## 4.8 Terrestrial Fauna

Comprehensive vertebrate fauna surveys over the project area were conducted during August 2005 and April 2006 (OES, 2006e).

Climatic conditions for both terrestrial vertebrate surveys were favourable. The inventory involved a variety of sampling techniques, including systematic and opportunistic sampling. Survey design was targeted at the local scale but employed methodology that was consistent with past and ongoing regional surveys. Fire history over the project area significantly affected the positioning of sample sites, with the focus on unburnt areas.

An additional one-off survey focussing on short-range endemic invertebrate fauna was undertaken during August–September 2006 (OES, 2007b). Particular invertebrate taxa known to possess ecological attributes associated with short-range endemism were targeted within the more mesic habitats of the project area.

A reconnaissance survey and assessment of vertebrate fauna and fauna habitats was also conducted over water supply areas and associated service corridors during April and May 2007 (OES, 2007c). Results of these surveys are summarised below.

### 4.8.1 Fauna Habitats

**Project Area**

Broad fauna habitat classifications were based upon dominant landform, and vegetation type present. Individual fauna survey sites within broad habitats were selected in regard to topography, wildfire, vegetation condition, patchiness and variability amongst vegetation associations, as well as considering local refugia. Six major terrestrial vertebrate fauna habitats (**Figure 4-27**) were delineated over the project area, as follows:

1) Spinifex plains: Stony to sandy, level spinifex plains of *Acacia inaequilatera* over spinifex hummock grassland, on granites (Sites SPS1 and SPS6)
2) Basalt ridges: Hilltops of spinifex hummock grassland (Site BRS3)
3) Rocky slopes: Slopes of massive ironstone range (Talga Range) with *Eucalyptus leucophloia* over *Acacia inaequilatera* and spinifex hummock grassland (Site LSS4)
4) Riverine communities: Creeklines of predominantly River Red Gums *(Eucalyptus camaldulensis)* over sedges and grasses (Site RES2)
5) Minor drainage lines: *Corymbia opaca* low open woodland over *Acacia inaequilatera* open shrubland and spinifex hummock grassland (Site DLS7)
6) Rocky gullies: Or gorges with semi-permanent pools adjacent to steep rocky ranges of ironstone (Site RGS5)

The project area is located within a working pastoral lease and all habitats have been impacted upon significantly by frequent broadscale wildfires, with up to four fires occurring within the last eight years. Grazing pressure, and weed invasion along riparian zones, is also evident.

Key habitats over the project area comprised those habitats with potentially narrow distributions, and those that provide potential fire-refuges, such as rugged slopes and mesas and riparian zones.

From a local perspective, the steeper southern flanks of the Talga Range (Rocky Slope habitat) provide habitat to many species of conservation significance, and the physical properties of caves, fissures, boulders and scree slopes offer a range of niches. These structural formations also provide an important fire refuge within a landscape that is currently subjected to frequent fires.

Coppin Gap (Rocky Gully habitat) is a local refugia that possesses a particular microclimate with a dependable supply of moisture and nutrients. It possesses important ecological qualities for a range of fauna species including semi-permanent water with riparian vegetation of dense sedges, large eucalypts and melaleucas within close proximity to rocky cliffs containing caves and fissures.

Riverine Community habitat over the project area generally recorded greater species richness and abundances than other habitats. Although riverine habitats are also affected by frequent burning, their linear configuration and more mesic characteristics facilitate dual roles as both fire refuge, as well as routes for fauna movement. Colour photographs of major habitat types are presented in **Plates 4-7** to **4-9**.

**Water Supply Areas and Service Corridors**

Vegetation mapping has been undertaken over the proposed water supply areas of Woodie Woodie and the De Grey Borefield, and an associated service corridor of 185 km length (G&G Environmental 2006; 2007a) , as well as the Canning borefield and associated service corridor (G&G Environmental, 2007b). Vegetation descriptions and delineations facilitated differentiation of broad fauna habitats that were ground-truthed (OES, 2007c), and nine broad fauna habitats were identified. These are:

1) Spinifex Plains: Stony to sandy level plains of *Acacia inaequilatera* over *Triodia epactia* - *Triodia longiceps* hummock grassland.
2) Plains supporting Shrublands: Scattered Acacia shrubs including *Acacia stellaticeps, A. bivenosa,* and *A. victorae* over hummock grasslands of *Triodia epactia, T. longiceps, Triodia wiseana.*
3) Plains Supporting Woodlands: Very open *Corymbia hamersleyana* woodland over *Triodia epactia* tussock to closed tussock grasslands.
4) Rocky Slopes and Hills Supporting Shrublands: High open to low scattered *Acacia victorae* and/or *Acacia bivenosa* shrubland over *Triodia brizoides* and/or *Triodia longiceps, Triodia wiseana* hummock grasslands.
5) Rocky Slopes and Hills Supporting Woodlands: Scattered trees including *Corymbia hamersleyana* and *C. flavescens* and/or *Corymbia candida* and *Acacia coriaceae* over shrubland including *Acacia inaequilatera* and *A. bivenosa* over a *Triodia brizoides* and *T. wiseana* hummock grassland.
6) Rocky Slopes and Hills supporting spinifex hummock grassland: *Triodia brizoides* and/or *Triodia longiceps, Triodia wiseana* hummock grasslands.

7) Riverine Communities: Major Rivers and Creeks supporting Riverine communities of *Eucalyptus camaldulensis* over sedges and/or grasses.
8) Minor Drainage Lines: *Corymbia hamersleyana* low open woodland over *Acacia inaequilatera* open shrubland over *Triodia epactia* hummock grassland.
9) Clay Depressions: Scattered *Triodia longiceps* hummocks over herbs including *Sclerolaena cornishiana*. Or grasslands of *Sporobolus australasicus* and/or *Eragrostis xerophila* with scattered herbs.

The De Grey River has been listed by the DEW in the Directory of Important Wetlands in Australia (De Grey River – WA065), and is also a recognised refugia in semi-arid Australia (Morton, Short and Baker, 1995). Listings recognise permanent pools that provide a drought refuge for freshwater fish and waterbirds in the bioregion.

Two pools are located within the vicinity of the proposed De Grey borefield:

- Muccanoo Pool; and
- Cooloolinnarriner Pool.

These pools and the riparian vegetation of the De Grey River, including large eucalypts and melaleucas, provide significant habitat to the fauna of the bioregion. Aquatic or semi-aquatic fauna such as fish and amphibians are particularly reliant on persistent pools but waterbirds and wading birds, including federally-listed migratory species, also utilise these habitats.

### 4.8.2 Vertebrate Fauna

The following information contains a summary of vertebrate fauna located in the project area. Further detail can be found in the survey report (OES, 2006e) **Appendix A**. A detailed description of fauna of significance is given in **Section 4.8.6**.

**Herpetofauna**

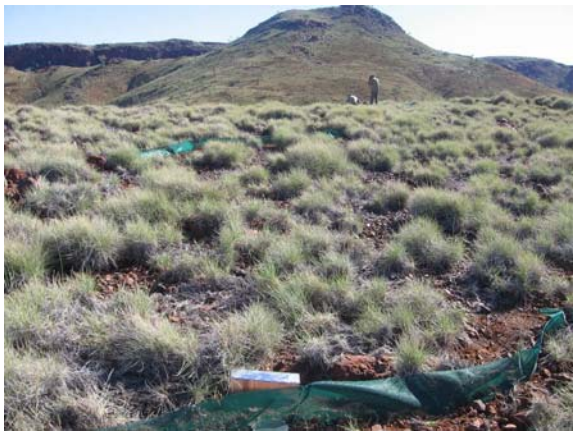
Thirty-four species of herpetofauna from ten families were identified from the project area; including 30 reptiles from eight families and four amphibians from two families.

The thirty reptile records comprised four species of Agamidae (dragon lizards), six species of Gekkonidae (geckos), three species of Pygopodidae (legless lizards), ten species of Scincidae (skinks), two species of Varanidae (monitor lizards), one species of Typhlopidae (blind snakes), one species of Boidae (pythons) and three species of Elapidae snakes.

The most abundant groups were Scincidae (skinks), and Agamidae (dragon lizards) which comprised 75% of all herpetofauna trapping records. Common species captured included *Lerista bipes, Ctenotus saxatilis, Ctenophorus isolepis* and *Lophognathus longirostris.*

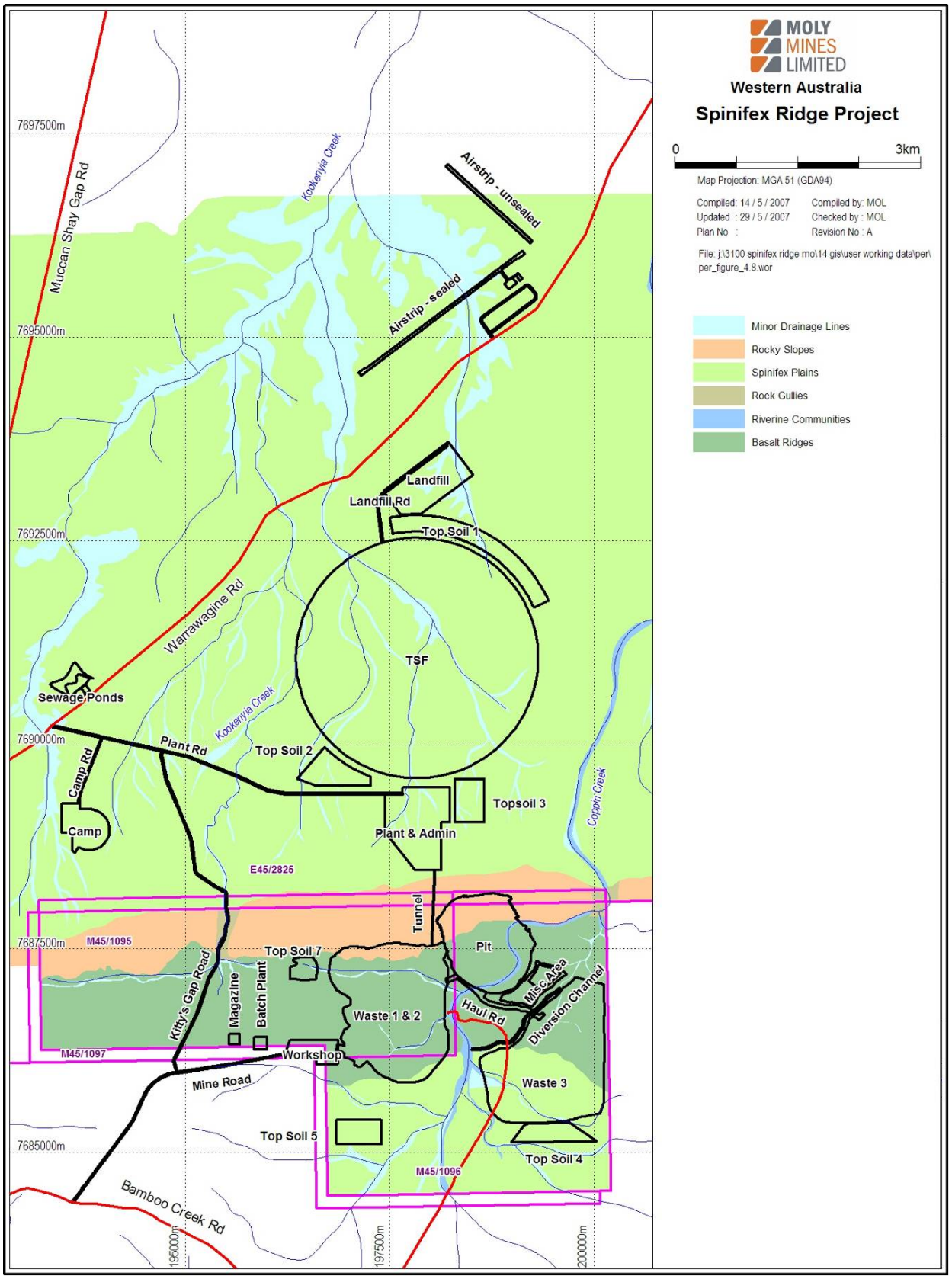
Frog species recorded were *Cyclorana maini, Litoria rubella, Limnodynastes spenceri* and *Uperoleia russelli.*

