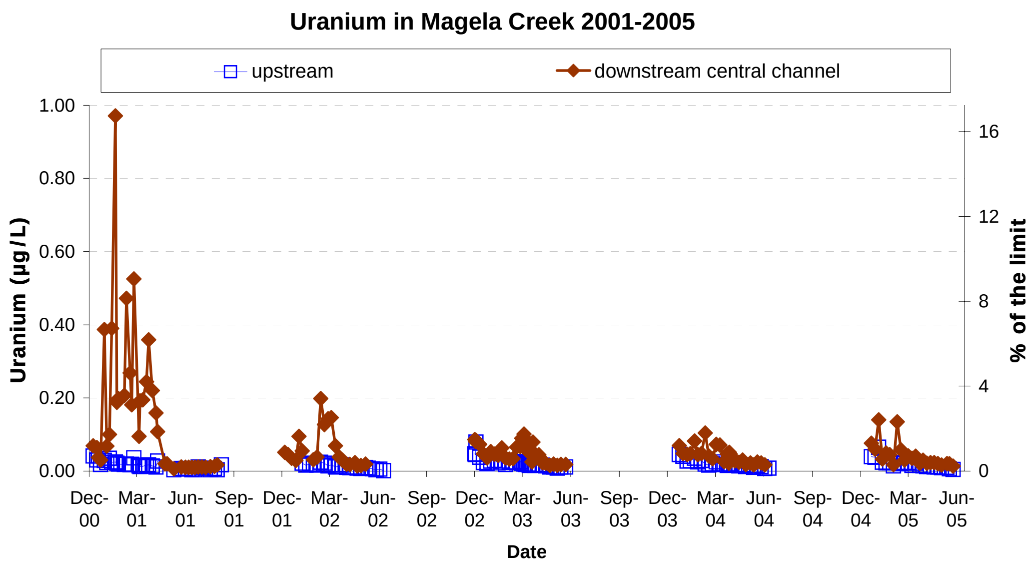

Figure 2.5 Uranium concentrations in Magela Creek since the 2000–01 wet season (SSD data)

Chemical and physical monitoring of Gulungul Creek

The first water chemistry samples for the Supervising Scientist's surface water monitoring programme for the 2005–06 wet season were collected from Gulungul Creek on 29 November 2005, the first week after flow commenced in the creek. Weekly sampling was conducted throughout the wet season, and continued while the creek was flowing, except for the last week of April 2006 when sites became inaccessible after Tropical Cyclone Monica passed over Jabiru (on 25 April 2006). SSD collected its last sample on 15 August 2006 shortly before Gulungul Creek ceased to flow.

The upstream and downstream water quality data from both the SSD and ERA programmes are summarised in Table 2.6 with uranium concentrations shown in Figure 2.6. There is good agreement between the datasets of both organisations and the overall water quality and seasonal trends for the 2005–06 wet season are comparable to those seen in previous years (Figure 2.7).

Although median values for most of the key variables were slightly higher downstream of the mine (Table 2.6), the concentrations were very low and not of environmental concern.

ERA measured elevated uranium on the first day of flow (Figure 2.6) when it sampled within hours of flow first occurring. Uranium concentrations were below the limit and the concentration at the upstream site was higher than that at the downstream site. In mid-January 2006, SSD measured a higher than usual uranium concentration of 0.393 µg/L (less than 7% of the 6 µg/L limit determined for Magela Creek). None of these excursions is considered to be environmentally significant: values this high experienced previously and for longer periods did not impact on the biodiversity. Available biological monitoring data (described later in this section) also indicate that the environment remained protected throughout the season.

TABLE 2.6 SUMMARY OF GULUNGUL CREEK 2005–06 WET SEASON WATER QUALITY UPSTREAM AND DOWNSTREAM OF RANGER

Parameter	Company	Median		Range	
		Upstream	Downstream	Upstream	Downstream
pH	SSD	6.3	6.5	5.4 – 6.7	5.7 – 6.7
	ERA	6.3	6.4	5.1 – 6.7	5.4 – 6.6
EC (µS/cm)	SSD	16	19	10 – 21	11 – 29
	ERA	13	15	8.7 – 24	8.4 – 26
Turbidity (NTU)	SSD	1.0	1.4	0.4 – 5.4	0.7 – 7.7
	ERA	1.	1.	<1 – 8.	<1 – 5.
Sulfate‡ (mg/L)	SSD	0.2	0.4	0.1 – 0.7	0.1 – 2.3
	ERA	0.2	0.5	0.1 – 1.2	0.1 – 1.8
Magnesium‡ (mg/L)	SSD	0.9	0.9	0.5 – 1.8	0.5 – 1.8
	ERA	0.8	0.8	0.3 – 1.6	0.4 – 1.3
Manganese‡ (µg/L)	SSD	2.1	3.6	1.2 – 8.5	2.0 – 18
	ERA	2.0	3.2	1.2 – 11	1.8 – 18
Uranium‡ * (µg/L)	SSD	0.054	0.095	0.030 – 0.169	0.058 – 0.393
	ERA	0.060	0.102	0.032 – 1.64	0.053 – 1.05

‡ dissolved (<0.45 µm), * limit = 6 µg/L

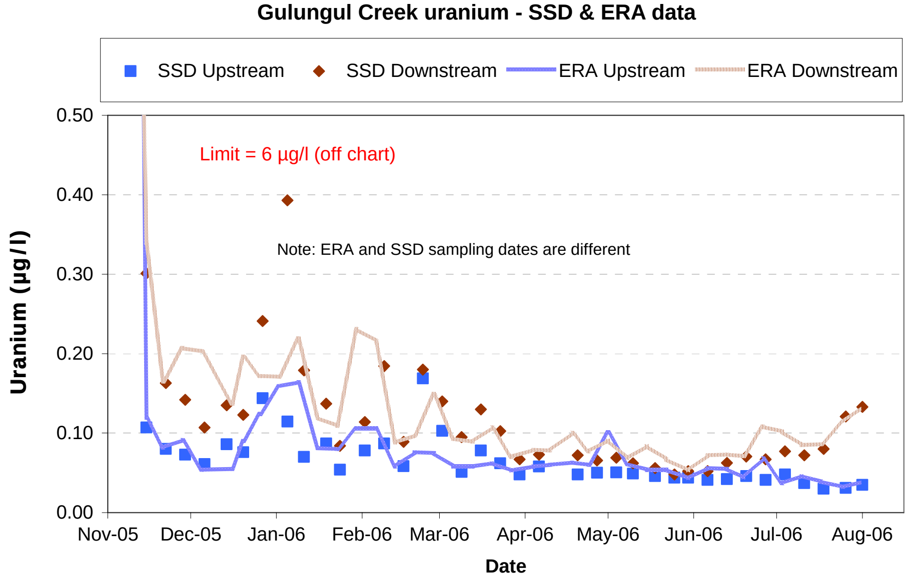

Figure 2.6 Uranium concentrations measured in Gulungul Creek by SSD and ERA during the 2005–06 wet season

