Appendix 15 Nolans Mine EIS, Stygofauna Pilot Survey (GHD 2011)

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Arafura Resources

Nolans Mine EIS

Stygofauna Pilot Survey

February 2011

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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Executive summary

Subterranean fauna is a collective term that refers to troglofauna (terrestrial subterranean fauna inhabiting air voids) and stygofauna (aquatic subterranean fauna). Calcrete aquifers are known to contain significant stygofauna communities in the Yilgarn region of Western Australia and in the nearby Ngalia Basin in the Northern Territory.

Stygofauna were sampled at the Nolans mine site using modified plankton nets in accordance with the Western Australian *Environmental Protection Authority Guidance Statement 54* and *54a*. Bores were sampled for stygofauna using a plankton net with a diameter (32 mm) to match the bore/well. The net (either 125 µm or 50 µm mesh), with a weighted vial attached, was lowered into the bore and hauled up through the water column.

Stygofauna was sampled in August 2010. Five (5) bores in the study area and two (2) reference bores north of the study area were sampled. Samples were sorted for stygofauna using a dissecting microscope.

No stygofauna, or other aquatic invertebrates, were recorded from any of the five (5) samples examined from the project area or the two (2) reference sites to the north of the project area. Sites examined for stygofauna were restricted to the central portion of the orebody within the fractured rock aquifer.

The calcrete aquifers located in the south-west of the Project Area are considered highly likely to contain stygofauna. If these calcrete areas are shown by hydrogeological studies to contain a superficial aquifer then additional sampling would be recommended prior to any dewatering occurring to determine the presence or absence of stygofauna. The extent and depth of mine dewatering cones will be required before impacts to potential stygofauna can be accurately determined. Impacts to stygofauna are likely be limited if drawdown extents do not completely dewater the aquifer. Severe impacts and potential extinction of locally endemic species (if present) of stygofauna could occur should localised drawdown completely dewater the calcrete aquifers.

The outcomes of current hydrogeological studies are required before potential impacts to the calcrete aquifers can be assessed. Stygofauna communities that may be in the calcrete aquifers may be impacted, depending on the requirements for project dewatering. If complete dewatering of these habitats is required it is recommended that additional sampling of the calcretes is undertaken to confirm the absence of these communities.

1. Introduction

1.1 Background

Arafura Resources Ltd (Arafura) proposes to construct a rare earth elements and phosphate mine at Nolans Bore, located 135 kilometres north of Alice Springs in the Northern Territory. The proposed mine and associated infrastructure are known as the Nolans Mine. It is proposed to extract ore for rare earth elements such as cerium, lanthanum, neodymium and europium, as well as phosphate and small amounts of uranium.

The Nolans Mine consists of the following components:

- An open cut mine and associated mine infrastructure including a beneficiation (processing) plant
- A transport corridor consisting of 75 kilometres of unsealed road from the mine site to a rail head on the Adelaide to Darwin railway
- A Mining Camp to be located in proximity to the existing Aileron Roadhouse
- Supporting infrastructure such as administration, utilities and waste storage

The Northern Territory Minister for Natural Resources, Environment and Heritage determined that a draft Environmental Impact Statement (EIS) is required for the Nolans Mine. The Department of Natural Resources, Environment, The Arts and Sport (NRETAS) subsequently issued Guidelines for the Preparation of a draft Environmental Impact Statement for the Nolans Mine. The EIS is being prepared under a bilateral arrangement between the Commonwealth and Northern Territory governments.

This pilot study addresses the requirements of the EIS Guidelines by providing information that allows for assessment of the mine's potential impacts on stygofauna.

1.2 Project description

The Nolans Mine is proposed to be located in a 14 square kilometre mining lease application (the mine site). An open pit operation would mine to a depth of approximately 150 metres.

In addition to the mining pits, the mine site would contain:

- Overburden storage areas
- Ore stock pile
- Benefication plant
- Natural gas power plant
- Water treatment plant
- Office and amenities
- Tailings dams
- A repository for thorium rich residues from processing off-site
- Chemical, fuel and explosives storage facilities

Accommodation for employees is proposed to be provided in a purpose built accommodation facility located adjacent to the existing Aileron Roadhouse, approximately 12 kilometres south of the mine.

Ore would be open cut mined and removed by excavators and haul trucks. Ore would be partially processed on-site in the benefaction plant.

The beneficiation process would include crushing, screening, and gravity and flotation separation of impurities from the mined material. The mineral concentrate formed by these processes would be dried to approximately 10 % moisture content.