- **Plate 4-7 Spinifex Plains (Left) and Riverine Communities (Right)**



- **Plate 4-8 Basalt Ridge (Left) and Rocky Slopes (Right)**

- **Plate 4-9 Minor drainage lines (Left) and Rocky Gully (Right)**




- **Figure 4-27 Fauna Habitats**

**Mammals**

Evidence of 26 species of mammal, representing 11 families, was recorded during the surveys. These comprised six carnivorous mammals (Dasyuridae), two kangaroos / wallabies (Macropodidae), four native rodents (Muridae), at least nine bats, as well as the Dingo, feral Cat, One-humped Camel, and Cattle.

Small to medium-sized ground-dwelling mammals were recorded from all sites, with the Muridae and Dasyuridae particularly well represented. The rodents, Sandy Inland Mouse *(Pseudomys hermannsburgensis)* and Common Rock-rat *(Zyzomys argurus)*, were particularly common, together representing over 60% of trapping records. The Little Red Kaluta (*Dasykaluta rosamondae)* was the most frequently captured Dasyurid and the threatened Northern Quoll (*Dasyurus hallucatus)* was also recorded regularly.

At least nine, and a probable ten bat species from four families are present over the project area, identified via recordings of echo-location calls by electronic detectors on 18 separate occasions, as well as by direct observation. The bat species recorded during surveys represents all the species reasonably expected to occur in the area.

Numerous small caves and fissures suitable for bat roosts are present throughout the Talga Range, and a variety of sizes, shapes and depths offer a range of roost sites, particularly in consideration to requirements of humidity, temperature and accessibility. Particular bat species also utilise tree hollows, such as within River Red Gums *(Eucalyptus camaldulensis)* which occur predominantly along the riverine systems.

**Avifauna**

Sixty-three bird species representing 28 families were recorded from the project area, or areas immediately adjacent, during the surveys. The number of birds recorded is probably a reflection of the diversity of habitats over the project area and the favourable seasonal conditions experienced at the time of the surveys. For example, several migratory/nomadic species were recorded that would not be present at other times.

The most species-rich family recorded was the Meliphagidae (Honeyeaters) with seven species. Birds commonly recorded were the granivores such as Spinifex Pigeon, Diamond Dove, Little Corella, and Zebra Finch, as well as the nectarivores such as Grey-headed Honeyeater, Whiteplumed Honeyeater, Brown Honeyeater and the Yellow-throated Miner.

**Fish**

Three species of native freshwater fish, representing three families, were identified from freshwater pools along Coppin Creek. No exotic species were recorded. Species recorded were the Western Rainbowfish (*Melanotaenia australis)*, Spangled Perch *(Leiopotherapon unicolour)* and Hyrtl's Tanden (*Neosilurus hyrtlii)*. All species were identified from a riverine pool and tributary leading

directly into Coppin Gap. Fish do not occur, or only irregularly occur, within the Kookenyia Creek catchment including Kitty's Gap due to extended periods of drying.

### 4.8.3 Aquatic Ecology

#### 4.8.3.1 Coppin Creek

The aquatic environment of Coppin Creek includes algae and macroinvertebrates. Emergent riparian vegetation, also described in **Section 4.7**, provides habitat for these organisms. Other groups that inhabit the aquatic environment, including fish, reptiles and amphibians, are described in **Section 4.8.2**.

A transient aquatic community comprising macroinvertebrates and algae, was recorded in Coppin Creek. The species that were identified in two surveys were cosmopolitan and opportunistic. These traits are common in the ephemeral systems of Australian inland waters. No rare or locally endemic species were identified from the two baseline surveys at Spinifex Ridge (OES, 2006e).

During high flow events, the creek supports a diverse ecosystem consisting of insects and crustaceans, charophytes, filamentous algae and nitrogen-fixing cyanobacteria, and a highly-diverse periphytic diatom community. Many of these groups are highly adapted to ephemeral systems.

A total of 37 macroinvertebrate taxa have been recorded in Coppin Creek (OES, 2006e). Species richness was variable between the two surveys, ranging from two to eleven species. The three taxonomic Classes represented in Coppin Creek were the Insecta, Arachnida and Crustacea. Within these Classes, the dominant macroinvertebrate groups in Coppin Creek were the Chironomids, Baetidae (Insecta) and Cyclopoid copepods (Crustacea).

In terms of algae, both the microscopic and macroalgal forms have been assessed. The periphyton (a type of microalgae) of Coppin Creek was dominated by diatoms. All diatoms identified from the project area are considered to have a cosmopolitan distribution in stream environments throughout Western Australia. The samples recorded high species richness, indicating that the creek is highly productive and conducive to diatom colonisation. Dominant species recorded from Coppin Creek included *Achnanthudium exiguum* and *Nitzschia palea*.

The species composition of the two surveys reflected different conditions at the time of sampling, varying according to pH and salinity, and level of inundation. The genus *Nitzschia*, in particular, is associated with eroding riverine systems and their presence is probably a reflection of both the exposed nature of Coppin Creek, and a catchment subject to frequent fire.

The benthic microbial communities of Coppin Creek were composed of freshwater filamentous forms of algae that are well known cosmopolitan taxa including *Oscillatoria* and *Nostoc*. Generally these species occurred amongst the emergent vegetation and the shallow edges of the pools. They are adapted to lotic environments but can survive extended periods of desiccation.

One macroalgal species, the Charophyte *Chara globularis* Thuil was recorded in Coppin Creek. The genus *Chara* is exclusive to fresh waters, and is cosmopolitan, with a wide distribution within Australia (Garcia, 1999).

Riparian vegetation condition was described as being in 'poor to moderate' condition at the time of survey in 2006, according to Waters and Rivers Commission criteria (1999). Riparian vegetation showed the effects of a recent bushfire, as well as grazing by cattle and invasion of Buffel Grass (OES, 2006e). The recent bush fire had caused at least short term changes to vegetation structure.

Many of the aquatic biota within the microalgae and aquatic invertebrates in Coppin Creek flourish in the sheltered littoral zone amongst the vegetation. Riparian vegetation provide an increase in oxygen levels, refuge and nutrients, and minimises extremes of desiccation that are common in the Pilbara.

The algae and emergent riparian vegetation recorded at Coppin Gap, have a wide distribution in many aquatic systems throughout Western Australia, and also Australia. The species recorded from Coppin Gap was also recorded in other sections of Coppin Creek (**Section 4.6.3**). Furthermore, all were also recorded from the Kookenyia Creek catchment immediately to the west, at Kitty's Gap.

#### 4.8.3.2 Coppin Gap Pool

The aquatic environment of Coppin Gap includes algae and macroinvertebrates. Emergent riparian vegetation, also described in **Section 4.7.3** provides habitat for these organisms. Other groups that inhabit the aquatic environment, including fish, reptiles, amphibians, are described in **Section 4.8.3**.

Coppin Gap supports a transient aquatic community of algae and macroinvertebrates, comprising species that are cosmopolitan and opportunistic. These traits are common in the ephemeral systems of Australian inland waters. No rare or locally endemic species have been identified from the two baseline surveys at Spinifex Ridge.

In terms of algae, both the microscopic and macroalgal forms have been assessed. A high level of diversity in the microalgae was recorded at Coppin Gap, indicative of a productive environment that is conducive to colonisation, particularly by diatoms. A total of 27 diatom taxa were identified. The dominant taxa were *Pleurosigma* sp. aff *saliniarum*, *Navicula symmetrica*, *Achnanthidium exigua*, *Thalassionema* sp. aff *nitzschoides*, *Calonies bacillum* with a number of *Nitzschia* and *Navicula* species.

A dense bed of the charophyte, *Chara globularis* (a macroalgae) was located along the western edge of Coppin Gap, during the 2005 and 2006 surveys. *Chara globularis* is a native, cosmopolitan species, with a wide distribution across Australia (Garcia, 1999).

The structure of the macroinvertebrate community in Coppin Gap remained consistent over two surveys, although the community was not as diverse as other sites along Coppin Creek. These features were a reflection of the persistence of water in Coppin Gap, the sparse nature of emergent vegetation, and the lithic nature of the site. Abundance was variable between sampling events. The community was dominated by four invertebrate groups, two Insecta – the Chironomidae and the Mayfly, *Cloeon*

sp. (Ephemeroptera: Baetidae), one Arachnida – the prostigmata water mites (Acari), and one Crustacea – cyclopoid copepod. The species present were mostly higher-order species, which play an important role in recycling nutrients. All taxa were typical of northern, inland, freshwaters of Western Australia.

Sparse emergent vegetation was recorded from Coppin Gap. River Red Gums *(Eucalyptus camaldulensis)* and *Melaleuca leucadendra* were dispersed along the banks with Lake Club-Rush (*Schoenoplectus validus)* (Cyperaceae) scattered in sections of the water body (**Section 4.7.3**). The entrance to Coppin Gap was heavily vegetated with Lake Club-Rush, which performs a filtering function. Because of the absence of sloping banks within the gap itself, dense fringing vegetation that is typical of many freshwater systems, is absent.

