

# Environmental monitoring to support rehabilitation outcomes

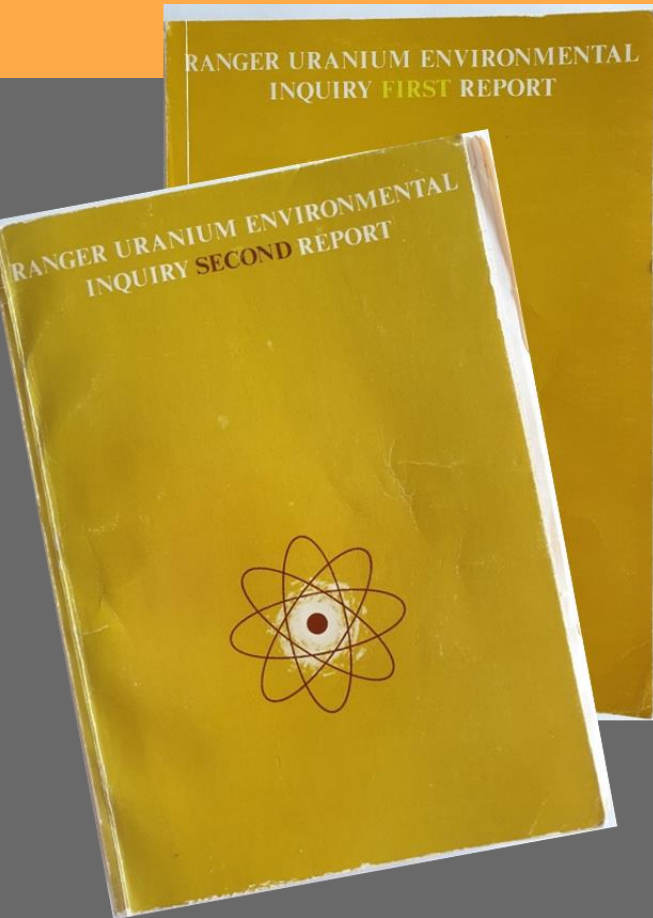
Amie Leggett

Assistant Director Monitoring

# Ranger Uranium Mine

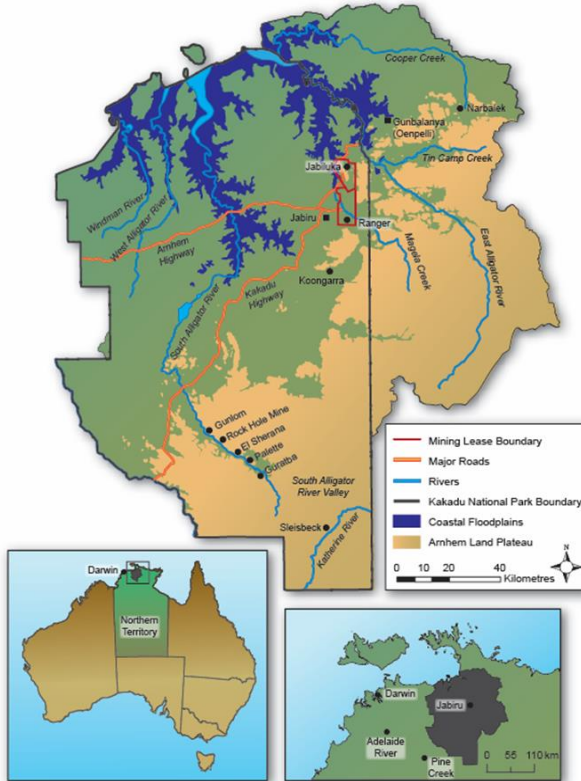
## Ranger Environmental Assessment

- Fox Reports



## The Nuclear Industry

- Economy



## The Local Community

- Social



## The Unique Environment

- Environment





# Fox Recommendations





# The Environmental Requirements

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Set out stringent ***objectives*** for environmental protection that align with the high conservation value of the region surrounding the mine.

