PHOENIX
ENVIRONMENTAL SCIENCES

Targeted short-range endemic invertebrate survey for the Anketell Point Rail Alignment and Port Projects – Addendum

Prepared for Australian Premium Iron Management Pty Ltd

Final Report

November 2010

Targeted short-range endemic invertebrate survey– Addendum

Anketell Point Rail Alignment and Port Projects

Draft Report

Prepared for Australian Premium Iron Management Pty Ltd

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Project code: 958-AP-API-SRE

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EXECUTIVE SUMMARY

On 4 May 2010, Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by Ms Michelle Carey of Australian Premium Iron Management Pty Ltd (API) to undertake a targeted short-range endemic (SRE) invertebrate fauna survey of the Anketell Point Rail Alignment and Port Projects (the Project). The survey is supplementary to an earlier baseline SRE survey undertaken for the Project (Phoenix 2010). This report therefore forms an addendum to the technical report for baseline survey.

The baseline survey recorded four potential SRE taxa and included several records within the proposed impact footprint. In light of these results, it was recommended that an additional survey be undertaken to target the potential SRE species more broadly and further define the distribution of these taxa.

Accordingly, a targeted survey in additional locations outside the original study area was conducted from 18 - 21 May 2010 for the following potential SRE taxa:

- *Quistrachia* sp. (Mollusca)
- *Eucyrtops* sp. (Mygalomorphae)
- *Synsphyronus* sp. (Pseudoscorpiones)
- *Lychas* 'near harveyi' (Scorpiones)

The survey comprised active searches and collection of leaf litter samples in suitable habitat. Customised search strategies were employed for each target species.

Of the targeted species, only the land snail species, *Quistrachia* sp. was recorded during the targeted survey. The species was recorded from 12 of 27 sampled sites and from five of eight sampled habitat types, nearly all of which contained rocky features. The records further indicate the species is confined to rocky habitats and is likely to be an SRE. It is considered likely that the species' range extends further along the coastline east and west of the project area, although the degree of genetic variation is uncertain.

Burrows of the trap-door spider species, *Eucyrtops* sp. were not recorded but the results are likely to have been influenced by the survey techniques being confined to hand foraging, as burrows of *Eucyrtops* are known to be cryptic and are difficult to find. Suitable habitat was observed in several locations within the targeted study area and it is considered likely that this species' range extends beyond the original (June-July 2009 survey) study area.

Although three pseudoscorpion species and numerous specimens were collected from coastal dune areas and rocky hillslopes, no additional collections of the *Synsphyronus* sp. were obtained. The results of the June-July and targeted surveys suggest this species is confined to Dixon Island and is therefore an SRE species.

Despite extensive night searching in suitable habitats, no additional records of *Lychas* 'near harveyi' were recorded. Only its common near relative *Lychas* 'harveyi' was recorded which is known to reside in similar habitat. While the survey targeted the desired habitats (flat stony plains and creeklines), the intensity of hand foraging effort may not have been sufficient to record the species presence. However, it is considered likely that the species' range extends beyond the original (June-July 2009 survey) study area, but it may be quite habitat restricted.

1 INTRODUCTION

On 4 May 2010, Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by Ms Michelle Carey of Australian Premium Iron Management Pty Ltd (API) to undertake a targeted short-range endemic (SRE) invertebrate fauna survey of the Anketell Point Rail Alignment and Port Projects (the Project). The survey is supplementary to an earlier baseline SRE survey undertaken for the Project (Phoenix 2010). This report therefore forms an addendum to the technical report for baseline survey.

1.1 BACKGROUND

API is developing the West Pilbara Iron Ore Project (WPIOP) on behalf of equal joint venture partners Aquila Resources Ltd and America Metals and Coal Industries. The Project is located within the Shire of Roebourne, approximately 1,500km north of Perth and 30km northeast of Karratha in the Pilbara Region of Western Australia. The total project area is approximately 80km^2. The current proposed infrastructure associated with the WPIOP includes port facilities at Anketell Point and a rail alignment to the port facilities (Figure 1-1).

A baseline SRE survey was undertaken by Phoenix for the Project in June-July 2009 (the June-July 2009 survey). The original study area for the June-July 2009 survey comprised the port project area and the northern-most section of the rail alignment. The survey recorded 31 species from groups known to include SRE taxa, of which four were determined to be potential SRE taxa (16%). From the initial baseline survey results the likelihood of short-range endemism for each of these species ranged from moderate to high. Further, these specimens were recorded from 12 of the 24 sites surveyed, including several records within the proposed impact footprint.

In light of these June-July 2009 survey results, it was recommended that an additional survey be undertaken to target the potential SRE species more broadly and further define the distribution of these taxa. The targeted study area extended outside the original survey extent, particularly into suitable habitat east and west of the project area.

1.2 SCOPE OF WORK AND SURVEY OBJECTIVES

The aims and scope of works were as follows:

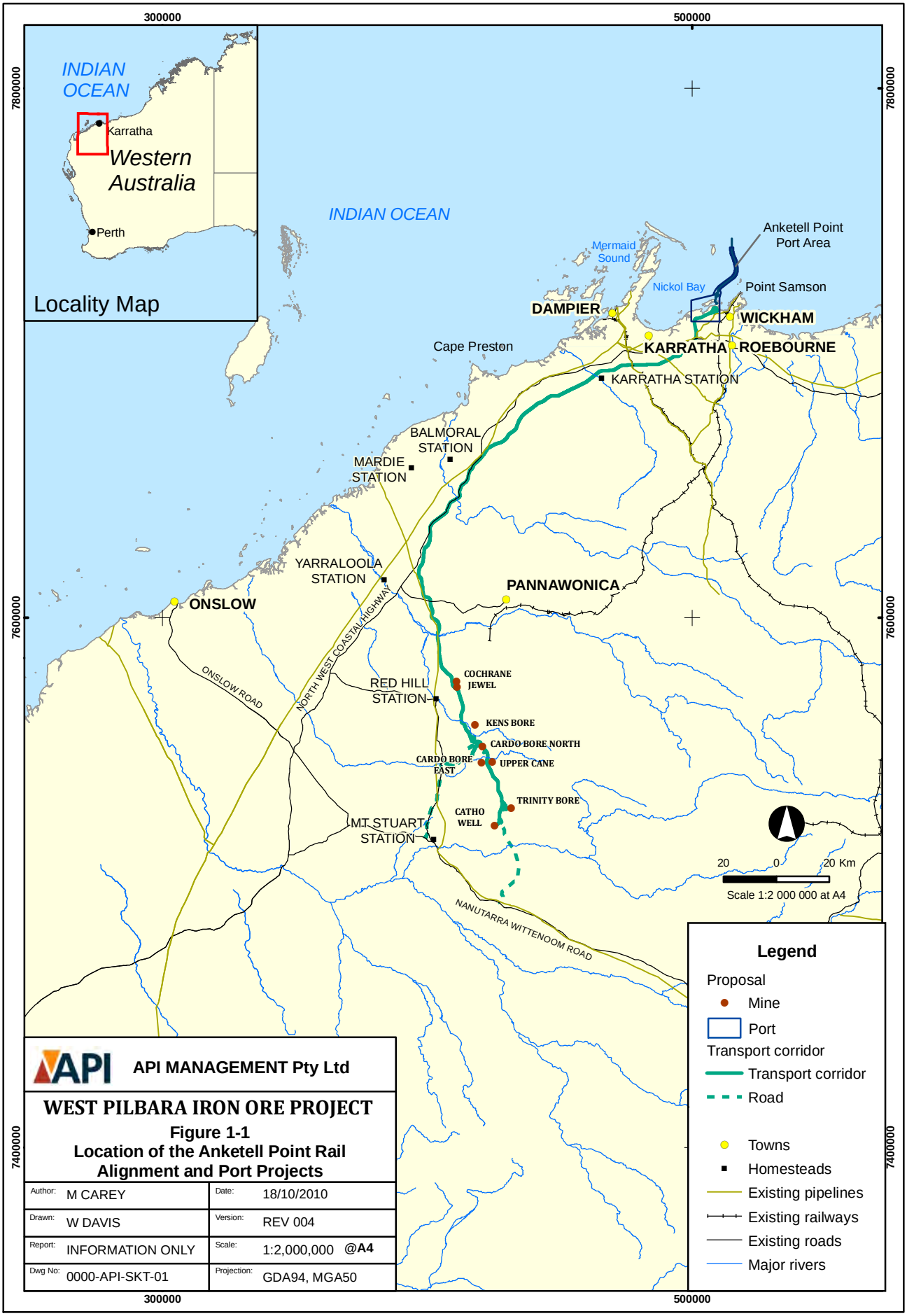
- to conduct a Level 1 (targeted) SRE survey within the study area for the following species;
    - *Quistrachia* sp. (Mollusca)
    - *Eucyrtops* sp. (Mygalomorphae)
    - *Synsphyronus* sp. (Pseudoscorpiones)
    - *Lychas* 'near harveyi' (Scorpiones)
- to undertake data analysis and prepare a technical report on the results of the survey.

