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ENVIRONMENTAL SCIENCE

Strategen Pty Ltd
(for FerrAus Ltd)

Davidson Creek Iron Ore Project

Short-range Endemic Invertebrate Fauna Survey

Draft Report

June 2009

Short-range Endemic Invertebrate Fauna Survey
Draft Report Version 1
Project: Davidson Creek Iron Ore Project

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EXECUTIVE SUMMARY

Phoenix Environmental Sciences Pty Ltd was commissioned by Strategen Pty Ltd, acting on behalf of FerrAus Ltd, to undertake a short-range endemic (SRE) invertebrate fauna survey of the Davidson Creek Iron Ore Project area and associated tenement (the study area). The report herein documents the results of the survey, which was undertaken in October – November 2008.

Prior to the survey, a desktop assessment of the study area (based on aerial photographs and vegetation reports) was undertaken to identify any potential SRE habitat. The study area was determined to contain no obvious habitat with high potential to contain SRE taxa. The study area has a relatively undulating topographic nature and high presence of large-scale, regionally common vegetation communities. Despite this assessment, the Department of Environment and Conservation advised that a survey should be undertaken due to the paucity of information concerning invertebrate communities and species within the western extremity of the Little Sandy Desert.

A total of ten wet pitfall trap sites, each containing ten 1-litre traps with roofs were installed. These were left open for a total of 40 nights each. Foraging was also conducted for at each site for an average of 75 minutes. Leaf litter samples were taken from eight of the ten sites. The survey effort was considered adequate given the study area is considered to have low potential to contain SRE taxa.

All groups known to include SRE taxa, and which occur in the Pilbara, were targeted during this survey using both systematic and opportunistic techniques. A total of 17 taxa were recorded from groups known to contain SRE taxa, representing ten genera, eight families, six orders, and three classes. Arachnids were the most speciose with 11 taxa recorded. Of those, five scorpion species and four pseudoscorpion species were recorded. No land snails were recorded, and given the largely sandy nature of the site, with little in the way of microhabitats or sheltered rocky areas, this was expected.

Twelve of the 17 taxa recorded have known or probable distributions which preclude them from being considered SRE taxa. An additional three taxa were collected that have not previously been recorded, a mite Caeculidae sp. and two pseudoscorpions *Oratumnus* sp. and *Austrohorus* sp. All three are considered unlikely to be SRE taxa, either due to known distributions of other members of their family or genus, or due to the diversity and type of habitat the species was recorded in.

The final two species that were recorded could not be confidently identified:

- A single juvenile specimen of a scorpion species from the genus *Urodacus* was recorded. As only adult specimens can be identified with any certainty, it was not possible to identify the species beyond genus level. The genus *Urodacus* does contain SRE taxa, but also many species with more widespread distributions.
- A species of centipede from the family Scolopendridae was recorded, however due to specimen damage, it could not be confidently identified below the family level. Scolopendridae is not currently known to contain any SRE taxa.

While determinations on these species cannot be made with certainty, the very low potential of the study area to contain SRE taxa suggests these species are not likely to be SRE's. Both were collected from minor drainage lines in low hills, a habitat which is fairly well represented in the local area. Further, the broader study area contains no obvious dispersal barriers or clearly restricted habitats suggesting the likelihood of any SRE taxa occurring in this area is low.

As the study area contains no habitats of significance to SRE taxa, no modification to the proposed development is considered necessary to protect fauna values from the perspective of SRE taxa.

1. INTRODUCTION

In August 2008, Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by Strategen Pty Ltd (Strategen), acting on behalf of FerrAus Pty Ltd (FerrAus) to undertake a short-range endemic (SRE) invertebrate fauna survey of the Davidson Creek Iron Ore Project area and associated tenement (the study area). This report documents the results of the survey, which was undertaken in October – November 2008.

1.1 BACKGROUND

The study area is located approximately 80km southeast of Newman and lies on the boundary of the Gascoyne and Pilbara bioregions. The specified survey area covers approximately13.5km^2 (Figure 1-1).

Both the Pilbara and Gascoyne bioregions are classed as "Group 2" areas by the EPA. Within these groups, any disturbance to an area greater than 50 hectares requires a "Level 2" biological survey. A Level 2 survey requires a detailed survey to enhance the level of knowledge at the local scale. Further, as the invertebrate fauna of this area is poorly documented, discussions with the Environmental Management Branch of the Department of Environment and Conservation (DEC) concluded that a trapping programme was required, despite there being no obvious dispersal barriers or, clearly restricted habitats that might give rise to short-range endemism in the invertebrate fauna.

1.2 SCOPE OF WORK AND SURVEY OBJECTIVES

The aim of the survey was to provide baseline information on the presence and/or likelihood of presence of SRE species occurring in the study area.

The scope of the works was to:

- Undertake a desktop habitat assessment and database searches for SRE species;
- Conduct an SRE survey of the study area;
- Provide a technical report that includes:
  - ⇒ Identification and discussion of any SRE species recorded in the survey;
  - ⇒ Assessment of SRE habitats;
  - ⇒ Assessment of potential impacts on SRE habitats and taxa from the proposed project; and
  - ⇒ Recommendations for management of potential impacts on SRE habitats and taxa.

1.3 SURVEY SIGNIFICANCE

SRE fauna are defined as arthropods that display restricted geographic distributions that may be disjunct and highly localised (nominally defined as <10,000 km^2 in Harvey 2002). The most appropriate analogy is that of an island, where the movement of fauna is restricted by the surrounding marine waters, thus isolating the fauna from other terrestrial island populations. The restricted ranges of SRE species (often due to highly restricted habitats or geological dispersal barriers) makes them more vulnerable to adverse impacts and local extinction.

The study area has few landscape features with the potential to drive short-range endemism in the invertebrate fauna. The study area is dominated by an extensive floodplain, orientated in a north-

south direction, which is flanked to the South-West by a low ridge line that is further dissected by a number of moderate ephemeral creek lines.

There are a number of existing or potential threatening processes that may impact SRE habitats within the study area:

- Land clearing
- Grazing

  ⇒ much of the study area is impacted from stock grazing

- Weeds

  ⇒ infestations of Buffel Grass (*Cenchrus ciliaris*) occur along most drainage courses

- Changed fire regimes

  ⇒ an altered fire regime may act to promote the premature 'drying' of mesic refuge habitats for SREs

- Changed hydrology, such as altered flow regimes affecting riparian vegetation, due to need to realign one of the creek lines that dissect the ridge.