## **Operational *objectives***

- No detrimental impacts in the surrounding environment

## **Rehabilitation *objectives***

- All tailings must be returned to the mine pits and contaminants from tailings must not impact the surrounding environment for 10,000 years
- A sustainable ecosystem must be restored which is similar to the surrounding environment

***Overarching objective – best practicable technology***

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## **Environmental Requirements of the Commonwealth of Australia for the Operation of Ranger Uranium Mine**

### **Preamble**

The Environmental Requirements for the Ranger uranium mine set out the Commonwealth's environmental protection conditions with which the company must comply. These are conditions of the Authority issued under s41 of the *Atomic Energy Act 1953* and also reflect the Commonwealth's role in the Alligator Rivers Region under the *Environment Protection (Alligator Rivers Region) Act 1978*. The operational procedures and practices, and environmental standards, guidelines, codes, regulations or limits relevant to meeting these conditions are set out in Northern Territory legislation and the Ranger General Authorisation established under the *Uranium Mining (Environment Control) Act 1979 (NT)*.

Arrangements for consultation and approval concerning operations at Ranger are set out in the "Working Arrangements" contained in the Memorandum of Understanding between the Commonwealth and Northern Territory governments, as amended from time to time. These arrangements require the Supervising Authority to consult with and have regard to the views of the Supervising Scientist and the Northern Land Council (NLC) prior to:

# 40 Years of Research and Monitoring

## Pre-mining characterization

- **Objective:** Collect baseline data



## Operational monitoring and management

- **Objective:** Set standards to prevent impacts
- **Objective:** Undertake independent monitoring to detect impacts

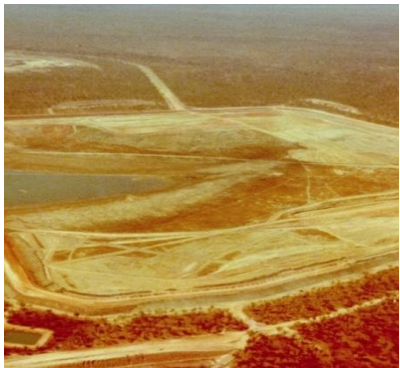
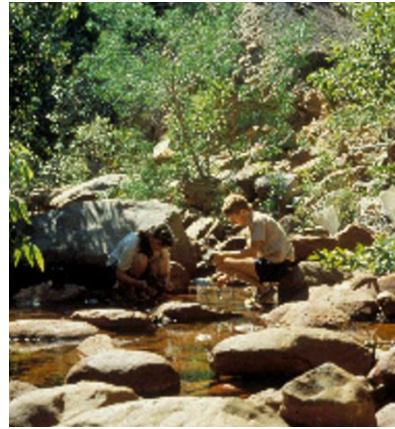
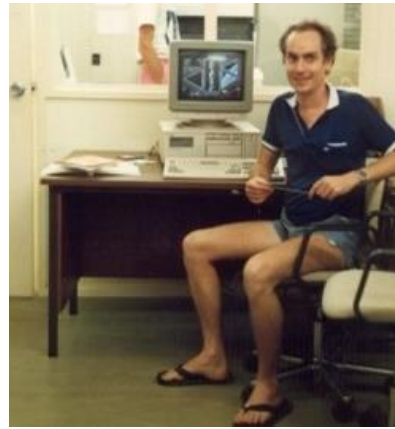


## Progressive Rehabilitation

- **Objective:** Inform rehabilitation and final designs
- **Objective:** Model calibration and validation



# Pre-mining Baseline



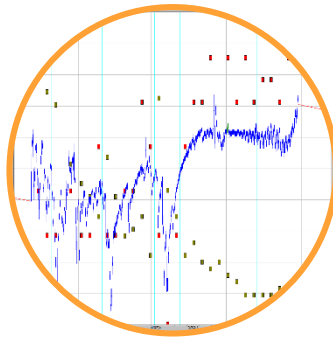
- Research facility established in Jabiru
- Physicochemical, hydrological and geomorphological baseline
- Characterising aquatic and terrestrial ecosystems