Where practicable, the survey design, methodology and report-writing aspects scope of work adhere 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)
- EPA *Guidance Statement No. 20: Sampling methods and survey considerations for Short-range endemic invertebrate fauna in Western Australia*. (EPA 2007).
- EPA Guidance Statement No. 56: *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004).

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 < 10km^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. This analogy has relevance to some habitats / geographic features within the project area. In particular, the rock piles and the low hills that reside within the tidal mudflat areas are effectively isolated, as well as Dixon Island which is separated from the mainland. Mesic drainage basins along the coast are also considered to provide potential isolating habitat for SRE taxa. All four potential SRE taxa were recorded from these habitat types.


300000
500000
7800000
7600000
7400000
INDIAN OCEAN
Karratha
Western Australia
Perth
Locality Map
INDIAN OCEAN
Mermaid Sound
Anketell Point Port Area
Nickol Bay
Point Samson
DAMPIER
WICKHAM
Cape Preston
KARRATHA
ROEBOURNE
KARRATHA STATION
BALMORAL STATION
MARDIE STATION
YARRALOOLA STATION
PANNAWONICA
ONSLOW
NORTH WEST COASTAL HIGHWAY
ONSLOW ROAD
RED HILL STATION
COCHRANE JEWEL
KENS BORE
CARDO BORE NORTH
CARDO BORE EAST
UPPER CANE
TRINITY BORE
CATHO WELL
MT STUART STATION
NANUTARRA WITTENOOM ROAD
20 0 20 Km
Scale 1:2 000 000 at A4
Legend
Proposal
Mine
Port
Transport corridor
Transport corridor
Road
Towns
Homesteads
Existing pipelines
Existing railways
Existing roads
Major rivers
API MANAGEMENT Pty Ltd
WEST PILBARA IRON ORE PROJECT
Figure 1-1
Location of the Anketell Point Rail Alignment and Port Projects
Author: M CAREY
Date: 18/10/2010
Drawn: W DAVIS
Version: REV 004
Report: INFORMATION ONLY
Scale: 1:2,000,000 @A4
Dwg No: 0000-API-SKT-01
Projection: GDA94, MGA50

2 METHODS

2.1 HABITAT ASSESSMENT AND SITE SELECTION

Sampling sites were determined using aerial photography and other GIS data based on the previous survey results. At the broadest scale, site selection considered aspect, topography and land systems, while at the finer scale, consideration was given to vegetation and soil type, individual trap aspect (e.g. trap placement and foraging on the southern side of trees, shrubs and boulders) and proximity to water bodies and drainage lines or soaks. Final site selection was determined at the commencement of the initial field survey, following site verification.

Sampling sites for targeted foraging for each species focused on:

- Location and excavation of *Eucyrtops* and *Lychas* burrows in spinifex plain and low rocky slope habitats to the east and west of the project area;
- Nocturnal black-light searching for *Lychas* specimens to the east and west of the project area;
- Inspection of rock piles and rocky outcrops / slopes for *Quistrachia* specimens to the east and west of the project area, particularly to the west of Cleaverville; and
- Leaf litter sample collection for *Synsphyronus* specimens in coastal dune habitats to the east and west of the project area.

2.2 TARGET TAXA

The survey targeted four potential SRE species identified in the 2009 baseline SRE survey (Phoenix 2010), as follows:

- *Quistrachia* sp. (Mollusca);
- *Eucyrtops* sp. (Mygalomorphae);
- *Synsphyronus* sp. (Pseudoscorpiones); and
- *Lychas* 'near harveyi' (Scorpiones).

2.3 SAMPLING METHODOLOGY

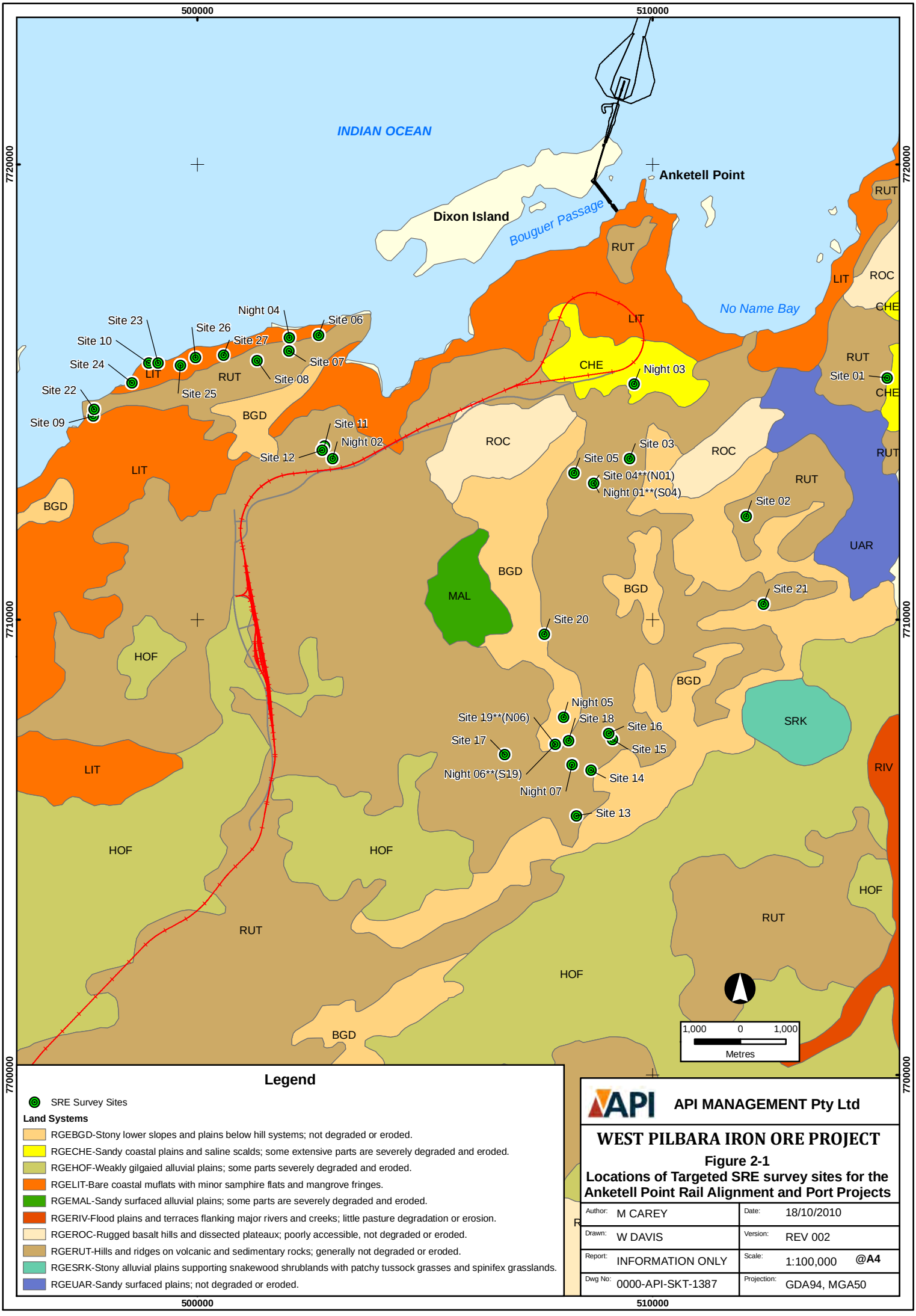
The field survey comprised:

- Active searches (foraging) during both day and night; and
- The collection of leaf litter samples.

Active foraging was conducted at 27 sites (Figure 2-1). The foraging technique incorporated the systematic inspection of logs, larger plant debris, and 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. A temporally and spatially standardised approach was undertaken for the foraging component, whereby each site was sampled for 60 - 90 minutes within a 50m x 50m area (Table 2-1).

Customised search strategies were also employed for each target species. For example, rocks and rock crevices were inspected and leaf litter samples were collected and sieved from 27sites for *Synsphyronus* sp. All rocky outcroppings observed at each site were searched for *Quistrachia*. Conditions were favourable for the collection of land snails as rainfall occurred in the study area at the start of the survey (24.2mm on 18 - 19 May). Black-lighting for *Lychas* 'near harveyi' was undertaken at a total of seven sites, spread throughout the survey area for a total of 60 - 90 minutes across two 100mx100m areas at each site (Table 2-1).

Mygalomorphae trap door spider burrows (for *Eucyrtops* sp.) 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.