Three species of fish have been recorded in Coppin Gap; the Western Rainbowfish (Rainbowfishes), Spangled Perch (Grunters) and Hyrtl's Tanden (Eel-tailed catfishes). None of these fish are endemic to the bioregion (**Section 4.8.3**) (OES, 2006e).

The aquatic macroinvertebrate fauna recorded at Coppin Gap has a wide distribution in many aquatic systems throughout Western Australia, and also Australia. The aquatic biota recorded from Coppin Gap was also recorded in other sections of Coppin Creek (**Section 4.6.3**). Furthermore, apart from the fish fauna, all were also recorded from the Kookenyia Creek catchment immediately to the west, at Kitty's Gap.

### 4.8.4 Short-range Endemics

Endemism refers to the restriction of species to a particular area. Short-range Endemic (SRE) taxa are those with naturally-restricted distributional ranges, and are generally characterized by poor dispersal, heavy reliance on discontinuous habitats, low growth rates and low fecundity (Harvey, 2002). Fauna that are endemic to exceptionally limited areas are particularly vulnerable to threatening processes. Short-range endemic fauna are dominated, but not restricted to, invertebrate species. As with many invertebrate species SRE taxa have been poorly studied and their true status is often unknown due to a lack of scientific knowledge.

**Invertebrates**

The Western Australian Museum (WAM) suggests that the groups of terrestrial invertebrate SRE that are most likely to occur in the survey region include species of terrestrial molluscs, scorpions, pseudoscorpions, mygalomorph spiders, and myriapods (e.g. millipedes and centipedes).

Few SRE surveys have been undertaken in the vicinity of the project area in the past, and the one-off survey completed during August–September 2006 was undertaken in consultation with Dr Mark Harvey of the WAM to target the above groups within the more mesic habitats present (OES, 2006f) (**Appendix G**). In particular the rocky gullies, riverine communities and rocky slopes habitats identified during the terrestrial vertebrate study (OES, 2006e). Results are summarised below.

Specimens from the survey, identified by WAM, included at least two species of pseudoscorpions from the families Olpiidae (probably *Indolpium* sp.), and Chernetidae *(Haplochernes* sp.). The pseudoscorpions identified belong to genera that have wide ranging species, and both species are probably widespread throughout the drier portions of Western Australia without SRE attributes.

Myriapods identified were centipedes from four genera and at least four species. *Scolopendra morsitans,* and *Scolopendra laeta* are found over much of Australia, within a variety of habitats. Little is known of the identification and taxonomy of the Geophilomorph centipedes collected. These species could possibly be short-range endemics, but no information is currently available to verify this.

Mollusc samples comprised at least six species of both terrestrial and aquatic groups. Little is known of the distributional ranges of the species of the aquatic genus *Gyraulus* (Planoribidae) in WA. However, due to the small size of these animals and their occurrence in periodically flowing waters, it is assumed that the species are widespread.

Of particular relevance is an undescribed species of terrestrial snail, "*Quistrachia* sp.*"* (Camaenidae), collected from five sites at Spinifex Ridge. This unknown species is representative of a group that is typified by short-range endemism. Although the species was found in three habitats, based on the condition of specimens collected it appears that rocky slopes and ranges associated with the Talga Range is typical habitat that may offer the local refugial conditions required to support this species.

Preliminary inspections suggest that no mygalomorph spiders were collected during the survey. However, members of the Theraphosidae, Barychelidae, Ctenizidae, Idiopidae, Dipluridae and Nemesiidae families may all be present over the project area.

**Fish**

Short-range endemism can also occur amongst freshwater fish. In arid and semi-arid regions, in particular, dispersal can be limited due to geographic isolation both within, and between, drainage systems. Drying of water bodies for extended periods can isolate local populations and speciation, or genetic divergence at a finer scale, can occur. The extent of this divergence is largely dependent upon the frequency and scale of connectivity with other waterways, thereby influencing the genetic composition of populations.

None of the fish species recorded during surveys of the project area are endemic to the region. However, there is some debate as to the genetic relationships of separate populations of the Western Rainbowfish (*Melanotaenia australis*), however, it is abundant and particularly widespread in streams, lakes and ponds of the Kimberley and Pilbara regions in the state. The taxonomic status of Hyrtl's Tandan *(Neosilurus hyrtlii),* common in major streams of the Pilbara and widespread in northern Australia, is also unclear in regard to the many geographic populations that occur.

### 4.8.5 Regional Representation

The project area lies in the Pilbara Biogeographic Region and more specifically in the Chichester Bioregional Subregion (PIL1) of the northern Pilbara. The majority of terrestrial vertebrate fauna recorded at Spinifex Ridge have Eyrean (arid zone) biogeographic affinities, but Torresian (tropical) fauna are also present. Due to the presence of the Great Sandy Desert, that acts as a biogeographic barrier approximately 60 km to the north-east, examples of widespread fauna that reach their northern distribution relatively close to the project area are present. Similarly, several species endemic to the Pilbara also reach the northern edges of their distributions relatively close to the project area.

The vertebrate fauna assemblages of Spinifex Ridge are similar to other sites within 60 km of where other comprehensive vertebrate surveys have been undertaken (OES, 2006e).

The only mammal recorded for Spinifex Ridge that has not been recorded at these other sites was Beccari's Freetail-bat *(Mormopterus becarri)*. The reptile assembledge recorded from Spinifex Ridge is similar to other regional sites, however, *Menetia surda, Tiliqua multifasciata,* and *Ctenotus grandis* were recorded at Spinifex Ridge and not at other sites within 60 kms.

The bird community recorded at Spinifex Ridge is similar to that found elsewhere in the bioregion in consideration of habitats available. However, a number of additional bird species were recorded at Spinifex Ridge that were not documented at other sites within 60 km, probably due to the favourable climatic conditions and particular seasonal timing of the surveys. Moreover, waterbirds and migratory waders have been recorded at other sites but not at Spinifex Ridge due to limited habitat. However, it is likely that at least some of these species may utilise the semi permanent pools associated with Coppin Gap at times of drought.

The three fish species and four frog species recorded at Spinifex Ridge are all known from, and widely represented in the Pilbara bioregion.

The vertebrate faunal assemblages present over the project area do not represent significant proportions of the local to regional total population of any species. There is no indication that the vertebrate fauna populations or habitats recorded are significant at a genetic, species or ecosystem level.

Of the potential invertebrate SRE species recorded at Spinifex Ridge little is known of the distribution and taxonomic relationship of the un-named species of terrestrial snail, "*Quistrachia* sp." However, the habitat that this species was recorded from is common in the local and regional context.

### 4.8.6 Fauna of Conservation Significance

Fauna species that have been formally recognised as rare, threatened with extinction, or as having high conservation value are protected by law under Commonwealth and State legislation. At the national level, fauna are protected under the EPBC Act. Within Western Australia fauna can be listed under various schedules of the *Wildlife Conservation Act 1950* (**Table 4-19**).

The International Union for the Conservation of Nature (IUCN) reviews conservation status and lists fauna under various categories (i.e. the IUCN 'Red List'). Categories for fauna and their conservation status used in the EPBC Act are those recommended by the IUCN and include 'critically endangered', 'endangered' and 'vulnerable' categories. The *Wildlife Conservation Act 1950* uses a set of schedules, but the DEC also classifies species using IUCN categories.

International agreements that Australia has entered into include the Japan-Australia Migratory Bird Agreement (JAMBA) and the China-Australia Migratory Bird Agreement (CAMBA). These agreements cover migratory species of avifauna, particularly trans-equatorial waders and those protected under the Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals). The EPBC Act has lists of migratory species that are recognised under these international agreements.

The DEC also recognises species not listed under the *Wildlife Conservation Act 1950*, but for which there is some concern, and has produced a supplementary list of Priority Fauna. These species, as well as those listed in various Government endorsed action plans, are also of recognised conservation significance. Other species of conservation significance include endemics, those with restricted, isolated or fragmented ranges, or those that are at the extreme limits of their distribution.

- **Table 4-19 State Schedule and Priority Definition for Significant Fauna**

| Category | Description |
|---|---|
| Schedule 1 | Fauna that is rare or is likely to be extinct (and declared to be fauna in need of special protection). |
| Schedule 2 | Fauna presumed to be extinct (and declared to be fauna in need of special protection). |
| Schedule 3 | Birds protected under an international agreement (and declared to be fauna in need of special protection). |
| Schedule 4 | Other specially protected fauna other than for the reasons above (declared to be fauna in need of special protection). |
| Priority 1 | Taxa with few, poorly known populations on threatened lands. |
| Priority 2 | Taxa with few, poorly known populations on conservation lands. |
| Priority 3 | Taxa with several, poorly known populations, some on conservation lands. |
| Priority 4 | Taxa in need of monitoring. |
| Priority 5 | Taxa in need of monitoring and subject to a specific conservation program. |

**Terrestrial Vertebrate Fauna**

The conservation significance of the terrestrial vertebrate fauna of the Project Area has been assessed by OES (2006e) at four spatial scales:

- International-National (Species listed under the EPBC Act, IUCN, and International Treaties);
- State (Species listed under the *Wildlife Conservation Act 1950*);
- Regional (CALM Priority Species); and
- Local (Species not listed under Acts or publications, but considered of conservation significance due to patterns of distribution).

State and Federally-listed vertebrate species either recorded, or predicted to occur over the project area are shown in **Table 4-20**. Other species not included in **Table 4-20** that are of conservation significance, at least at the local scale, also occur within the project area.

In addition, three Schedule 1 species, one Schedule 4 species, one Priority 3 species and two Priority 4 species are also known from the region, but are unlikely to occur due to typical distribution patterns not coinciding with the project area, and/or a lack of suitable habitat or particular habitat attributes.

**Significant vertebrate fauna listed by State or Federal Government agencies recorded, or predicted to occur, over the Project Area**

Northern Quoll *Dasyurus hallucatus* (Endangered)

The Northern Quoll was captured on six occasions during the surveys (three at site LSS4, and three at RGS5), including a sub-adult. All captures were in close proximity to rocky substrates adjacent to the Talga Range. This species has also been captured regularly at sites, approximately 50 km to the north (BHPB, 2005).

The Northern Quoll was listed under the EPBC Act in April, 2005, and has recently been listed as Schedule 1 under the *Wildlife Conservation Act 1950.* The species once occurred continuously across northern Australia from the Pilbara to near Brisbane in Queensland in one geographic unit, but now occurs as six separate units of which the Pilbara is one. The preferred habitat for the species is rocky escarpments, open forest and woodland.