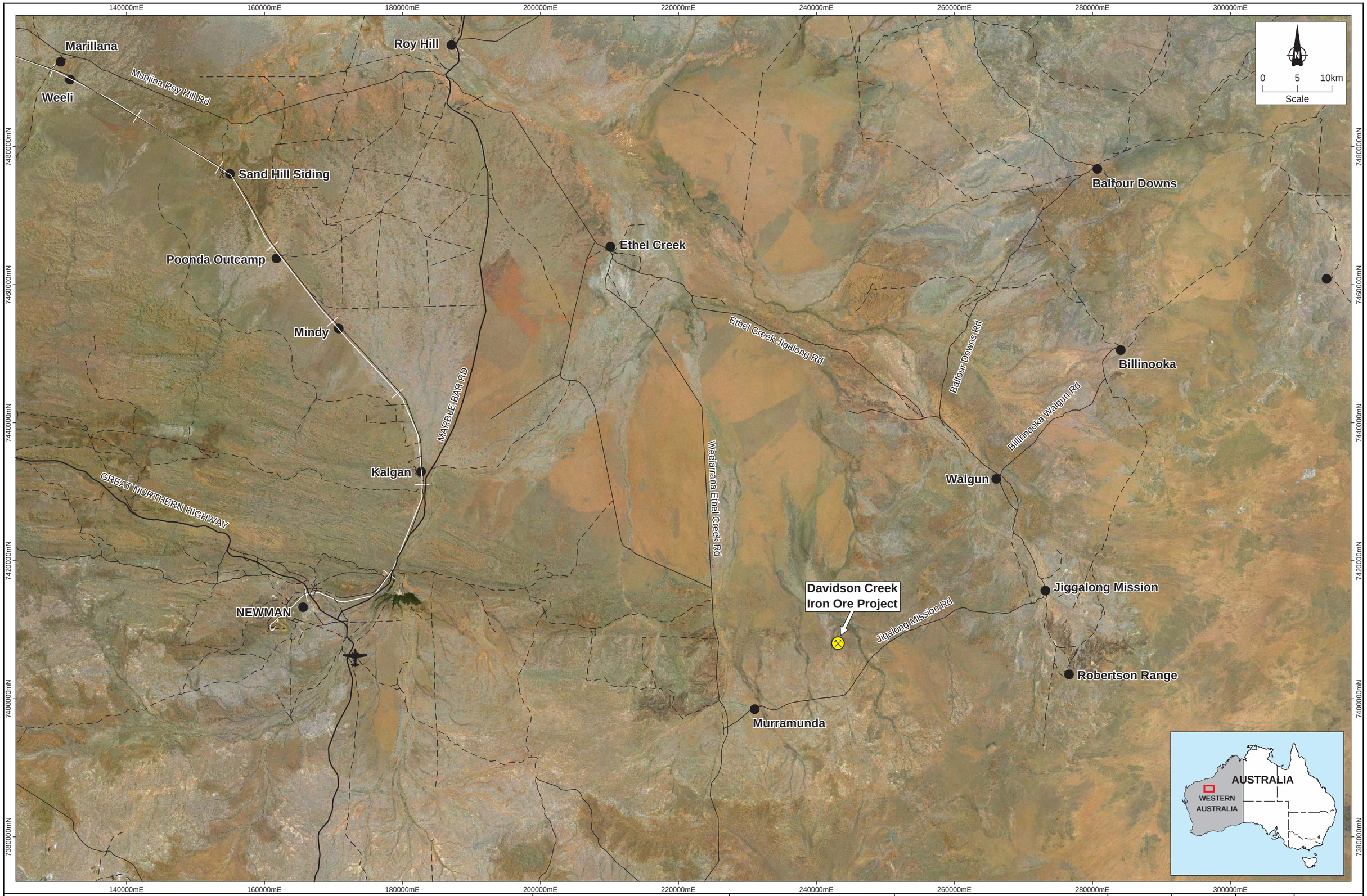

Figure 2-1: Location of Davidson Creek Iron Ore Project

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Notes:

Size: A3	Scale: 1:500,000	Drawn: CAD Resources	Phoenix Job No: 909-DC-STR-SRE
Projection: GDA94 MGA Zone 51		CAD Resources File No: g1737_Rpt_F101.dgn	

1.4 EXISTING ENVIRONMENT

1.4.1 Interim Biogeographic Regionalisation of Australia (IBRA)

The study area is located on the borders of the Pilbara, and Gascoyne bioregions as defined by IBRA (Thackway and Cresswell 1995). More specifically, the study area is situated within the Fortescue Plains subregion of the Pilbara bioregion and the Augustus subregion of the Gascoyne bioregion.

The landscape and vegetation characteristics of the Davidson Creek project area most closely resemble the Augustus subregion. The Augustus subregion is characterised by rugged low Proterozoic sedimentary and granite ranges divided by broad flat valleys with extensive areas of alluvial valley-fill deposits. Dominant vegetation includes Mulga woodland with *Triodia* on the rises and Mulga parkland on the plains (Department of Conservation and Land Management 2003).

1.4.2 Geology and Land Systems

The study area is located on the eastern margin of the Hamersley Province of the Pilbara Craton. The Hamersley province consists predominantly of late-Archaean and Lower Proterozoic (2800-230Ma) sedimentary rocks situated between the large Yilgarn and Pilbara Cratons.

Within the study area, the Marra Mamba Iron Formation outcrops as a low ridge. The Formation is divided into the Nammuldi, McLeod, and Mount Newman Members. The Mt Newman Member is the primary host unit for the iron ore mineralization within the study area. It consists of a thick succession of BIF, shale, and carbonate rocks. Typically, the Mount Newman Member is poorly exposed at surface; most of the orebody is below Cainozoic colluvial and alluvial material. Overlying the Mount Newman Member, also below Cainozoic cover, is stratigraphy of the Wittenoom Formation.

1.4.3 Climate

The Pilbara region has a semi-desert to tropical climate with highly variable, mostly summer rainfall occurring as a result of cyclonic activity. The average rainfall over the broader Pilbara area ranges from about 200mm to 350mm, although rainfall may vary widely from the average from year to year (Australian Natural Resources Atlas, 2008).

The nearest Bureau of Meteorology (BOM) weather station is located at Newman, 75km west of the study area. Newman has the highest maximum mean monthly temperature (39°C) in January, the lowest maximum mean annual temperature (22.3°C) in July and an average annual rainfall of 310mm (Bureau of Meteorology, 2009).

1.4.4 Biological context

No biological surveys have previously been conducted within the study area other than a targeted rare and priority flora search (ecologia 2007).

Previous surveys commissioned by FerrAus, have been conducted on their nearby Robertson Range tenements approximately 20km to the south east of the study area and for a proposed haul route, just south of the study area (ecologia, 2007a and 2007b). However, no SRE surveys were undertaken. A desktop review concluded that no SRE survey was required due to the fact no potential SRE habitat was present (ecologia 2007).

1.4.5 Land use

Land use in the study area comprises pastoral grazing and exploration activities. The study area has been impacted by cattle grazing, exploration activities, and recent fires.

2. METHODS

2.1 HABITAT ASSESSMENT AND SITE SELECTION

A review of aerial photography identified several habitat types within the study area that were considered to have minor potential to facilitate short-range endemism among the resident invertebrate fauna:

- Rocky outcrops on low stony slopes;
- Major and minor drainage lines;
- Floodplains;
- South-facing minor slopes on low stony hills;
- *Triodia* hummock grasslands
- Low shrublands

Final site selection was determined on commencement of the field survey, following site verification. A total of 10 sites were surveyed across the study area Figure 2-2.