Legend

- SRE Survey Sites

Land Systems

- RGEBGD-Stony lower slopes and plains below hill systems; not degraded or eroded.
- RGECHE-Sandy coastal plains and saline scalds; some extensive parts are severely degraded and eroded.
- RGEHOF-Weakly gilgaied alluvial plains; some parts severely degraded and eroded.
- RGELIT-Bare coastal muflats with minor samphire flats and mangrove fringes.
- RGEMAL-Sandy surfaced alluvial plains; some parts are severely degraded and eroded.
- RGERIV-Flood plains and terraces flanking major rivers and creeks; little pasture degradation or erosion.
- RGEROC-Rugged basalt hills and dissected plateaux; poorly accessible, not degraded or eroded.
- RGERUT-Hills and ridges on volcanic and sedimentary rocks; generally not degraded or eroded.
- RGESRK-Stony alluvial plains supporting snakewood shrublands with patchy tussock grasses and spinifex grasslands.
- RGEUAR-Sandy surfaced plains; not degraded or eroded.

API MANAGEMENT Pty Ltd

WEST PILBARA IRON ORE PROJECT

Figure 2-1
Locations of Targeted SRE survey sites for the Anketell Point Rail Alignment and Port Projects

Author:	M CAREY	Date:	18/10/2010
Drawn:	W DAVIS	Version:	REV 002
Report:	INFORMATION ONLY	Scale:	1:100,000 @A4
Dwg No:	0000-API-SKT-1387	Projection:	GDA94, MGA50

Leaf litter and soil samples were taken from sites where there was considered to be potential for SRE occurrence. The collection of leaf litter samples was not standardised (either volumetrically or by weight) due to the high variability of the soil and leaf litter depth throughout the project area. However, a leaf litter sample from an area 30cm x 30cm was collected from underneath an average of three trees at each site with sufficient leaf litter accumulation (Table 2-1). Samples were taken from any prospective habitat available.

Habitat descriptions were recorded and photographs taken for each site (Appendix 1). The coordinates of each site were recorded by a hand held GPS device (Appendix 2).

2.4 SAMPLE HANDLING

All specimens were transported to Perth for sorting and identification. Specimens collected by foraging techniques were placed in glass vials. All leaf litter samples were sieved (18mm, 8mm and 5mm stack) in the field and live specimens were labelled accordingly and sorted on return to Perth using a stereo dissecting microscope.

2.5 TAXONOMY AND NOMENCLATURE

Taxonomy was conducted in-house as far as possible, in most instances to genus or morpho-species level. Where specific identifications could not be determined in-house, taxonomic services were sought by the following relevant experts:

- Dr Mark Harvey, WA Museum (pseudoscorpions);
- Dr Erich Volschenk (WA Museum (scorpions);
- Ms Shirley Slack-Smith, WA Museum (land snails);

2.6 SURVEY TIMING AND EFFORT

The survey was conducted from 18 - 21 May 2010. Sampling effort is summarised in Table 2-1.

Table 2-1 Sampling effort for the survey.

Techniques	No. sites	No. traps / Area (m^2)	No. nights / Time (mins)	Total sample size (n)
Black-lighting	7	100m x 100m	420 mins	840 mins 140,000m^2
Foraging	27	50m x 50m	1620 mins	3240 mins 135,000m^2
Leaf litter samples	14	n/a	n/a	14

2.7 SURVEY PERSONNEL

Personnel involved in the survey are listed in Table 2-2.

Table 2-2 Personnel involved in the survey.

Person	Title	Qualifications
Mr. Jarrad Clark	Senior Invertebrate Zoologist, Project Manager	B.Sc. Env. Mgt. (Post. Grad. Dip.)
Ms Conor O'Neill	Environmental Scientist	B.Sc. Sust. Dev. and Cons. Biol.

3 RESULTS

This survey was a supplementary survey to the 2009 survey (Phoenix 2010) and covered new areas that have not previously been surveyed for SRE's. As expected, additional species were collected to the target species. These have been included in the results for completeness. Coastal dunes, north and south facing gullies and southern rocky slopes were the most sampled habitat types (Table 3-1). A lesser number of rock piles, slopes and breakaways were also sampled. A single creek-line site was sampled during the day, but a number of additional creek-line sites were surveyed for scorpions at night using a black light (sites N1-7).

Table 3-1 Habitat-Site matrix.

	Habitat						*Coastal	**Saddle
Site	North Facing Gully	South Facing Gully	Rock Hilltop/ Rock Slope	Isolated Rocky Knoll	Creek-line	Rock Pile	Low Wooded Basin	Coastal Dune
1			✓					
2			✓					
3			✓					
4			✓					
5		✓						
6	✓							
7	✓							
8	✓							
9			✓					
10			✓*					
11				✓				
12			✓					
13		✓						
14		✓						
15					✓			
16						✓**		
17						✓		
18						✓		
19							✓	
20		✓						
21	✓							
22								✓
23								✓
24								✓
25								✓
26								✓
27								✓
N1					✓			
N2					✓			
N3					✓			
N4					✓			
N5					✓			
N6					✓			
N7					✓			

The survey recorded species from each of the target taxonomic groups; Mollusca, Pseudoscorpiones, Scorpiones and Mygalomorphae. Millipedes (Diplopoda) were also recorded. This group was not recorded in the original (2009) survey, which was surprising given that rainfall during the 2009 survey triggered large-scale mobilisation of land snails across the study area.

Thirteen species were recorded from taxonomic groups known to include SRE species, representing 11 genera and eight families (Table 3-2). Twelve of these species were from the four target taxonomic groups.

Of the four target species, only the land snail *Quistrachia* sp. was recorded. This species was the second most frequently collected in the survey, recorded from 12 of the 27 sites and from five of the eight sampled habitat types, nearly all of which contained rocky features.

No records of *Eucyrtops* sp., *Synsphyronus* sp. or *Lychas* 'near harveyi' were made. Further, no burrows resembling those of *Eucyrtops* sp. were observed, however the lack of additional records for this species may be due to the survey techniques. Species of the genus *Eucyrtops* build very cryptic burrows which are difficult to locate by foraging. Males wandering in search of female burrows may be caught by pitfall trapping, however no trapping was undertaken during the targeted survey.

In light of these limitations an assessment of suitable habitat for this species was undertaken during the field survey. Suitable habitat was observed in several parts of the study area, including Site 04, 11, 12, 13 and 15. It is considered likely that the species is present in at least some of these areas.

The pseudoscorpion *Synsphyronus* sp. was only collected from Dixon Island in the 2009 survey. Despite a very intensive foraging effort in similar habitat along the coast and inland it was not recorded in the targeted survey. The intensive foraging effort and lack of additional results suggests that this species is probably restricted to Dixon Island confirming it as an SRE species.

Despite a lack of additional records, suitable habitat was observed for the target scorpion species, *Lychas* 'near harveyi' in the extended survey and it is considered likely that this species range extends beyond the original study area. A scorpion similar to *Lychas* 'near harveyi' (*Lychas* 'harveyi') was recorded in the targeted survey, in habitat considered suitable for the target species. *Lychas* 'harveyi' is considered common and therefore more likely to be collected.

Two additional potential SRE species was recorded in the targeted survey, a scorpion *Isometroides* sp. and a millipede, *Antichiropus* sp. Both species were located approximately 11km southeast of the project area.

Table 3-2 The invertebrate species from groups known to include SRE taxa recorded during the survey.

Family	Genus	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	N2	N5	N7	Total # Sites	% Presence
Mygalomorphae (trapdoor spider)																																		
Nemesiidae	*Aname*	*?MYG001*									1			1																			**2**	**6**
Scorpiones																																		
Buthidae	*Isometroides*	sp. *(SRE)*																			1												**1**	**3**
	Lychas	'harveyi '																												1	1		**2**	**6**
		'hairy tail group'				1																										1	**2**	**6**
Pseudoscorpiones																																		
Atemnidae	*Oratemnus*	sp.																										1					**1**	**3**
Olpiidae	*Beierolpium*	sp. *8/2*									1					1																	**2**	**6**
	Indolpium	sp.			1	1					1	1			1						1					1	1						**8**	**26**
Polydesmida (millipedes)																																		
Paradoxomatidae	*Antichiropus*	sp.(fem)																1															**1**	**3**
Gastropoda (land snails)																																		
Camaenidae	*Rhagada*	*convicta*	1	1				1	1	1	1		1	1	1	1		1	1	1	1	1	1		1			1	1				**19**	**63**
	Quistrachia	sp. indet *(SRE)*		1	1	1	1	1	1	1						1		1		1			1		1								**12**	**40**
Pupillidae	*Pupoides*	*contrarius*																							1			1	1				**3**	**10**
		lepidulus						1			1					1									1			1	1				**6**	**20**
Succineidae	*Succinea*	sp. indet								1											1												**2**	**6**

(SRE) Denotes a potential short-range endemic species
1 denotes the presence at the site

Table 3-3 Habitat-Site matrix for potential SRE species collected in the survey.

