



**ASSESSMENT REPORT 18**

# **UNION REEFS PROJECT**

**ENVIRONMENTAL ASSESSMENT REPORT**

**AND**

**RECOMMENDATIONS**

**by the**

**ENVIRONMENT PROTECTION UNIT  
CONSERVATION COMMISSION OF THE NT**

**DECEMBER 1993**

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## EXECUTIVE SUMMARY

This report assesses the environmental impact of a proposal by the Shell Company of Australia to establish and operate a two pit open cut gold mine and associated infrastructure at the Union Reefs Prospect, 12 km north of Pine Creek in the Northern Territory.

The report reviews the draft EIS, public comments on the draft, and the proponent's response to these comments in the Supplement to the draft EIS. It is based on information and advice provided by Northern Territory Government agencies.

Environmental impact assessment is based on fully defining those elements of the environment which may be affected by a proposed development, and on quantifying the significance, risks and consequences of the potential impacts of the development at a local and regional level.

This report assesses the adequacy of the Environmental Impact Statement (EIS) in achieving the above objectives, and evaluates the undertakings and environmental safeguards proposed by the proponent to mitigate against the potential impacts. Further safeguards are recommended as appropriate.

The contents of this report form the basis of advice to the Northern Territory Minister for Conservation on the environmental issues associated with the Union Reefs Project.

### Major Issues

The major issues associated with the construction and operation of the Union Reefs Project raised during the review of the draft EIS and Supplement are listed below and are the focus of the contents of this assessment report.

- . *Expanded Development proposal*
- . *surface water management*
- . *groundwater management*
- . *waste rock and residue management*
- . *heritage and Aboriginal archaeological site conservation*
- . *impact on infrastructure*
- . *impact on the community of Pine Creek*

It is important for interpretation purposes that the recommendations in this report are not considered in isolation, as the text contains a number of identified concerns, suggestions, and some considerations to assist decision-making.

It is acknowledged that during detailed implementation of proposals, flexibility is necessary and desirable to allow for minor and non-substantial changes to the designs and specifications which have been examined as part of this assessment. It is considered that subsequent statutory

approvals for this proposal could make provision for such changes, where it can be shown that the changes are not likely to have a significant effect on the environment.

Subject to decisions which permit the Union Reefs Project to proceed, the primary recommendation resulting from the assessment is as follows:

#### **Recommendation 1**

**The proponent shall ensure that the proposal is implemented in accordance with the environmental commitments and safeguards identified in the Union Reefs Project draft Environmental Impact Statement, or as modified in the Supplement to the draft EIS, this assessment report or an approved Environmental Management Plan.**

*A. Recommendation associated with the Expanded Development*

#### **Recommendation 2**

**The proponent shall ensure that all relevant information regarding the proposed Expanded Development as outlined in the draft Environmental Impact Statement and Supplement is submitted to the Department of Mines and Energy for review and assessment.**

*B. Recommendation associated with Aboriginal archaeological sites*

#### **Recommendation 3**

**The proponent shall ensure that any proposal for site disturbance associated with the Core Project and Expanded Development fulfils site identification, reporting and clearance requirements under the *Heritage Conservation Act*.**

*C. Recommendation associated with water supply to the Pine Creek community*

#### **Recommendation 4**

**Contingency measures for water supply to the Pine Creek community should be agreed and documented between the proponent and the Power and Water Authority.**

*D. Recommendation associated with insect disease vectors*

#### **Recommendation 5**

**The proponent is to consult with the Department of Health and Community Services (DH&CS) to ensure the proposed baseline and operational monitoring and control programme for biting insects fulfils the requirements of the Department.**

## **1. INTRODUCTION AND BACKGROUND**

This report assesses the environmental impact of a proposal by the Shell Company of Australia Limited, through its subsidiary the Union Reefs Project (URP), to establish a gold mine consisting of two open cut pits and associated infrastructure at Union Reefs Prospect, approximately 12 km north of Pine Creek in the Northern Territory. **Figure 1** shows the location of the project.

The report reviews the draft Environmental Impact Statement (DEIS), public comments on the DEIS, and the proponent's responses to these comments in the Supplement to the DEIS (the DEIS plus the Supplement constitutes the final EIS). It also relies on information, comments and advice provided by Northern Territory Government agencies.

### **1.1 Environmental Assessment Process**

Environmental impact assessment is predicated on fully defining those elements of the environment which may be affected by a proposed development, and on quantifying the significance, risks and consequences of the potential impacts of the proposal at a local and regional level.

This report will assess the adequacy of the EIS in achieving the above objectives, and will evaluate the undertakings and environmental safeguards proposed by the proponent to mitigate the potential impacts. Further safeguards may be recommended as appropriate.

The safeguards may be implemented at various levels within the planning framework of a project. These are:

- \*Site Selection
- \*Layout of Facilities
- \*Design of Facilities
- \*Processes used in Facilities (ie. inputs and outputs)
- \*Management of Processes and Facilities

The recommendations arising from the assessment of the proposal will refer to these different aspects of the project.

The contents of this report form the basis of advice to the Northern Territory Minister for Conservation on the environmental issues associated with the mine.

## **1.2 Environmental Assessment History**

A Preliminary Environmental Report was prepared in April 1993. The Minister for Conservation subsequently determined that an EIS was necessary to address the potential impacts arising from the project. In accordance with the provisions of the Northern Territory *Environmental Assessment Act 1982*, URP was directed to prepare an EIS on the project in June 1993.

Guidelines for the preparation of the EIS were prepared by the Conservation Commission (CCNT) in consultation with Northern Territory Government agencies and are included as Appendix L of the DEIS.

On 10 September 1993 the proponent submitted the DEIS to the Northern Territory Government, and placed the document on public exhibition until 11 October 1993.

A total of thirteen written submissions were received on the DEIS; nine from Northern Territory Government agencies and four from the public sector. All submissions were forwarded to the proponent to assist in the preparation of the Supplement to the DEIS.

A list of the respondents to the DEIS is provided at Appendix 1 of this report. Appendix 2 provides a breakdown of the issues and subissues raised.

The Supplement to the DEIS was received on 8 November 1993 and distributed to Northern Territory Government agencies for examination and comment. These comments are incorporated where relevant in the body of the report.