Mineral concentrate, stored in sealed containers, would be transported to the Darwin-Adelaide railway line approximately 65 kilometres from the mine site. It would then be transported to Arafura's Rare Earth Complex in South Australia. The complex is subject to a separate approvals process in South Australia, and is not within the scope of this assessment.

Refinement of the mineral concentrate would generate a thorium-containing residue. This would be transported by rail and road in sealed containers for storage at the mine site. The residue would be stored on the mine site in a purpose built storage facility.

1.3 Study area

The study area for this assessment is defined as including land within:

- The mineral lease boundary (mine site)
- A transport corridor 300 metres wide extending from the mine site to the Darwin-Adelaide Railway to the east
- A rail siding located a the junction of the transport corridor and the Darwin-Adelaide Railway line
- The mine accommodation facility located adjacent to the Aileron Roadhouse and an access road from the accommodation to the mine site

The study area boundary is shown in Figure 1.

1.4 Survey staff qualifications

Stygofauna field investigations were undertaken by experienced GHD ecologists:

- Dr Timothy Moulds *BSc (Hons) Geol., PhD. Invert. Ecol.*
- Gaynor Owen *BSc (Hons) Env Sc.*

Survey work was authorised under a licence issued by the Parks and Wildlife Commission of the Northern Territory, License no. 37642; Licensee T Moulds; Issued 16/08/2010

1.5 Report limitations and constraints

The study was designed to provide baseline information on stygofauna occurrence and distribution in the Project deposit areas, and provide a base for future survey work as required. The study was limited to requirements specified by the client and the extent of information made available to the consultant at the time of undertaking the work. Assessment of potential impacts was based on mine plans provided by Arafura Resources. No modelling of potential drawdown depths from abstraction were available for this report.

GHD has prepared this Report on the basis of information provided by Arafura Resources, which GHD has not independently verified or checked ("Unverified Information") beyond the agreed scope of work.

GHD expressly disclaims responsibility in connection with the Unverified Information, including (but not limited to) errors in, or omissions from, the Report, which were caused or contributed to by errors in, or omissions from, the Unverified Information.

The opinions, conclusions and any recommendations in this Report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this Report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this Report.

Site conditions (including any the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD expressly disclaims responsibility:

arising from, or in connection with, any change to the site conditions; and

to update this Report if the site conditions change.

2. Method

Stygofauna were sampled from bores using modified plankton nets in accordance with the Western Australian *Environmental Protection Authority Guidance Statement 54* and *54a* (EPA 2003, 2007). The plankton net had a diameter (32 mm) to match the bore/well. The net (either 125 µm or 50 µm mesh), with a weighted vial attached, was lowered into the base of the bore and then agitated up and down (±1 m) several times to disturb the bottom sediment and any contained stygofauna. Stygofauna were captured by hauling the net up through the water column. At most bores six hauls of the entire water column were conducted. Three hauls were made with the 125 µm mesh net, and three with the 50 µm mesh net. Depths to the water table and total depth of bores were calculated using the number of rotations of the fishing reel. Each net haul sample was transferred to a labelled polycarbonate container, and kept in a cool location for later sorting. Samples with large quantities of sediment were elutriated prior to preservation. The nets were treated with Decon 90 solution, thoroughly rinsed in water and air-dried to minimise the possibility of stygofaunal cross contamination among samples.

Dr Timothy Moulds sorted samples using a dissecting microscope.

2.1 Survey effort and timing

Stygofauna was sampled during August 2010. Five (5) bores in the study area, and two (2) reference bores to the north of the study area were sampled for stygofauna (Appendix A). Sampled bores were between 26 – 121 metres deep (Table 1). Other bores in references areas were examined and found to be dry or blocked.

Table 1 Bores sampled for stygofauna

Hole ID	Date of Sample	Aquifer	Impact/ reference	Easting	Northing	Depth to water (m)	Water Depth (m)	Total Depth (m)
Reference Bore 3	16/08/2010	unknown	Reference	318332	7511213	Blocked	-	2
Reference Bore 4	16/08/2010	unknown	Reference	323335	7521116	48	18	66
Reference Bore 5	16/08/2010	unknown	Reference	308439	7521898	13	13	26
NBGW 811	17/08/2010	Fractured rock	Impact	318708	7502128	13	78	91
NBGW 813	17/08/2010	Fractured rock	Impact	318842	7502099	13	107	120
NBGW 814	17/08/2010	Fractured rock	Impact	318581	7502026	13	100	113
NBGW 816	17/08/2010	Fractured rock	Impact	318768	7502188	13	108	121
NBRC 354	17/08/2010	Fractured rock	Impact	318177	7500687	Dry	-	37
GORC 019	17/08/2010	Calcrete	Impact	318201	7500298	14	0.2	14

Oxidation reduction potential (ORP)

The oxidation reduction potential (ORP) or redox potential of groundwater is a measure of a systems capacity to oxidise materials through chemical reactions. During reduction-oxidation reactions, one chemical species loses electrons (is oxidized) while another gains electrons (is reduced). Redox is measured indirectly as the ability of an aquatic system to conduct electricity, in millivolts (mV).