	Habitat Type							
Site	**North Facing Gully**	**South Facing Gully**	**Rock Hilltop / Rock Slope**	**Isolated Rocky Knoll**	**Creek Line**	**Rock Pile**	**Low Wooded Basin**	**Coastal Dune**
1			0					
2			1					
3			1					
4			1					
5		1						
6	1							
7	1							
8	1							
9			0					
10			0					
11				0				
12			0					
13		0						
14		1						
15					0			
16						1		
17						0		
18						1		
19							1	
20		0						
21	1							
22								0
23								1
24								0
25								0
26								0
27								0
N01					0			
N02					0			
N03					0			
N04					0			
N05					0			
N06					0			
N07					0			
Total	**4/4**	**2/4**	**3/7**	**0/1**	**0/8**	**2/3**	**1/1**	**1/6**

1 Denotes the presence of a potential SRE species at the site; 0 Denotes the absence of any SRE taxa from the site.

3.1 MYGALOMORPHAE

3.1.1 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 mountain tops. Species belonging to genera that dominate in drier forest to desert habitats (e.g. *Aname*) have generally wider distributions, but depending on the biogeographical history of the area, they may still have disjunct distributions.

Aname ?MYG001

According to the Descriptive Language for Taxonomy (DELTA) database, the genus *Aname* and its relatives (e.g. *Kwonkan*) have diversified strongly in Western Australia and show higher degrees of endemism than those genera in eastern Australia.

There are currently four named and numerous unnamed species from many different regions in Western Australia. Taxonomic revisions of Australian Nemesiidae have been predominantly of Queensland species where 47 new species have been described in the previous three decades (Raven 1981, 1982a, b, c, 1983, 1984a, b, 1985a, b; Raven 1994). In Western Australia, although the studies have been numerous (Main 1972, 1975, 1977, 1982a, b, 1983, 1985a, b, 1986, 1991, 1994, 2004, 2008), few have dealt with species outside the south–west land division. The result is that many species from large parts of Western Australia remain formally undescribed.

Despite taxonomic information which suggests that there may be a number of species within this species group, *Aname* MYG001 is the most commonly recorded Pilbara *Aname* species. *Aname* MYG001 was recorded from two rocky hilltop/slope sites (Figure 3-1, Table 3-2 and Table 3-4). It was also recorded in the June-July 2009 survey from all habitat types except rocky hilltop/slope sites, so this record can be considered a habitat extension of the species for the area.

Due to the large numbers of records of this species from all different habitat types, *Aname* MYG001 **is not considered an SRE species**.

Table 3-4 Mygalomorph records by habitat type.

FAMILY	GENUS	SPECIES	NFG	SFG	RHRS	IRK	CL	RP	LWB	CD
Nemesiidae	*Aname?*	'MYG001'			1					

NFG – North Facing Gully, SFG – South Facing Gully, RHRS – Rock Hilltop/Rock Slope, IRK – Isolated Rocky Knoll, CL – Creekline, RP – Rock Pile, LWB – Low Woodland Basin, CD – Coastal Dune.

1 – Denotes presence of species within the habitat type.

3.2 SCORPIONES: BUTHIDAE

One family of scorpion (Buthidae), represented by two genera (*Isometroides* and *Lychas*) were recorded in the survey (Figure 3-1). Similar to the original survey effort, no members of the endemic Australian family Urodacidae were recorded.

3.2.1 Buthidae

Isometroides sp.

Taxonomically, only two species of *Isometroides* are presently recognised in Western Australia although there are many that are undescribed in current collections. *Isometroides* are ground

dwelling scorpions which have been known to prey on and have often been collected in trapdoor spider burrows (Volschenk 2010). While their taxonomy is not current, most species are known to have fairly broad distributions,

Isometroides sp. was collected from a low wooded basin site (Site 19) within the study area (Table 3-2, Table 3-5). It was not recorded in the June-July 2009 survey. **This species is considered to be of low risk of being SRE**.

Lychas 'hairy-tail group'

Two specimens of *Lychas* 'hairy-tail group' were collected from Site 4 and 'Night' Site N7, along the base of a rocky slope and within creekline vegetation respectively (Table 3-2, Table 3-5). It was recorded in the June-July 2009 survey from a creekline location. This group is currently known to be restricted to the Pilbara Region of Western Australia, **but it is thought unlikely to contain any SRE species** (Framenau and Harvey 2009a).

Lychas 'harveyi'

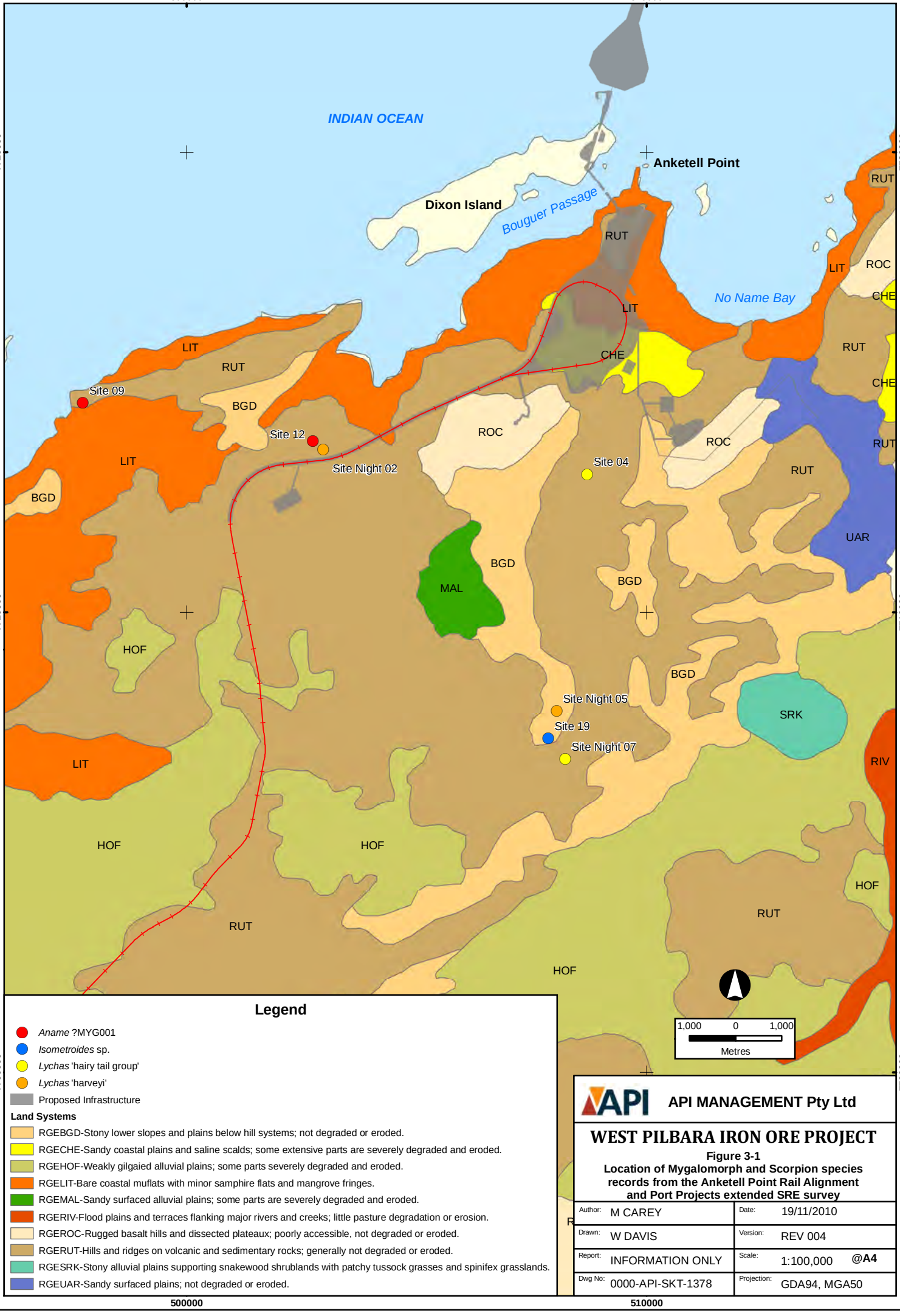
Outside the project area, *Lychas* 'harveyi' specimens were recorded from two sites (N2 and N5) each within a creekline (Table 3-2, Table 3-5). While similar to the target species *Lychas* 'near harveyi', this species *Lychas* 'harveyi'is not the target species but one of the most commonly recorded scorpion species from the Pilbara. In the June-July 2009 survey it was not recorded, however **this species is not an SRE**.

Table 3-5 Scorpion records by habitat type.