Orange Leaf-nosed Bat (Pilbara Form) *Rhinonicteris aurantius* (Vulnerable, Schedule 1)

Two suspected calls of the Orange Leaf-nosed Bat were recorded during the 2006 survey conducted by OES at Coppin Gap. The species is thought to have a disjunct Pilbara population, although relatively few records exist. The Orange Leaf-nosed Bat has very restrictive roost requirements, in particular caves and underground mines with hot to very hot and humid roost sites at 28º to 32º C and with 96 to 100% relative humidity (Churchill, 1998). It is unlikely that these roost requirements are present at Spinifex Ridge for more than short periods of time. The two calls recorded from Coppin Gap were both very short, and a sequence of calls is preferable for positive identification to be made.

### Table 4-20 Listed Vertebrate Species Recorded/Predicted to occur, in Project Area

| Species | Recorded (R) Predicted (P) | Conservation Status | | Comment |
|---|---|---|---|---|
| | | State | Federal | |
| Northern Quoll<br>*Dasyurus hallucatus* | R | | En | Species and species habitat recorded within project area |
| Orange Leaf-nosed Bat (Pilbara)<br>*Rhinonicteris aurantius* | R | Sch. 1 | Vu | Probable record of species within project area |
| Mulgara<br>*Dasycercus cristicauda* | P | Sch. 1 | Vu | Regional record of species and species habitat present |
| Pilbara Olive Python<br>*Liasis olivaceus barroni* | P | Sch. 1 | Vu | Regional record of species and species habitat present |
| Peregrine Falcon<br>*Falco peregrinus* | P | Sch. 4 | | Regional record of species and species habitat present |
| Ghost Bat<br>*Macroderma gigas* | R | P4 | | Species and species habitat recorded within project area |
| Western Pebble-mound Mouse<br>*Pseudomys chapmani* | R | P4 | | Species and species habitat recorded within project area |
| Lakeland Downs Mouse<br>*Leggadina lakedownensis* | P | P4 | | Regional record of species and species habitat present |
| Australian Bustard<br>*Ardeotis australis* | R | P4 | | Species recorded near project area and species habitat present |
| Bush Stone-curlew<br>*Burhinus grallarius* | R | P4 | | Species recorded near project area and species habitat present |
| Grey Falcon<br>*Falco hypoleucos* | P | P4 | | Regional record of species and species habitat present |
| Star Finch<br>*Neochima ruficauda* | P | P4 | | Regional record of species and species habitat present |
| Rainbow Bee-eater<br>*Merops ornatus* | R | | Mig | Species and species habitat recorded within project area |
| Fork-tailed Swift<br>*Apus pacificus* | P | | Mig | Aerial species that may overfly the project area |
| 'Migratory Waders and Waterbirds' | P | | Mig | Regional record of species and species habitat present |

En Endangered
Vu Vulnerable
Sch Schedule
Mig Migratory
P Priority

Nevertheless, the Orange Leaf-nosed Bat is likely to be present. Roosts of the Orange Leaf-nosed Bat have been confirmed within 50 km to the north, near Yarrie (BHPB, 2005), 15 km to the east at Bamboo Creek (Armstrong, 2001), 50 km to the south near Marble Bar and 60 km to the northeast near Callawa (R. Bullen, *pers comm.).* All of these sites are within a reasonable range for the Orange Leaf-nosed Bat, and it is likely that the species would at least traverse the area during foraging, or possibly use caves within the Talga Range for temporary or seasonal roosting.

Two natural roost sites are known from a gorge in the Gascoyne region. In the Pilbara the species is primarily known to roost within disused mines which are often structurally complex, however cave roosts in sandstone bedding have also been identified (Armstrong, 2001). The availability of groundwater to caves to facilitate the required roost microclimate, particularly humidity, may be important. One of the few known breeding sites is located at the nearby Bamboo Creek Gold Mine, within an abandoned underground mine. However, the small number of recordings at Spinifex Ridge, and the lack of suitable deep caves low in the landscape (thereby influenced by groundwater), suggests that there are no breeding sites present.

Mulgara *Dasycercus cristicauda* (Vulnerable, Schedule 1)

The Mulgara inhabits sandplains dominated by spinifex, where it burrows between low sand dunes. It is infrequently recorded, in part due to boom-bust cycles, contracting to core habitat areas in lean times and expanding rapidly after favourable conditions prevail. Even though surveys at Spinifex Ridge were conducted during favourable conditions the species was not recorded, and core habitat is not likely available. However, given a regional record approximately 50kms to the north of the project area the species may occur at least intermittently.

Pilbara Olive Python *Liasis olivaceus barroni* (Vulnerable, Schedule 1)

Two sub-species of this large python occur in Western Australia, one in the Kimberley and one in the Pilbara, separated by the Great Sandy Desert. It is widespread in the bioregion, occurring as scattered populations in rugged ranges often associated with drainage systems and waterholes, and has been recorded in the region at such locations including at the Goldsworthy extension sites. Despite targeted searches in typical habitat this species was not recorded during the recent surveys. However, the Talga Range and gorges with semi-permanent water such as Coppin Gap offer the habitat variables required for this species over the project area.

Peregrine Falcon *Falco peregrinus* (Schedule 4)

The Peregrine Falcon is widespread in Australia, but requires specific breeding sites. It does not construct a nest, and requires cliffs, rocky outcrops or large tree hollows. This species prefers to be near water and in the arid zone breeding is restricted to gorges and rocky ranges, such as those present over the project area. Although not recorded during surveys, quality habitat exists for this species along the length of the Talga Range where ledges and overhangs offer nesting locations.

Ghost Bat *Macroderma gigas* (Priority 4)

The Ghost Bat was identified from calls recorded at Coppin Gap during August 2006. The species is widespread in the region and is known from Goldsworthy, approximately 60 km to the north (BHPB, 2005), as well as the nearby Bamboo Creek Gold Mine and Marble Bar district (R. Bullen, *pers comm.)*.

The Ghost Bat is known from a wide range of habitats in northern Australia; from the arid Pilbara to tropical rainforests in Queensland. The Pilbara population is probably disjunct from the wider distribution. The species is dependant upon suitable roosting habitat such as caves, crevices, deep overhangs and artificial roosts such as abandoned mines. The causes for its range reduction are unclear, however it is known that its distribution is limited by the availability of suitable roost sites and that it is sensitive to disturbance of roost sites (Richards and Hand, 1995). Natural roost sites suitable for this species are likely to occur over the project area within the Talga Range.

Western Pebble-mound Mouse *Pseudomys chapmani* (Priority 4)

The Western Pebble-mound Mouse was captured during fauna surveys over the project area. Both active and inactive mounds were also identified during the surveys throughout the Basalt Ridge habitat over the Rocklea Land System. Inactive mounds were also recorded on the northern footslopes of the Talga Range.

This species has been confused in the past with the Sandy Inland Mouse (*Pseudomys hermannsburgensis)*. However, these species occur in different habitats with the Western Pebble-mound Mouse occurring on skeletal soils containing an abundance of small pebbles and the sandy inland mouse favouring sandplains. When first described it was thought that the range and abundance of this species had decreased dramatically. However, since that time it has been recorded on numerous occasions and it is widespread in the bioregion. Its status has subsequently been downgraded from Schedule 1 under the *Wildlife Conservation Act 1950* to Priority 4.

Lakeland Downs Mouse *Leggadina lakedownensis* (Priority 4)

The Lakeland Downs Mouse was not recorded during the surveys, but is known from the region and was recorded at the Goldsworthy extension sites. The species is rarely captured and has a distribution across northern Australia, with a disjunct population in the Pilbara. It occurs on sandy soils or cracking clays and like many arid zone species is omnivorous, eating invertebrates as well as plant matter, and constructs burrows within which to shelter. The species is infrequently recorded in part due to boom-bust cycles, expanding rapidly after favourable conditions prevail. Given the regional record and available habitat of sandy soils this species may occur over the project area.

Australian Bustard *Ardeotis australis* (Priority 4)

The Australian Bustard was recorded on four occasions during the April 2006 fauna survey, between the project area and the Bamboo Creek Gold Mine site, 15 km to the east. There have also been accounts and descriptions of the bustard's presence from Moly Mines staff based at the Spinifex Ridge

camp. The species has a wide range across Australia. However, introduced predators impact upon recruitment of this ground-nesting bird and changed fire regimes influence availability of its food source of seed and invertebrates. Suitable habitat exists for this species over the project area, particularly in the more open habitats of the MacRoy and Rocklea Land Systems.

Bush Stone-curlew *Burhinus grallarius* (Priority 4)

The Bush Stone-curlew was recorded during the April 2006 survey between the project area and the Bamboo Creek Gold Mine. This species is known from the bioregion and is widespread throughout much of Australia. Inappropriate fire regimes, grazing pressures and impacts of introduced predators have all contributed to the general decline of this ground-nesting bird. Habitat for this species occurs over the project area, particularly the open habitats of the MacRoy and Rocklea Land Systems.

Grey Falcon *Falco hypoleucos* (Priority 4)

This falcon has a very broad but scattered distribution across Australia including the Pilbara bioregion. It is highly mobile and occurs in lightly wooded riverine plains, and is known to nest in eucalypts along watercourses. The Grey Falcon was not recorded during surveys and only limited habitat is available over the project area. If and when present, the larger creeklines supporting River Red Gums would be favoured.

Star Finch *Neochima ruficauda* (Priority 4)

The range of the Star Finch may have decreased more than any other Australian finch (Blakers *et al.*, 1984) and the Pilbara population appears to be isolated by the Great Sandy Desert. The Star Finch is a seed-eating bird of eucalypt woodlands along rivers. Suitable, though limited habitat occurs over the project area, but frequent fires have impacted significantly on habitat quality and seed supply. The Star Finch was not recorded during surveys at Spinifex Ridge but it is known from the region.

Rainbow Bee-eater *Merops ornatus* (Migratory species)

The Rainbow Bee-eater was observed over the majority of the project area during both surveys. The species is a breeding resident in northern Western Australia, migrating between Australia and north as far as Japan (Pizzey and Knight, 1998). It occupies numerous habitats including open woodlands with sandy loamy soil, sandridges, sandpits, riverbanks, beaches, dunes, cliffs, mangroves and rainforests.

Fork-tailed Swift *Apus pacificus* (Migratory species)

The Fork-tailed Swift is an aerial species that may over-fly the project area only. The species does not breed in Australia.

Migratory Waders and Waterbirds (Migratory and Marine listed species)

Although no migratory waders and/or waterbirds listed on JAMBA and CAMBA were recorded during the surveys at Spinifex Ridge, some species have been recorded at the Goldworthy extension sites within persistent waterbodies. Waterbirds and migratory waders are also likely to utilise the De

Grey River, approximately 25 km to the north of the project area. Although the watercourses of the project area are not ideal wader habitat, some of these species may occur from time to time, particularly after flooding events during the summer months. Species known from the region include Common Sandpiper *(Tringa hypoleucos)*, Marsh Sandpiper *(Tringa stagnatilis)*, Common Greenshank *(Tringa nebularia)*, Snipe (*Gallinago* sp.*)* and the Great Egret *(Ardea alba)*.