## **2. THE PROPOSAL**

### **2.1 The Mine**

The Union Reefs deposit is a small, moderate grade gold ore body averaging 2.25 g gold/t (as defined in the Supplement). The Core Project will nominally produce 1.25 Mt/a of ore over an expected mine life of nine years, based on identified ore resources at the Crosscourse and

Union North pits. Additional ore could be identified through continuing exploration drilling. If further resources are identified it will form part of an Expanded Development scenario, producing up to 1.5 Mt/a of ore.

The ore will be mined by open-cut methods and treated by cyanide leaching in a carbon-in-leach (CIL) plant. Process residues will be contained by impoundment, and recovered water will be recycled to the mill. Waste rock will be placed in waste dumps.

All project components will be located on Mineral Lease MLN 1109, which has a total area of 4000 ha. The Core Project facilities will cover 7% of the lease area totalling some 294 ha. This will include major infrastructure such as a residue storage area, three waste rock dumps and two water dams. The water supply will be supplemented by make-up water from the McKinlay River during the wet season. **Figure 2** shows the project layout and associated infrastructure.

A water management system will be implemented for the whole site, based on segregation and management of waters according to quality. Seven water management areas have been identified to ensure clean and contaminated surface waters are separated, captured, diverted

or contained. The emphasis is on re-use of as much of the mine water as possible throughout the operation of the mine.

Mine staff will be accommodated at Pine Creek and transported to the mine on a daily basis. The project will employ approximately 80 personnel during construction, peaking at 120, and the expected work force for the Core Project is 95 personnel.

## **2.2 Major Issues**

Major issues associated with the construction and operation of the Union Reefs gold project raised during the review of the DEIS and Supplement are listed below and are the focus of the contents of this assessment report.

*Expanded Development proposal*

*surface water management*

*groundwater management*

*waste rock and residue management*

*heritage and Aboriginal archaeological site conservation*

*impact on infrastructure*

*impact on the community of Pine Creek*

## **3. REGIONAL SETTING**

### **3.1 The Region**

The Union Reefs Project is located in the Pine Creek region, in the Top End of the Northern Territory. The mine site is approximately 200 km southeast of Darwin, and 12 km north of Pine Creek. The site is secluded, being 7 km to the east of the Stuart Highway and 4.5 km from the nearest dwelling.

The project area has a history of gold exploration and mining, with gold first discovered in 1873. The area was predominantly worked by Chinese tributers and comprises some 2300 small pits, shafts, adits and open cuts. The Union town settlement was quite substantial during the late 1800's and was estimated to have a population of 400 people in 1899.

### **3.2 Biogeography**

There are two main geomorphic elements in the project area; ridge crests and hillslopes, grading to lower slopes and alluvial flats. Gold mineralisation to be developed by URP is hosted in the ridge crests and hillslopes, however alluvial gold has been worked from the alluvial flats in the recent past.



The alluvial flats are dominated by the McKinlay River drainage system which drains north to the Mary River.

The ridge crests and hillslopes are dominated by *Eucalyptus dichromophloia* low woodland and mixed *Eucalyptus* spp. low woodland or low open forest. The lower slopes and alluvial flats are dominated by mixed low woodland and low open forest species.

The climate is tropical monsoon with two distinct seasons, the wet and dry. Rainfall is thus strongly seasonal, and the project area receives in excess of 1000 mm/year. The nearest recorded average rainfall is at the community of Pine Creek, which has an annual average record of 1146 mm. Air temperatures are high and relatively constant throughout the year. Mean maximum temperatures range from 29°C to 41°C, and mean minimum temperatures range from 10°C to 27°C. The annual average evaporation is 3360 mm and based on an average year, evaporation exceeds rainfall by 2200 mm. The wind pattern is distinctive and predictable, with strong southeast trade winds in the dry season, and variable, but predominantly northwest winds in the wet season.

Groundwater at Union Reefs is associated with the geology of the Pine Creek Shear Zone, an extensive regional geological feature located within the Pine Creek Geosyncline. The shear zone within the Union Reefs Prospect comprises the Burrell Creek Formation. At the Esmeralda Borefield southeast of the Union Reefs Prospect, the shear zone comprises the Mount Bonnie Formation. Both rock types are low in permeability.

### **3.3 Areas of Conservation Significance**

There are no parks or reserves in the vicinity of the project, although the McKinlay River, which is located less than one kilometre from the project area, is an important water source for local wildlife, where permanent pools of water and riverine flora serve as refuge habitats through to the end of the dry season.

The Union Reefs prospect also has historical significance in regards to its development as a gold mining community in the 1800's. Aboriginal archaeological sites and artefacts are also associated with specific geological features of the region.

### **3.4 Demography**

The region is sparsely populated, with Pine Creek being the focus of social and economic activity. In May 1992 the population of Pine Creek was estimated at 645 people, with an additional 150 on surrounding properties and mines.

The nearest dwelling not associated with the project is Esmeralda Farm, located some 4.5 km to the east of the proposed Crosscourse pit.

### **3.5 Economy**

Mining is a significant contributor to employment in the Pine Creek region, while the community of Pine Creek benefits from its juxtaposition on the tourist crossroads between Darwin, Katherine and the Kakadu National Park.

The pastoral industry is a minor contributor to the economy of the region.

## **4 ENVIRONMENTAL ASSESSMENT**

It is important for interpretation purposes that the recommendations (in **bold type**) are not considered in isolation, as the text identifies concerns, suggestions and undertakings associated with the project.

It is acknowledged that during detailed implementation of proposals, flexibility is necessary and desirable to allow for minor and non-substantial changes to the designs and specifications which have been examined as part of this assessment. It is considered that subsequent statutory approvals for this proposal could make provision for such changes, where it can be shown that the changes are not likely to have a significant effect on the environment.

Subject to decisions which permit the Union Reefs Project to proceed, the primary recommendation resulting from the assessment is as follows:

### **Recommendation 1**

**The proponent shall ensure that the proposal is implemented in accordance with the environmental commitments and safeguards identified in the Union Reefs Project draft Environmental Impact Statement, or as modified in the Supplement to the draft EIS, this assessment report or an approved Environmental Management Plan.**

### **4.1 Major Issues**

Seven major issues were identified associated with the construction and operation of the mine project.