FAMILY	GENUS	SPECIES	NFG	SFG	RHRS	IRK	CL	RP	LWB	CD
Buthidae	*Isometroides*	sp.(SRE)							1	
	Lychas	'hairy tail group'			1		1			
		'harveyi'					1			

NFG – North Facing Gully, SFG – South Facing Gully, RHRS – Rock Hilltop/Rock Slope, IRK – Isolated Rocky Knoll, CL – Creek Line, RP – Rock Pile, LWB – Low Woodland Basin, CD – Coastal Dune.

1 – Denotes presence of species within the habitat type.



Legend

- *Aname* ?MYG001
- *Isometroides* sp.
- *Lychas* 'hairy tail group'
- *Lychas* 'harveyi'
- Proposed Infrastructure

Land Systems

- RGEBGD-Stony lower slopes and plains below hill systems; not degraded or eroded.
- RGECHE-Sandy coastal plains and saline scalds; some extensive parts are severely degraded and eroded.
- RGEHOF-Weakly gilgaied alluvial plains; some parts severely degraded and eroded.
- RGELIT-Bare coastal muflats with minor samphire flats and mangrove fringes.
- RGEMAL-Sandy surfaced alluvial plains; some parts are severely degraded and eroded.
- RGERIV-Flood plains and terraces flanking major rivers and creeks; little pasture degradation or erosion.
- RGEROC-Rugged basalt hills and dissected plateaux; poorly accessible, not degraded or eroded.
- RGERUT-Hills and ridges on volcanic and sedimentary rocks; generally not degraded or eroded.
- RGESRK-Stony alluvial plains supporting snakewood shrublands with patchy tussock grasses and spinifex grasslands.
- RGEUAR-Sandy surfaced plains; not degraded or eroded.

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WEST PILBARA IRON ORE PROJECT

Figure 3-1
Location of Mygalomorph and Scorpion species records from the Anketell Point Rail Alignment and Port Projects extended SRE survey

Author:	M CAREY	Date:	19/11/2010
Drawn:	W DAVIS	Version:	REV 004
Report:	INFORMATION ONLY	Scale:	1:100,000 @A4
Dwg No:	0000-API-SKT-1378	Projection:	GDA94, MGA50

3.3 PSEUDOSCORPIONES

The Western Australian pseudoscorpion fauna is fairly diverse with representatives of 17 different families. They are found in a variety of biotopes, but can be most commonly collected from the bark of trees, from the underside of rocks, or from leaf litter habitats. The pseudoscorpion fauna from Anketell Point was found to consist of species in the families Chernetidae, Chthoniidae, Garypidae and Olpiidae. In the targeted survey round, species from the families Atemnidae and Olpiidae were recorded (Figure 3-2, Table 3-2,Table 3-6).

3.3.1 Atemnidae

***Oratemnus* sp.**

Atemnids are frequently found under the bark of trees in Western Australia and the genus *Oratemnus* is thought to be widespread, hence it is believed that most species will be found to be widely distributed. *Oratemnus* sp. was recorded at a single coastal dune site (Site 26) (Figure 3-2). In the June-July 2009 survey it was not recorded, however **this species does not represent a SRE species.**

3.3.2 Olpiidae

Throughout the world, this family contains 33 genera and more than 250 species divided into two tribes, the Olpiini and the Hesperolpiini based on the length of the venom ducts (Framenau and Harvey 2009b). Olpiids are found under stones, in leaf litter and under the bark of trees.

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

In Australasia, members of the genus *Beierolpium* are considered to be widespread (Framenau and Harvey 2009b); however the systematic status of members of this genus in the Pilbara has not been fully assessed. It is not possible to firmly establish the identity of these specimens, or determine whether any are short-range endemics, until a complete systematic revision of the Western Australian members of *Beierolpium* is undertaken in the Pilbara and other bioregions. Nonetheless, this species, *Beierolpium* sp. 8/2, was recorded in two rocky hilltop and south facing gully sites (Site 9 and 14). It was the second most abundant species collected during the June-July 2009 survey. *Beierolpium* sp. 8/2 was also recorded near Cape Preston 80km west of Karratha (Phoenix 2009a) and Davidson Creek, 80km east of Newman (Phoenix 2009b). ***Beierolpium* sp. 8/2 is unlikely to be an SRE species.**

***Indolpium* sp.**

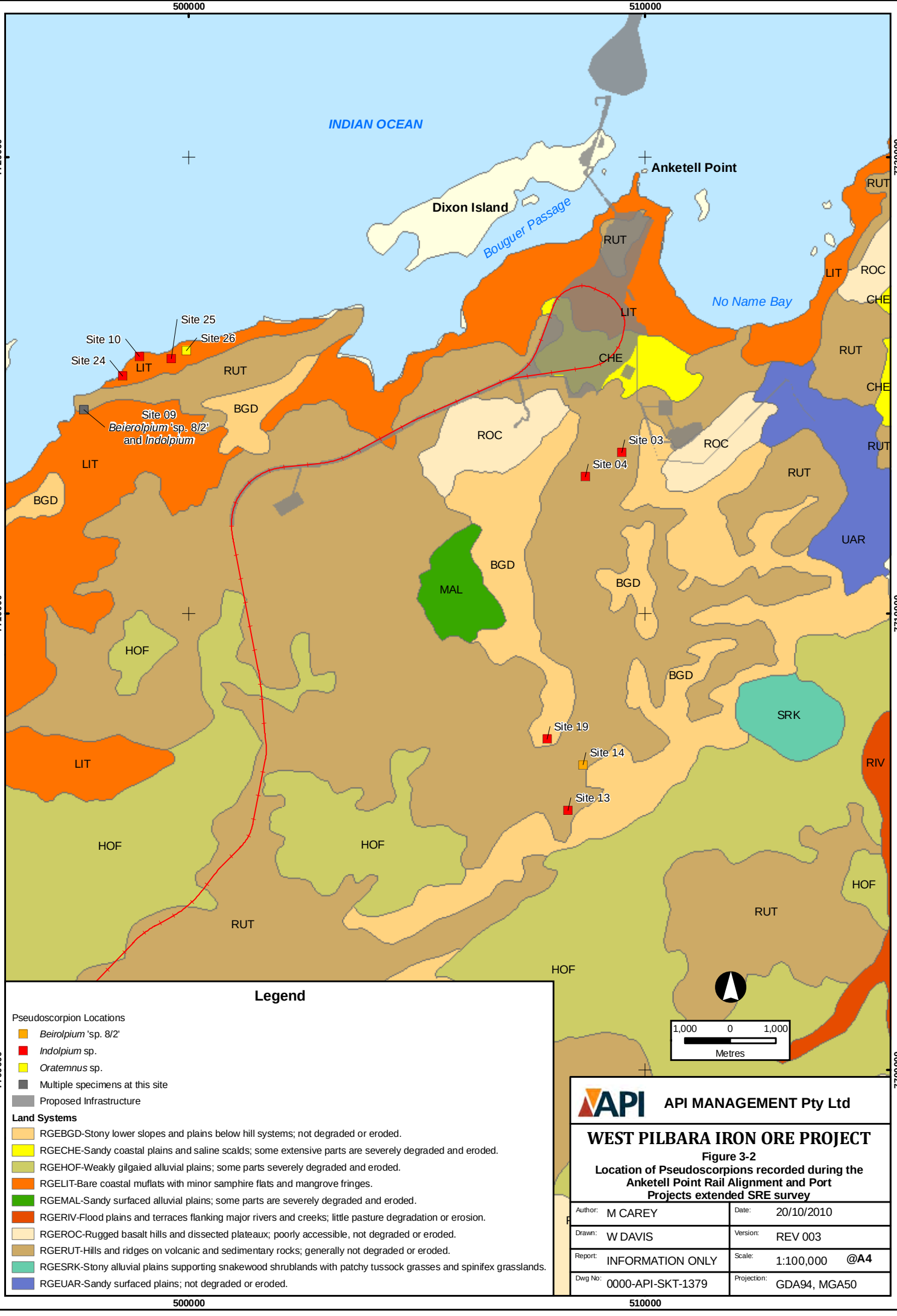
Indolpium sp. was the most abundant pseudoscorpion species recorded in the survey, collected from four habitat types (Table 3-6). All specimens represent a single species, known from other regions of Western Australia. In the June-July 2009 survey this species was recorded from rock piles, rocky slopes, dunes, basins and sandy ridges on the coast, and at a drainage basin at the foot of low hills. Based on the current levels of knowledge of this species, ***Indolpium* sp. is considered unlikely to be a SRE species**.

Table 3-6 Pseudoscorpion records by habitat type.