# Operational Monitoring - Impact Prevention



	Chl a (µg/L)	TP (µg/L)	FRP (µg/L)	TN (µg/L)	TP (µg/L)
Land river	na <sup>a</sup>	20 <sup>a</sup>	15 <sup>a</sup>	250 <sup>a</sup>	15 <sup>a</sup>
Lowland river <sup>b</sup>	5	50	20	500	40 <sup>a</sup>
Freshwater lakes & Reservoirs	5 <sup>a</sup>	10	5	350	10
Wetlands	no data	no data	no data	no data	no data
Wetlands <sup>c</sup>	4 <sup>a</sup>	30	5 <sup>a</sup>	300	15
Wetlands <sup>d</sup>	1 <sup>a</sup>	25 <sup>a</sup>	10	100	

National and international biological effects data



Reference site data



Site-specific biological effects data



# Operational Monitoring - Impact Prevention

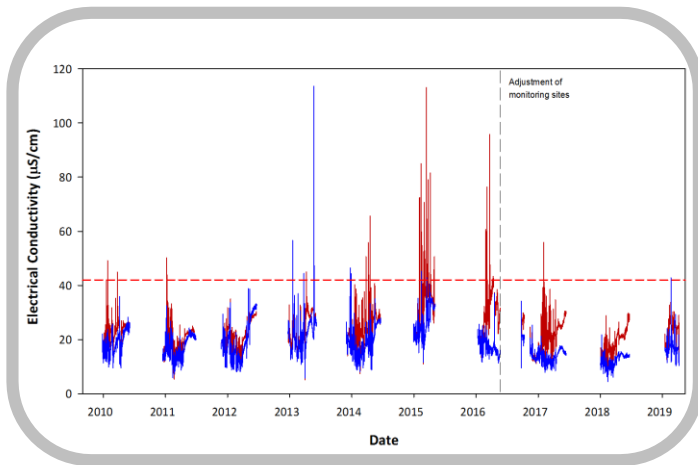
## Monitoring

Observed deterioration in water quality downstream of the mine site



## Mitigation

Interception trench and water extraction bores installed



## Investigation

Identified the source – acidic seepage in vicinity of the Tailings Storage Facility



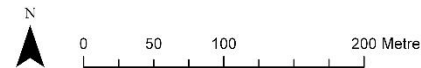
# Operational Monitoring – Impact Detection

- Routine fish and macroinvertebrate surveys for species richness and diversity
- In-situ toxicity testing
- Metal and radionuclide accumulation in freshwater mussels and other bush foods
- All data and reports are made public



# Progressive Rehabilitation – Optimisation of final designs and processes

- **Trial Landform** – built 2008/2009
- **Pit 1 landform** – current
- **Monitoring**
  - Erosion characteristics – water quality, suspended sediments, bedload, discharge.
  - Revegetation success – full suite of vegetation metrics
  - Impact of events/interventions – controlled burns
  - Plant available water – infiltration, particle size, soil development.