The definition of "mine project" for this assessment includes all operations associated with the extraction and processing of ore, surface and groundwater management, appropriate disposal of wastes, rehabilitation and supporting on-site infrastructure.

#### **4.1.1 Expanded Development**

The proponent has identified the potential for the project to expand beyond the Core Project. This has been called the Expanded Development in the DEIS. The Core Project, as further outlined in the Supplement, is based on the processing of an identified resource of 1.25 Mt ore/a from two open cut pits, Crosscourse and Union North. The Expanded Development, involves the processing of up to 1.5 Mt ore/a (ie. an additional 0.25 Mt ore/a), based on the confirmation of an additional resource or resources.

In considering the Expanded Development, the proponent has defined the maximum area of impact, and has covered the area of impact in all land-based technical studies as well as undertaking to provide design concepts for additional pits and waste dumps. The proponent also contends that the environmental management and monitoring principles detailed for the Core Project in the DEIS and Supplement are adequate to allow for a decision to be made on the Expanded Development.

Issues which require additional information in relation to the Expanded Development include location of the pit or pits; alteration to the management of waste rock dumps; ore and waste rock characterisation; quality and management of surface and groundwater; Aboriginal archaeology; safeguards and monitoring programmes; and rehabilitation. Such issues cannot be fully detailed or assessed until the additional resource is defined.

## **Recommendation 2**

**The proponent shall ensure that all relevant information regarding the proposed Expanded Development as outlined in the draft Environmental Impact Statement and Supplement is submitted to the Department of Mines and Energy for review and assessment.**

### **4.1.2 Surface Water Management**

The main objective of surface water management is to utilise suitable surface water in the mine process, and to contain process and incidental waters which may be of unacceptable quality for release to the environment.

Other important objectives are to control stormwater runoff, sedimentation and erosion, and to ensure that the operation of the water supply weir will not adversely affect the McKinlay River.

### **Adequacy of Description of Existing Environment**

The description of the existing environment in the DEIS included the rainfall regime, evaporation, runoff discharge and flood levels, McKinlay River drainage system, turbid water management, water quality and water harvesting.

The proponent has satisfactorily described the existing surface water regime on the site, including estimates of average and extreme events for rainfall and river flows.

The proponent has adequately characterised water quality over the site, and has recorded variable concentrations of arsenic, zinc, lead and cadmium. The abandoned alluvial mining operation has generated elevated levels of arsenic, zinc and lead associated with suspended particulate matter.

The Lower Water Dam results for arsenic were consistently higher than other monitoring site, but the reasons for this are not clear.

Water harvesting from the McKinlay River for process make-up water is described in Section 4.2.

## **Evaluation of Potential Impacts and Safeguards**

The proponent has stated a number of principles by which the water management system will be designed and operated, involving segregation and management according to water quality. Three water quality classes have been identified; clean runoff water from undisturbed parts of the lease, turbid runoff with elevated levels of suspended solids and trace metals, and process water of quality not suitable for direct discharge.

Clean runoff will be diverted away from disturbed areas and allowed to return unimpeded to the drainage system.

### Turbid Water

Turbid water will be managed through seven designated water management areas over the mine site. Surface water will be separated, contained and released depending on its source and water quality. Such water will include runoff from mine haul roads, areas of bulk fill, waste dumps, other disturbed areas and pit water. The majority of this water will be controlled through a diversion bund and sediment trap system. The Lower and Upper Water Dams are also involved in the water management system, receiving excess water from the two pits and the northern half of the waste dump east. It is considered that the water management system adequately addresses the issues of separating and controlling water over the mine site.

The proposed erosion control measures, drains, diversion bunds and sediment traps detailed by the proponent are adequately described, however their detailed design will require approval by the Department of Mines and Energy within the mine plan. The design will need to ensure the structures contain and direct surface flow and suspended solids as outlined in the water management system. The proponent has also undertaken to rehabilitate the abandoned alluvial workings and associated tailings by re-establishing the aquatic ecosystem through a revegetation programme. This will further reduce the level of suspended solids entering the natural drainage regime.

The management of turbid water quality centres on separating and containing water with variable and elevated levels of arsenic, zinc, lead and cadmium. The majority of high values occur in the abandoned alluvial workings, the proposed pit and the Lower Water Dam. The alluvial workings water will be contained and controlled as the site is progressively developed for the plant site and residue impoundment, ultimately becoming a source for process water. All pit water will be pumped to the Upper Water Dam and any overflow will be contained in the Lower Water Dam.

The high trace element levels (particularly arsenic) in some turbid water sources could become problematic if released into the environment during low water flows. The storage of these waters via the Upper Water Dam and Lower Water Dam and their use through the mill process is an acceptable practice. The proponent contends that the arsenic-rich water collected in the dry season will be stored in the Upper Water Dam and diluted by the existing volume of stored water. The dam will not overflow in the dry season and the elevated levels of arsenic will be limited to the dam. During the wet season pit water will be diluted by pit runoff and further dilution will occur within the Upper Water Dam (which will be maintained at full supply level). The expected dilution for a median wet season is expected to be 50 to 1, decreasing arsenic concentration to less than 10 µg/L.

Due to the unexplained high levels of arsenic in the Lower Water Dam, the proponent will have to ensure the proposed water monitoring programme accurately records the level of arsenic, and that any water discharged from the mine site meets the Australian and New Zealand Environment and Conservation Council (ANZECC) water quality criteria for livestock (as per their undertaking in the Supplement). The proponent should also ensure it fulfils its undertaking as soon as practicable to conduct research on the level and speciation of arsenic in the Lower Water Dam.

Due to the proposed containment of arsenic-rich water in the Upper and Lower Dams and subsequent dilution, the effects of elevated trace elements off-site are expected to be negligible.

#### Process Water

On-site process water will comprise water draining from the mill processing plant and decant water from the residue storage area (mill process-process residue circuit). This water will be variably elevated in arsenic, cadmium, lead, tungsten, zinc, molybdenum and sulfur, depending on whether the water has originated from residue liquid or residue solids, and from weathered or primary ore. The water will be contained within the process plant pond and a purpose built residue storage dam. It will be selectively re-used through the processing plant along with make-up water from the Upper and Lower Water Dams.