2.2 TARGET TAXA

The survey targeted all taxonomic groups known to include SRE species in the Pilbara region:

- Trap-door spiders (Archnida);
- Scorpions (Arachnida);
- Pseudoscorpions (Arachnida);
- Non-marine snails (Gastropoda);
- Millipedes (Diplopoda);
- Isopods (Malacostraca);
- Schizomids (Arachnida);
- Mites (Arachnida); and
- Centipedes (Chilopoda).

2.3 SURVEY TIMING AND WEATHER

The survey was commenced on the 30th September - 4th October 2008 (trap installation) and concluded the 6th – 8th November 2008 (trap removal and foraging).

Daily maximum and minimum temperatures at Newman ranged from 28.9 – 41.4°C and 14.2 – 26.8°C respectively, during the survey period. The mean maximum and minimum temperatures were 35.2°C and 19.5°C respectively during this period and are comparable to the long term averages for Newman.

Rainfall in the study area during the period 30th September - 18th November was negligible. Newman received below average rainfall during the months of the survey (September – November).

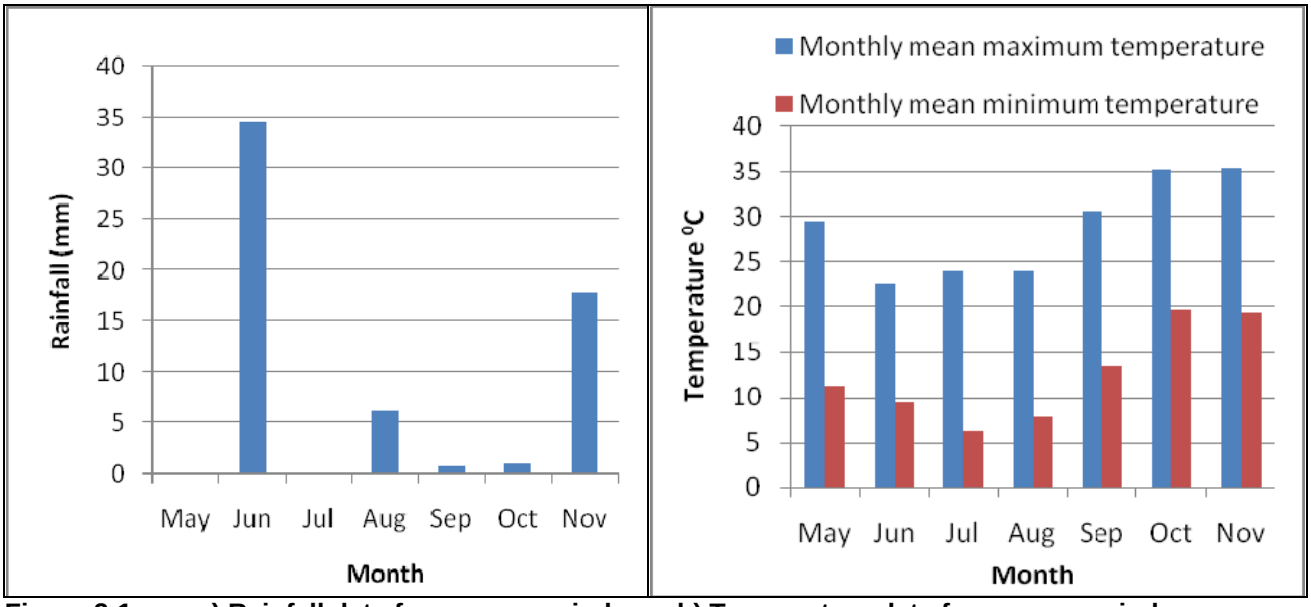

Figure 2-1 a) Rainfall data for survey period b) Temperature data for survey period
Source: Bureau of Meteorology

2.4 ENVIRONMENTAL PROTECTION AUTHORITY GUIDANCE

At the commencement of the survey no formal guidelines on the preferred survey methods for terrestrial SRE invertebrates were available. The methods employed in this survey were based on Phoenix's previous experience in undertaking SRE surveys throughout many regions of Western Australia.

Where practicable, the survey design, methodology and report-writing aspects scope of the work adhered to appropriate principles and guidelines, including:

- Environmental Protection Authority (EPA) Position Statement No. 3: *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002); and
- EPA Guidance Statement No. 56: *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004).

In May, the EPA released a guidance statement with respect to SRE invertebrate surveys in EIA:

- EPA Guidance Statement No. 20: (EPA 2009). Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia.

The survey presented here largely adheres to this guidance. The limitations to the study with respect to the new guidance statement are discussed in Section 4.0.