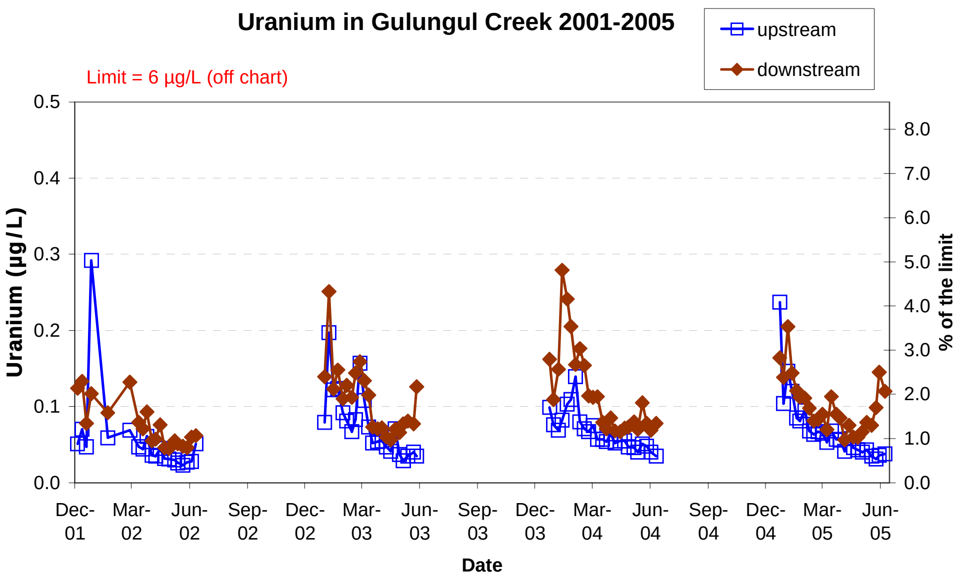

Figure 2.7 Uranium concentrations in Gulungul Creek between 2000 and 2005 (SSD data)

Biological monitoring in Magela Creek

Based on ***eriss*** research since 1987, biological monitoring techniques have been developed that can be used to assess the environmental impact of uranium mining on aquatic ecosystems downstream of the Ranger mine. Two broad approaches are used: early detection studies and assessment of overall ecosystem-level responses.

Creekside monitoring is used for *early detection* of effects in Magela Creek arising from any dispersion of mine waters during the wet season. For *ecosystem-level responses*, benthic macroinvertebrate and fish communities from Magela and Gulungul Creek sites are compared with historical data and data from control streams. Results of creekside monitoring and fish community studies conducted during the 2005–06 wet and early dry seasons are summarised here. (Macroinvertebrate samples collected from stream sites in May 2006 had not been processed at the time this report was being prepared. Associated and additional data and results will be more fully reported in a Supervising Scientist Report to be compiled later in 2006.)

Creekside monitoring

In this form of monitoring, effects of Ranger mine wastewater dispersion are evaluated using responses of aquatic animals held in tanks on the creek side. The responses of two test species are measured over a four-day period:

- reproduction (egg production) in the freshwater snail, *Amerianna cumingi*; and
- survival of black-banded rainbowfish, *Melanotaenia nigrans*, larvae.

Animals are exposed to a continuous flow of water pumped from upstream of the mine site (control site) and from the creek just below gauging station G8210009, some 5 km downstream of the mine (Map 2, Magela d/s). Tests usually commence in December and cease in early April each year, the period of significant creek flow in Magela Creek.

Seven creekside tests were conducted in the 2005–06 wet season. Significant pump failure occurred during the fourth test at the upstream site, to the extent that the test did not meet acceptance and validity criteria. While the data for this test are displayed in the accompanying figures, they are not used in formal statistical analysis to detect and assess potential mining impact. (By convention, the upstream-downstream ‘difference’ value is omitted from the graphs of test organism responses to signify an invalid test.)

Amongst the snail tests, egg production at upstream and downstream sites was similar across all tests conducted for the wet season (Figure 2.8). The results also resemble the pattern of egg production observed in previous wet seasons with the possible exception of the relatively low egg production observed at the downstream site in the fifth test. This value was a consequence of significantly lower ($P<0.05$) egg production observed in the duplicate water drawn from the west bank of the creek at the downstream site (mean of 54 eggs per snail vial), relative to the corresponding duplicate water drawn from the east bank at this site (107 eggs per snail vial) and from the two duplicate waters drawn from the upstream site (117 and 123 eggs per snail vial). Corresponding spot water chemistry data collected during this test as part of the SSD’s routine monitoring programme do not indicate any significant elevation of analytes at this site. Additional water chemistry data, together with continuous datasonde records for key parameters including conductivity and pH, were also collected during this creekside test and results, similarly, do not show any major discrepancies in water quality. Thus the reduced snail egg production observed at the downstream west bank site during the fifth test does not appear to be mine-related.

Using the snail egg production data shown in Figure 2.8, 'difference' values for 2005–06 were compared with those from previous years. No significant difference was found (P>0.05).

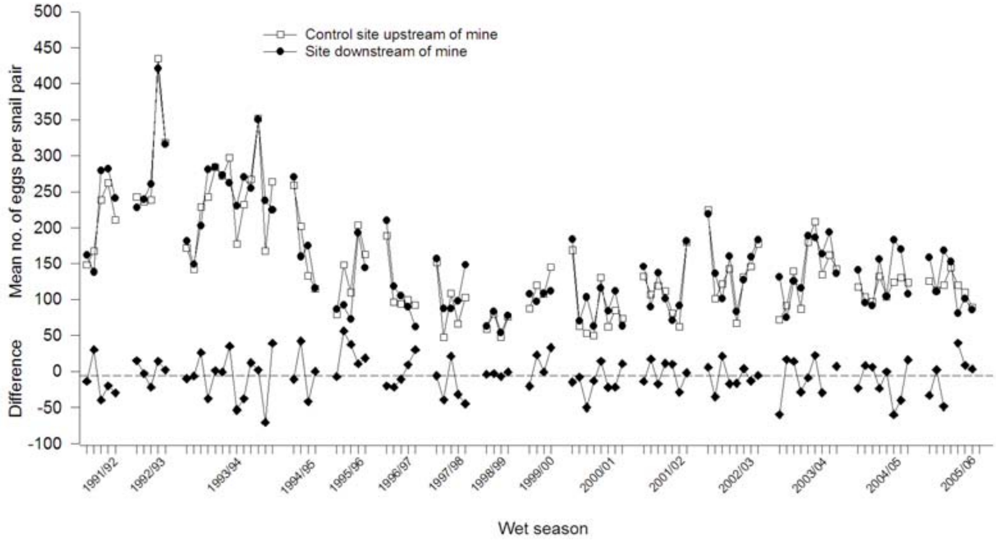

Figure 2.8 Creekside monitoring results for freshwater snail egg production for wet seasons between 1992 and 2006. (Snail egg production data for the first three tests of 1995/96, all tests for 1997/98, 1998/99 and 1999/00, and the last four tests in 2000/01, were provided by ERA.)