Trial landform - 26 September 2019

# Progressive Rehabilitation – Model Calibration and Validation

**Landform Evolution Model**

**Plant Available Water Model**

**Conceptual Groundwater Model**

**Flood Model**

**Site-based Water Balance Model**

**Groundwater Flow Model**

**Reactive Transport Model**

**Geochemical Models**

**Site-based Water Balance Model**

**Groundwater Head Recovery Model**

**Solute Transport Model**

**Tailings Consolidation Model**

**Source term Model**

**Cumulative Environmental Risk Assessment Model**

**Radiation Dose Assessment Models**

**State and Transition Ecosystem Model**

**Groundwater / Surface Water Interactions**

**Atmospheric Dispersion Model**

**Surface Water Contaminant Transport Model**



# Setting Rehabilitation Standards



▶ Landform



▶ Ecosystem Restoration



▶ Radiation

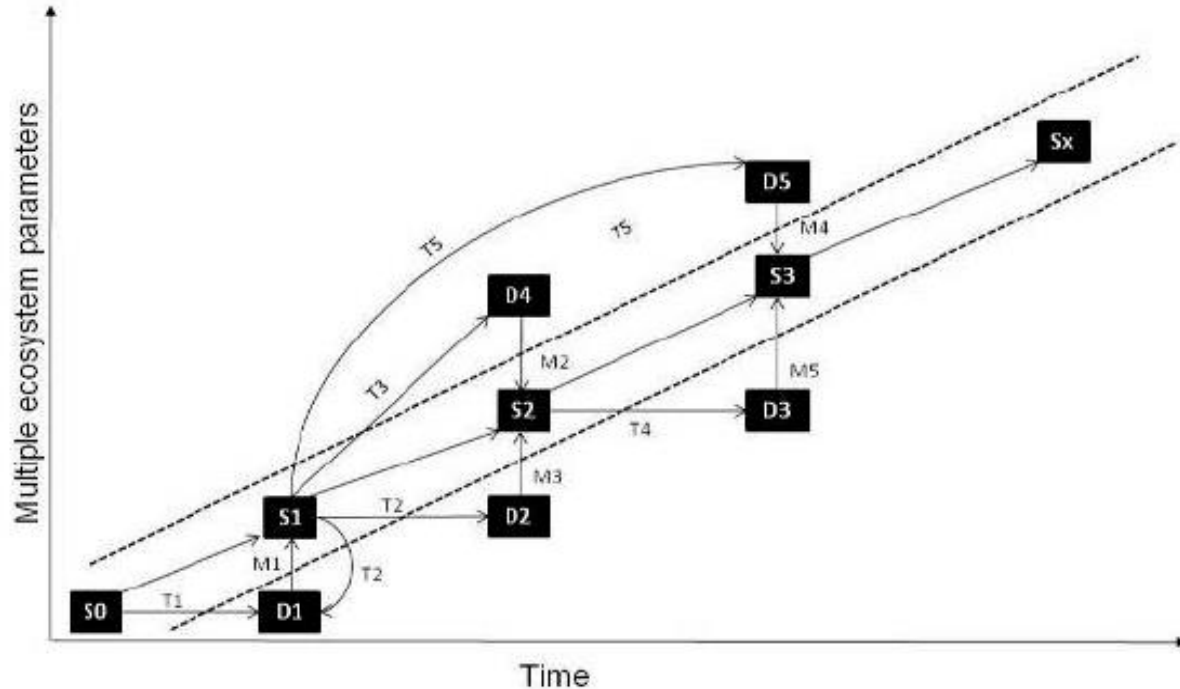


▶ Water and Sediment

End-state is a **sustainable ecosystem** that is **similar** to the surrounding area, and is physically, chemically and radiologically **stable**

- Based upon the Environmental Requirements
- Provide clear targets to inform design and upon which to assess success
- Incorporate 40 years of research undertaken by both the Supervising Scientist and the mine operator
- Will underpin the regulatory assessment and approval of the final closure criteria for Ranger mine

# Post-closure Monitoring



- Ensure the environment remains protected under a changed management regime.
- Making sure we are tracking towards the end-state.
- Monitoring needs to have sufficient spatial and temporal scales to ensure specific targets are being met.
- Involve traditional landowners to build capacity and ensure environmental stewardship