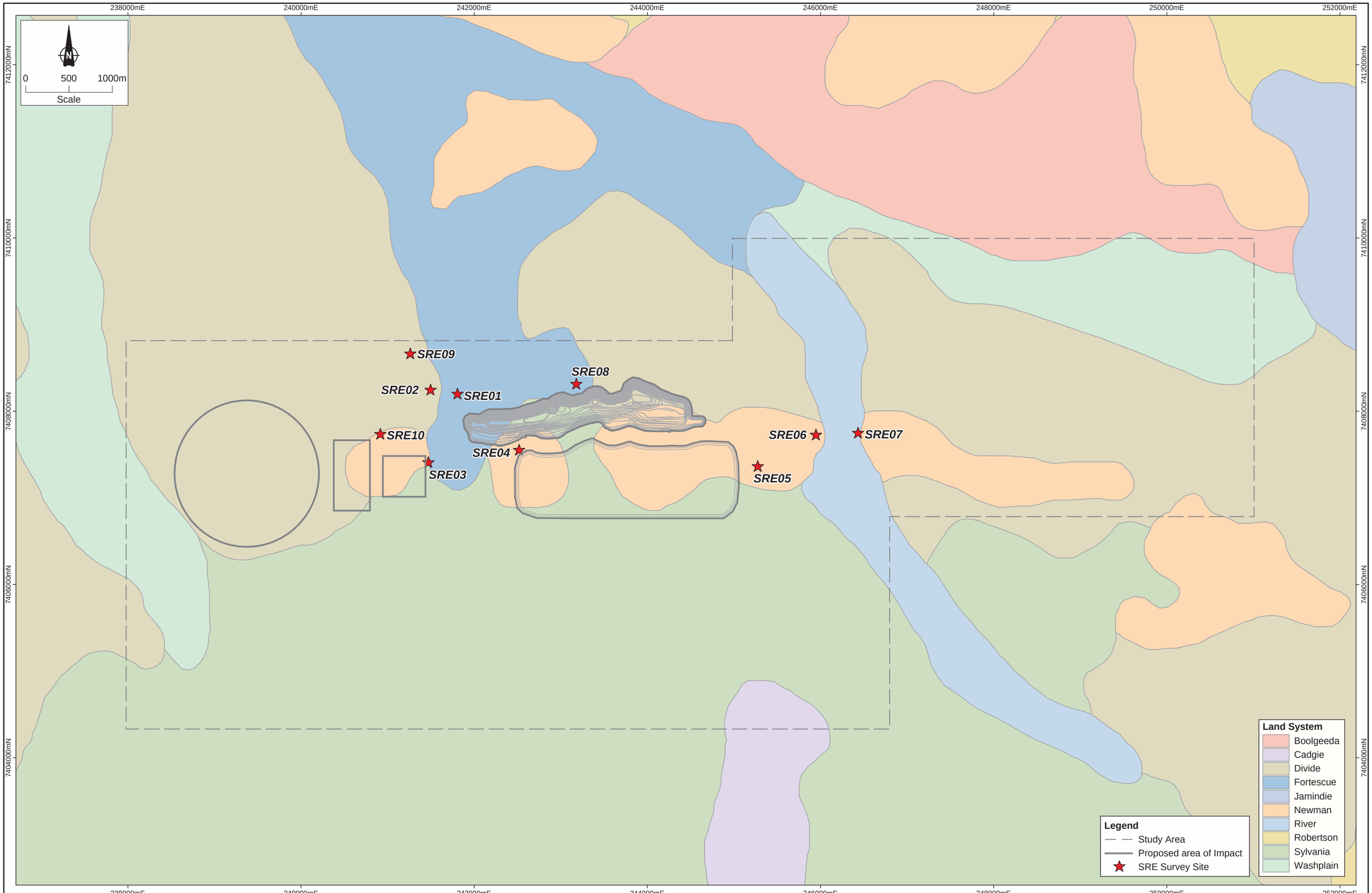

Figure 3-1: Location of SRE survey sites within the Davidson Creek Iron Ore Project

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Notes:

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2.5 SAMPLING METHODOLOGY

The field survey consisted of three proven, industry-recognised sampling techniques which target SRE taxa; wet pitfall trapping; active searches (foraging); and the collection of leaf litter samples.

Wet pitfall trapping was conducted at 10 sites, with five sites being established within the proposed project footprint and five sites outside of the footprint as reference sites. Ten traps were dug in at each site in suitable microhabitats. The traps comprised one litre plastic containers with a 70 mm diameter that were partly-filled with a solution of ethylene glycol and formaldehyde (2.5% by volume). All traps were left open for a period of 40 days. A total sample size of 4,000 trap nights was attained (Table 2-1).

Foraging incorporated the systematic inspection of logs, larger plant debris, under the bark of larger trees and the underside of larger rocks (outcrops). Methodical searches were also conducted amongst the leaf litter of shade-bearing tall shrubs and trees. Rocks and rock crevices were also inspected, particularly for pseudoscorpions. A temporally and spatially standardised approach was undertaken, whereby each of the ten sites was sampled for 60 - 90 minutes within a 50m x 50m area (30 - 45 mins x 2 people; 75 mins average). This equated to 12.5 hours of hand searching, and a total search area of 2.5 hectare (Table 2-1).

Mygalomorphae trap door spider burrows identified during the searches were excavated if they were considered to be inhabited. Excavation involved removing soil from around the burrow to expose the burrow chamber and remove the spider. None of the excavated burrows produced Mygalomorphae spiders. Some burrows revealed huntsman spiders, centipedes, and geckos (*Diplodactylus conspicillatus*) upon excavation, which may have predated upon or displaced the trap door spiders.

Leaf litter samples were taken from sites where target taxa were not recorded during the foraging component but where there was potential for occurrence. The collection of leaf litter samples was not standardized (either volumetrically or by weight) due to the high variability of the soil and leaf litter depth throughout the study area. Standardisation of samples was not critical to the survey as the principle objective was to determine the presence of SRE species rather than assessing (for example) relative abundance or species diversity. Searching was therefore conducted in any prospective habitat available.

Site descriptions, vegetation, and sampling activity were recorded at each site (Appendix 1). The coordinates of each site were recorded by a hand held GPS device (Appendix 2).

Table 2-1 Sampling effort for the Davidson Creek SRE Survey.

Techniques	No. Sites	No. Traps[a] / Area (m^2)[b]	No. Nights[c] / Time (mins)[d]	Total Sample Size (n)
Wet pitfall trapping	10	10	40	4,000 trap nights
Foraging	10	50m x 50m	75 mins (average)	750 mins 25,000m^2
Leaf litter samples	8[e]	n/a	n/a	8

a, c – Wet pitfall trapping.

b, d – Foraging.

e – No leaf litter samples taken from sites 7 and 10 due to absence of leaf litter.

2.6 SAMPLE HANDLING

All specimens collected were transported to Perth for sorting and identification. The specimens from the 10 wet pitfall traps at each site were combined in a single, labelled container, with the trapping fluid being replaced by 100% ethanol. Specimens collected by foraging techniques were placed in a glass vial preserved in 100% ethanol and labelled accordingly.

All leaf litter samples were sieved (18mm, 8mm and 5mm stack) and sorted in Perth under a stereo dissecting microscope. Tulgren funnel extraction was then used on the coarse sieved leaf litter component.

2.7 TAXONOMY AND NOMENCLATURE

Specimens of Mygalomorphae spiders, scorpions, and centipedes were identified by Phoenix scientists to at least the level of Genus. Species level identification of Mygalomorphae spiders largely requires an extensive voucher collection; so final species level determinations were made by Dr Robert Raven (Queensland Museum). Pseudoscorpion and scorpion specimens were identified by taxonomists at the Western Australian Museum. Isopod specimens were identified by Dr Simon Judd. Species level identifications of the remaining groups were undertaken by Phoenix. All groups were submitted for identification in early February 2009.

3. RESULTS

The results section discusses all species recorded in the survey that are from groups known to contain SRE taxa. Many insect taxa (e.g. beetles, mantids, modern spiders were particularly abundant and diverse) were also collected in the survey. The beetle taxa (Coleoptera) were identified to morpho-species but further analysis was not undertaken. Insect groups are not currently considered to contain SRE taxa (within the environmental impact assessment process), despite the occurrence of numerous species that are restricted in their distribution either through geological and climatic variables or ecological constraints (Harvey 2002). Given that the invertebrate fauna of any ecosystem is so important to its functioning and long term viability (nutrient cycling, soil aeration, seed dispersal, species control etc) there is a strong case for considering invertebrate community patterns within the EIA approvals process (Majer 2009; Ponder and Lunney 1999; Wilson 1987). This is particularly of relevance to developing appropriate mine closure plans and criteria, and considering ecosystem linkages (Majer 2009).

A total of 17 taxa from groups known (or suspected) to contain SRE species were recorded during the survey. These were represented by ten genera, eight families, six orders, and three classes. Arachnids were the most speciose, with 11 taxa recorded. Of those, five scorpion species and four pseudoscorpion species were recorded. No land snails were recorded. The location of all taxa recorded (excluding insects) is presented in Figure 3-1.

Despite many of the taxa only being recorded from a single site and thus a single habitat type, many were formally described and are not considered to be SRE species. Of the specimens collected that have not previously been recorded, none were considered likely to be SRE species by the specialist taxonomists who identified them.