Across all fish tests, larval fish survival at upstream and downstream sites was consistent with the same relative survival rates observed in previous wet seasons with, typically, reduced survival at the upstream site relative to the downstream site (Figure 2.9). (Possible causes were discussed in the Supervising Scientist Annual Report for 2002–03.)

From the collective creekside results, it was concluded that there were no adverse effects of dispersed Ranger mine wastewaters to Magela Creek on either of the creekside test species over the 2005–06 wet season.

Monitoring using macroinvertebrate community structure

Macroinvertebrate sampling is conducted in May each year. Results of the studies conducted in 2005 and previous years were reported in the 2004–05 Supervising Scientist Annual Report. The samples collected in May 2006 were still undergoing analysis and interpretation at the time of report writing.

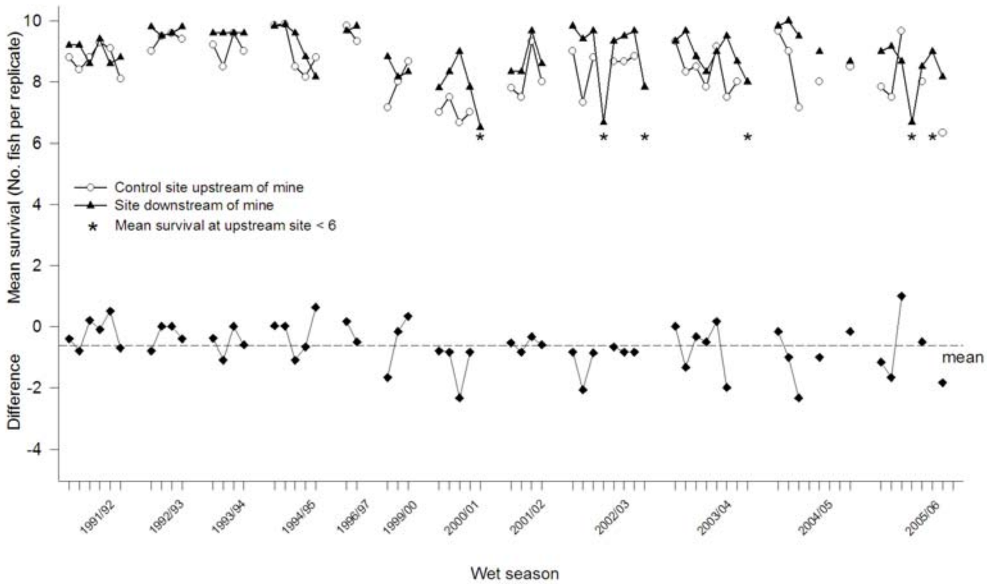

Figure 2.9 Creekside monitoring results for larval black-banded rainbowfish survival, for wet seasons between 1992 and 2006. (Larval fish survival data for the second test in 1999/00 were provided by ERA.)

Monitoring using fish community structure

Sampling of fish communities in billabongs is conducted in late April to the end of June of each year. Data are gathered, using non-destructive sampling methods, from 'exposed' and 'control' sites in deep channel billabongs and shallow weedy lowland billabongs. Details of the sampling methods and sites were provided in the 2003–04 Supervising Scientist Annual Report.

For both deep channel and shallow lowland billabongs comparisons can be made between: (i) directly exposed billabong versus control billabong from independent catchments (Nourlangie Creek, East Alligator River, Wirnmuyurr Creek); and/or (ii) directly exposed versus indirectly exposed billabongs in Magela Creek, recognising that this second approach is confounded by possible movement of fish between the two lowland billabong types in the same stream system.

Channel billabongs

The similarity of fish communities in Mudginberri Billabong (directly exposed site downstream of Ranger) and Sandy Billabong (control site in the Nourlangie catchment) was determined using multivariate dissimilarity indices. Calculated for each annual sampling occasion, the dissimilarity index is a measure of the extent to which fish communities of the two sites differ from one another. A value of 'zero' indicates identical fish communities while a value of 100% indicates totally dissimilar communities, sharing no common species. A significant change or trend in the dissimilarity values over time could imply mining impact. A plot of the dissimilarity values from 1994 to the present is shown in Figure 2.10.

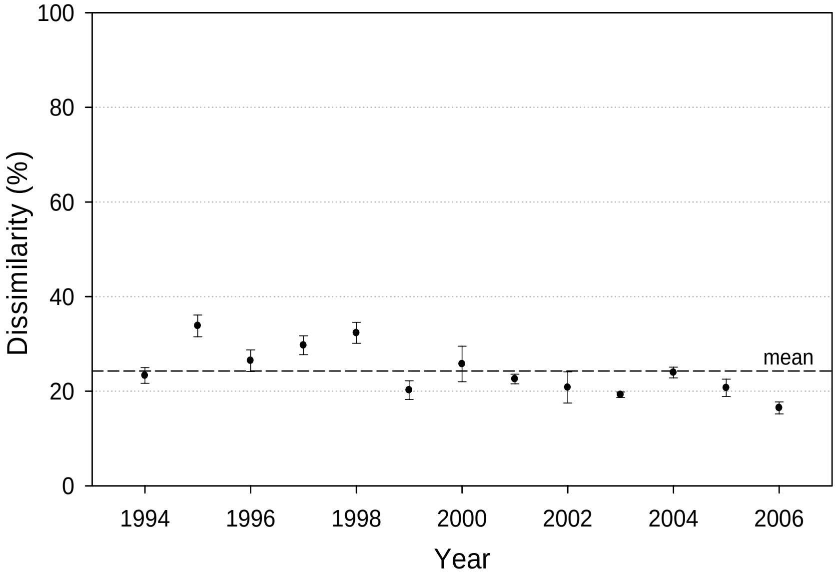

Figure 2.10 Paired control-exposed dissimilarity values (using the Bray-Curtis measure) calculated for community structure of fish in Mudginberri ('exposed') and Sandy ('control') billabongs in the vicinity of the Ranger uranium mine over time. Values are means (± standard error) of the 5 possible (randomly-selected) pairwise comparisons of transect data between the two billabongs. There has been a significant decline in paired-site dissimilarity over time but there is no evidence that this decline is mine-related (see text for further explanation).

In the Supervising Scientist Annual Report for 2003–2004, a significant decline was noted in the paired-site dissimilarity measures over time. This decline has continued (Pearson's correlation $R = -0.70$, $P<0.05$) with the value reported in 2006 the lowest yet recorded (Figure 2.10). The decline is primarily attributed to the particularly high abundances of chequered rainbowfish (*Melanotaenia splendida inornata*) and to a lesser extent glassfish (*Ambassis* spp) in Mudginberri Billabong in the early years of the study, relative to Sandy Billabong. Chequered rainbowfish have declined in Mudginberri Billabong since sampling commenced in 1989. The decline in rainbowfish numbers, and by association, the paired billabong dissimilarity value, is not related to any change in water quality over time as a consequence of water management practices at Ranger. This issue was examined in more detail in the Supervising Scientist's 2004–05 Annual Report where the environmental correlates (1) wet season stream discharge, (2) natural, wet season stream solute concentration, (3) length of previous dry season, and (4) habitat conditions on Magela Creek floodplain, were identified as possible causes of the decline in rainbowfish.