Water from process plant runoff and decant water from the residue decant system will be utilised first within the mill process-process residue circuit. The circuit will operate as a closed system, minimising the stored volumes of process water to ensure sufficient storage capacity to meet the 100-year average recurrence interval (ARI) wet season. All process water will be contained for the extreme wet conditions associated with the 100-year ARI wet season. This practice is supported. The design plans for the process plant pond and residue storage dam will require approval by the Department of Mines and Energy within the mine plan.

The proponent has undertaken to prepare an Environmental Management Plan (EMP), also referred to as the Environmental Operating Plan. The water quality and sediment monitoring programme outlined in the DEIS and Supplement will be incorporated in the EMP. The proponent has also undertaken to liaise with the Department of Mines and Energy to finalise the water monitoring programme during operations, and to further sample and test the elevated levels of arsenic in the Lower Water Dam to explain the current phenomenon.

The proposed monitoring programme will assist in meeting the principles of the water management system and allow practices to be modified if results fall below the expected quality levels.

### **4.1.3 Groundwater Management**

There are three important aspects of groundwater management for the project; alteration of the groundwater regime on site, interference with the Esmeralda Borefield (which provides the potable supply to Pine Creek), and groundwater pollution from seepage water. The first two issues will be discussed here and the latter will be discussed under Section 4.1.4 (Waste Rock and Residue Management).

#### **Adequacy of Description of Existing Environment**

Hydrogeological investigations by the proponent have identified that the existing groundwater level in the Crosscourse area is about RL 170 m, which indicates a level some 20 m below the expected rim of the pit. This equates to up to 50 m below the ground surface along the Union Reefs ridge. The hydraulic gradient falls 2% toward the west to a level of approximately RL 150 m along the McKinlay River. The north - south hydraulic gradient in the region is not well defined, but is expected to be low. In relation to Union Reefs and the Esmeralda Borefield the proponent records that groundwater movement will therefore be generally to the north, placing the mine downstream of the borefield.

The hydrogeological investigations have also confirmed that the surrounding rocks are low in permeability and that the pit dewatering will cause a cone of groundwater depression encompassing the mine site and extending toward the Esmeralda Borefield. However any drawdown is expected to be slow and small in magnitude.

It is considered that the proponent has provided a sound analysis of the groundwater regime associated with the mine site and Esmeralda Borefield, although the conclusions on the hydraulic gradient in the north - south direction are uncertain, and monitoring by the proponent is required to determine the actual direction and gradient.

### **Evaluation of Potential Impacts and Safeguards**

Localised drawdown of the groundwater due to the mine operation is not expected to adversely affect vegetation or fauna due to the deep nature of the current groundwater level (up to 50 m below the ridgeline).

As a consequence of the mining operation in the main pit, pit dewatering will draw down the water table in the surrounding rock. If this rock has low permeability (as is likely), there will be a steep gradient towards the pit. Preliminary investigations by the proponent have indicated that the halo of drawdown could eventually extend as far as the Esmeralda Borefield, some 8 km southeast of the main pit. The drawdown is expected to be very slow and the magnitude to be small, less than 2 m at the borefield by the end of the mine life. The proponent reports that these results are at best estimates and do not take into account variations in aquifer parameters and recharge levels. This raises a level of uncertainty in regards to if, when and how much the aquifer will be impacted.

The estimates of drawdown on Esmeralda Borefield are conservative due to the lack of data on aquifer parameters and recharge levels, and cannot be accurately calculated for the long term.

Due to the uncertainty about impacts on the borefield, the proponent has undertaken to establish a set of observation bores to monitor the groundwater between the mine and borefield. Bores established for monitoring groundwater quality on the mine site will also measure water levels. The location of the observation bores will be determined in consultation with Department of Mines and Energy and the Power and Water Authority. The proposed monitoring programme has been detailed in the DEIS and will be further refined in the EMP.

The proponent has adequately identified the groundwater regime for the mine site and provided a reasonable scenario for the Esmeralda Borefield. Drawdown estimates for the borefield will need to be verified by the monitoring programme to the satisfaction of the Department of Mines and Energy and the Power and Water Authority.

The need for contingency water supply plans for the Pine Creek community is discussed under Section 4.1.7 (Impact on the Community of Pine Creek).

#### **4.1.4 Waste Rock and Residue Management**

The Union Reefs Project will involve the establishment of three waste rock dumps (Figure 2). The nominal waste production is 48.4 Mt, comprising approximately 48% weathered, 11% transition and 41% primary rock.

Residue will be stored via the down valley single point method. The DEIS discussed this method as well as the paddock-type option, but the down-valley single point method has now been adopted.

There are three issues relevant to waste rock and residue management; the formation of acid rock drainage (ARD), the production of runoff or leachate containing acid- or water-soluble contaminants, and toxicity to vegetation growth.

#### **Adequacy of Description of Existing Environment**

##### Waste Rock

The proponent investigated waste rock geochemistry on 35 composite samples each collected over 10 m of drill core. Core intervals were selected to provide a representative spatial spread throughout the proposed pit shapes and to cover the range of waste rock types.

All samples were pH neutral or naturally alkaline and the total sulfur content of waste samples were generally low. All were tested to determine net acid producing potential (NAPP), and 33 were classified as not acid-forming. Two samples (one transition and one primary sample) were classified as potentially acid-forming. NAG testing (accelerated oxidation tests for net acid generation) of these confirmed the production of acid, but at a low level. The two samples were therefore classified as potentially acid-forming, but with a low risk.

A number of respondents indicated that the sample size for geochemical testing of waste rock may not be representative and that the small sample size may not allow for an accurate estimate of the acid forming potential of the waste rock. The results to date may be accurate for the samples tested, however there is still a level of uncertainty in regards to projecting the sample results for the life of the mine.

The proponent has commenced long-term column leach tests to simulate the natural acid-forming and acid-neutralising processes associated with the waste rock. Results from the first three months of tests indicate an initial flush of sulfates attributable to soluble salts rather than oxidation of sulfide minerals. The leaching potential for arsenic, cadmium, lead and zinc will be targeted in the long-term column leach tests. This undertaking is supported.