3.1 ACARINA

The mite fauna of Australia is extremely diverse and while substantive efforts have been made to summarise the state of knowledge of this order (see Halliday 1998) there is no complete checklist at this stage. A single species of mite collected during the survey was suspected of being troglobitic and therefore submitted for identification. However, Harvey and Framenau (2009) suggest that troglobitic mites are not likely to represent short-range endemic species based on previous studies. For example, in a troglofauna survey conducted by Biota (Biota 2006a; 2006b) at Mesa A and the Robe Valley near Pannawonica, genetic analysis confirmed that all 26 recorded mite species were edaphobitic rather than obligate subterranean fauna, capable of extensive dispersal and therefore not short-range endemic taxa.

3.1.1 Caeculidae

Caeculidae sp.

There are only three named species from the predatory family Caeculidae in Australia, one from New South Wales and two from the Kimberley region (Coineau 1970; Otto 1993). Twelve records of this family currently exist in the collection of the WA Museum. Caeculidae sp. was collected in a leaf litter sample from Site 10 (Figure 3-1). The specimens could not be identified further due to a lack of taxonomic expertise in mite systematics in Australia. The taxonomy of species from the Caeculidae family is poorly resolved but it is considered unlikely that they contain any SRE taxa (Framenau and Harvey 2009).

Table 3-1 The invertebrate taxa recorded during the Davidson Creek SRE Survey.

Class/Order	Family	Genus	Species	1	2	3	4	5	6	7	8	9	10	Total # sites	% presence
Arachnida															
Acarina	Caeculidae												2	1	10
Araneae	Mygalomorphae	*Kwonkan*	sp.	1								1	1	3	30
Pseudoscorpiones	Atemnidae	*Oratemnus*	sp.							3				1	10
Pseudoscorpiones	Olpiidae	*Austrohorus*	sp.		12							10	10	3	30
Pseudoscorpiones	Olpiidae	*Beierolpium*	sp. 8/2		5								3	2	20
Pseudoscorpiones	Olpiidae	*Indolpium*	sp.	23	15		10	1	3	1		23	10	8	80
Scorpiones	Buthidae	*Lychas*	*harveyi* gp									1		1	10
Scorpiones	Buthidae	*Lychas*	*adonis*										6	1	10
Scorpiones	Buthidae	*Lychas*	*annulatus*		1									1	10
Scorpiones	Buthidae	*Lychas*	*mullipunctatus*		1									1	10
Scorpiones	Urodacidae	*Urodacus*	sp.						1					1	10
Chilopoda															
Scolopendromorpha	Scolopendridae	*Cormocephalus*	*aurantiipes*		1									1	10
Scolopendromorpha	Scolopendridae	*Cormocephalus*	*turneri*										1	1	10
Scolopendromorpha	Scolopendridae	*Ethmostigmus*	*rubripes*										6	1	10
Scolopendromorpha	Scolopendridae	*Scolopendra*	*morsitans*	7	5	8	9	8	8		10	3	4	9	90
Malacostraca															
Isopoda	Armadillidae	*Buddelundia*	sp.1	4	3		3	5			6	5	1	7	70
Isopoda	Armadillidae	*Buddelundia*	sp.2						4					1	10
Insecta															
Coleoptera	Buprestidae		sp.1	1	1		2					2		4	40
Coleoptera	Buprestidae		sp.2							3				1	10
Coleoptera	Buprestidae		sp.3							3				1	10
Coleoptera	Chrysomeloidea		sp.1										1	1	10
Coleoptera	Coccinellidae		sp.1										1	1	10
Coleoptera	Curculionidae		sp.1						1					1	10
Coleoptera	Curculionidae		sp.2						1					1	10
Coleoptera	Curculionidae		sp.3			2			1					2	20

Class/Order	Family	Genus	Species	1	2	3	4	5	6	7	8	9	10	Total # sites	% presence
Coleoptera	Curculionidae		sp.4				1							1	10
Coleoptera	Curculionidae		sp.5	1		2					1			3	30
Coleoptera	Curculionidae		sp.6							1				1	10
Coleoptera	Curculionidae		sp.7									2		1	10
Coleoptera	Curculionidae		sp.8					2						1	10
Coleoptera	Curculionidae		sp.9			1								1	10
Coleoptera	Eucnemidae		sp.1			1			1	1			1	4	40
Coleoptera	Eucnemidae		sp.2							2				1	10
Coleoptera	Eucnemidae		sp.3			1								1	10
Coleoptera	Geotrupidae		sp.1						1					1	10
Coleoptera	Geotrupidae		sp.2	5	1	2	1	1	1		1	6	1	9	90
Coleoptera	Geotrupidae		sp.3	1	1	4			1		1	2	2	7	70
Coleoptera	Scarabaeoidea		sp.1										1	1	10
Coleoptera			sp.1										1	1	10
Coleoptera			sp.2										1	1	10
Coleoptera			sp.3										1	1	10
Coleoptera			sp.4										1	1	10
Coleoptera			sp.5							2				1	10
Coleoptera			sp.6		3							1		2	20
Coleoptera			sp.7									1		1	10
Coleoptera			sp.8									1		1	10
Coleoptera			sp.9			1								1	10
Coleoptera			sp.10	1										1	10
Coleoptera			sp.11			1								1	10
Mantodea	Amorphoscelidae		sp.1	1										1	10
Mantodea	Amorphoscelidae		sp.2			1			3			2	3	4	40
Mantodea	Amorphoscelidae		sp.3			1			1					2	20
Mantodea			sp.1		2					2				2	20
Mantodea			sp.2		4	1				2	1			4	40
Mantodea			sp.3			1								1	10

a – Percentage of sites the species was recorded at.

3.2 MYGALOMORPHAE

3.2.1 Nemesiidae

Nemesiidae are burrowing trapdoor spiders, commonly called Wishbone spiders. The family reaches its highest diversity in Australia with different genera occurring in different habitats. Species of genera found in rainforests in eastern Australia tend to have highly localised distributions being restricted to one or two adjacent mountaintops. Species belonging to genera that dominate in drier forest to desert (e.g. *Aname*) have generally wider distributions, but depending on the biogeographical events that have occurred, they may still have disjunct distributions. One species of Nemesiid was recorded in the survey.

***Kwonkan* sp.**

The genus *Kwonkan* is generally considered to occur in the south-western part of Western Australia; however, it is increasingly being recorded from the sub-tropical Pilbara region. Three specimens of *Kwonkan* sp. (one adult and two juveniles) were recorded from three sites in two habitat types (Figure 3-1; Table 3-2). The adult specimen closely resembles a male specimen recorded from McLarty Hills (19°30'S 123°30'E, WAM 94/265), approximately 515km from the Davidson Creek study area, suggesting they are the same species (Raven, pers. comm.). The distance between the records prevents this species from being considered an SRE species (photographs of a male and female of the species are provided in Plate 1 and Plate 2).

Table 3-2 The number of sites in each habitat type that recorded spider and mite species.