Further work is required to elucidate the cause of the decreasing dissimilarity of fish communities between Sandy and Mudginberri billabongs. The continued decline has been less influenced by chequered rainbowfish and glassfish in the latter years, suggesting more subtle changes in community structure are also occurring.

Shallow lowland billabongs

Fish in shallow billabongs were not sampled in 2006. While the current baseline of fish community data (pre-closure) from these sites is reasonably extensive, this is not the case for macroinvertebrate communities. Biological data in association with water chemistry data are being used to develop mine site closure criteria for the shallow water bodies around Ranger mine. To this end, resources during 2006 were diverted to the collection of macroinvertebrate samples from the shallow lowland billabongs to redress data deficiencies required for developing closure criteria for these sites. Currently macroinvertebrate samples collected in May are being sorted and identified. Interim closure criteria will be available in December 2006 following sample processing and data analysis. Sampling of fish communities in shallow billabongs will be reviewed, along with the broader biological monitoring programme, in October 2006.

2.2.4 Outcome of investigations into incidents at Ranger in 2003–04

The Supervising Scientist's reports on the incidents, *Investigation of the potable water contamination incident at Ranger mine March 2004* (Supervising Scientist Report 184) and *Investigation of radiation clearance procedures for vehicles leaving the Ranger mine* (Supervising Scientist Report 185), were tabled in Parliament on 30 August 2004 and subsequently made available to all major stakeholders in hard copy format and through the Supervising Scientist's web site.

Following consideration of issues raised in the reports, the Minister for Industry, Tourism and Resources, the Hon Ian Macfarlane MP, wrote to ERA requiring the company to comply with a series of conditions under the *Atomic Energy Act 1953*. These conditions were based on the recommendations in the Supervising Scientist's two reports. Minister Macfarlane required that the conditions be met in accordance with a timeframe involving deadlines of 10 September 2004, 31 October 2004 and 31 December 2004.

The final of the conditions, involving the implementation of workplace safety standard AS4801/2001 (*Occupational health and safety management systems – Specification with guidance for use*) by 30 September 2005, was met by the required date.

The Ranger Minesite Technical Committee has, at each of its meetings, reviewed the status of compliance by ERA against the Supervising Scientist's full set of recommendations. In July 2005 the Supervising Scientist engaged ARPANSA to conduct an additional detailed audit of the Radiation Safety Practices at the Ranger mine. The purpose of this audit was to examine the steps that ERA has taken to upgrade its radiation management system and, as a result, to address concerns about the radiation protection culture at Ranger. The audit concluded that the Radiation Safety Management System was a comprehensive system that if implemented would ensure radiation safety at the Ranger site.

2.3 Jabiluka

2.3.1 Developments

No developments occurred at the Jabiluka site during the reporting period. The site is maintained as a passive discharge site under the long-term care and maintenance regime of management.

Decommissioning of Djarr Djarr camp commenced in September 2005, with core from the sheds being transported to storage sheds at Ranger Mine. The removal of the infrastructure was completed in October 2005 and rehabilitation works are in progress.

2.3.2 On-site environmental management

Water management

The site is continuing to be maintained as a passive discharge site.

Figure 2.11 Jabiluka Project Area during the 2005–06 wet season

Audit outcomes

The Annual Environmental Audit on behalf of external stakeholders of the Jabiluka Project Area was undertaken on 18–19 May 2006. The audit team was made up of personnel from the Office of the Supervising Scientist, the Department of Primary Industry, Fisheries and Mines, and the Northern Land Council. The subject of the audit was compliance with the Jabiluka Authorisation 0140-03.

The audit team were generally satisfied that the Jabiluka Project Area complied with the major components of the Authorisation.

Minesite Technical Committee

The Jabiluka Minesite Technical Committee (MTC) met six times during 2005–06. Dates of meetings and significant issues discussed are shown in Table 2.7.

TABLE 2.7 JABILUKA MINESITE TECHNICAL COMMITTEE MEETINGS

Date	Significant additional agenda items
29 August 2005	Mining Management Plan, Decommissioning and rehabilitation of Djarr Djarr, Updated progress against environmental conditions of the Jabiluka Environmental Impact Statement (EIS) and Public Environment Report (PER), Jabiluka surface and groundwater monitoring programme.
7 October 2005	No new items
18 November 2005	No new items
20 January 2006	Mining Management Plan; Decommissioning and rehabilitation of Djarr Djarr; Updated progress against environmental conditions of the Jabiluka EIS and PER; Jabiluka surface and groundwater monitoring programme; Anomalous results from eriss sampling programme; Mine Valley access.
27 March 2006	As above plus: Submission date for Jabiluka Annual Plan of Rehabilitation.
30 May 2006	Mining Management Plan; Updated progress against environmental conditions of the Jabiluka EIS and PER; Mine Valley access; Access to monitoring sites following Cyclone Monica.

Authorisations and Approvals

Changes to, and approvals under, the Authorisation during 2005–06 are listed in Table 2.8.

TABLE 2.8 JABILUKA AUTHORISATION CHANGES/APPROVALS

Date	Issue
27 September 2005	Approval to modify the water monitoring programme to align with the current low environmental risk of the site (the site being in long-term care and maintenance).

Incidents

There were no reportable incidents at Jabiluka during the year.

2.3.3 Off-site environmental protection

Surface water quality

In accordance with the Jabiluka Authorisation, ERA is required to monitor a range of surface and ground waters on the lease and to demonstrate that the environment remains protected. Specific water quality objectives (criteria thresholds were described in Supervising Scientist Annual Report 2003–04) must be achieved. Each month during the wet season, ERA reports the water quality in Ngarradj (Swift Creek) to the major stakeholders (SSD, DPIFM and NLC). A detailed interpretation of water quality across the site is provided at the end of each wet season in the ERA Jabiluka Annual Wet-season Report.

In addition to the ERA programme, SSD conducts monthly chemical and physical monitoring in Ngarradj (Swift Creek). Key water quality data from SSD and ERA routine monitoring of Ngarradj are reported at www.deh.gov.au/ssd/monitoring/ngarradj-chem.html.

A summary of the data collected is provided below.