The redox state of aquatic environments, i.e. whether they are in an oxidising or reducing environment, is defined by the oxygen content. Typically, in well-aerated aquatic environments, the water provides an oxidizing environment and has a positive, or nearing positive, ORP value. Anoxic (zero oxygen) waters and soils are often the result of high biological (BOD) and/or chemical oxygen demand (COD) and have low redox potential (often measured as negative millivolts, mV). The redox potential of aquatic environments controls the reactivity and solubility of many chemical constituents including metals. For example the redox potential of groundwater has important implications for metal mobility, bio-availability and toxicity.

Temperature

The temperature of ground water in central Australia is generally fairly constant throughout the year and reflects the average surface temperature of the area. Ground water temperature was measured in degrees Celsius (ºC). Stygofauna have been recorded from a variety of temperatures in Australia and no direct correlation has been detected between temperature and either presence, diversity or abundance of stygofauna.

pH

pH is a measure of acidity using the concentration of hydrogen ions (H^+) is shown as a logarithmic scale, where a low value indicates a high concentration and higher values indicate a more basic solution. The neutral value of 7 is more likely to support stygofauna, however, communities of stygofauna have been found to occur in a wide variety of pH values.

Electrical conductivity

Electrical conductivity was measured in milli Siemens per centimetre (mS/cm), and provides an indication of salinity. The results from the sampling show little variation in conductivity between areas on the site, with the entire site having water very close to fresh. Stygofauna has detected in a wide variety of salinities from completely fresh to groundwater that is equivalent to seawater.

3. Existing conditions

No stygofauna, or other aquatic invertebrates, were recorded from any of the five (5) samples examined from the project area or the two (2) reference sites to the north of the project area. Sites examined for stygofauna were restricted to the central portion of the orebody within the fractured rock aquifer.

Sampling within the project area consisted of four (4) samples in the fractured rock aquifer that lies directly within the mineralised zone. An additional sample was obtained from hole GORC019, situated within the project area, but located in a calcrete area to the south west of the central project area. This hole was believed to contain rainwater (meteoric), rather than groundwater, due to the very low salt levels and shallow depth of water encountered. Water was not recorded in drill logs for the hole when it was drilled.

Multiple holes in the calcrete situated within the project area were examined for the possibility of sampling for stygofauna. None were found to contain water. This may be due to the holes not being deep enough to intersect the groundwater, or a lack of water in these strata. Calcretes in arid Australia commonly form superficial aquifers approximately 10m deep (Magee 2009). These aquifers are considered to have a very high likelihood of containing stygofauna according to the risk assessment guidelines listed in the EPA Guidance Statement 54A (2007).

The calcrete aquifers could not be sampled, and the potential for stygofauna communities to be present within the project area, and potentially impacted, will remain unknown until additional hydrogeological information becomes available.

3.1 Water quality

Water quality parameters were collected from each bore sampled for stygofauna using a Hydrolab Quanta water quality meter. Water samples were collected in a bailer from the upper 1 - 2 metres of the water column prior to stygofauna sampling being undertaken. Samples were analysed in the field to provide a measure of temperature, electrical conductivity, Oxidation reduction potential, and pH. Results are shown in Table 2. Values collected are presented to provide an indication of general water quality.