Family / Genus	Species	Rocky Outcrop	South-facing Slope	Major Drainage Line/ Floodplain	Minor Drainage Line	Hummock Grassland	Low – Medium Shrubland	Total Number of Habitats
Caeculidae								
Caeculidae	sp.						1	**1**
Nemesiidae								
Kwonkan	sp.			1			2	**1**

3.3 PSEUDOSCORPIONES

Western Australia has a fairly diverse pseudoscorpion fauna, with representatives known from 17 different families. Pseudoscorpions occupy a range of habitats but are most commonly collected from the bark of trees, from the underside of rocks, or from leaf litter habitats. Four species of pseudoscorpions from the families Atemnidae and Olpiidae were recorded. The number of individual records in relation to habitat type for each species is provided in Table 3-3. The location of each species is shown in Figure 3-1.

3.3.1 Atemnidae

The family Atemnidae comprise medium to large sized scorpions that typically inhabit the bark of trees in WA but may also be found under rocks or in soil.

***Oratemnus* sp.**

Oratemnus sp. was recorded from a grassland floodplain (Site 7) in a pitfall trap. Three specimens were collected, comprising one female and two juveniles. The systematics of the Atemnidae family, and particularly the genus *Oratemnus* is uncertain. However, based upon current evidence Harvey

a) Dorsal view

b) Ventral view

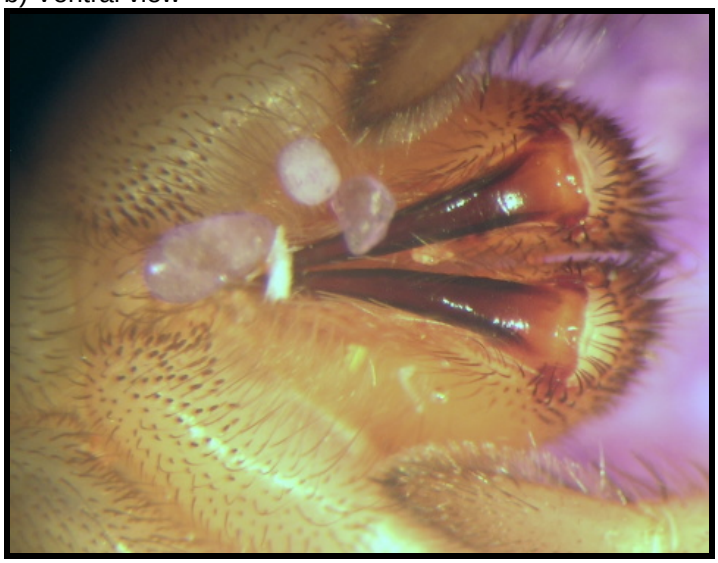
c) Embolus (male reproductive organ) at tip of left palp

d) Tibial Spur for defending against females during mating and probably whilst feeding on larger prey items.

Plate 1a-d Photographs of the Male *Kwonkan* sp. recorded.

a) Dorsal view

b) Ventral view



c) close-up view of fangs and maxillae ornamentation

Plate 2a-c Photographs of the Female *Kwonkan* sp. recorded.

and Framenau (2009) consider it likely that most *Oratemnus* species will eventually be found to be widely distributed and therefore do not consider *Oratemnu*s sp. to represent an SRE species.

3.3.2 Olpiidae

Olpiidae are a large family of small to large sized pseudoscorpions with a worldwide distribution. They are found in a variety of habitats and bioregions.

***Austrohorus* sp.**

Three specimens of *Austrohorus* sp. were recorded from three sites (2, 9 and 10) in two habitat types; *Triodia* hummock grassland, and low-medium shrublands. Based on current levels of knowledge, it is not possible to definitively state whether *Austrohorus* sp. represents an SRE species. However, as the specimens were recorded from regionally well represented habitat types, this is unlikely to be an SRE species.

***Beierolpium* sp. 8/2**

Beierolpium sp. 8/2 was recorded from two sites (2 and 10) in *Triodia* hummock grassland and moderately dense *Acacia* shrubland. The systematics of members of the *Beierolpium* genus occurring in the Pilbara has not been fully assessed. Thus, it is not currently possible to firmly establish the identity of this species until a full taxonomic revision has been undertaken. However, given that *Beierolpium* sp. 8/2 has previously been recorded from coastal habitats near Cape Preston (Phoenix Environmental Sciences 2009) approximately 500km northwest of Davidson Creek, it is unlikely to be an SRE species.

***Indolpium* sp.**

Indolpium sp. was recorded from several sites and habitat types in the study area. Extremely similar specimens have been collected from other regions of Western Australia, suggesting that the species has a broad distribution. Based on current levels of knowledge, this species is not considered a short-range endemic species.

Table 3-3 The number of sites in each habitat type that recorded pseudoscorpion species.

Family / Genus	Species	Rocky Outcrop	South-facing Slope	Major Drainage Line/ Floodplain	Minor Drainage Line	Hummock Grassland	Low – Medium Shrubland	Total Number of Habitats
Atemnidae								
Oratemnus	sp.			1				**1**
Olpiidae								
Austrohorus	sp.					1	2	**2**
Beierolpium	sp. 8/2					1	1	**2**
Indolpium	sp.		2	2	3	1	2	**5**

3.4 SCORPIONES

Current classification of the Scorpiones usually recognise five superfamilies, of which two, Buthoidea and Scorpionoidea, are represented in the Australian fauna (Department of Environment, Water, Heritage and the Arts, 2009). Five species of scorpion representing both superfamilies were recorded. The number of records in relation to habitat type is provided in Table 3-4. The location of records of each species is shown in Figure 3-1.

3.4.1 Buthidae

The family Buthidae is diverse with some 50 genera and over 500 species currently recognised (Sissom 1990). The Australian buthid fauna currently contains five genera and 11 extant species (Koch 1983) but unpublished research indicates that the fauna is actually much more diverse, with substantial changes at the generic level, and numerous new species yet to be described (Voschenk pers. comm.; Department of Environment, Water, Heritage and the Arts, 2009). Four species from the genus *Lychas* were recorded in the survey. This genus is abundant and increasingly diverse (due to taxonomic work) across all of mainland Australia (Framenau and Harvey 2009). All *Lychas* species are generally quite small with slender pedipalps and mottled colouration.

Lychas annulatus

A single specimen of *Lychas annulatus* was recorded in *Triodia* hummock grassland at Site 2. This species is common throughout Western Australia and is therefore not an SRE species.

***Lychas 'adonis'* Volschenk, ms name**

Six specimens of *Lychas 'adonis'* were recorded at a single location (Site 2) in moderately dense shrubland. This species is common throughout Western Australia and is therefore not an SRE species.

***Lychas 'harveyi'*-group**

A single specimen likely belonging to the *Lychas 'harveyi'*-group was recorded in low shrubland at Site 9. This group is widespread throughout the Pilbara region and is considered unlikely to contain any SRE taxa.