Chemical and physical monitoring of Ngarradj (Swift Creek)

Toward the end of 2003 Jabiluka entered a long-term care and maintenance phase. Since the site poses a very low risk to the environment, SSD's water chemistry monitoring programme at Ngarradj was reduced to monthly sampling for the 2004–05 wet season, augmented by automatic recordings of turbidity and hydrological data at six-minute intervals. DPIFM resumed the role of performing check monitoring at Ngarradj, also on a monthly basis, but offset by two weeks from the SSD programme. These independent programmes complemented each other, providing an approximately fortnightly frequency of water sampling and a combined dataset to assess the water quality at Ngarradj. ERA continued to carry out monitoring on a weekly basis.

The first water chemistry samples for SSD's 2005–06 wet season surface water monitoring programme were collected from Ngarradj on 10 January 2006 and ERA collected samples from Ngarradj on 29 December 2005 from the downstream site only (the upstream site was not yet flowing). SSD collected samples monthly until June. ERA and DPIFM have also sampled monthly but to a different schedule. ERA collected samples up to July shortly before the creek stopped flowing.

The upstream and downstream water quality data from both the SSD and ERA programmes are summarised in Table 2.9. ERA and SSD data are in good agreement with values and trends similar to those seen in previous years measured again this season. Uranium concentrations measured by ERA and SSD during the 2005–06 wet season are shown in Figure 2.12. Uranium concentrations are only marginally higher at the downstream site and are less than 0.5% of the limit. These trends have been observed since data collection began in 1998 (Figure 2.13.

The water quality objectives set to protect the aquatic ecosystems downstream of Jabiluka were achieved, providing assurance that the environment remained protected throughout the wet season.

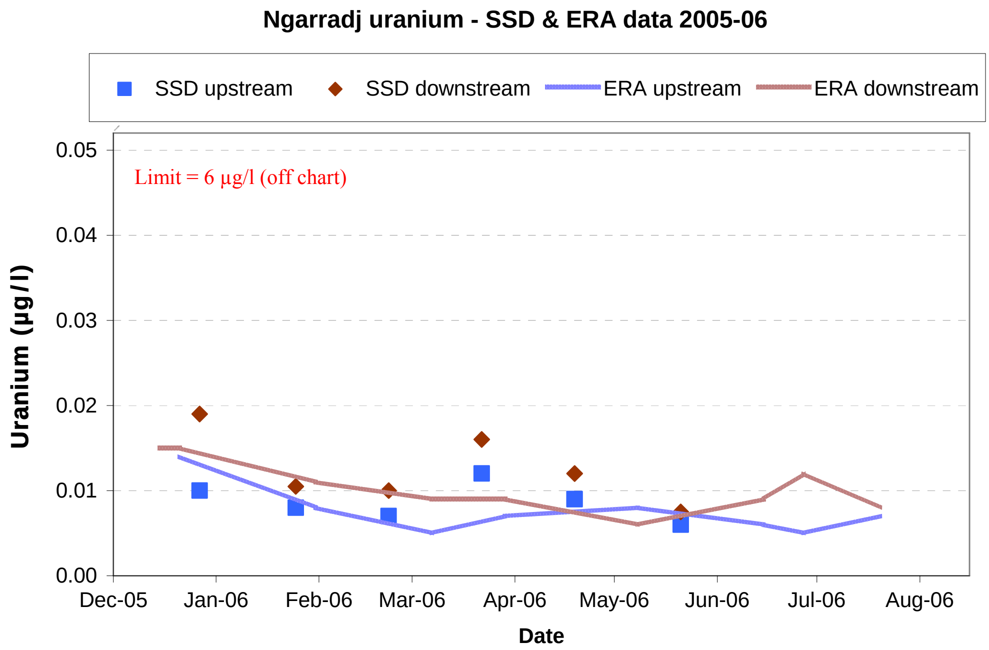

Figure 2.12 Uranium concentrations measured in Ngarradj by SSD and ERA in the 2005–06 wet season

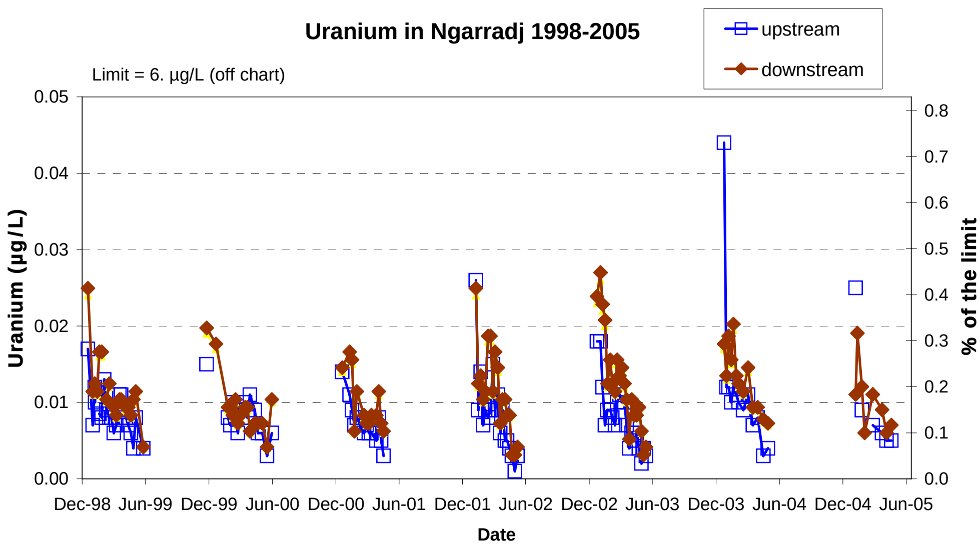

Figure 2.13 Uranium concentrations in Ngarradj since the 1998–99 wet season (SSD data 1998–99 to 2003–04, SSD & ERA data 2004–05)

TABLE 2.9 SUMMARY OF NGARRADJ (SWIFT CREEK) 2005–06 WET SEASON WATER QUALITY UPSTREAM AND DOWNSTREAM OF JABILUKA

Parameter	Guideline or Limit	Organisation	Median		Range	
			Upstream	Downstream	Upstream	Downstream
PH (field data)	3.9–6.0	SSD	5.1	5.5	4.6 – 5.4	4.8 – 5.8
		ERA	5.2	5.6	4.7 – 5.4	4.8 – 5.8
EC (μS/cm) (field data)	21	SSD	15	13	10 – 18	9.3 – 15
		ERA	11	12	10 – 14	8.7 – 13
Turbidity (NTU)	–	SSD	0.6	1.1	0.4 – 1.8	0.6– 3.2
		ERA	1.	1.	<1 – 1.	<1 – 2.
NO_3 (as NO_3) (mg/L)	1.26	SSD	ND	ND	ND	ND
		ERA	<0.02	0.04	<0.02 – 0.11	<0.02 – 0.06
Sulfate‡ (mg/L)	1.5	SSD	0.4	0.3	0.3 – 0.8	0.2 – 0.6
		ERA	0.3	0.2	0.2 – 0.9	0.1 – 0.7
Magnesium‡ (mg/L)	0.76	SSD	0.3	0.3	0.1 – 0.3	0.1 – 0.4
		ERA	0.2	0.4	0.2 – 0.4	0.2 – 0.6
Uranium‡ (μg/L)	6.	SSD	0.009	0.011	0.006 – 0.012	0.008 – 0.019
		ERA	0.007	0.009	0.005 – 0.014	0.006 – 0.015

ERA data taken from the ERA Weekly Water Quality Report 11 August 2006; * SSD data laboratory data; pH & EC based on field data – the common measurement to all organisations; ‡ dissolved (<0.45 μm); A compliance limit applies to uranium, management guidelines apply all other parameters shown. ND = no data.