**Vertebrate fauna of conservation significance not listed by State or Federal Government agencies**

Other than the species listed above, the IUCN also lists two species as Lower Risk (near threatened) that were recorded during surveys at Spinifex Ridge. These are the Desert Mouse *(Pseudomys desertor)* and the Yellow-bellied Sheathtail Bat *(Saccolaimus flaviventris)*. Both species are common, with the Desert Mouse widespread in arid areas in central Australia, east of the Project Area. Extended drought conditions and a lack of survey intensity probably explain why the species was once considered rare (Kerle, 1995). However, Cooper, *et al.* (2006) document recent extensive trapping in the Pilbara that has dramatically increased the range of this species; which may be a consequence of a population irruption in response to good seasons. The authors note that small and isolated refugia may be important in times of drought. The Yellow-bellied Sheathtail Bat has now been listed as Lower Risk (least concern) in the Action Plan for Australian Bats (Duncan, *et al*. 1999).

Bioregional endemic mammals recorded during surveys at Spinifex Ridge include the Little Red Kaluta *(Dasykaluta rosamondae)*, Pilbara Ningaui *(Ningaui timealeyi)*, *Planigale* sp., as well as the Western Pebble-mound Mouse *(Pseudomys chapmani)*. Several endemic reptiles also occur in the region, but none were recorded during the surveys.

Due to the location of the project area toward the northern end of the Pilbara bioregion, with the Great Sandy Desert some 60 km to the north-east, many species are toward the edge of their distributions. However, none are at the limit of their distribution.

Species complexes recorded at Spinifex Ridge where taxonomy is poorly understood include *Heteronotia binoei*, *Diplodactylus stenodactylus*, *Menetia greyii* and *Crytoblepharus plagiocephalus* (Aplin and Smith, 2001), as well as *Planigale* sp.

Kendrick and McKenzie (2001) identified priority species for off-reserve conservation, including Rothschild's Rock-wallaby *(Petrogale rothschildi)*, and state that this is a locally significant species. Rothschild's Rock-wallaby was recorded during surveys at Spinifex Ridge along the southern edge of the Talga Range. Rothschild's Rock-wallaby is still present throughout the bioregion in suitable habitat of rocky outcrops and ranges (Kendrick and McKenzie, 2001) which provide shelter against extreme temperatures.

**Significant vertebrate fauna recorded, or predicted to occur, over the water supply areas and associated service corridor.**

The majority of the species outlined above also have the potential to occur over water supply areas and an associated service corridor (OES, 2007c). However, due to the length of the service corridor

(approximately 250 kms) and proximity to the adjacent Great Sandy Desert bioregion additional species of conservation significance have the potential to occur over these areas. These include Greater Bilby *(Macrotis lagotis)*, Northern Marsupial Mole *(Notoryctes caurinus)*. 'Striped Skink' *Ctenotus nigrilineatus*, Princess Parrot *(Polytelis alexandrae)*, Major Mitchell's Cockatoo *(Cacatua leadbeateri*), and Pictorella Mannikin (*Heteromunia pectoralis*). Approximately 20 federally-listed migratory wading birds and/or listed marine species also have the potential to utilise riparian habitats such as pools associated with the De Grey River. Of these, at least 8 species of migratory wading birds are likely to utilise these habitats during their time in Australia during the summer (wet) period (OES, 2007c).

## 4.9 Aquatic Ecology

### 4.9.1 Coppin Creek

During the landscape assessment in the field, five distinct landscape zones were identified within Coppin Creek: flat wide banks; flat then steep banks; medium banks; steep banks; and creek beds. Each of these habitat zones had distinct characteristics. Only one site exhibited recent, active erosion of the creek bank with a near-vertical, incised bank.

During the aquatic assessment (**Appendix K**), three key aquatic habitats were defined in Coppin Creek:

- semi-permanent water bodies with minimal emergent vegetation and littoral zone, and a mostly rocky base (i.e. Coppin Gap, Kitty's Gap);
- temporary creekline habitats with emergent vegetation, slightly sloping banks, sandy base, connected during high flow events; and
- temporary creekline comprised of isolated pools, little to no emergent vegetation or submerged macrophytes and minimal retention of surface water.

The aquatic environment of Coppin Creek includes a transient community comprising algae and macroinvertebrates. Emergent riparian vegetation, also described in **Section 4.7**, provides habitat for these organisms. Other groups that inhabit the aquatic environment, including fish, reptiles and amphibians, are described in **Section 4.8.2**.

The species that were identified in two surveys were cosmopolitan and opportunistic. These traits are common in the ephemeral systems of Australian inland waters. No rare or locally endemic species were identified from the two baseline surveys at Spinifex Ridge (OES, 2006e).

During high flow events, the creek supports a diverse ecosystem consisting of insects and crustaceans, charophytes, filamentous algae and nitrogen-fixing cyanobacteria, and a highly-diverse periphytic diatom community. Many of these groups are highly adapted to ephemeral systems.

A total of 37 macroinvertebrate taxa have been recorded in Coppin Creek (OES, 2006e). Species richness was variable between the two surveys, ranging from two to eleven species. The three taxonomic Classes represented in Coppin Creek were the Insecta, Arachnida and Crustacea. Within

these Classes, the dominant macroinvertebrate groups in Coppin Creek were the Chironomids, Baetidae (Insecta) and Cyclopoid copepods (Crustacea).

In terms of algae, both the microscopic and macroalgal forms have been assessed. The periphyton (a type of microalgae) of Coppin Creek was dominated by diatoms. All diatoms identified from the project area are considered to have a cosmopolitan distribution in Western Australia. The samples recorded high species richness, indicating that the creek is highly productive and conducive to diatom colonisation. Dominant species recorded from Coppin Creek included *Achnanthudium exiguum* and *Nitzschia palea*.

The species composition of the two surveys reflected different conditions at the time of sampling, varying according to pH and salinity, and level of inundation. The genus *Nitzschia*, in particular, is associated with eroding riverine systems and their presence is probably a reflection of both the exposed nature of Coppin Creek, and a catchment subject to frequent fire.

The benthic microbial communities of Coppin Creek were composed of freshwater filamentous forms of algae that are well known cosmopolitan taxa including *Oscillatoria* and *Nostoc*. Generally these species occurred amongst the emergent vegetation and the shallow edges of the pools. They are adapted to lotic environments but can survive extended periods of desiccation.

One macroalgal species, the Charophyte *Chara globularis* Thuil was recorded in Coppin Creek. The genus *Chara* is exclusive to fresh waters, and is cosmopolitan, with a wide distribution within Australia (Garcia, 1999).

Riparian vegetation condition was described as being in 'poor to moderate' condition at the time of survey in 2006, according to Waters and Rivers Commission criteria (1999). Riparian vegetation showed the effects of a recent bushfire, as well as grazing by cattle and invasion of Buffel Grass (OES, 2006e). The recent bush fire had caused at least short term changes to vegetation structure.

Many of the aquatic biota within the microalgae and aquatic invertebrates in Coppin Creek flourish in the sheltered littoral zone amongst the vegetation. Riparian vegetation provide an increase in oxygen levels, refuge and nutrients, and minimises extremes of desiccation that are common in the Pilbara.

The algae and emergent riparian vegetation recorded at Coppin Gap, have a wide distribution in many aquatic systems throughout Western Australia, and also Australia. The species recorded from Coppin Gap was also recorded in other sections of Coppin Creek (**Section 4.6.3**). Furthermore, all were also recorded from the Kookenyia Creek catchment immediately to the west, at Kitty's Gap.

### 4.9.2 Coppin Gap Pool

The aquatic environment of Coppin Gap includes algae and macroinvertebrates. Emergent riparian vegetation, also described in **Section 4.7.3** provides habitat for these organisms. Other groups that inhabit the aquatic environment, including fish, reptiles, amphibians, are described in **Section 4.9**.

Coppin Gap supports a transient aquatic community of algae and macroinvertebrates, comprising species that are cosmopolitan and opportunistic. These traits are common in the ephemeral systems of

Australian inland waters. No rare or locally endemic species have been identified from the two baseline surveys at Spinifex Ridge.

In terms of algae, both the microscopic and macroalgal forms have been assessed. A high level of diversity in the microalgae was recorded at Coppin Gap, indicative of a productive environment that is conducive to colonisation, particularly by diatoms. A total of 27 diatom taxa were identified. The dominant taxa were *Pleurosigma* sp. aff *saliniarum*, *Navicula symmetrica*, *Achnanthidium exigua*, *Thalassionema* sp. aff *nitzschoides*, *Calonies bacillum* with a number of *Nitzschia* and *Navicula* species.

A dense bed of the charophyte, *Chara globularis* (a macroalgae) was located along the western edge of Coppin Gap, during the 2005 and 2006 surveys. *Chara globularis* is a native, cosmopolitan species, with a wide distribution across Australia (Garcia, 1999).

The structure of the macroinvertebrate community in Coppin Gap remained consistent over two surveys, although the community was not as diverse as other sites along Coppin Creek. These features were a reflection of the persistence of water in Coppin Gap, the sparse nature of emergent vegetation, and the lithic nature of the site. Abundance was variable between sampling events. The community was dominated by four invertebrate groups, two Insecta – the Chironomidae and the Mayfly, *Cloeon* sp. (Ephemeroptera: Baetidae), one Arachnida – the prostigmata water mites (Acari), and one Crustacea – cyclopoid copepod. The species present were mostly higher-order species, which play an important role in recycling nutrients. All taxa were typical of northern, inland, freshwaters of Western Australia.

Sparse emergent vegetation was recorded from Coppin Gap. River Red Gums *(Eucalyptus camaldulensis)* and *Melaleuca leucadendra* were dispersed along the banks with Lake Club-Rush (*Schoenoplectus validus)* (Cyperaceae) scattered in sections of the water body (**Section 4.7.3**). The entrance to Coppin Gap was heavily vegetated with Lake Club-Rush, which performs a filtering function. Because of the absence of sloping banks within the gap itself, dense fringing vegetation that is typical of many freshwater systems, is absent.

Three species of fish have been recorded in Coppin Gap; the Western Rainbowfish (Rainbowfishes), Spangled Perch (Grunters) and Hyrtl's Tanden (Eel-tailed catfishes). None of these fish are endemic to the bioregion (**Section 4.9**) (OES, 2006e).