FAMILY	GENUS	SPECIES	NFG	SFG	RHRS	IRK	CL	RP	LWB	CD
Atemnidae	*Oratemnus*	sp.								1
Olpiidae	*Beierolpium*	sp.8/2		1	1					
	Indolpium	sp.		1	1				1	1

NFG – North Facing Gully, SFG – South Facing Gully, RHRS – Rock Hilltop/Rock Slope, IRK – Isolated Rocky Knoll, CL – Creek Line, RP – Rock Pile, LWB – Low Woodland Basin, CD – Coastal Dune.

1 – Denotes presence of species within the habitat type



Legend

Pseudoscorpion Locations

- *Beirolpium* 'sp. 8/2'
- *Indolpium* sp.
- *Oratemnus* sp.
- Multiple specimens at this site
- Proposed Infrastructure

Land Systems

- RGEBGD-Stony lower slopes and plains below hill systems; not degraded or eroded.
- RGECHE-Sandy coastal plains and saline scalds; some extensive parts are severely degraded and eroded.
- RGEHOF-Weakly gilgaied alluvial plains; some parts severely degraded and eroded.
- RGELIT-Bare coastal muflats with minor samphire flats and mangrove fringes.
- RGEMAL-Sandy surfaced alluvial plains; some parts are severely degraded and eroded.
- RGERIV-Flood plains and terraces flanking major rivers and creeks; little pasture degradation or erosion.
- RGEROC-Rugged basalt hills and dissected plateaux; poorly accessible, not degraded or eroded.
- RGERUT-Hills and ridges on volcanic and sedimentary rocks; generally not degraded or eroded.
- RGESRK-Stony alluvial plains supporting snakewood shrublands with patchy tussock grasses and spinifex grasslands.
- RGEUAR-Sandy surfaced plains; not degraded or eroded.

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WEST PILBARA IRON ORE PROJECT

Figure 3-2
Location of Pseudoscorpions recorded during the Anketell Point Rail Alignment and Port Projects extended SRE survey

Author:	M CAREY	Date:	20/10/2010
Drawn:	W DAVIS	Version:	REV 003
Report:	INFORMATION ONLY	Scale:	1:100,000 @A4
Dwg No:	0000-API-SKT-1379	Projection:	GDA94, MGA50

3.4 DIPLOPODA

While not targeted during this survey a single collection of Diplopoda (millipede) was made from the survey area from a location where the target land snail was recorded. Millipedes are a diverse group and have eight recorded orders within Australia. They are herbivores and scavengers which inhabit cool, moist environments. Millipedes were the least collected throughout the survey, with only a single record from Site 16 (Figure 3-1).

3.4.1 Paradoxosomatidae

Members of the Paradoxosomatidae family are abundant and widely occurring within Australia. Although there are hundreds of undescribed species many from diverse habitats, most appear to have small ranges and many parts of Australia have not been sampled. Many genera contain SRE taxa although they may be locally abundant. Many paradoxosomatids are relatively large with adults that range from 20-40mm in length (Mesibov 2006).

***Antichiropus* sp. (fem)**

There are nine described and many undescribed species of *Antichiropus* in Western Australia (Mesibov 2006). **All known members of the genus within Western Australia are SREs, except for the southwest species *Antichiropus variabilis*, which inhabits the Jarrah forests** (EPA 2009). Many species are known from only a few hundred square kilometres (Harvey 2002). .

A single *Antichiropus* specimen was recorded from a rock pile within a gully, Site 16 (Table 3-2, Table 3-7). The species was not recorded in the June-July 2009 survey.

Table 3-7 Millipede records by habitat type.

FAMILY	GENUS	SPECIES	NFG	SFG	RHRS	IRK	CL	RP	LWB	CD
Paradoxomatidae	*Antichiropus*	sp.(fem)						1		

NFG – North Facing Gully, SFG – South Facing Gully, RHRS – Rock Hilltop/Rock Slope, IRK – Isolated Rocky Knoll, CL – Creek Line, RP – Rock Pile, LWB – Low Woodland Basin, CD – Coastal Dune.

1 – Denotes presence of species within the habitat type.

3.5 MOLLUSCA

Land snail species were collected from various habitats within the survey area (Figure 3-3, Table 3-8).

3.5.1 Camaenidae

The family Camaenidae is diverse and abundant in the north of Australia. The taxa of the coastal areas of the Pilbara have been fairly well studied in contrast to other areas such as the inland Pilbara (for example, Solem 1985, 1997). Two species representing two genera from this family were recorded in the survey. Two indeterminate Camaenid specimens were also collected. The Camaenid family includes many SRE species.

***Rhagada convicta* (Cox, 1870)**

Rhagada convicta was the most frequently collected species in the survey. It was collected live and dead from 20 of the 27 sites where collections were made from all habitat sites (Table 3-2, Table 3-8). The species was also recorded live and dead from several sites on Dixon Island and the mainland in the original survey round. It has also been recorded along the northern WA coastline from the Minilya River to Dampier (Solem 1997) and **is not considered to be an SRE species.** The extent of isolation between the recorded populations is currently being investigated.

***Quistrachia* sp. indet**

Species of *Quistrachia* have been identified from the inland Western Kimberley to the coastal region between Exmouth Gulf and Shark Bay. *Quistrachia* 'n. sp.1' and 'n.sp.2' were recently recorded from Cape Preston (~140km to the west of the project area) and specimens of the same genus have been recorded from a few other nearby localities to the west and south of the project area. Species of the genus *Quistrachia* are generally associated with rock habitats (O'Neill 2008).

Quistrachia sp. indet. was collected from most of the habitat types which featured rocky areas. Within these habitats it was found almost exclusively in the moister earth underneath rocky crevices and below *Ficus* sp. tree roots. It was also collected from a coastal dune site, however many of the coastal dune habitats also contain rocky outcrops and the specimen may have been transported by a predator to the dune. The habitat records are generally consistent with the records of this species from the June-July 2009 survey, being confined to rock habitats and further support the likelihood that **this species is an SRE species.**

3.5.2 Pupillidae

Members of the Pupillid family are known to be widespread throughout the Pilbara. They are almost all minute, air breathing terrestrial gastropods.

***Pupoides contrarius* (E.A. Smith, 1894)**

Pupoides contrarius is regarded as having a widespread distribution from the Pilbara Region to the Houtman Abrolhos. While only collected from the coastal dune habitat in the targeted survey, in the June-July 2009 survey it was recorded from five of the eight habitat types including rocky slopes and coastal drainage basins. ***P. contrarius* is not considered to be an SRE species.**

***Pupoides lepidulus* (Adams & Angus, 1864)**

Pupoides lepidulus was originally described from collections in the Shark Bay area of Western Australia. In the targeted survey, *Pupoides lepidulus* was collected from four of the eight habitat types from coastal dunes, rocky hilltops/rock slopes, and north and south facing gullies. In the June-July 2009 survey it was collected from six of the eight habitat sites including breakaways and rocky slopes, coastal dunes, basins and sandy ridges, and within creek lines. *Pupoides lepidulus* is known as a habitat generalist and **is not considered to be an SRE.**

3.5.3 Succineidae

***Succinea* sp.**

In the targeted survey *Succinea* sp. was collected from a low wooded basin (Site 19) and a north facing gully site (Site 8). In the June-July 2009 survey it was collected from stony/rocky habitats and creek line habitats from within the project area. This species is showing preference for a number of different habitat types and members of the genera collected from the Southwestern Australia and from the Fitzroy area of the Kimberley have not displayed SRE characteristics. ***Succinea sp.* is considered unlikely to be an SRE species**.

Table 3-8 Mollusc species records by habitat type.

FAMILY	GENUS	SPECIES	NFG	SFG	RHRS	IRK	CL	RP	LWB	CD
Camaenidae	*Rhagada*	*convicta*	1	1	1	1	1	1	1	1
	Quistrachia	sp. indet (SRE)	1	1	1			1		1
Pupillidae	*Pupoides*	*lepidulus*	1	1	1					1
		contrarius								1
Succineidae	*Succinea*	sp. indet	1						1	

NFG – North Facing Gully, SFG – South Facing Gully, RHRS – Rock Hilltop/Rock Slope, IRK – Isolated Rocky Knoll, CL – Creek Line, RP – Rock Pile, LWB – Low Woodland Basin, CD – Coastal Dune.

1 – Denotes presence of species within the habitat type.