It is considered that the geochemical results to date for the Core Project are a conservative reflection of the potential for the waste rock to produce acid mine drainage. The small sample size, albeit based on a best estimate of representative samples, places some doubt over the certainty of the results presented by the proponent, particularly over the long term.

There is also some uncertainty associated with the increased waste rock estimates recorded in the Supplement (now 48 Mt, up from 35 Mt in the DEIS) in regards to the adequacy of the three waste dumps to cater for the increased load. Variable gold prices over the life of the mine may also vary the ratio of ore to waste rock. Both issues will need to be monitored by the Department of Mines and Energy and taken into account when assessing and approving the mine plan and associated Environmental Management Plans.

### Residue

Residue will be a final product of the carbon in leach (CIL) process to extract gold from the ore. The process will produce a slurry thickened to 60% solids prior to discharge to the residue storage. Decant water collected in the impoundment and runoff dam will be recycled to the processing plant.

The results from testwork by the proponent on composite samples of weathered and primary ore and multi-element scans of liquor and solids are summarised as follows in the DEIS: residue liquor from weathered and primary ore is saline and alkaline (with elevated arsenic and zinc in the primary ore residue); residue solids from weathered ore are classed as non-acid forming, while residue solids from primary ore are potentially acid forming (but with low risk); both weathered and primary ore showed elevated levels of arsenic, cadmium, lead and tungsten or molybdenum respectively.

The results appear valid as an adequate reflection of the expected residue chemistry. Volume estimates for ore and waste rock may vary as a result of improved test results during mining and an alteration to the gold price over time.

## **Evaluation of Potential Impacts and Safeguards**

### Waste Rock

Waste dump management is based on URP'S hypothesis that "elevated levels of zinc and arsenic in waste dump leachate will not translate into problems of water quality downstream". The hypothesis is founded on the speciation and toxicity of arsenic, dilution of waste dump runoff and attenuation of trace metals as observed at other mines. The DEIS concludes that the trace metals occur in forms associated with particulate matter, at levels of low toxicity (below levels set by ANZECC for aquatic ecosystems) and in a highly diluted state if they flood through the designed sediment traps and spillways. As a result the proponent has not designed the waste rock dumps to prevent acid rock drainage, but drains, sumps and sediment traps will be constructed to direct and contain turbid water runoff.

The proponent has undertaken to validate the predictions made in the DEIS through laboratory test work (column leach tests are underway) and water quality monitoring. If testwork results or monitoring indicates other than the predicted low levels of impact on ambient water quality, then the current preference for unsealed dumps and maximum infiltration will be reviewed and if necessary revised. An option for such a contingency discussed in the Supplement included compacting the waste dump surfaces to minimise infiltration, and consideration of the progressive construction of a pad of weathered material as a base for the waste dump.

The DEIS records that monitoring will include routine testing of waste rock for NAPP (and NAG testing if NAPP results indicate), and disturbed catchment site sampling in the vicinity



of the pits and waste rock dumps. The proponent has undertaken to further develop its waste rock dumping strategy in the EMP.

It is considered that the proponent has addressed the predicted impacts associated with the management of waste rock for the Core Project, although the sample size for geochemical testing is considered the minimum to provide a representative result, and that the results are conservative. The long term impacts are somewhat uncertain and the level of impact cannot be predicted accurately.

The validation and monitoring programme of undisturbed sites, dam sites, sediment traps, and disturbed catchment sites outlined by the proponent will assist in reducing the uncertainty of the results over time and allow for appropriate contingency measures to be implemented in a timely manner. The programme will need to be implemented as soon as possible during the operation phase of the mine to allow appropriate disposal of waste rock.

If new pits are proposed for the Expanded Development, further waste rock characterisation tests and reporting to the Department of Mines and Energy will be required.

The rehabilitation proposals for the waste rock dumps are aimed at progressive rehabilitation over the life of the mine. Rehabilitation will follow the basic methods outlined in the DEIS, with refinements as indicated by the waste geochemistry, revegetation studies and mine site surface material results. The strategy outlined by the proponent is supported, however the proposal will require input from the validation and monitoring programme outlined above to ensure long term stability.

### Residue

The residue storage proposal is based on limiting seepage volume, attenuating contaminants, protecting the embankment from floods, and creating a final landform that is safe, stable, free draining and conducive to revegetation.

The DEIS records that the residue storage site (impoundment) was selected on storage volume requirements, the results of hydrogeological and geotechnical site investigations, and the physical and chemical characteristics of the residue slurry. The impoundment will have a capacity of up to 13 Mt which will allow for the containment of all water in the mill process-process residue circuit for extreme wet conditions up to an extreme wet season having a 100-year ARI.

Storage will follow the construction of an impoundment which is filled via the down-valley single point method. This method relies on thickening of the slurry in the processing plant circuit to minimise water and reagent loss. The combination of the thickened slurry and down-valley method prevents sorting and segregation of the slurry, allowing ease of access and progressive rehabilitation of the impoundment. All surface drainage will be directed toward the cut-off trench and runoff dam, and recycled through the mill processing plant.

The impoundment design and construction method for the residue storage dam and cut-off trench is adequate, however a new source of suitable clay for lining and embankments will need to be identified as soon as possible before the year four deadline (when the impoundment borrow material will be exhausted), and endorsed by the Department of Mines and Energy. The use of river flats for borrow material only as a last resort is also supported.

The proponent has identified two forms of seepage which may occur from the residue storage impoundment: shallow seepage through embankments, and deeper seepage through the rock foundations. The proposal to intercept shallow seepage by collection trenches around the embankment toes and direct it to collection sumps for recycling through the process plant is supported. In response to comments on the DEIS the proponent has also undertaken to locate the cutoff trenches in competent rock and to ensure that embankments will be founded on competent rock. Deeper seepage will be minimised through the thickening process (which promotes the consolidation and drying of the deposited residue), decanting of the bleed water and evaporation of pore water. The deeper seepage is expected to flow toward the pit as it exerts its influence on the groundwater profile by changing the hydraulic gradient.

Seepage will be further controlled through the use of a clay lining sourced from within the impoundment area and from excavations associated with project construction. Seepage tests were carried out on disturbed weathered material and validates its use for borrow material.