The aquatic macroinvertebrate fauna recorded at Coppin Gap has a wide distribution in many aquatic systems throughout Western Australia, and also Australia. The aquatic biota recorded from Coppin Gap was also recorded in other sections of Coppin Creek (**Section 4.6.3**). Furthermore, apart from the fish fauna, all were also recorded from the Kookenyia Creek catchment immediately to the west, at Kitty's Gap.

## 4.10 Subterranean Fauna

Subterranean fauna consist of two types – stygofauna and troglofauna. Stygofauna are obligate, groundwater inhabitants that fulfil their entire lifecycle below ground. Troglofauna are terrestrial

fauna that live in subterranean environments, such as air chambers in caves. Subterranean fauna display characteristics that enable them to adapt to an existence below ground with the stygofauna displaying greater troglomorphic features (reduction or absence of pigment, eyes reduced or absent, extended locomotory and sensory appendages) than the troglofauna (Thurgate *et al*., 2001).

Outback Ecology conducted stygofauna surveys for Moly Mines between July 2005 to February 2007 (OES 2005; 2007d) (**Appendix E**). **Figure 4-28** shows the locations of the stygofauna bore sites across the Spinifex Ridge project area and Woodie Woodie mine. Four surveys were conducted within the immediate project area, and two each at the proposed alternative water sources of Woodie Woodie and the De Grey River borefields. Additional studies are planned for all three areas until appropriate sampling frequency is obtained. A troglofauna survey was conducted over the project area in June 2006. A description of the aquifer and related information for each of these areas is discussed in **Sections 4.5.2** and **4.5.3**.

Sampling was consistent with the methodologies outlined in EPA Guidance Statement Number 54 (EPA, 2003).

### 4.10.1 Stygofauna

Stygofauna are an ancient group with Pangaean and Gondwanan affinities (Humphreys, 2001). Within the Pilbara region, the amphipods are the dominant group of stygal crustaceans (Bradbury, 2001). An increase in understanding of subterranean fauna in the last decade has revealed that Western Australia, in particular, displays exceptional diversity within stygal communities (Humphreys *et al.*, 2004). This understanding is currently being strengthened by a regional-scale survey of the Pilbara by the DEC.

Subterranean ecosystems are more diverse in the classic karst systems such as the Tertiary systems found in the Cape Range, Western Australia, and until recently, it was perceived that stygal species were confined to such systems (Humphreys, 2006). There are three broad types of aquifers commonly inhabited by stygofauna; karst (limestone), fissured rock (e.g. granite) and porous rock (e.g. alluvium) (Marmonier *et al.*, 1993).

**Spinifex Ridge Project Area**

The geology of Spinifex Ridge project area generally consists of Archaean rocks, overlain by recent alluvial deposits housing modern drainage systems. Three aquifer types have been identified within the Spinifex Ridge catchment; fractured bedrock of typically low yield, in-situ calcretes overlying ultramafic bedrock within the creek systems, and alluvial sediments associated with recent drainage lines (OES, 2007d). Full details of the geology and hydrogeology of project area are presented in **Sections 4.2** and **4.5.**

Taxa were only recorded from 14 of 22 groundwater wells sampled within the project area (**Appendix E).** These were a mixture of non-stygal surface water invertebrates and common stygofauna taxa. While more than 22 bores were present in the project area, many were less than six months old at the time of field survey and were subsequently excluded from the sampling program. Four sampling

events recorded fauna in 21 of the 46 samples collected from the 22 groundwater wells. The majority of the taxa are considered common within the Pilbara aside from one species of limited known distribution (OES, 2007d). Due to current taxonomic limitation, some incomplete or damaged specimens and some fauna being immature, not all could be identified to species level.

The species of limited known distribution was identified from bore SRC057 as *Leicandona quasihalsei*. This species has only recently been described from the type locality at Skull Spring on the Davis River, in the upper De Grey catchment, and was collected on the most recent survey of the project area. Further sampling is required to verify the distribution of this species.

All stygofauna identified belonged to the Crustacea (Arthropoda), with the highest diversity being displayed by the Subclass Copepoda with nine genera from two Orders – Cyclopoida and Harpacticoida. The Cyclopoida (Cyclopoid copepods) recorded eight taxa from five genera, with *Diacyclops humphreysi humphreysi* being numerically dominant, followed by *Fierscyclops* cf. *frustratio*.

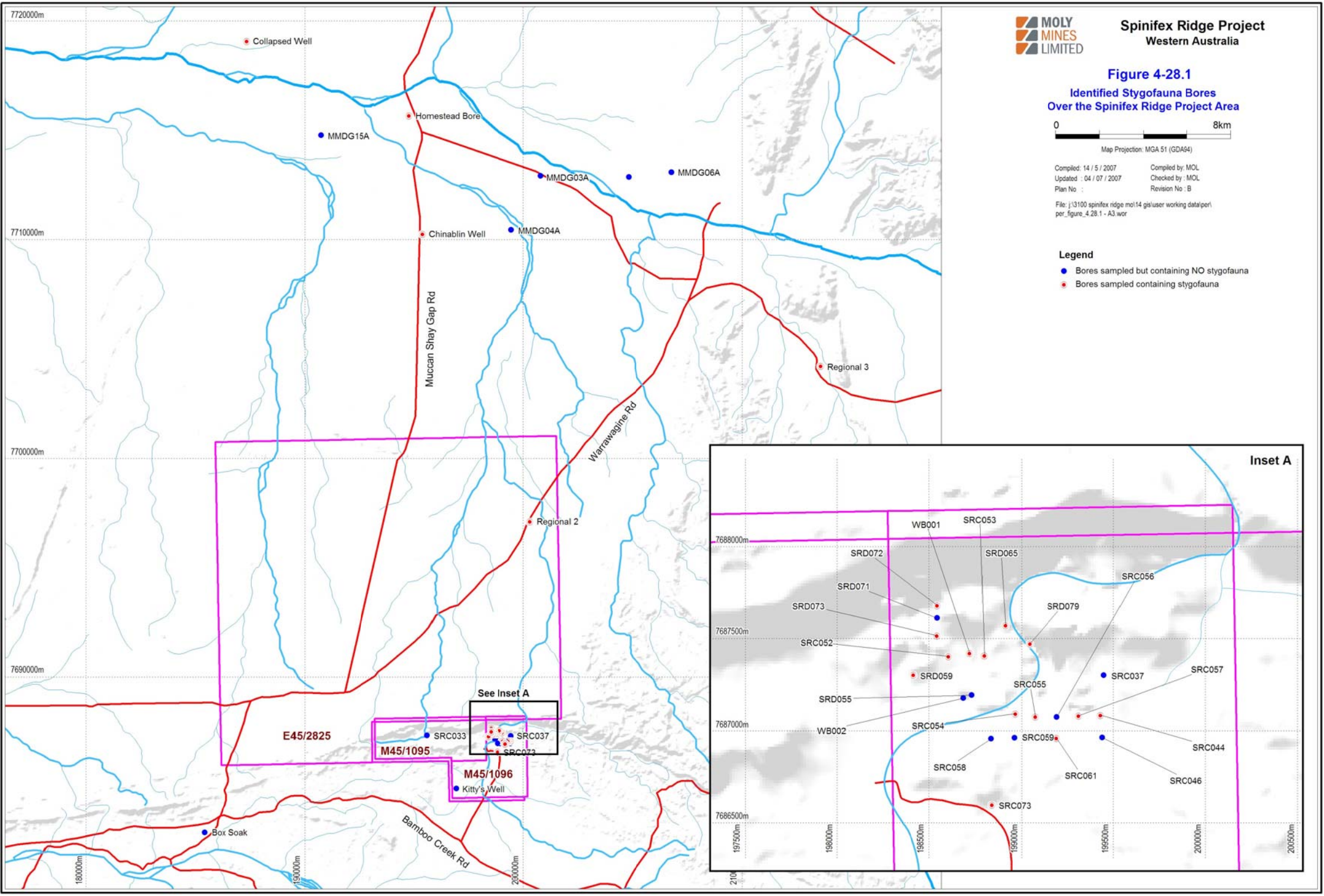
All families of stygofauna recorded during surveys, including taxa only known to family and genus level at present, have a known distribution outside of the project area. Further studies are planned for this area to achieve adequate sampling frequency (OES, 2007d).

**Woodie Woodie**

The Woodie Woodie Borefield is located within the Oakover Syncline, a large platform carbonate structure overlying the Jeerinah Formation. The main aquifers in the area are the Pinjan Chert Breccia aquifer, which is often vuggy, and the Upper Carawine Dolomite, which is unconfined and highly permeable due to discontinuities and vughs (OES, 2007d). Details of the hydrogeology of Woodie Woodie Borefield area are presented in **Section 4.5.3**.

The survey of Woodie Woodie shows that seven of 16 groundwater wells sampled in immediate and adjacent areas of the Cracker Pit contained stygofauna. An additional two wells were dry at the time of sampling. The majority of taxa found are considered to be common within the Pilbara apart from two new species of conservation significance (OES, 2007d). Due to current taxonomic limitations, and some fauna being immature, not all could be identified to species level.

The two species of conservation significance were *Goniocyclops* sp. 1 n. sp. (Karanovic), in bore DEPH02, and *Halophytophilus* sp. 1 n. sp. (Karanovic), in bore DEPH01. These bores are located near the >5m drawdown contour of the Cracker Pit. The genus *Goniocyclops* is known from the Murchison, and unpublished records from the Kimberley and Queensland. It is closely related to *Goniocyclops uniarticulatus* Karanovic 2004. The genus *Halophytophilus* is only known by five marine species, to date, but this is the first record of the genus in Australia. Both species occur in pit monitoring bores, in an area that has been previously subjected to mining and dewatering. Further sampling is required to confirm the distribution of these species in the Pilbara (OES, 2007d).