# Monitoring for the future

## Pre-mining characterization

- Collecting baseline data and information

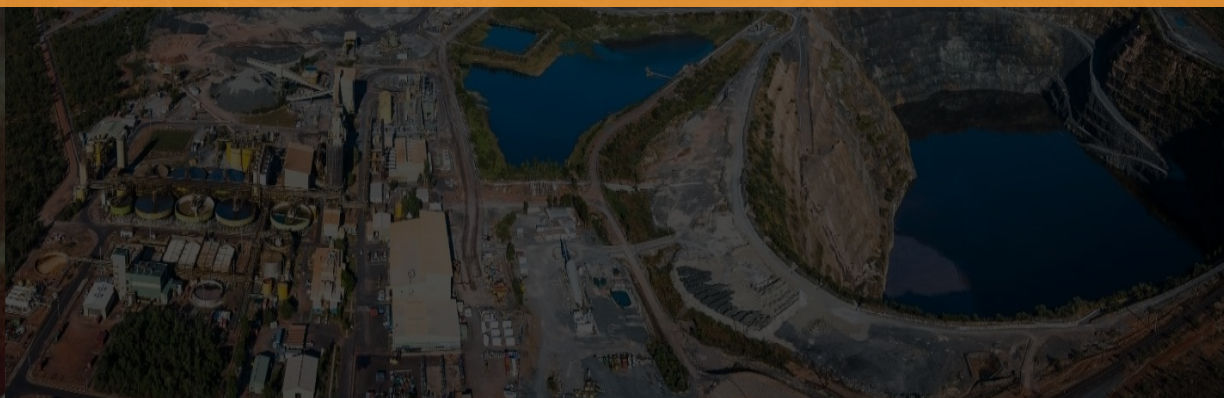
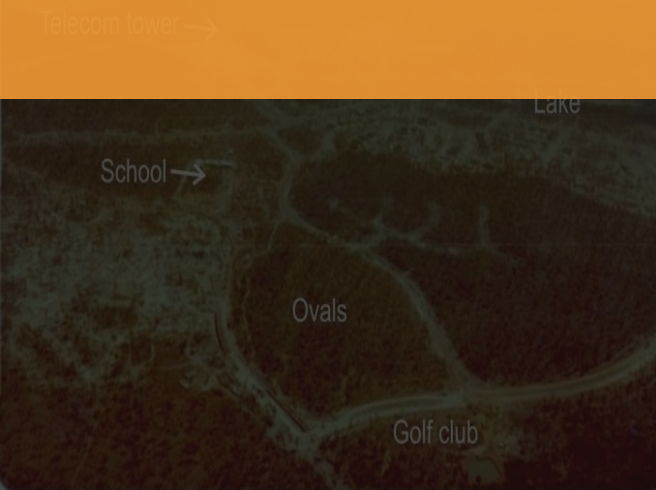
## Operational monitoring and management

- Setting standards for environment protection
- Developing methods for monitoring the effects of mining
- Investigation, management and mitigation

## Rehabilitation

- Setting standards for rehabilitation
- Developing methods to assess rehabilitation

## Evaluation and Optimisation



# Evaluation and Optimisation





# Evaluation and Optimisation







# Evaluation and Optimisation

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# 40 Years of Research and Monitoring

## Environmental Characterisation

Sufficient baseline data and information to *understand the values being protected*



## Site-specific Standards

Accounting for the sensitivity of the local environment to ensure the *level of protection is appropriate*