Biological monitoring in Ngarradj (Swift Creek)

The biological monitoring programme for Jabiluka has ceased, commensurate with the low risk posed while the site is in long-term care and maintenance mode. The last sampling event took place in the 2004 dry season. Results from six-years (1999–2004) of fish community structure studies were reported in the 2003–04 Supervising Scientist Annual Report along with available results for macroinvertebrate community structures.

2.4 Nabarlek

2.4.1 Developments

The impact of Tropical Cyclone Monica (which passed directly over Nabarlek in the early hours of 25 April 2006) in addition to a number of fires caused considerable damage to the site, hampering rehabilitation. Discussions are underway between Hanson (the Nabarlek leaseholder) and the Northern Land Council (on behalf of the traditional Aboriginal owners) on issues related to the repair and clean up of Nabarlek.

Nabarlek Rehabilitation Bond

Stakeholders continue to work on identifying suitable closure criteria for the site. A revised revegetation plan is required to update the Nabarlek Mining Management Plan upon which the rehabilitation security is based. The current Mining Management Plan and level of security applies until a new Mining Management Plan is approved.

Minesite Technical Committee

The Nabarlek Minesite Technical Committee met twice during the year. Table 2.10 provides information on the meeting and the major points of discussion.

TABLE 2.10 NABARLEK MINESITE TECHNICAL COMMITTEE MEETINGS

Date	Significant agenda items
5 December 2005	Radiologically anomalous area, Rehabilitation status issues paper update, Environmental monitoring, Mining management plan and security, Closure criteria,
3 April 2006	Radiologically anomalous area, Rehabilitation status issues paper update, Environmental monitoring, Mining management plan and security, Closure criteria, Cameco survey, and Community water grant

Authorisations and Approvals

There were no changes to the Authorisation during the reporting period.

Incidents

There were no reportable incidents at Nabarlek during the year.

2.4.2 On-site conditions

Staff from ***eriss*** continue to undertake research programs at Nabarlek and the site is subject to at least two formal visits from ***oss*** staff during the year. In addition, ***oss*** often carries out opportunistic site inspections if in the area on other business (eg exploration inspections).

The formal site inspections carried out at Nabarlek each year are:

- The post-wet season inspection – the intent of this inspection is to check site stability and erosion following the wet season and to plan works for the coming dry season.
- The annual audit (in November) of compliance with the Mining Management Plan. The Audit report is tabled under a separate agenda item.

Tropical Cyclone Monica passed directly over Nabarlek during the early hours of 25 April 2006. The site was further damaged by a large fire in early May 2006. The post-wet season inspection, conducted on 30 June 2006 by representatives from SSD, DPIFM, NLC and Hanson Pty Ltd, focused on recording the damage caused by these two events.

Audit outcomes

A compliance audit of the Nabarlek Mining Management Plan February 2003 (the currently authorised document) was undertaken by a team of auditors from NLC, DPIFM and ***oss***. The aim was to assess the effectiveness of management systems and to provide feedback to Hanson (the audited company) on establishment and status of these systems. The audit outcomes were:

- Conditional – The audit team identified one Conditional issue, which related to the radiologically anomalous area. A decision on management of the radioactive material from the area is pending.
- Not Verified – No items were considered as not verified.
- Acceptable – 13 of the 14 issues audited were considered acceptable.

NB: This audit was undertaken prior to the new ranking system being introduced.

Radiologically Anomalous Area

The radiologically anomalous area is an area of approximately 0.4 ha lying to the southwest of the former pit area. The area has elevated levels of radioactivity and has been identified to contribute about one quarter of the total radon flux from the rehabilitated mine site and three quarters of the radionuclide flux from the site via the erosion pathway (greater detail is provided in the Supervising Scientist's 2004–05 Annual Report).

The issue remains a standing item on the Nabarlek MTC agenda. A proposal to remediate the area will be included in the next Mining Management Plan.

2.4.3 Off-site environmental protection

Statutory monitoring of the site continues to be undertaken by DPIFM and the lease holder, Hanson. DPIFM carries out all surface and groundwater monitoring on and off-site, including surface water monitoring downstream of the mine in Kadjirrikamarnda and Cooper Creeks. DPIFM reports the results of this monitoring in the six-monthly Northern Territory Supervising Authorities Environmental Surveillance Monitoring in the Alligator Rivers Region reports. These creeks are reported to have low electrical conductivities (<24 µS/cm) and low concentrations of the key mining indicators, sulfate (< 1 mg/L) and uranium (< 0.1 µg/L).

SSD continues to undertake research programmes at Nabarlek including radiation assessments, revegetation success and monitoring techniques, and erosion and contaminant transport. The research is aimed at enabling an overall assessment of rehabilitation success at Nabarlek. Progress on these programmes is reported in Supervising Scientist Annual Reports and in the Internal Report series.

2.5 Other activities in the Alligator Rivers Region

2.5.1 Rehabilitation of the South Alligator Valley uranium mines

Staff of SSD continue to liaise with Parks Australia regarding the rehabilitation of former mine and mill sites in the South Alligator Valley. In May 2006, the Hon Greg Hunt MP, Parliamentary Secretary to the Minister for the Environment and Heritage, announced funding of $7.3 million over a four year period for rehabilitation of abandoned uranium mine sites in the South Alligator Valley. SSD is represented on the Project Steering

Committee which was established to provide advice to Parks Australia, ensure that communication is effective, and resolve issues related to the rehabilitation and incorporation of the mineral leases into Kakadu National Park.

The Steering Committee, Parks Australia staff and some of the traditional Aboriginal owners and representatives of the Werenbun Aboriginal Corporation met for two days in the South Alligator Valley to discuss the way forward and visit sites of interest. During that visit SSD staff carried out the routine inspection of the radioactive material containment sites and collected water from Rockhole Mine Creek as part of an investigation into the behaviour of the acid drainage affecting the creek.

The triennial radiometric survey of the containment sites that ***oss*** conducts to meet ARPANSA licence requirements is planned for late in the 2006 dry season. The Environmental Radioactivity section of ***eriss*** will be involved in characterising the wastes at Sleisbeck and other South Alligator Valley sites and in establishing preferred sites for long-term waste containment.