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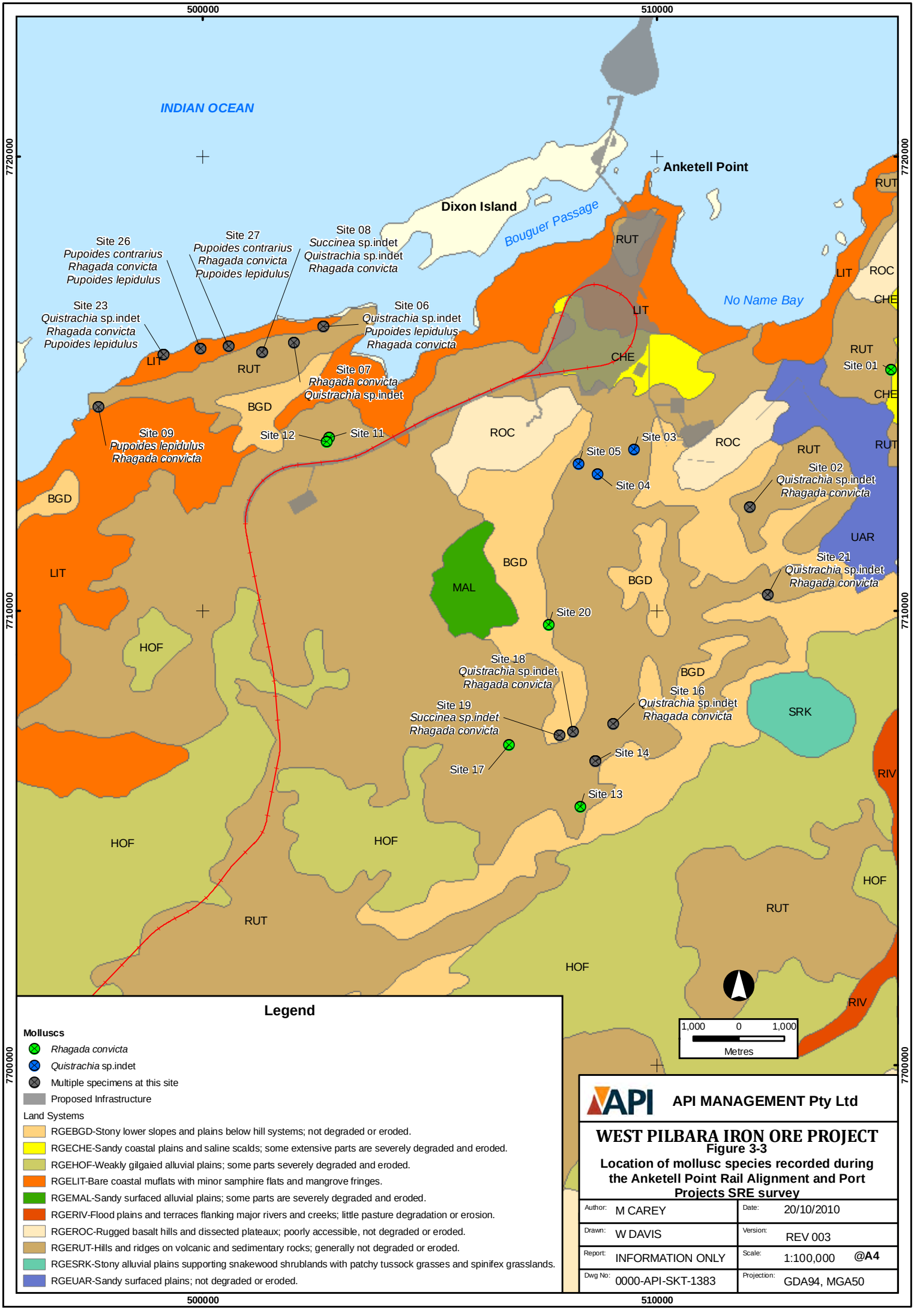

Legend

Molluscs

- *Rhagada convicta*
- *Quistrachia* sp.indet
- Multiple specimens at this site
- Proposed Infrastructure

Land Systems

- RGEBGD-Stony lower slopes and plains below hill systems; not degraded or eroded.
- RGECHE-Sandy coastal plains and saline scalds; some extensive parts are severely degraded and eroded.
- RGEHOF-Weakly gilgaied alluvial plains; some parts severely degraded and eroded.
- RGELIT-Bare coastal muflats with minor samphire flats and mangrove fringes.
- RGEMAL-Sandy surfaced alluvial plains; some parts are severely degraded and eroded.
- RGERIV-Flood plains and terraces flanking major rivers and creeks; little pasture degradation or erosion.
- RGEROC-Rugged basalt hills and dissected plateaux; poorly accessible, not degraded or eroded.
- RGERUT-Hills and ridges on volcanic and sedimentary rocks; generally not degraded or eroded.
- RGESRK-Stony alluvial plains supporting snakewood shrublands with patchy tussock grasses and spinifex grasslands.
- RGEUAR-Sandy surfaced plains; not degraded or eroded.

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Figure 3-3

Location of mollusc species recorded during the Anketell Point Rail Alignment and Port Projects SRE survey

Author:	M CAREY	Date:	20/10/2010
Drawn:	W DAVIS	Version:	REV 003
Report:	INFORMATION ONLY	Scale:	1:100,000 @A4
Dwg No:	0000-API-SKT-1383	Projection:	GDA94, MGA50

3.6 LIMITATIONS

Limitations of the survey were reviewed and discussed (Table 3-9).

Table 3-9 The survey limitations.

Limitations	Relevant to this survey? Yes / no	Comments
Competency / experience of the consultant carrying out the survey.	No	The project manager has extensive experience in conducting 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 for potential SRE species.. Survey methods were designed to target each species.
Proportion of fauna identified, recorded and/or collected.	Yes	Only one of the four target species was recorded.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	Yes	The initial survey conducted in 2009 collated the available data from the project area. It provided a relevant new source of data to extrapolate survey areas for this, the current survey.
Timing/weather/season/cycle.	No	In the past SRE surveys have been recommended for the May – September period in the Pilbara; however, the recent publication of EPA Guidance Statement 20 has amended that recommendation to the wet season (December – March). The survey commenced in May and concluded in May. However, good rainfall was experienced during the foraging activities leading to the collection of live snail specimens. The targeted nature of the survey was designed to off-set the timing issue.
The proportion of the task achieved and further work which might be needed.	No	The program was implemented as planned. A total of 27 foraging sites and seven night spotting sites were established.
Disturbances (e.g. fire, flood, accidental human intervention etc.) which affected results of survey.	No	Exploration activities have taken place in the survey area. Fire scars were present and the area has a history of human use, including pastoral use.
Intensity (in retrospect, was the intensity adequate?)	Yes	The sample size was large, the area covered in the additional survey outside the proposed project area was extensive.
Completeness (was relevant area fully surveyed?)	No	The survey target habitats considered most likely to harbor the target species. All habitats selected were surveyed adequately.
Remoteness and/or access problems.	No	No access issues were encountered. Pastoral

Limitations	Relevant to this survey? Yes / no	Comments
		tracks and recreational tracks were used to access some remote locations.
Availability of contextual (e.g. biogeographic) information on the region.	No	The Pilbara coast is fairly well known from a floristic and vertebrate faunal context. However, as stated above, Pilbara terrestrial invertebrate biology, taxonomy and biogeography are still in their infancy, but a number of reports were available on the region.

4 DISCUSSION

The scope of the survey was to conduct targeted searches for four potential SRE species in suitable habitats outside the proposed impact area, with the aim of expanding their known distribution and knowledge of habitat preferences.

Of the target species, only the land snail *Quistrachia* sp. indet was recorded. It was collected in live, dead, adult and juvenile form indicating a healthy and strong population is present. As a large collection of live specimens were obtained from across the study area, further taxonomic studies can now be undertaken to define any genetic variance and determine species distribution boundaries with other populations.

The additional records of *Quistrachia* sp. from the targeted survey further support the likelihood that it is an SRE species as it was collected almost exclusively from restricted rocky habitats and the outlier records may be explained by predator movement or having been washed downstream during rain events. The survey results have increased the known range of the species, with the new records from the targeted survey extending a further 10km inland from the previous records. Based on the large number and spatial distribution of samples collected it is considered likely that the species' range extends further along the coastline east and west of the project area, although the degree of genetic variation is uncertain.

Burrows of the trap-door spider species, *Eucyrtops* sp. were not recorded but the results are likely to have been influenced by the survey techniques being confined to hand foraging, as burrows of *Eucyrtops* are known to be cryptic and are difficult to find. Suitable habitat was observed in several locations within the targeted study area and it is considered likely that this species' range extends beyond the original (June-July 2009 survey) study area.

Although three pseudoscorpion species and numerous specimens were collected from the coastal dune areas and rocky hillslopes of the study area, no additional collections of the *Synsphyronus* sp. were obtained. The results of the June-July and targeted surveys suggest this species is confined to Dixon Island and is therefore an SRE species.

Despite extensive night searching in suitable habitats, no additional records of *Lychas* 'near harveyi' were recorded. Only its common near relative *Lychas* 'harveyi' was recorded which is known to reside in similar habitat. While the survey targeted the desired habitats (flat stony plains and creeklines), the intensity of hand foraging effort may not have been sufficient to record the species presence. It is considered likely that the species' range extends beyond the original (June-July 2009 survey) study area, however the targeted survey results suggest it may be quite habitat restricted.