MOLY MINES LIMITED
Spinifex Ridge Project
Western Australia
Figure 4-28.1
Identified Stygofauna Bores
Over the Spinifex Ridge Project Area
0
8km
Map Projection: MGA 51 (GDA94)
Compiled: 14 / 5 / 2007
Updated : 04 / 07 / 2007
Plan No :
Compiled by: MOL
Checked by : MOL
Revision No : B
File: j:\3100 spinifex ridge mo\14 gis\user working data\per\per_figure_4.28.1 - A3.wor
Legend
Bores sampled but containing NO stygofauna
Bores sampled containing stygofauna
7720000m
7710000m
7700000m
7690000m
Collapsed Well
Homestead Bore
MMDG15A
MMDG03A
MMDG06A
Chinablin Well
MMDG04A
Muccan Shay Gap Rd
Warrawagine Rd
Regional 3
Regional 2
See Inset A
E45/2825
M45/1095
M45/1096
SRC033
SRC037
SRC073
Kitty's Well
Box Soak
Bamboo Creek Rd
180000m
190000m
200000m
Inset A
7688000m
7687500m
7687000m
7686500m
WB001
SRC053
SRD072
SRD065
SRC056
SRD071
SRD073
SRD079
SRC052
SRD059
SRC037
SRC057
SRC055
SRD055
WB002
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SRC059
SRC044
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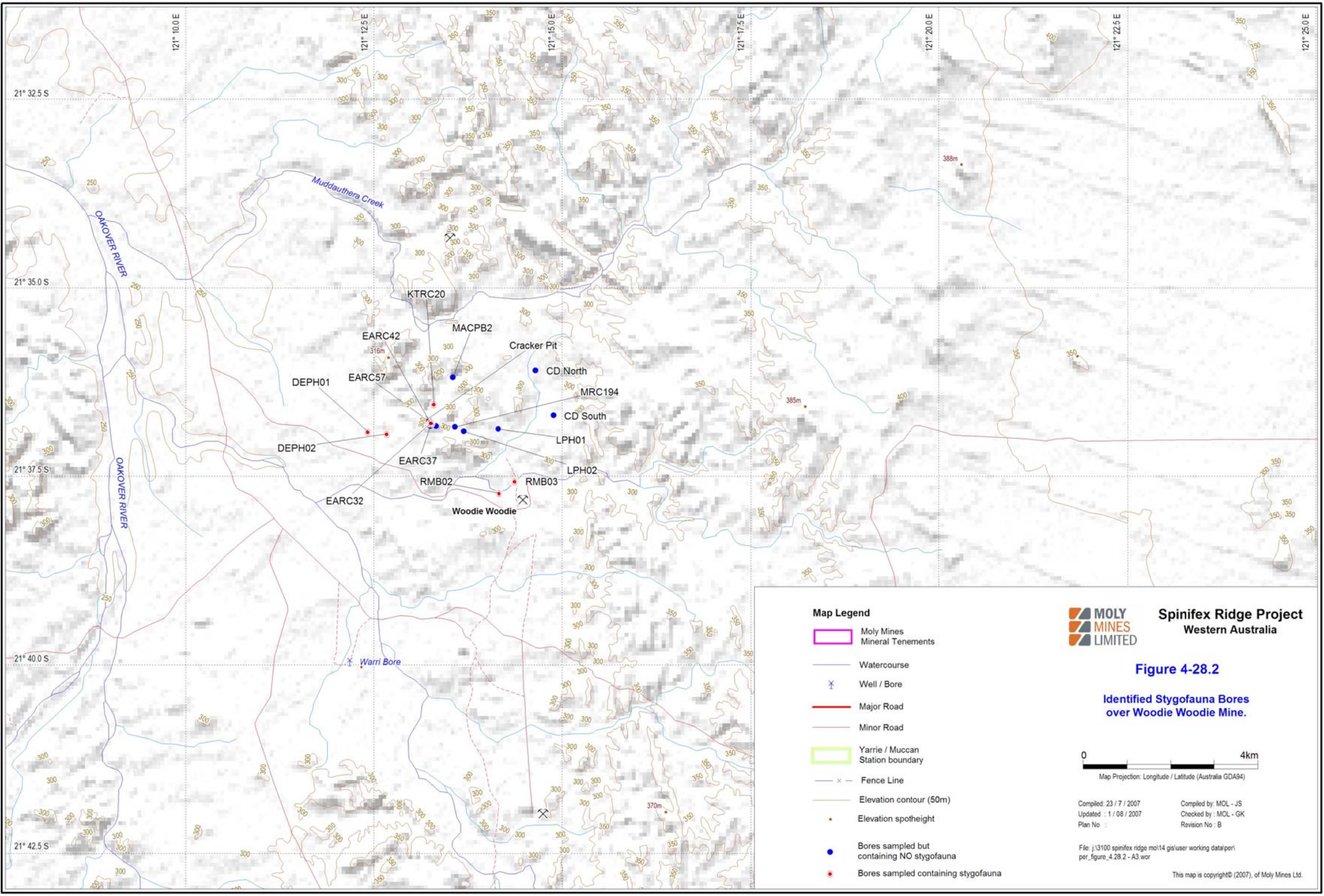

121° 10.0 E
121° 12.5 E
121° 15.0 E
121° 17.5 E
121° 20.0 E
121° 22.5 E
121° 25.0 E
21° 32.5 S
21° 35.0 S
21° 37.5 S
21° 40.0 S
21° 42.5 S
Muddauthera Creek
OAKOVER RIVER
OAKOVER RIVER
KTRC20
MACPB2
EARC42
316m
Cracker Pit
CD North
DEPH01
EARC57
MRC194
CD South
LPH01
DEPH02
EARC37
LPH02
RMB02
RMB03
EARC32
Woodie Woodie
Warri Bore
388m
385m
370m
Map Legend
Moly Mines Mineral Tenements
Watercourse
Well / Bore
Major Road
Minor Road
Yarrie / Muccan Station boundary
Fence Line
Elevation contour (50m)
Elevation spotheight
Bores sampled but containing NO stygofauna
Bores sampled containing stygofauna
MOLY MINES LIMITED
Spinifex Ridge Project
Western Australia
Figure 4-28.2
Identified Stygofauna Bores over Woodie Woodie Mine.
0
4km
Map Projection: Longitude / Latitude (Australia GDA94)
Compiled: 23 / 7 / 2007
Updated : 1 / 08 / 2007
Plan No :
Compiled by: MOL - JS
Checked by : MOL - GK
Revision No : B
File: j:\3100 spinifex ridge mol\14 gis\user working data\per\per_figure_4.28.2 - A3.wor
This map is copyright© (2007), of Moly Mines Ltd.

All stygofauna identified at Woodie Woodie belonged to the Crustacean (Arthropoda) and Oligochaeta (Annelida), with the highest diversity being displayed by Cycloipoida (Crustacea) with five taxa within one family (Cyclopidae).

The majority of stygofauna recorded during the surveys conducted to date have a known distribution outside of the Woodie Woodie Borefield, according to current knowledge. Although two new species of conservation significance were recorded, they are located near the predicted >5m drawdown contour of the Cracker Pit. Further studies are planned for this area to achieve adequate sampling frequency (OES, 2007d).

**De Grey River**

Most of the De Grey Borefield area comprises basement granite rocks overlain by quaternary alluvial sediments. A significant grey and sandy clay zone separates two aquifers; a shallow (6 – 10m deep) alluvial aquifer that is extensive and continuous, and a deeper alluvial aquifer that is semi-confined (OES, 2007d). Full details of the hydrogeology of De Grey Borefield area are presented in **Section 4.5.4**.

The survey of the De Grey River Borefield area shows that one of eight groundwater wells sampled within the survey area contained stygofauna. The low yield from this area is expected, in light of similar results form the sampling programs of nearby mines. The majority of these species are considered to be common within the Pilbara, apart from one potential new species found near the edge of the survey area, which requires further description (OES, 2007d). Due to current taxonomic limitations, and some fauna being immature, not all could be identified to species level.

The potential new species *Mesocyclops* cf. *kieferi* n. sp.? (Karanovic) was identified from a pastoral (control) bore Chinablin Well. This could be a new species, but requires more study to verify its identity and distribution. If it is a new species then it would be very close to *M. kieferi*. Currently, there are three known species of *Mesocyclops* in the Pilbara. Chinablin well is a shallow pastoral bore in poor condition with collapsing sides, and is susceptible to overland flow.

All stygofauna identified belonged to the Crustacea (Arthropoda) and Oligochaeta (Annelida), with the highest diversity being displayed by oligochaetes with four taxa within two families (Tubificiadae and Naididae).

Apart from the potential new species, all stygofauna recorded during the survey have a known distribution outside of the De Grey River Borefield. Further studies are planned for this area to achieve adequate sampling frequency (OES, 2007d).

**Canning**

The Canning borefield is located approximately 80km north of the Spinifex Ridge Project area, and 40km north of BHP's Yarrie Mine. The surficial Broome Sandstone aquifer in this area is extensive

and unconfined. Details of investigative work completed for the Canning A borefield are presented in **Section 4.5.2**.

The stygofauna survey for the proposed Canning borefield will assess approximately ten monitoring/production bores installed during or prior to May 2007. These bores will be sampled in September 2007 and subsequently in December 2007. Moly Mines will continue to liaise with DEC during the sampling program for Canning.

Stygofauna data from sampling of nearby bores, shows that stygofauna yield has been very low to date. Only one of twelve bores sampled in early 2006 at the nearby Yarrie Mine contained stygofauna, and no stygofauna were recorded in the 8 bores sampled at Nimingarra. Two bores north of Shay Gap, drilled into the same aquifer as the Canning borefield and only 5 kilometres to the west, also did not yield Stygofauna when sampled (Biota, 2006).

### 4.10.2 Troglofauna

Troglofauna are obligate inhabitants of caves and other subterranean voids and are dominated by the arthropods which include insects, arachnids, crustacea and myriapods. Within Western Australia, troglofauna have been recorded from caves in Tertiary limestones at Cape Range, Barrow Island and the Nullarbor Plain (Playford, 2001; Gray and Thompson, 2001; Harvey, 2002). They have also been recorded from Pleistocene aeolian limestones on the coastal strip south from Shark Bay and Devonian limestones in the Kimberley (Playford, 2001). Seven orders of troglofauna have recently (2006) been identified as endemic to the individual mesa formations in the Robe Valley (EPA, 2007b).

**Spinifex Ridge Project Area**

Two potential troglofauna habitats were identified at Spinifex Ridge:

- internal caves and voids within the Talga Range, and
- subterranean voids.

Both potential habitats were investigated.

Exploration drilling of the Talga Range shows that the range is comprised of BIF and cherts that form part of the Gorge Creek Group. The southern and northern sides of the ridge are characterised by steep (50 - 70°) cliffs of resistive silica rich chert and BIF which are up to 10 to 20m in height. These sub-vertical cliffs are typically fractured on the edges but the fractures do not penetrate beyond the ridge face to any significant extent. Drilling to date within the BIF has shown it to be highly competent and extremely hard. It lacks any significant porosity or void space and for geotechnical purposes it is considered massive, albeit for minor internal fracturing. In this context, troglofauna surveys were limited to hand-searching of external fissures and overhangs for short range endemics, including troglofauna.

Subterranean habitats were sampled using purpose-built traps placed in 18 slotted groundwater wells within the project area. These traps were suspended above groundwater for up to six weeks. No

trogolofauna were trapped during this time. A few non-target species (ants and mites) were recorded, with none displaying any troglomorphic characteristics (OES, 2007d).