## Long-term Monitoring

Assessment of long-term trends to *informing mitigation* activities



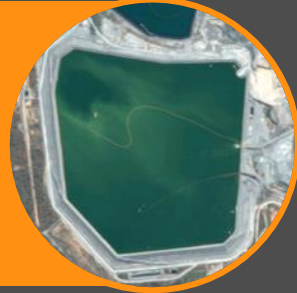
## Evidence-based Decisions

Clear *justification for the cost* of management and mitigation activities



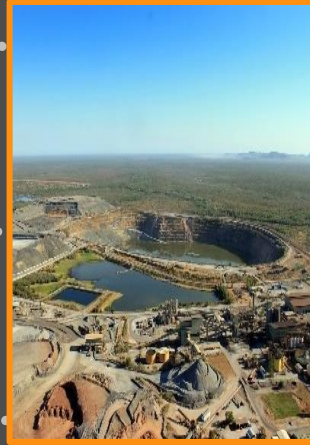
## Transparent Advice

Public *assurance* and establishing *trust*



## Evaluation and Optimisation

Allowing for innovation in methods and *adaptability* over time



**No environmental impact detected for nearly 40 years**

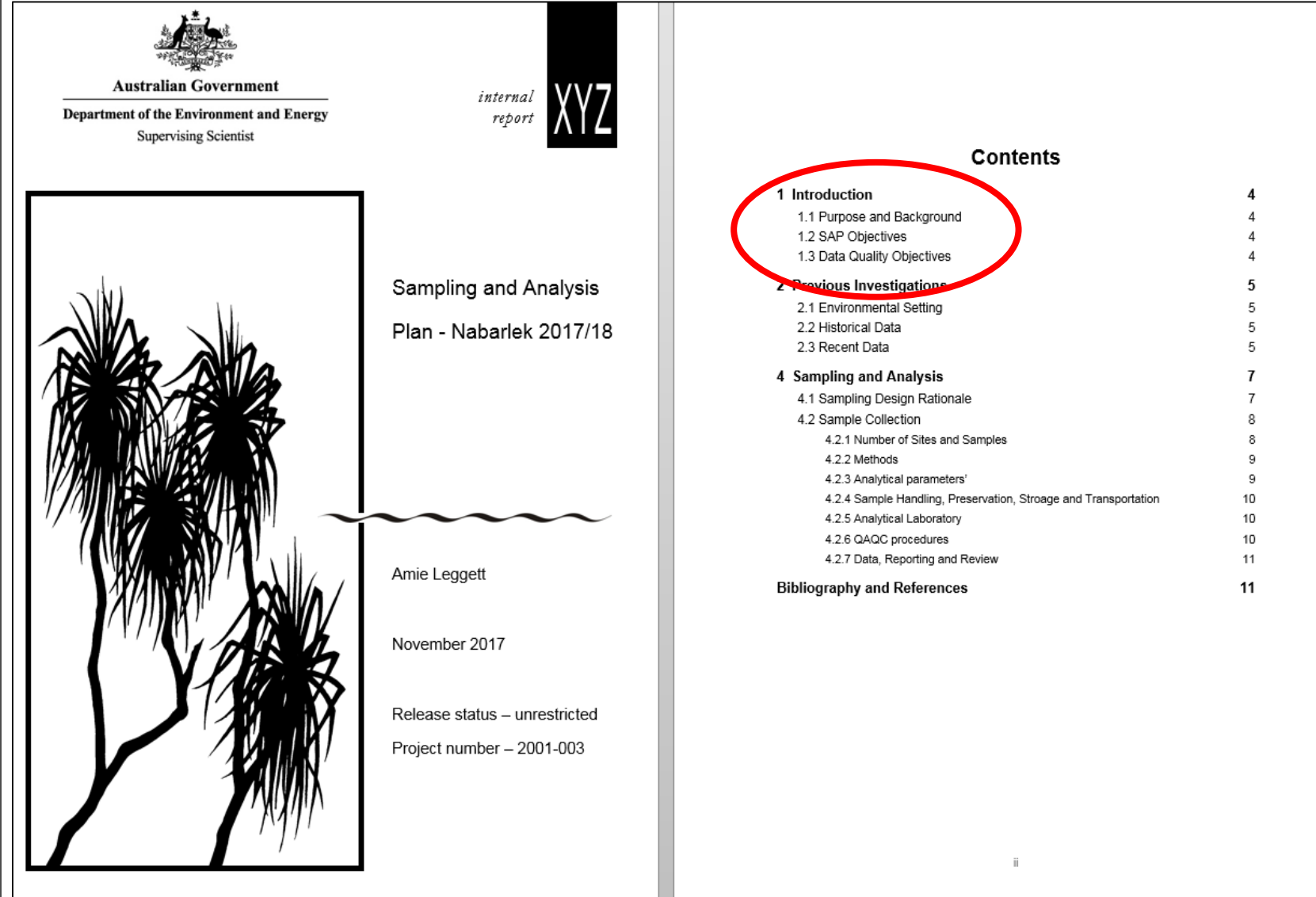
## Monitoring

Clear objectives are critical!

*Documented* monitoring plan and data management plan.

Data quality needs to be a key part of monitoring design.

Evaluation and review.



The image shows the cover and contents page of an internal report. The cover page (left) features the Australian Government logo, the Department of the Environment and Energy, and the Supervising Scientist title. It includes a large black silhouette of a mangrove tree and the title 'Sampling and Analysis Plan - Nabarlek 2017/18' by Amie Leggett, dated November 2017. The report status is 'unrestricted' and the project number is '2001-003'. The contents page (right) lists sections: 1 Introduction (4), 2 Previous Investigations (5), 4 Sampling and Analysis (7), and Bibliography and References (11). The 'Introduction' section is circled in red, with sub-sections 1.1 Purpose and Background (4), 1.2 SAP Objectives (4), and 1.3 Data Quality Objectives (4).