The potential impact of residue entering the surface water regime is considered minimal due to the proposed design of the impoundment and runoff dam based on the extreme wet season 100-year ARI criteria. Such criteria will ensure that residue will only flood beyond the impoundment and associated dams when dilution rates are high due to the extreme wet conditions.

Seepage quality has been discussed in detail by the proponent in the DEIS and the results of the test work indicate that decant water will initially contain elevated levels of arsenic and various metal-cyanide complexes. The proponent considers that seepage plumes will take 4 to 8 years to travel 150 m down gradient from the residue storage due to hydraulic and rock porosity parameters. During this time the cyanide, arsenic and other contaminants will be subject to geochemical ageing processes such as attenuation by adsorption and precipitation. Through this process, the proponent considers that neither arsenic, zinc or cyanide species will be significantly elevated above background levels in groundwater around the residue storage.

Assessment of the impact of residue seepage relies heavily on the test work and results presented in the DEIS. Based on these results the potential impact is considered low. The implementation of the proposed operations monitoring programme is expected to provide early warning if the predicted seepage rates and levels of contamination are higher than predicted.

Issues associated with decant water quality relate specifically to the level of cyanide expected in the residue liquors. Results of tests indicate such liquor will approximate 25 mg/L  $CN_{WAD}$ , well below the toxicity threshold level of 50 mg/L  $CN_{WAD}$  for birds coming into contact with the solution (Smith and Mudder 1991). The proponent will need to ensure the proposed monitoring programme identifies changes in the quality of the decant water to ensure a timely implementation of contingency measures to prevent birds from accessing the decant if it rises above the threshold level.

The operations monitoring programme outlined in the DEIS and updated in the Supplement is endorsed. The proponent should ensure the undertakings to liaise with the Department of Mines and Energy and the Power and Water are carried out in a timely manner.

Principles for the rehabilitation of the residue storage impoundment will follow those outlined for the waste rock dumps. Storage embankments will be protected from erosion and rehabilitated as soon as possible after construction, and the impoundment will be constructed

to require minimal additional earthworks or drainage works. Weathered marginal ore will provide a final cover.

The general principles for rehabilitation of the residue storage impoundment are endorsed, however the proponent will need to update the Environmental Management Plan as test results provide a firmer basis for detailing the final rehabilitation strategy. This is particularly important in the light of the life of the mine and the expected release from liability by the proponent from the Department of Mines and Energy.

#### **4.1.5 Heritage and Aboriginal Archaeological Site Conservation**

This section will discuss the issues associated with Aboriginal archaeology and historical mining, rail, telegraph and WWII issues.

##### **Adequacy of Description of Existing Environment**

###### Historical Sites

The Union Reefs Prospect was intensively worked at the turn of the century for gold. A community was established along with numerous adits, shafts, shallow open pits and mullock heaps. The Northern Australian Railway and the Overland Telegraph to Moline also passed through the Union Reefs Prospect (both are now abandoned).

The proponent has undertaken an initial survey and thence a detailed survey of the prospect to identify sites which would be affected by exploration and mine development. The initial survey was reported in the DEIS and the detailed survey was reported in the Supplement. All survey work has been undertaken in consultation with the Heritage Unit of the Conservation Commission.

The initial survey identified three Chinese archaeological sites of historical interest as well as a number other Chinese sites of less historical value associated with mining, the rail line, telegraph line, Union Reefs community and WWII sites.

The survey work and reporting by the proponent has provided a sound knowledge of the historical background for the Union Reefs Prospect.

###### Aboriginal Archaeology

The proponent has undertaken a prehistoric (Aboriginal) archaeological survey of the Union Reefs Prospect to locate any sites in the project area. The survey methods and results were reported in the DEIS.

Archaeological sites were located at hornfels outcrops and along creeklines. The proponent contends that the sites correspond to similar sites throughout the Pine Creek Shear Zone and are well represented in the region, and that their value is based in their scientific interest and research potential. All the sites identified have been registered by the proponent in accordance with the *Heritage Conservation Act*.

Respondents on the DEIS have reported that the survey and results presented in the DEIS did not provide sufficient data to fully assess the level of impact the project may have on Aboriginal archaeological sites in the prospect. The survey was an initial one and did not fully address the Job Brief.

The proponent has agreed that the survey reported in the DEIS was of a preliminary nature and has since commissioned another investigation to complete the survey (the supplementary survey reported in the Supplement). This involved surveying the waste dump east site (not completed in earlier survey) and conducting a detailed survey of the Upper Water Dam site, where archaeological sites had been identified previously. No sites were identified in the waste dump east site, however five sites were identified in and adjacent to the proposed areal extent of the Upper Water Dam.

## **Evaluation of Potential Impacts and Safeguards**

### Historical Sites

From the results of the initial survey of the historical sites, the three Chinese sites considered of historical interest were further surveyed, recorded and collected for cataloguing (after consultation with the Heritage Unit) prior to the sites being disturbed by exploration. The material has been stored for future exhibition at the Museums and Art Galleries of the Northern Territory.

In regards to other historical sites which may be impacted by the project, the proponent has undertaken to implement the recommendations listed in the second survey, namely; the overland telegraph poles will be sampled for storage in the NT Museum, and the WWII site adjacent to the access road will be maintained in its present state and access controlled.

The proponent has also undertaken to brief employees on the presence, significance and location of remaining historical sites.

In summary, the proponent has conducted a comprehensive survey, recording and collection programme of the historical sites at the Union Reefs Prospect. This will ensure that the historical knowledge of the site will be available for future research and teaching.

### Aboriginal Archaeology

In discussing the Core Project the proponent has indicated in the DEIS that it will obtain site clearances from the Minister for Conservation prior to project construction, as required under the provisions of the *Heritage Conservation Act*.

The conclusions drawn in the supplementary survey report are supported, however the undertakings listed in the Supplement associated with the Upper Water Dam are amended as follows:

- a. Should the height of the water in the dam exceed RL 175 m, a systematic archaeological collection of sites AS1/b and AS1/d should occur.
- b. Should the height of the water in the dam exceed RL 180 m, a systematic archaeological collection of sites AS1/a, AS1/b, AS1/c and AS1/d should occur.