2.5.2 Exploration

oss undertakes a programme of site inspections at exploration sites in west Arnhem Land where Cameco Australia Pty Ltd is exploring for uranium. This entails two inspections, one of Myra Falls Camp and associated exploration activities and the other of King River Camp and associated exploration activities. The inspections are scheduled to take place when the camps are operating and exploration is being actively undertaken, which is during the dry season.

On 22 August 2005, representatives from ***oss***, NLC and DPIFM conducted the second dry season inspection of Cameco’s exploration sites, the first being undertaken at the end of the 04–05 reporting period. The inspection entailed a visit to the heli-drilling programme operating out of Myra Falls Camp and the camp itself. There were no issues identified with the heli-drilling operations or the operations at the Myra Falls Camp.

The inspection of King River Camp was undertaken outside of this reporting period and will be reported in the 06–07 Annual Report.

2.6 Radiological issues

2.6.1 Background

Applicable standards

The radiation dose limit for workers recommended by the International Commission on Radiological Protection (ICRP) and adopted in Australia by the National Health and Medical Research Council (NHMRC) is 100 milliSieverts (mSv) in a five-year period with a maximum of 50 mSv in any one year. The *Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores (1987)* has now been replaced by the *Code of Practice and Safety Guide on Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing (2005).* The Code of Practice recommends separating radiation workers into designated and non-designated, where designated workers are those who may be expected to receive an occupational radiation dose exceeding 5 mSv in one year. These workers are monitored more intensely than the non-designated workers. The radiation dose limit to the public from a practice such as uranium mining recommended by the ICRP is 1 mSv per year.

Consequently, there are three levels of radiation dose limits to distinguish, which specify the maximum allowable annual radiation dose from other-than-natural sources:

- the public (1 mSv)
- non-designated workers (5 mSv)
- designated workers (20 mSv).

Monitoring and research programs

ERA conducts statutory and operational monitoring of external gamma exposure to employees through the use of dose badges, radon decay products and long lived alpha activity (dust) in the air, and surface contamination levels. The statutory aspects of the programme are prescribed in Annex B of the Ranger Authorisation (0108-04) with results reported to the MTC members on a quarterly basis.

The ERA Radiation Monitoring Programme is undergoing review with input from the MTC Radiation Working Group. The Alligator Rivers Region Technical Committee has expressed support for the overall approach used in radiation monitoring and protection.

The Supervising Scientist conducts routine monitoring of the atmospheric pathways of radiation dispersion from Ranger and a number of radiation research projects for human and environmental protection.

2.6.2 Radiation at and from Ranger

Radiological exposure of employees

The three primary radiation exposure pathways to workers at Ranger are:

- Inhalation of radioactive dust
- Exposure to external gamma radiation
- Inhalation of radon decay products (RDP).

Mill maintenance workers and electricians receive approximately half of their dose from inhalation of radioactivity trapped in or on dust. The majority of the radiation dose received by employees in the mine and mill production is from external gamma radiation.

Table 2.11 shows the annual doses received by designated and non-designated workers in 2005, and a comparison with the average doses from the year before as reported by ERA. The average and maximum radiation doses received in 2005 were approximately 5% and 24% respectively of the recommended ICRP 60 annual dose limits.

TABLE 2.11 ANNUAL RADIATION DOSES RECEIVED BY WORKERS AT RANGER URANIUM MINE

	Annual dose in 2004		Annual dose in 2005	
	Average mSv	Maximum mSv	Average mSv	Maximum mSv
Non-designated worker	Not calculated[1]	0.7	Not calculated	1.1
Designated worker	1.0	4.6	1.0	4.8

1 A hypothetical maximum radiation dose to non-designated employees is calculated using the gamma exposure results of employees of the Emergency Services Group, and dust and radon results measured at the Acid Plant. Consequently, the dose is conservative and would exceed actual doses received by non-designated employees, and are hence considered maximum doses.

Radiological exposure of the public

The ICRP recommends that the annual dose received from a practice such as uranium mining and milling should not exceed 1 milliSievert (mSv) per year. This dose is on top of the radiation dose received naturally, which averages approximately 2 mSv per year in Australia, but typically varies between 1–10 mSv per year. Furthermore the dose limit applies to the sum of all pathways and practices, and the ICRP (1997) states in paragraph 6.2.1 that:

> to allow for exposures to multiple sources, the maximum value of the constraint used in the optimisation of protection for a single source should be less than 1 mSv in a year. A value of no more than about 0.3 mSv in a year would be appropriate.

There are two main pathways of potential exposure to the public during the operational phase of a uranium mine and Ranger is the main potential source of additional (to natural levels) radiation exposure to the community in the Alligator Rivers Region. The two pathways are the inhalation pathway, which is a result of dispersion of radionuclides from the mine site into the air, and the ingestion pathway, which is caused by the uptake of radionuclides into bushfoods from the Magela Creek system downstream of Ranger.

Inhalation pathway

Both ERA and SSD monitor the two airborne pathways:

- Radioactivity trapped in or on dust (or long lived alpha activity, LLAA)
- Radon decay products (RDP).

The main areas of habitation in the vicinity of Ranger and Jabiluka are Jabiru, Mudginberri and Jabiru East, consequently the SSD monitoring focuses on those three population centres in the region (see Map 3). Airborne RDP and LLAA concentrations are measured monthly and the results compared with ERA's quarterly atmospheric monitoring results from Jabiru and Jabiru East. Of the two airborne pathways RDP accounts for most of the dose received.

In 2005, Ranger calculated an average background RDP concentration of 0.081 µJ per m^3 and a mine derived concentration on top of the background of 0.03 µJ per m^3. Multiplied with the hours when the wind was blowing from the mine and background areas, respectively, one can calculate that approximately 0.78 mSv are received from the inhalation of natural background and 0.037 mSv (approximately 5% of the total) from mine derived radon.

Figure 2.14 shows Jabiru and Jabiru East RDP data and a comparison with ERA data from June 2003 up to June 2006. Both, RDP and LLAA concentrations measured by SSD and ERA show the expected seasonal trend with higher values during the dry and lower values during the wet season. Differences in sampling time and location may be the cause of the slight differences in RDP concentrations observed at Jabiru, with ERA's values being higher than values measured by SSD.

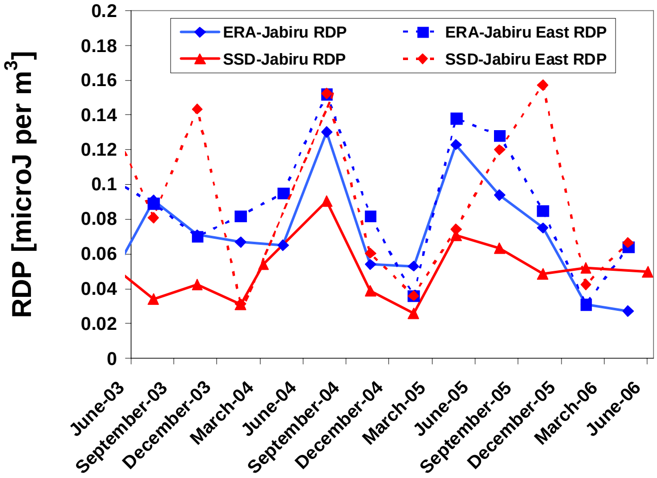

Figure 2.14 Radon decay product concentration measured by SSD and ERA in Jabiru and Jabiru East from June 2003 to June 2006

Table 2.12 shows the average annual doses received from the inhalation of radon decay products in the air, as calculated from the RDP concentration data from ERA and SSD (in brackets) at Jabiru. This is assuming an occupancy of 8760 hrs (one year) and a dose conversion factor for the public of 0.0011mSv per µJ·h/m³. Mine derived annual doses from the inhalation of radon progeny are shown, as calculated by ERA using a wind correlation model developed by ***eriss***, which correlates wind direction with airborne radon decay product concentration.