**Australian Government**  
Department of the Environment and Energy  
Supervising Scientist

*internal report* **XYZ**

**Sampling and Analysis**  
Plan - Nabarlek 2017/18

Amie Leggett

November 2017

Release status – unrestricted  
Project number – 2001-003

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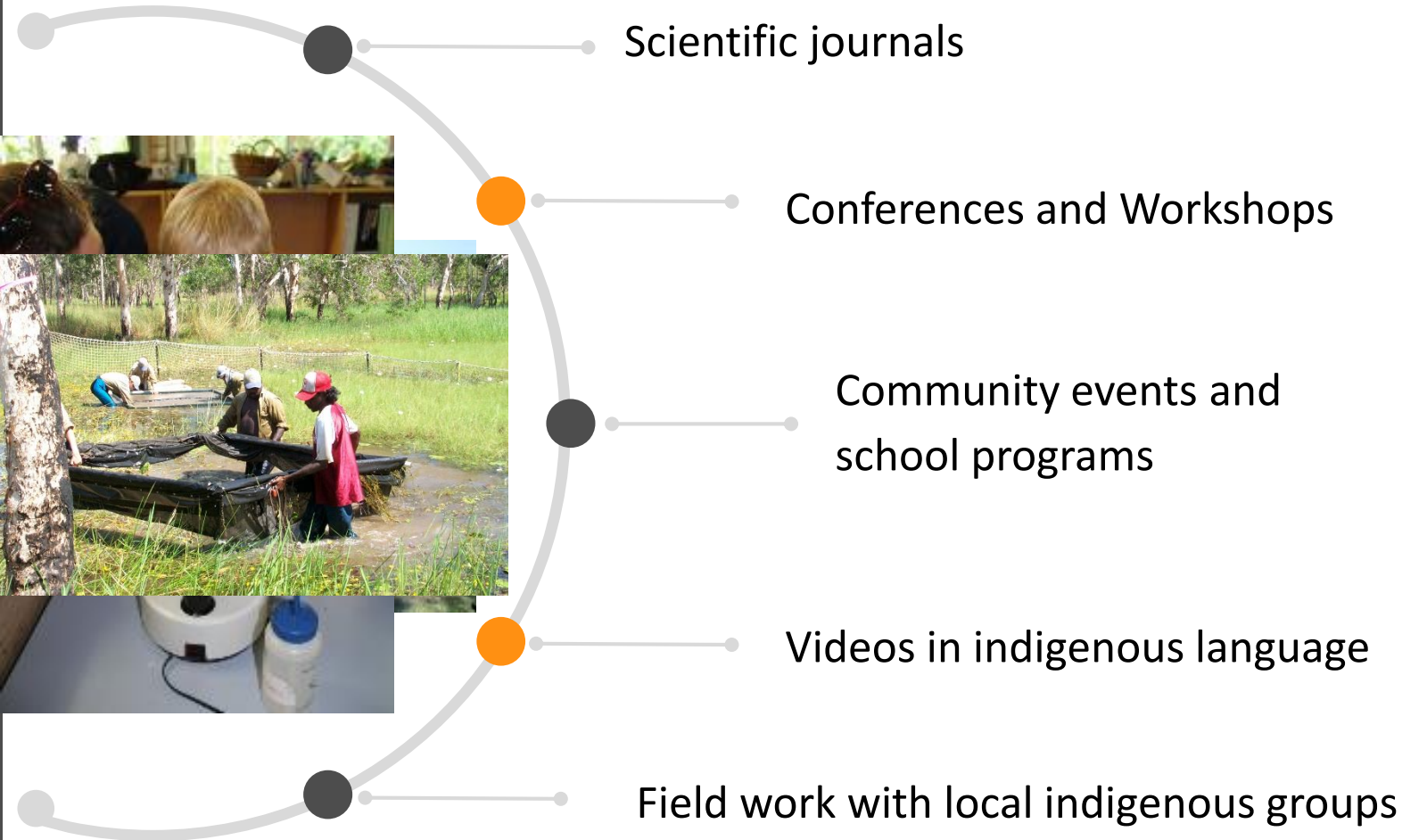
# Lessons to Share