- c. Site ASI/a should be fenced and flagged in order to ensure construction of the dam wall does not impinge upon the site.

The collection programme for the listed sites will need to be acceptable to the Conservation Commission and the Museums and Art Galleries of the Northern Territory.

To conclude, while the initial survey was considered unsuitable for a complete assessment of Aboriginal archaeology within the project area, the second investigation did cover areas not previously surveyed and provided for a more detailed assessment of the Upper Water Dam. Assessment of both surveys provides a suitable data set to determine the level of impact by the Core Project on the sites and the measures required to protect or salvage them.

An assessment on impacts associated with the Expanded Development cannot be made, as not all site disturbance is known at this stage.

### **Recommendation 3**

**The proponent shall ensure that any proposal for site disturbance associated with the Core Project and Expanded Development fulfils site identification, reporting and clearance requirements under the *Heritage Conservation Act*.**

#### **4.1.6 Impact on Infrastructure**

The implementation of the project has a number of impacts on infrastructure associated with the development of the site. These include a 66-kV transmission line, gas pipeline and Darwin to Alice Springs rail corridor.

##### 66-kV Transmission Line

The DEIS reports that a 66-kV transmission line runs north-south through the central portion of the mineral lease, in-line with the waste dump north, process plant site and residue storage.

The proponent has undertaken in the DEIS to break the powerline and re-locate a 4 km section to the west of the infrastructure which would otherwise conflict with the line.

The re-location of the line is considered appropriate and the operation will be conducted by the proponent in consultation with the Department of Mines and Energy and the Power and Water Authority.

The necessary clearances under the *Sacred Sites Act* and *Heritage Conservation Act* will be required.

##### Gas Pipeline

The Amadeus Basin to Darwin gas pipeline runs north-south through the eastern portion of the mineral lease. The proponent has reported that the pipeline will be in close proximity to waste dump east and inundated by the upper reaches of the Upper Water Dam if it reached a full supply level of RL 182 m. The proponent has listed in the DEIS a number of undertakings

associated with the operation of the mine and the protection of the pipeline. These included protection measures, buffer zones, employer education and mitigation measures.

In regards to the protection of the pipeline from operations associated with the waste dump east, the proponent has further undertaken in the Supplement to increase the buffer between the cut-off drains for waste dump east and the edge of the pipeline corridor from 12.5 m to 20 m, provide additional markers at 200 m intervals along the top of the gas pipeline adjacent to waste dump east, and to undertake employee and contractor education about the pipeline at induction and regular intervals thereafter.

The proponent has also undertaken in the Supplement to liaise with NT Gas to discuss options for protection of the pipeline if the Upper Water Dam rises above its projected capacity of RL 180 m as recorded in the Supplement.

Blasting associated with pit development could pose problems for the protection of the pipeline, however measures reported by the proponent have been assessed by the Department of Mines and Energy as falling within acceptable limits (as per AS 2187 Part 2). The proponent has undertaken to notify the Department of Mines and Energy and NT Gas in advance should there be any change to the charge weight, location or method of blasting.

It is considered that the proponent has adequately addressed issues associated with development of the mine and the protection of the gas pipeline. As long as the proponent fulfils measures outlined in the DEIS and Supplement, the integrity of the gas pipeline should be maintained through the life of the mine.

#### Rail Corridor

The DEIS did not record that the proposed Darwin to Alice Springs railway corridor runs through the central portion of the mineral lease along the abandoned railway line. The proposed corridor will be disrupted by the construction and operation of the waste dump north, processing plant site and residue storage.

Comment by the Department of Transport and Works on the DEIS indicated that the proponent would have to identify a suitable alternative corridor to the satisfaction of the Department. In response the proponent undertook to define an alternative route to the west of the project and prepare a preliminary investigation report for the alignment. The Department of Transport and Works has reviewed the report and recorded that it satisfies the requirements for an alternative alignment, and that there are no objections to the surrender of the existing corridor through the mine site.

The Department of Transport and Works has confirmed with the proponent that the new corridor has to be protected from any further mine related activities and it should be 100 m wide.

#### **4.1.7 Impact on the Community of Pine Creek**

A number of respondents to the DEIS listed impacts which may occur at the Pine Creek community in response to operations at the mine. These included an accommodation shortage for mine personnel, and pressure on the provision of sewerage services and water supply to the

community. Of particular concern to respondents was the potential to reduce the capacity of the Esmeralda Borefield to supply water to the Pine Creek community.

The proponent acknowledged these issues in the DEIS, but did not identify measures to accommodate such issues, or outline contingencies if the mine did adversely impact on the level of available accommodation, sewerage services and water supply to the community of Pine Creek.

In response to submissions on the DEIS, the proponent has;

- a. Met with relevant officers of the Department of Lands, Housing and Local Government to discuss housing requirements. Discussions have not been finalised, but are proceeding satisfactorily.

The proponent has also undertaken to keep the Regional Director of the Department and the Pine Creek Community Government Council informed of its intentions to avoid potential problems with accommodation.

- b. Undertaken to independently assess the projects' impact on the water supply and sewerage systems.
- c. In consultation with the Power and Water Authority, undertaken to drill a number of groundwater bores to monitor drawdown occurring between the mine and the Esmeralda Borefield caused by mine dewatering.
- c. Undertaken to utilise appropriate design criteria for the single person accommodation, in particular water reduction practices.
- d. Undertaken to implement "management strategies to provide water during peak periods by, for example, saving water and trucking water."

The actual impacts on water and sewerage at Pine Creek are dependent on the closer or continuation of the mining ventures near the Pine Creek community, in particular the Pine Creek Goldfields gold mine ventures. In the light of this and the uncertainty over impacts, the proponents' undertakings concerning borefield monitoring, sewerage services and water supply are considered appropriate. They should be implemented in conjunction with the Power and Water Authority as agreed measures between the two parties.