Table 2 Water quality parameters from water bores

Hole ID	Date of Sample	Aquifer	Impact/ reference	Temp ºC	pH	EC mS/cm	ORP (mv)
Reference Bore 4	16/08/2010	unknown	Reference	26.48	7.04	2.95	44
Reference Bore 5	16/08/2010	unknown	Reference	26.77	6.97	11.5	164
NBGW 811	17/08/2010	Fractured rock	Impact	27.26	7.30	6.37	170
NBGW 813	17/08/2010	Fractured rock	Impact	26.19	7.48	6.74	183
NBGW 814	17/08/2010	Fractured rock	Impact	26.39	7.25	5.82	154
NBGW 816	17/08/2010	Fractured rock	Impact	26.76	7.49	6.49	170
GORC 019	17/08/2010	Calcrete	Impact	24.12	7.6	0.001	114

4. Impact assessment

4.1 Potential impacts of mining on subterranean fauna

The potential impacts of mining on subterranean fauna may be categorised as;

- Direct impacts
- Indirect impacts

Direct impacts are the obvious and unavoidable destruction or degradation of habitat that occurs in pit voids and adjacent terrain, including associated aquifer dewatering. Indirect impacts are generally gradational, and more difficult to predict and manage because they may occur at moderate to large distances from the project footprint. These impacts may be expressed some time after mining has begun.

Some examples include changes to hydrology, nutrient and microclimate regimes, contamination, reduced habitat area, water quality, and population viability. The zone of influence for indirect impacts may be considerably larger than the area of the mine pit and surface footprint (waste rock, stockpiles, roads and infrastructure). Potential indirect impacts of mining include:

- Alteration of surface hydrology that affects groundwater recharge regimes, sedimentation, and water quality (e.g. under and proximal to overburden storage areas, roads and infrastructure)
- Changes to subterranean microclimate in rock masses surrounding excavation pits (exposure to atmosphere of subsurface matrix and voids causing drying)
- Changes to subterranean microclimate in the zone of influence of pit dewatering drawdown (drying of habitat)
- Surface and groundwater contamination from plant equipment and infrastructure
- Reduction in organic inputs beneath areas cleared of vegetation and sealed surfaces
- Vibration disturbance from mining activities
- Risk of extinction from reduction and/or fragmentation in habitat

4.2 Potential impacts of the Nolans mine

The pilot survey provides an adequate assessment of potential stygofauna in the fractured rock aquifer that hosts the rare earth deposit. The absence of stygofauna from any of the water bores sampled indicates the fractured rock aquifer has a low likelihood of stygofauna being present, and consequent low likelihood of being impacted by project development.

The calcrete areas present in the south-west of the Project Area are likely to contain superficial aquifers that may show hydrogeological linkages with the deeper fractured rock aquifer. This will need to be determined by hydrogeological studies currently being undertaken. Calcrete aquifers have been shown throughout arid and semi-arid Australia to be highly likely to contain stygofauna. If this habitat is likely to be impacted during mining activities (i.e. dewatering) there is a high risk of significant impacts being caused to local stygofauna communities. It is unknown if stygofauna are present in these calcrete as they could not be sampled during field surveys undertaken during August 2010. Impacts to potential communities in the calcrete aquifers would depend on the amount of dewatering to be undertaken in the study area.

5. Mitigation measures

The low likelihood of stygofauna being present in the majority of the study area (fractured rock aquifer) means no specific mitigation measures are required.

The calcrete aquifers located in the south-west of the Project Area are considered highly likely to contain stygofauna. Additional sampling to determine the presence or absence of stygofauna would be recommended if hydrogeological studies show that the calcrete areas contain a superficial aquifer. This would need to be done prior to dewatering of the mine. Knowledge of the extent and depth of mine dewatering cones need to be known before impacts to potential stygofauna can be accurately determined. Impacts to stygofauna are likely be limited if drawdown extents do not completely dewater the aquifer. Severe impacts and potential extinction of locally endemic species (if present) of stygofauna could occur should localised drawdown completely dewater the calcrete aquifers

Rapid dewatering of an aquifer can strand larger stygofauna species (>3mm) (Dillon et al. 2009). Maintenance of stygofauna habitat may require retention of some water, and management of the rate of dewatering.

Additional sampling of calcrete aquifers in the study area would establish whether stygofauna are present.

6. Conclusion

The pilot survey for stygofauna in the project area suggests a low probability of the presence of stygofauna in the fractured rock aquifer. The project has a low likelihood of impacting stygofauna communities in the immediate project area.

The calcrete areas present in the south-west of the Project Area are likely to contain superficial aquifers that may exhibit hydrogeological linkages with the deeper fractured rock aquifer. Calcrete aquifers have a high likelihood of stygofaunal occurrence. They could not be sampled during the survey because of the absence of drill holes intersecting the water table in the calcretes. Calcretes are known to contain diverse and highly endemic stygofauna communities in Western Australia, and from the nearby Ngalia Basin in the Northern Territory.