***Lychas 'multipunctatus'* Volschenk, ms name**

A single female record of Lychas '*multipunctatus*' was made in hummock grassland (Site 2). This species is widespread throughout the Pilbara and Kimberley regions and is not an SRE species.

3.4.2 Urodacidae

The family Urodacidae consists of a single genus, *Urodacus* that is confined to mainland Australia. The Western Australian Urodacidae fauna is extremely diverse with high numbers of new species remaining to be formally described. Numerous SRE species are known but others are more widespread.

***Urodacus* sp.**

A single juvenile specimen of the genus *Urodacus* was recorded from a minor drainage line in low hills (Site 6). As only adult scorpion specimens can be identified with any certainty, it is not possible to identify this species beyond genus level. It is therefore unclear if the specimen represents an SRE species, but is considered unlikely as the habitat is fairly well represented in the local area and the overall study area is considered to have low potential for containing any SRE taxa.

Table 3-4 The number of sites in each habitat type that recorded scorpion species.

Family / Genus	Species	Rocky Outcrop	South-facing Slope	Major Drainage Line/ Floodplain	Minor Drainage Line	Hummock Grassland	Low – Medium Shrubland	Total Number of Habitats
Buthidae								
Lychas	*annulatus*					1		**1**
Lychas	'*adonis*'						1	**1**
Lychas	'*?harveyi*'-gp						1	**1**
Lychas	'*multipunctatus*'					1		**1**
Urodacidae								
Urodacus	sp.				1			**1**

3.5 SCOLOPENDROMORPHA

Centipedes from the order Scolopendromorpha are generally strong and flexible with well-developed mandibles. They predominantly occur in tropical regions and are found in soil, or under rocks or bark. The order is divided into two families, the Scolopendridae and the Cryptopidae. Four species from the family Scolopendridae were recorded in the survey. The number of centipede records in relation to habitat type for each species is provided in Table 3-5. The location of each species is shown in Figure 3-1.

3.5.1 Scolopendridae

Cormocephalus aurantiipes

Cormocephalus aurantiipes was recorded from Triodia hummock grassland (Site 2). The species is widely distributed in coastal and near coastal locations, particularly in mid-western, southern and eastern Australia (Koch 1983). It is not an SRE species.

Cormocephalus turneri

This species was recorded from *Acacia* shrubland (Site 10). It has a fairly widespread distribution in WA from the Pilbara southwards. It is not an SRE species.

Ethmostigmus rubripes

Ethmostigmus rubripes was recorded from *Acacia* shrubland. It is the largest centipede in Australia and is widespread throughout the continent. It is not an SRE species.

Species 4

A fourth species of Scolopendridae was recorded from a minor drainage line; however due to specimen damage, it could not be confidently identified below the family level. Scolopendridae is not currently known to contain any SRE taxa.

Table 3-5 The number of sites in each habitat type that recorded centipede species.

Family / Genus	Species	Rocky Outcrop	South-facing Slope	Major Drainage Line/ Floodplain	Minor Drainage Line	Hummock Grassland	Low – Medium Shrubland	Total Number of Habitats
Scolopendridae								
Cormocephalus	*aurantiipes*					1		**1**
Cormocephalus	*turneri*						1	**1**
Ethmostigmus	*rubripes*						1	**1**
Sp4					1			

3.6 MALACOSTRACA

3.6.1 Armadillidae

Two species of isopod were recorded, both belonging to the family Armadillidae and the genus *Buddelundia*. The presence of each species in relation to habitat type is presented in Table 3-6. The recorded location of each species is shown in Figure 3-1.

***Buddelundia* sp. 1**

Buddelundia is a large genus with a high presence in Western Australia. All species are currently inadequately described and species cannot be assigned without reference to the type specimens. *Buddelundia* sp. 1 was recorded from Site 1. This species is widely distributed in the arid zone of Western Australia and is therefore not an SRE species.

Buddelundia sp. 2

Buddelundia sp. 2 was recorded from Site 6. It is atypical of the *Buddelundia* genus in that it has a much less convex body shape and smaller interlocking lobes on the margins of the pereonites 1 and 2. Specimens of this species or a very similar species have been recorded from several locations in the Pilbara (Judd pers. comm.). It is highly unlikely that *Buddelundia* sp.2 is an SRE species.

Table 3-6 The number of sites in each habitat type that recorded isopod species.

Family / Genus	Species	Rocky Outcrop	South-facing Slope	Major Drainage line/ Floodplain	Minor Drainage Line	Hummock Grassland	Low Shrubland	Total Number of Habitats
Armadillidae								
Buddelundia	sp. 1			1				**1**
Buddelundia	sp. 2				1			**1**

3.7 MOLLUSCA

No molluscan fauna were recorded during the survey either through systematic or opportunistic techniques employed. Given the general sandy nature of the study area, with very few rocky areas and few sheltered areas, this was expected.

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Figure 3-1 Locations of taxa recorded during the survey of the Davidson Creek Iron Ore Project (excluding insects).

4. LIMITATIONS

Limitations of the survey are outlined in Table 4-1.

Table 4-1 The limitations of the SRE survey of the Davidson Creek Iron Ore Project.

Limitations	Relevant to this survey? Yes / no	Comments
Competency / experience of the consultant carrying out the survey.	No	Jarrad Clark has extensive experience in undertaking SRE surveys throughout the Pilbara, Midwest, Southwest, Kimberley and Goldfields regions of W.A.
Scope (what faunal groups were sampled and were some sampling methods not able to be employed because of constraints such as weather conditions, e.g. pitfall trapping in waterlogged soils or inability to use pitfall traps.)	No	The survey targeted all groups known to include SREs. Extensive foraging effort supplemented the trapping program, to ensure that groups such as pseudoscorpions were targeted in the survey.
Proportion of fauna identified, recorded and/or collected.	Yes	Due to the paucity of knowledge concerning SREs and invertebrates in general, it is almost impossible to assess whether all SRE species have been recorded. Species area curves may be used to determine the likelihood that species are adequately represented, but only if multiple survey data is generated.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data	Yes	As above, there is little historic data concerning invertebrates in the little sandy desert and Gascoyne biogeographic regions.
Timing/weather/season/cycle.	Yes	The survey commenced in early October and concluded in early November. Temperatures increased over this period but there was no significant increase in humidity. Significant rainfall was experienced in December and January.
The proportion of the task achieved and further work which might be needed	Yes	The program was implemented as planned. A total of 10 pitfall sites were established and foraging was undertaken at all these sites.
Disturbances (e.g. fire, flood, accidental human intervention etc.) which affected results of survey.	No	Exploration activities had commenced within the study area, however, the activities were largely occurring in non-prospective SRE habitats and are therefore unlikely to have affected capture rates
Intensity (in retrospect, was the intensity adequate?)	No	The study area was fairly homogenous and is well represented regionally. There were no obvious isolated habitats or geographical barriers present and therefore the intensity of sampling was considered adequate for the site.
Completeness (was relevant area fully surveyed?)	No	The majority of habitats with the greatest potential to facilitate short-range endemism were sampled across the project area.
Remoteness and/or access problems.	No	As the site is relatively flat, no access issues were experienced
Availability of contextual (e.g. biogeographic) information on the region.	No	The project area lies on the western edge of the Little Sandy Desert at the junction of the Gascoyne and Pilbara bioregions. Little information exists on the invertebrate fauna of this area.