#### **Recommendation 4**

**Contingency measures for water supply to the Pine Creek community should be agreed and documented between the proponent and the Power and Water Authority.**

#### **4. Other Issues**

##### **Water Supply**

The proponent identified in the DEIS that a make-up water supply would be needed to service the total water needs for the mine. Estimates for make-up water were calculated taking into account ore moisture content, local runoff, pit water and recycling of residue decant, and the levels of demand were measured against wet season probabilities. Further refined water balance modelling for low rainfall years were calculated for driest on record, the 2%ile, 5%ile, 10%ile and 50%ile (average) by the proponent and reported in the Supplement to the DEIS.

Based on the refined wet season probabilities, the proponent has estimated that on average 5.3% of the McKinlay River flow would be needed to be harvested each year. This percentage equates to 0.01% of the total catchment of the McKinlay River/Mary River drainage basin and would be harvested during the peak flow periods at the onset of the wet season. The make-up water would be stored in two off-stream storage dams (the Lower and Upper Water Dams) whose storage requirements were set sufficient to accommodate the consecutive occurrence of an 8-month dry season, a wet season equivalent to the driest on record, followed by another 8-month dry season.

Estimates of yields from the McKinlay River were also modelled by the Power and Water Authority and initially gave differing results to URP, however those differences have now been satisfactorily resolved, and the proponent's water supply investigation is considered satisfactory.

The proponent reported in the DEIS that harvesting was to be carried out utilising a combination of 100 ML weir/sump serviced by a 20 ML/day pump. This estimate has been further refined in the Supplement to a weir capacity of 50 ML and pumping rate of 10 ML/day.

Estimates associated with the water supply and pumping requirements are considered adequate, and the proponent's undertaking to seek approval from the Department of Mines and Energy and Power and Water Authority to build the weir and abstract water is endorsed.

### **Species of Conservation Significance**

Baseline work carried out by the proponent has confirmed that there are no species of bird, mammal, reptile or frog restricted to the project area, however a number of species of conservation significance were observed.

The proponent contends that the loss of habitat due to the mine operation is expected to be minimal and will not have a significant effect on the conservation status of any fauna. It is considered that this is an adequate reflection of the status of the site.

#### **Ghost Bats**

The Ghost Bat was first documented at the Union Reefs Prospect on October 1987 and is accorded vulnerable status in the *Endangered Species Protection Act*.

The proponent has been conducting regular site inspections to monitor Ghost Bat populations within all the adits in the Union Reefs Prospect since April 1992. The inspections and counts have identified that Ghost Bats and the occasional Horse Shoe Bat forage in the Union Reefs area and roost intermittently in adits G and H. Monitoring indicates that the frequency of use in these two adits is low and the numbers of bats variable. The proponent has indicated that



neither adit is considered to be a maternity roost and the observations suggest that both adits are opportunistic foraging roosts.

The proponent undertook early consultation with the Conservation Commission over the use of the Union Reefs Prospect adits by the bats for roosting purposes and a plan to close those adits soon to be impacted by the Crosscourse pit was formulated. Adits G and H are not in danger of closure in the near future and were recommended by the Conservation Commission for continuous monitoring to determine the population dynamics in the two adits and provide an understanding of the role of such adits in a regional context.

Regular visual monitoring is continuing while a proposed infra-red counter system (funded by the proponent) is installed by the Conservation Commission. The proponent has undertaken to continue monitoring over the next 12 months, and adit H will be available for monitoring for a further 1 to 2 years.

It is considered that the proponent has adequately investigated the use of mine adits by Ghost Bats at the Union Reefs Prospect. Of particular note is the undertaking to assist in a research programme on the bats and to continue to monitor the bats in adits G and H. The proponent has confirmed that closure of the adits will be addressed in consultation with the Conservation Commission.

### **Fires**

The proponent has been practising controlled fuel-reduction burning under permit during exploration and has undertaken to adopt a formal fire management and control plan for the mining operation following discussions with the NT Bush Fires Council. The plan will operate as a Fire Management Plan and form part of the overall Environmental Operating Plan (known also as the Environmental Management Plan). The plan will include input from the NT Fire Service for site specific issues.

### **Weeds**

The proponent has undertaken to minimise the risk of weed infestation through a programme outlined in the DEIS, including a baseline survey and periodic inspections by the District Weeds Officer, developing preventive and control measures, and an employee education programme. The proponent has also undertaken to refine the undertakings in the Environmental Operating Plan.

### **Landfill**

The Conservation Commission does not agree with the use of waste rock dumps for solid refuse disposal. In response to this concern, the proponent has undertaken to employ an approved purpose-built landfill site for solid refuse.

### **Management of Hazardous Substances and Dangerous Goods**

The proponent has undertaken to comply with relevant statutory requirements and seek advice from the appropriate authority where necessary. The DEIS provided a comprehensive outline

of such substances and goods, their classification, transportation, storage, handling, contingency procedures and emergency response.

The DEIS also records that the management of these substances and goods will follow guidelines set out in the Environmental Operating Plan.

### **Insect Disease Vectors**

The proponent has identified in the DEIS a number of general safeguards to be incorporated in design of project facilities to minimise the possibility of insect breeding. These safeguards are supported. The proponent did not however identify the need for a baseline survey or monitoring programme to be undertaken.

The severity of the problems associated with biting insects should not be underestimated, particularly those which act as vectors for the Ross River Virus, dengue and yellow fever. The fact that the mine site is isolated and the population is low does not reduce the potential severity of the diseases on mine personnel if problematic biting insects are allowed to breed.

The DEIS and Supplement did not fully recognise or respond adequately to the issues associated with biting insects on the mine site. This is particularly important as the project water supply and site rehabilitation proposal relies on water dams and the creation of an aquatic ecosystem which will (through necessary design and operational requirements) create sites which may be suitable for biting insects to breed.

The proponent will need to resolve these issues with the Department of Health and Community Services. The Power and Water Authority should be included in the consultation over the sewerage treatment system if irrigation is considered an option for water release.

### **Recommendation 5**

**The proponent is to consult with the Department of Health and Community Services (DH&CS) to ensure the proposed baseline and operational monitoring and control programme for biting insects fulfils the requirements of the Department.**

## **5 CONCLUSIONS**

The requirements of the *Environmental Assessment Act* and the Administrative Procedures have been met by the proponent.

It is considered the issues raised in this report have been, or will be, satisfactorily addressed by the proponent provided that the undertakings and commitments made by the EIS, as modified by recommendations in this report, are complied with.