Potential impacts to calcrete aquifers can be assessed once current hydrogeological studies are complete. Depending upon the requirements for project dewatering of the mine has potential to impact on a stygofaunal community in the calcrete aquifers may be impacted. If complete dewatering of these habitats is required it is recommended that additional sampling of the calcretes is undertaken to confirm the absence of these communities.

7. References

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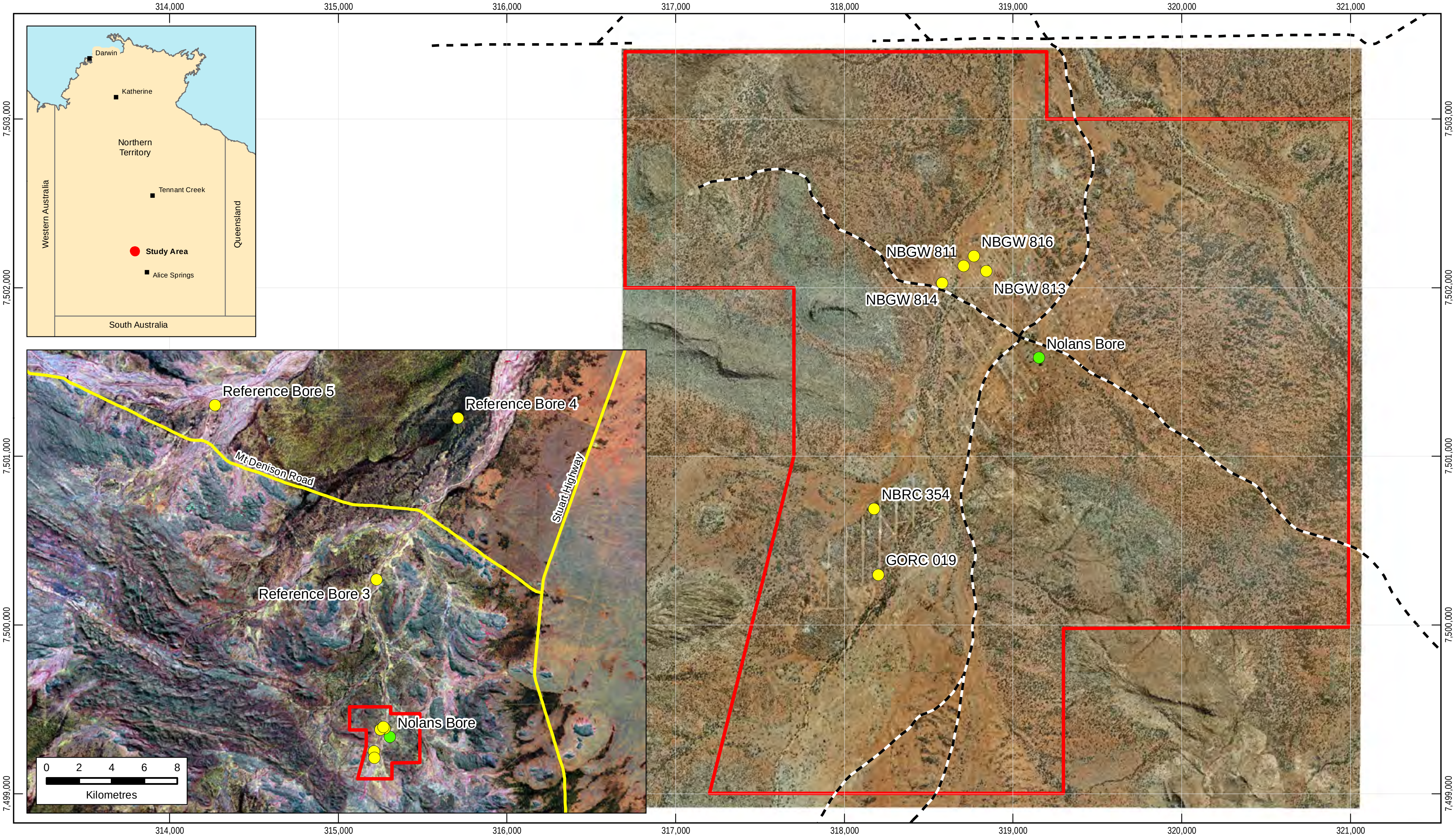
Appendix A

Figures

Figure 1 Sample locations for Stygofauna within Study Area.



0 250 500 750 1,000

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 53

N

LEGEND

Mineral Lease — Tracks

Major Roads — Drill Holes

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Arafura Resources
Nolans Rare Earth Project

Job Number 43-21732
Revision 0
Date 17 DEC 2010

Drill Holes

Figure 1

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