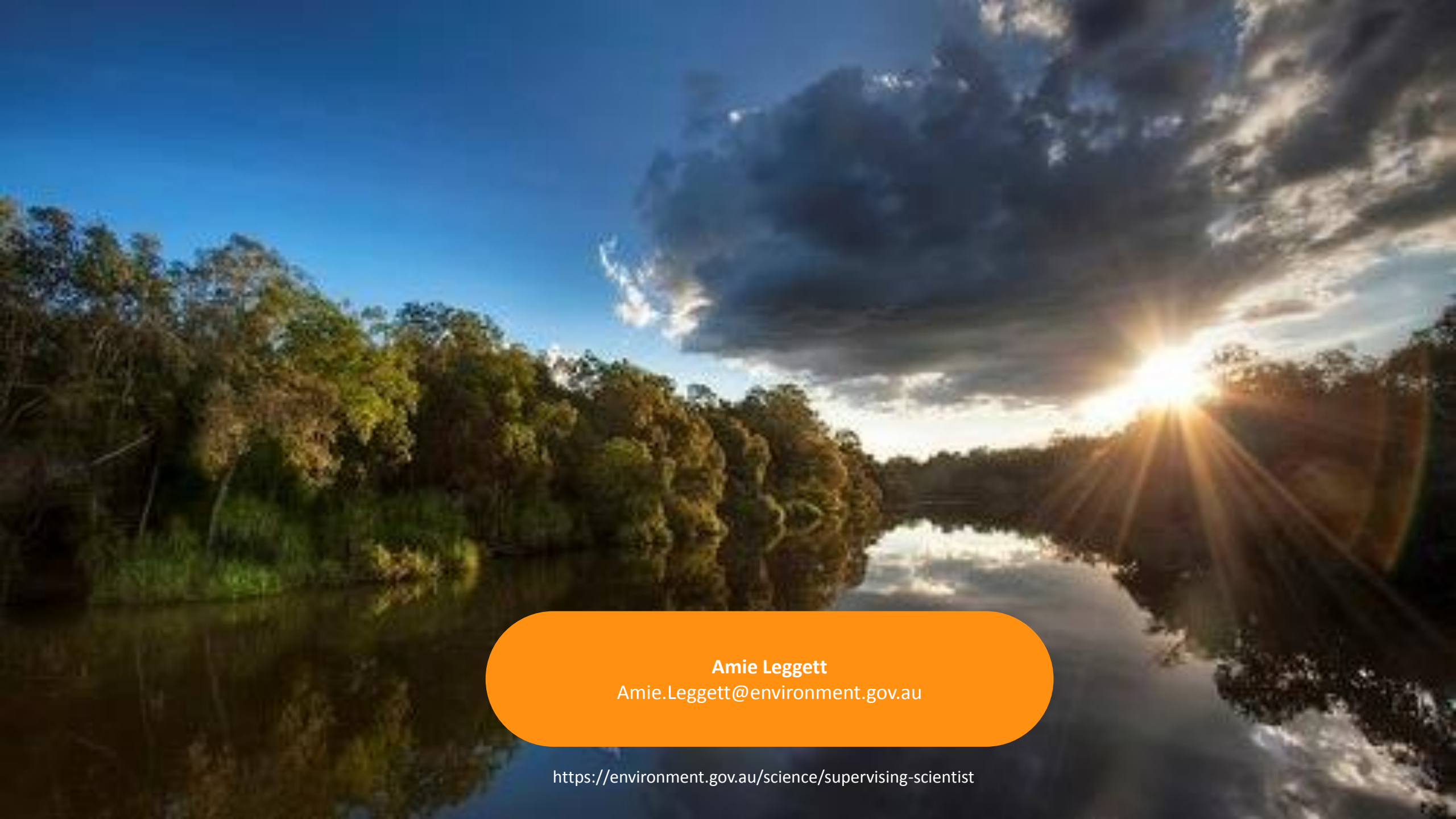
## Communication

Research outcomes must be conveyed in a way that people can understand.

Stakeholder interests need to be understood and met.

Opportunity to educate people, and to be educated.





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<https://environment.gov.au/science/supervising-scientist>