5. DISCUSSION

5.1 GENERAL COMMENTS ON THE SURVEY

The study area is considered to have low potential to harbour SRE taxa. There are no distinct SRE habitats present and vegetation communities within the study area are well represented regionally.

All groups known to include SRE taxa were targeted during this survey using both systematic and opportunistic techniques. A total of 17 taxa were recorded, representing ten genera, eight families, six orders and three classes. Arachnids were the most speciose with 11 taxa recorded. Of those, five scorpion species and four pseudoscorpion species were recorded. No land snails were recorded and given the largely sandy nature of the site, with little in the way of micro-habitats or sheltered rocky areas, this was not unexpected.

Twelve of the recorded taxa have known or probable distributions which preclude them from being considered SRE taxa. Three of the taxa that were collected have not previously been recorded (Caeculidae sp., *Oratumnus* sp. and *Austrohorus* sp.) but are considered unlikely to be SRE taxa, either due to known distributions of other members of their family or genus, or due to the diversity and type of habitat the species was recorded in. In the absence of adequate distributional data for invertebrate taxa, both assessment of habitat extent and consideration of known distribution patterns of related species are appropriate surrogates for determining whether a species is likely to be an SRE species (EPA 2009).

It is fairly unlikely that the two species that were recorded that could not be confidently identified due to specimen immaturity or damage (*Urodacu*s sp. and Scolopendridae sp.) are SRE taxa. Both were collected from minor drainage lines in low hills, a habitat which is fairly well represented in the local area. Further, the broader study area contains no obvious dispersal barriers or clearly restricted habitats suggesting the likelihood of any SRE taxa occurring in this area is low.

As the study area contains no habitats of significance to SRE taxa, no modification to the proposed development is considered necessary to protect fauna values from the perspective of SRE taxa.

6. SURVEY PERSONNEL

A summary of the personnel involved in the survey is provided in Table 6-1. Phoenix also gratefully acknowledges the taxonomists who assisted with the species identifications.

Table 6-1 Survey personnel.

Name	Title	Qualifications
Mr Jarrad Clark	Senior Invertebrate Zoologist, Project Manager	BSc Environmental Management
Ms Karen Crews	Senior Environmental Advisor	BSc (hons) Environmental Biology
Mr Jarrad Donald	Biologist	BSc Environmental Management
Mr Sean Steed	Biologist	BBus, Owner: Bushland Restoration Services

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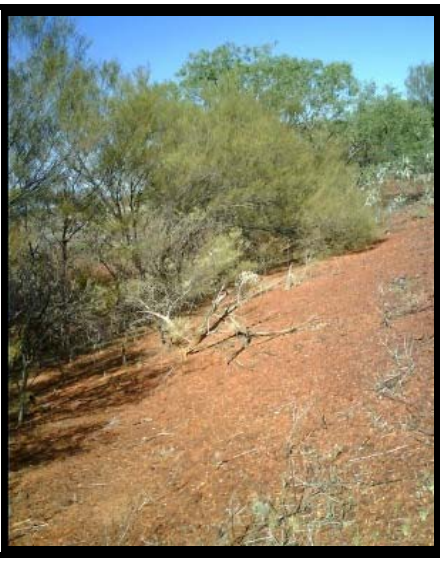
APPENDIX 1: DAVIDSON CREEK SITE DESCRIPTIONS

Site Description	Site Photograph
Site 1 01/10/2008 Major drainage line / floodplain. *Eucalyptus victrix* and *Acacia* sp. sparse low trees to 4m over *Cenchrus ciliaris* (buffel grass). Red/brown sandy clay.	
Site 2 01/10/2008 *Triodia* hummock grassland. *Acacia* sp. very open small trees to 4m over sparse low shrubs, over mature hummocks. Red/brown sandy clay. Pealing clay at surface.	
Site 3 01/10/2008 South slope (minor). *Acacia aneura* medium shrubs over mixed shrubs to 1.5m over *Triodia pungens*. Red sandy clay. Skeletal soils with large rocks and stones.	

Site Description	Site Photograph
Site 4 01/10/2008 Hilltop drainage line (minor) in low hills. *Acacia aneura* small trees to 4m over *Eremophila forrestii*. Stick debris plentiful. Red/brown sandy clay loam. Soils to 1m overlain by small stones.	
Site 5 01/10/2008 Minor South-facing slope. *Acacia aneura* small trees to 4m over *Eremophila forrestii* over *Triodia pungens* hummock grass. Stick debris plentiful. Red/brown sandy clay. Hard soils with large rocks and stones at surface. Outcropping present.	No Photo Available
Site 6 01/10/2008 Minor drainage line in low hills. *Acacia aneura* low trees to 4m over sparse mixed shrubs to 1.5m over mixed low scattered shrubs to 60cm. Red/brown sandy clay. Shallow soils, broken rocks and stones	

Site Description	Site Photograph
Site 7 01/10/2008 Floodplain grassland. *Eucalyptus victrix* and dead *Acacia* sp. over *Cenchrus ciliaris*. Red/brown sand.	
Site 8 01/10/2008 Mulga woodland Open mulga woodland to 4m over Poaceae sp.. Heavy litter under mulga, otherwise bare. Red/brown sandy clay. Deep sandy soils.	No Photo Available
Site 9 01/10/2008 Low Shrubland Sparse low open shrubland. Mixed shrubs 2.0 - 0.5m over Poaceae sp. Burnt within the past five years. Red/brown sandy clay.	

Site Description	Site Photograph
Site 10 01/10/2008 Shrubland. Moderately dense *Acacia* shrubland to 2m over *Triodia wiseana* hummock grass. Red/brown deep sandy clay.	

APPENDIX 2: DAVIDSON CREEK SRE SITE GPS COORDINATES

Datum:	WGS-84 (51 K)			
Name	Easting (UTM)	Northing (UTM)	Latitude	Longitude
SRE01	241806	7408197	-23° 24 56.513"S	120° 28 24.024"E
SRE02	241495	7408243	-23° 24 54.871"S	120° 28 13.102"E
SRE03	241470	7407406	-23° 25 22.037"S	120° 28 11.719"E
SRE04	242518	7407549	-23° 25 17.976"S	120° 28 48.716"E
SRE05	245275	7407361	-23° 25 25.651"S	120° 30 25.657"E
SRE06	245947	7407724	-23° 25 14.232"S	120° 30 49.54"E
SRE07	246433	7407746	-23° 25 13.793"S	120° 31 6.636"E
SRE08	243179	7408311	-23° 24 53.611"S	120° 29 12.44"E
SRE09	241261	7408661	-23° 24 41.148"S	120° 28 5.146"E
SRE10	240915	7407733	-23° 25 11.096"S	120° 27 52.384"E