### 4.10.3 Local and Regional Representation

The Pilbara in particular, and the Western Australian arid zone more generally, are recognised as having one of the world's most diverse and notable subterranean fauna (Humphreys, 2001; Karanovic, 2006). Historically, endemism was thought to be high with each aquifer presumed to be supporting a unique community. However, recent, intense sampling has found that the distribution of taxa within the Pilbara is high, with many species being found in a wider geographical distribution than previously known.

DEC's Pilbara bioregional survey has documented at least 322 occurrences of 78 species thus far, although sampling has been predominantly from bores or wells, with less than 4% of samples representing springs and hyporheic habitats. Species richness in the Pilbara region is roughly proportional to sampling effort. (Eberhard *et al.*, 2005; Eberhard and Halse, 2004).

The partially-completed surveys of the project area and borefields has recorded 24 species in the project area, 13 species at Woodie Woodie and 13 species at De Grey, to date. Based on species identifications to current knowledge;

- One recently-described species of limited distribution was recorded within the Spinifex Ridge project area;
- Two endemic stygofauna were found near the edge of the >5m drawdown contour within the Woodie Woodie borefields;
- One potentially new species was found near the edge of the survey area within the De Grey borefields.

To date, species identification and definitive comment regarding species distribution and endemism has been limited by factors including:

- The condition of specimens sampled (some samples contained damaged or incomplete specimens, which limited identification);
- The presence of juveniles which cannot be used to conclusively identify to species level;
- The lack of detailed, formally-described taxonomy for some groups; and
- The dynamic state of knowledge about stygofauna in the Pilbara.

Additional sampling is required to attain adequate sampling frequency within the project area and borefields, and provide definitive information about local and regional representation, and conservation status, of the species identified.

## 4.11 Air Quality and Noise

Baseline noise and air quality assessments were undertaken over the project area in January and February 2006 (Herring Storer, 2006; OES, 2006g). The assessments provided quantitative data on pre-existing ambient dust and noise levels.

### 4.11.1 Air Quality

The project area is in an arid environment subject to naturally high background dust levels. This is recognised in a discussion paper on a State-wide Air Quality Protection Policy (EPA, 1999) that notes that background levels of airborne dust in the Pilbara can be close to or higher than the National Environmental Protection (Ambient Air Quality) Measure (NEPM) standard (NEPC, 2003). Similarly, in 2002 the DEC recognised that particulate matter from natural sources (dust and wildfires) is generally very widespread during any particular high concentration event (DEP, 2002).

There are currently no major point source emitters of dust within or near the project area.

Baseline dust levels were measured at seven locations over the project area (**Figure 4-29**) during a 13-day period in January 2006 using a portable low volume MicroVol 1100 dust sampler fitted with a $PM_{10}$ filter head. An integrated 24-hr sample was collected at each sample location. Within the sampling period 52.4 mm of rainfall was received and contributed to the relatively low dust levels that were recorded.

Collected dust samples were analysed at an accredited National Association of Testing Authorities (NATA) laboratory for Total Dust as $PM_{10}$ and a suite of metals including: aluminium; arsenic; cadmium; copper; lead; manganese; molybdenum; and zinc. The results were compared to the following standards:

- Environmental Protection and Heritage Council (EPHC) (particulates and $PM_{10}$) NEPM guideline of 50 $\mu g/m^3$; and
- National Occupational Health and Safety Commission (NOHSC) Time Weighted Average (TWA) exposure levels (metals).

Sampling from all seven locations determined that $PM_{10}$ baseline conditions varied between 2.3 $\mu g/m^3$ to 32.3 $\mu g/m^3$ (**Table 4-21**). No dust monitoring locations exceeded the NEPM ambient 24-hour $PM_{10}$ guideline of 50 $\mu g/m^3$ during the sampling programme. All eight metals analysed for each of the seven monitoring sites were also well below the NOHSC limits for personal occupational exposure.

### 4.11.2 Noise

A baseline noise survey was completed over two periods in January and February 2006 (Herring Storer, 2006) to determine background noise levels in close proximity to the proposed mine site. Noise levels were monitored at Kitty's Well, located in the southwest corner of the project area, and a location immediately north of Coppin Gap (**Figure 4-29**). Kitty's Well was chosen because it was, at the time, the approximate location of the proposed Accommodation Village, and Coppin Gap because of its interest to tourists visiting the area. The nearest noise sensitive premises are at Yarrie Homestead, approximately 25 km to the north-east.

- **Table 4-21 Locations of Dust Monitoring Sites over the Project Area**

| Location Code: SR | $PM_{10}$ | Al | As | Cd | Cu | Pb | Mn | Mo | Zn |
|---|---|---|---|---|---|---|---|---|---|
| Limit | 50 | 10 | 0.05 | 0.01 | 1 | 0.15 | 1 | 10 | 10 |
| Unit | $\mu g/m^3$ | $mg/m^3$ | $mg/m^3$ | $mg/m^3$ | $mg/m^3$ | $mg/m^3$ | $mg/m^3$ | $mg/m^3$ | $mg/m^3$ |
| DUS01 | 20.9 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| DUS02 | 6.9 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| DUS03 | 32.3 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| DUS04 | 9.4 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| DUS05 | 4.6 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| DUS06 | 2.3 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| DUS07 | 30.1 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

The *Environmental Protection (Noise) Regulations 1997* is the appropriate legislation for determining compliance with assigned noise levels. The assigned noise levels chosen for the assessment were:

- $L_{A10}$ 45 dB(A) between 0700 hrs and 1900 hrs;
- $L_{A10}$ 40 dB(A) between 1900 hrs and 2200 hrs; and
- $L_{A10}$ 35 dB(A) between 2200 hrs and 0700 hrs Monday to Saturday, and 0700 hrs to 0900 hrs Sunday and Public Holidays.

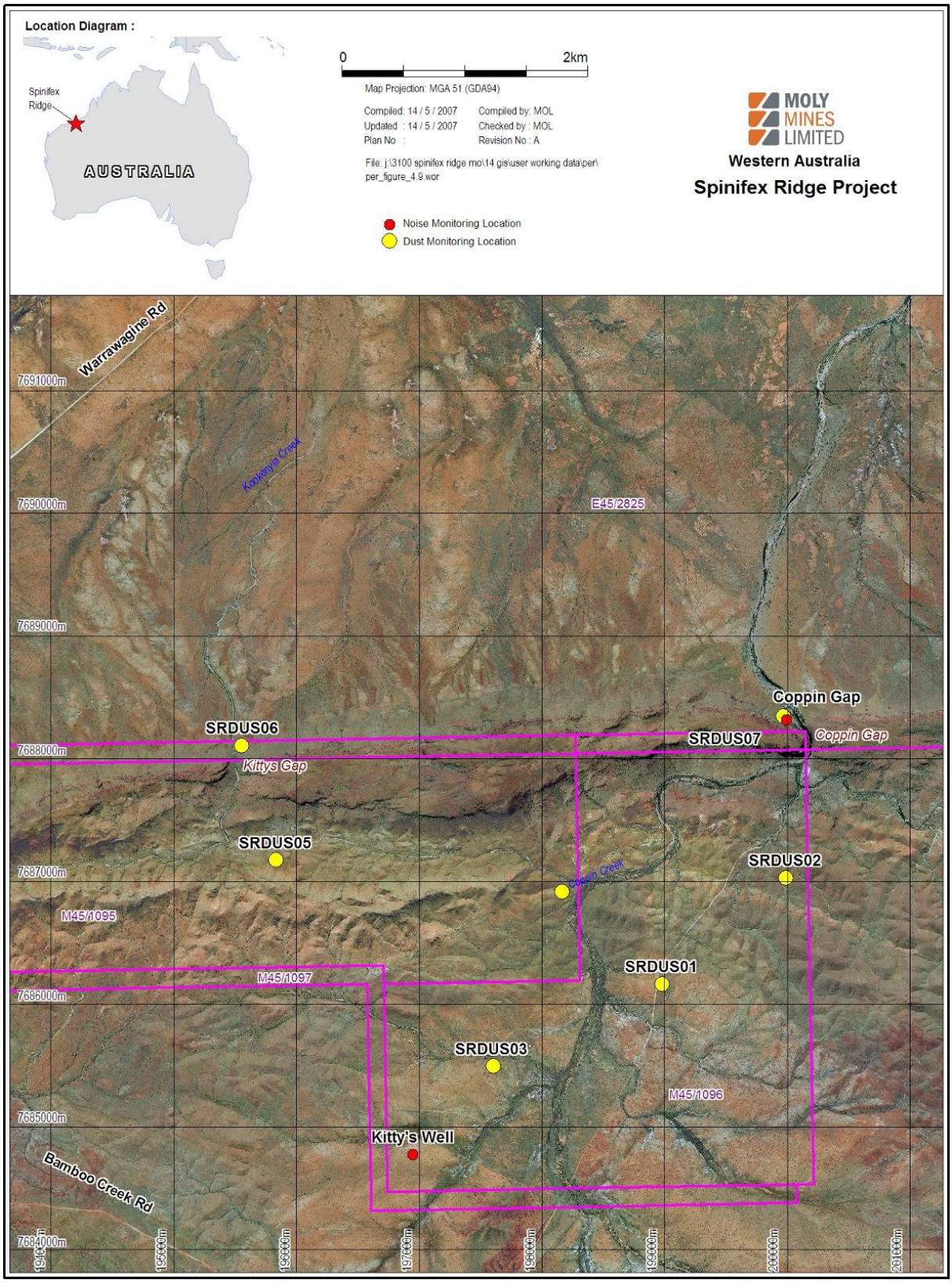
**Kitty's Well**

Monitored background $L_{A10}$ noise levels generally varied between 35 and 45 dB(A) between 0700 hrs to 1900 hrs with levels ranging from 38 to 50 dB(A) in the period 2200 hrs to 0700 hrs. During the period 1900 hrs to 2200 hrs, noise levels peaked between 50 and 60 dB(A).

**Coppin Gap**

The results were similar to Kitty's Well, with $L_{A10}$ noise levels generally varying between 32 and 48 dB(A) between 0700 hrs to 1900 hrs with levels ranging 40 to 50 dB(A) in the period 2200 hrs to 0700 hrs.

It is evident from these results that background noise levels can exceed the regulatory assigned noise levels, exclusive of any mining related activities. The higher sound levels observed during the monitoring period are likely to be a result of wind noise, noise from fauna or a combination of these. No extreme weather events (cyclones or intense rainfall) occurred during the monitoring period and the monitoring stations were positioned such that they wound not be influenced by noise from human activities.




- **Figure 4-29 Locations of Noise and Dust Monitoring Sites over the Project Area**