TABLE 2.12 RADON DECAY PRODUCT CONCENTRATIONS AT JABIRU AND JABIRU EAST, AND TOTAL AND MINE DERIVED ANNUAL DOSES RECEIVED AT JABIRU IN 2003–2005

		2003	2004	2005
RDP concentration [µJ/m³]	Jabiru East	0.075 (0.101)	0.103 (0.095)	0.097 (0.097)
	Jabiru	0.065 (0.043)	0.079 (0.063)	0.088 (0.052)
Total annual dose [mSv] Jabiru		0.63 (0.41)	0.76 (0.61)	0.85 (0.50)
Mine derived dose [mSv] at Jabiru		0.011	0.014	0.037

Ingestion pathway

Radium in Magela Creek waters is routinely monitored by both ERA and SSD and the limit for radium in Magela Creek is based on dietary uptake of the Aboriginal people downstream of the mine. Local Aboriginal people have expressed concerns about the radionuclide concentration in mussels from Mudginberri Billabong. Consequently, SSD routinely monitors the aquatic aspects of the ingestion pathway and bioacumulation monitoring samples have been collected each year and analysed for both radionuclides and heavy metals. The collections include yearly collections of mussels at Mudginberri (the potentially contaminated site) and Sandy Billabongs (control site) and fish being collected from these billabongs every two years.

^{226}Ra activity concentrations in mussel flesh from Mudginberri Billabong is higher than at the control site and the committed effective dose from the ingestion of 2 kg of mussels from Mudginberri Billabong is about four times the committed effective dose from the ingestion of the same amount of Sandy Billabong mussels. However, historical data show, that there is no indication of an increase of ^{226}Ra activity concentrations in mussel flesh in Mudginberri Billabong over time and thus the difference is unlikely to be mine-related. Reasons for the higher ^{226}Ra activity concentrations measured may include the mineralised nature of the Magela Creek catchment area and the associated naturally higher ^{226}Ra content in Mudginberri Billabong sediments and water as compared to Sandy Billabong, or differences in sediment particle size distribution. Furthermore, it has been shown that calcium levels influence radium uptake in mussels, and the higher calcium concentrations in Sandy Billabong water may decrease radium uptake in those mussels.

With the rehabilitation of Ranger there will be radiological protection issues associated with the land use by local Aboriginal people and a shift towards terrestrial food sources. These foodstuffs include both terrestrial animals and plants. Over the last 25 years, SSD has gathered radiological concentration data on bush foods throughout the Alligator Rivers Region in the Northern Territory. These data have been used to replace IAEA default radionuclide concentration factors with locally derived values, providing a more reliable estimate of ingestion doses.

2.6.3 Jabiluka

Radiological exposure of employees

The Jabiluka Authorisation was revised in July 2003 and the statutory requirement of quarterly reporting of radiological monitoring data for Jabiluka was removed. The current Authorisation requires reporting of radiation monitoring data only if any ground disturbing activities involving radioactive mineralisation occur on site. No ground disturbing activities took place during this reporting period.

Radiological exposure of the public

Although there were no activities reported at the Jabiluka mine site, the population group that may, in theory, receive a radiation dose due to future activities at Jabiluka is a small community approximately 10 km south of Jabiluka at Mudginberri, comprising around 60 individuals.

The Supervising Scientist has a permanent atmospheric research and monitoring station at Four Gates Rd radon station a few kilometres west of Mudginberri (see Map 3). Radon decay product (RDP) and long-lived alpha activity (LLAA) concentrations are measured there on a monthly basis. In addition, radon gas is continuously measured at the station with radon data being recorded every 30 minutes.

Figure 2.15 shows the quarterly averages of radon decay product and long-lived alpha activity concentrations measured at Four Gates Rd radon station by SSD up to June 2006. Radon decay product and long lived alpha activity concentrations are small and comparable with natural background levels. The average airborne radionuclide concentrations measured in 2005 would translate into an annual total effective dose, including natural background, of 0.52 mSv from RDP and less than 0.01 mSv from LLAA. Only a small fraction of these doses would be due to mine-derived radionuclides.

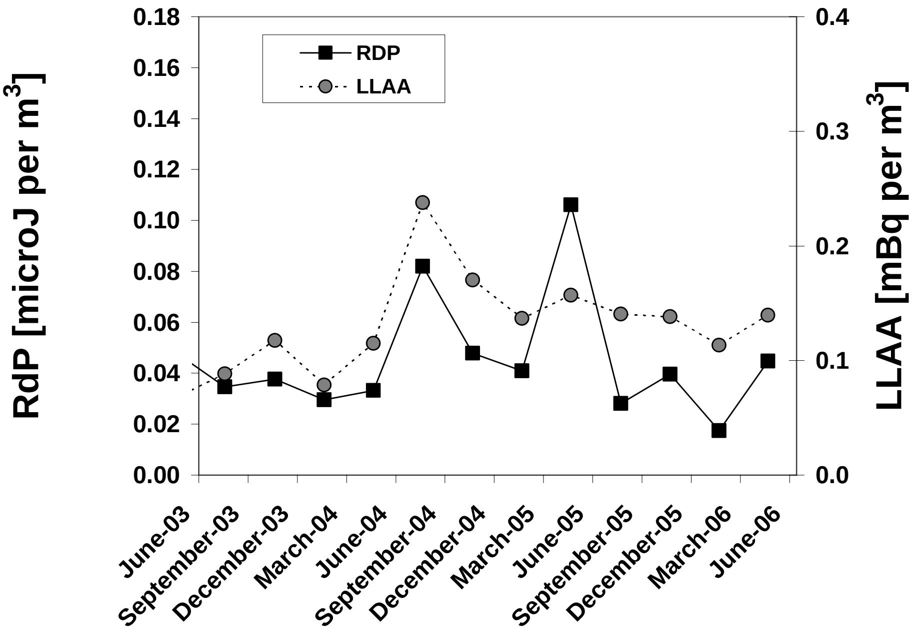

Figure 2.15 Radon decay product (RDP) and long-lived alpha activity (LLAA) concentrations measured at SSD's Mudginberri Four Gates Rd radon station