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APPENDIX 1: ANKETELL POINT RAIL ALIGNMENT AND PORT PROJECTS SRE SITE DESCRIPTIONS

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
01	Rock Hill Top (Slope)	<10%	<1cm	30%	<5%	>5yrs	Red-brown skeletal sandy clay. Rocks and boulders present.

Low Sparse *Acacia* Shrubs over introduced grasses and spinifex hummocks to 0.3m

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
02	North Facing Rock Hill Slope	<10%	<1cm	30%	<5%	>5yrs	Red-brown skeletal sandy clay. Rocks and boulders present.

Low Sparse Acacia Shrubs over introduced grasses

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
03	East Facing Rock Slope	<10%	<1cm	30%	<5%	>5yrs	Red-brown skeletal sandy clay. Rocks and boulders present.

Sparse low *Acacia* shrubs to 1.5m over Buffel grass (Cenchrus ciliaris) and immature spinifex hummocks to 0.25cm

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
04	South Facing Rocky Slope	40%	1-4cm	20%	10-20%	>5yrs	Red-brown sandy clays predominantly, but with pockets of deep brown red sandy clay loams. Rocks and boulders present

Moderately dense Acacia shrubs to 2.0m over mixed low shrubs to 0.5m over mature spinifex hummocks to 0.35m and grasses.

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
05	Minor South Facing Gully / Slope	60%	1-10cm	25%	10-40%	>10yrs	Red-brown sandy clays predominantly, but with pockets of deep brown red sandy clay loams. Rocks and boulders present

Large thicket of *Ficus* sp and *Acacia* sp to 2.5m over mixed low shrubs to 0.5m over mature spinifex hummocks and grasses to 0.45cm. Large rocks, boulders and slabs present.

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
06	Northern Facing Minor Gully	10-40%	1-10cm	25%	5-30%	5-10yrs	Red-brown sandy clays predominantly, but with pockets of deep brown red sandy clay loams. Rocks and boulders present

East-west trending Ridge with rocky outcropping. *Ficus* sp. to 2.0m over mixed low Acacia shrubs to 1.0m over spinifex hummocks and grasses to 0.4m

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
07	Northern Facing Minor Gully	10-40%	1-10cm	25	5-30%	5-10yrs	Red-brown sandy clays predominantly, but with pockets of deep brown red sandy clay loams. Rocks and boulders present

East-west trending Ridge with rocky outcropping. *Ficus* sp. to 2.0m over mixed low *Acacia* shrubs to 1.0m over spinifex hummocks and grasses to 0.4m

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
08	Northern Facing Minor Gully	10-40%	1-10cm	25	5-30%	5-10yrs	Red-brown sandy clays predominantly, but with pockets of deep brown red sandy clay loams. Rocks and boulders present

East-west trending Ridge with rocky outcropping. *Ficus* sp. to 2.0m over mixed low *Acacia* shrubs to 1.0m over spinifex hummocks and grasses to 0.4m

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
09	South Facing Rock Hill Slope	10-30%	1-5cm	25	<10%	5-10yrs	Red-brown sandy clays predominantly, but with pockets of deep brown red sandy clay loams. Rocks and boulders present

Sparse low *Acacia* shrubs to 1.5m, over mature spinifex hummocks and grasses to 0.4m

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
10	South Facing Minor Coastal Slope	<10	1	50	<5	>5yrs	Red-brown skeletal sandy clay. Rocks and boulders present.

Sparse low *Acacia* shrubs to 1.5m, over mixed low shrubs to 0.5m, over low spinifex hummocks and grasses to 0.25m

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
11	Isolated Rocky Knoll	20	1-10cm	30	10-20%	>5yrs	Red-brown sandy clays predominantly, but with pockets of deep brown red sandy clay loams. Rocks and boulders present
Moderately dense Acacia shrubs to 2.0m over low mixed shrubs to 0.5m, over mature spinifex hummocks to 0.3m							

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
12	South Slope and Hilltop of Minor Ridge	20	1-10cm	30	10-20%	>5yrs	Red-brown sandy clays predominantly, but with pockets of deep brown red sandy clay loams. Rocks and boulders present
Moderately dense Acacia shrubs to 2.0m over low mixed shrubs to 0.5m, over mature spinifex hummocks to 0.3m							
NO PHOTO AVAILABLE							
13	Minor Gully	5-80%	1-8cm	30	<10	>5yrs	Red-brown sandy clays predominantly, but with pockets of deep brown red sandy clay loams. Rocks and boulders present
Rocky outcropping of blue dolerite. Ficus sp and sparse Acacia sp to 2.5m over sparse Acacia shrubs to 1.0m over semi-mature spinifex hummocks to 0.45m							

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
14	Minor Gully	5-80%	1-8cm	30	<10	>5yrs	Red-brown sandy clays predominantly, but with pockets of deep brown red sandy clay loams. Rocks and boulders present

Rocky outcropping of blue dolerite. Ficus sp and sparse *Acacia* sp to 2.5m over sparse Acacia shrubs to 1.0m over semi-mature spinifex hummocks to 0.45m

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
15	Creekline	50	1-10cm	20	30	>5yrs	Red-brown sandy clays predominantly, but with pockets of deep brown red sandy clay loams. Rocks and boulders present
Dense *Acacia* shrubs to 3.0m over low *Grevillea* shrubs to 0.5m over spinifex hummocks to 0.3m							

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
16	Rock Pile in Ridge Saddle	50	1-10cm	20	5-25%	>10yrs	Red-brown sandy clays predominantly, but with pockets of deep brown red sandy clay loams. Rocks and boulders present

Sparse *Eucalyptus* to 4.0m over moderately dense *Acacia* shrubs to 2.5m, over spinifex hummocks and grasses to 0.4m

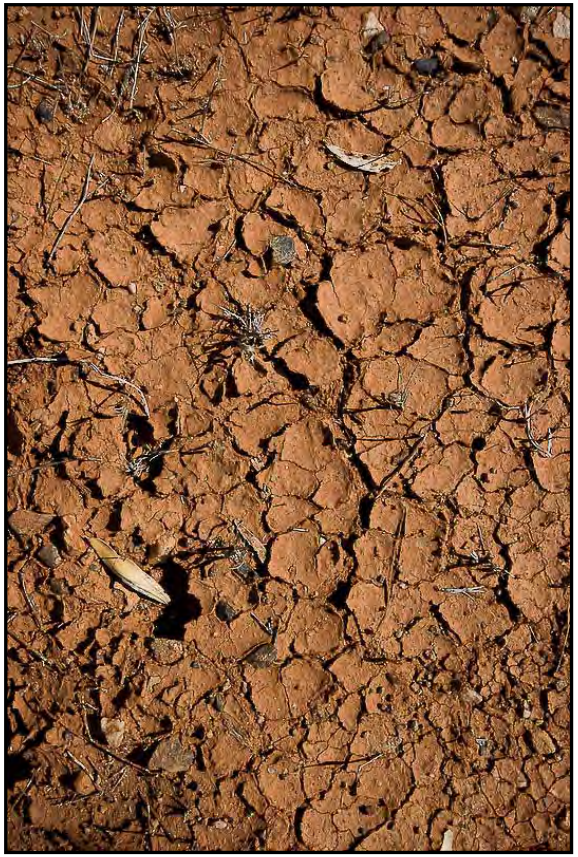
Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
17	Rock Pile	<5	<1	50	0	1-3yrs	Red-brown sandy clays predominantly, but with pockets of deep brown red sandy clay loams. Rocks and boulders present
Spinifex and grasses only, to 0.40m							

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
18	Rock Pile at base of large Ridge	<5	<1	50	0	1-3yrs	Red-brown sandy clays predominantly, but with pockets of deep brown red sandy clay loams. Rocks and boulders present

Spinifex and grasses only, to 0.40m

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
19	Low woodland on Cracking Clay	100	1-8cm	25-50	5-20%	>5yrs	Cracking Clays

Moderately dense low *Acacia* sp to 2.0m over Tumida grasses(?) and spinifex hummocks to 0.4m



Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
20	South Facing Gully	10-40%	1-15cm	20	10-30%	>10yrs	Red-brown sandy clays predominantly, but with pockets of deep brown red sandy clay loams. Rocks and boulders present

Moderately dense Acacia shrubs to 3.5m and Ficus sp, over sparse low shrubs to 0.5m, over mature spinifex hummocks to 0.35m and heavily grazed grasses. Large rocks and boulders throughout.

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
21	Minor Gully	20	1-3cm	20	<10%	>10yrs	Red-brown sandy clays predominantly, but with pockets of deep brown red sandy clay loams. Rocks and boulders present

Moderately dense Acacia shrubs to 1.0m over moderately dense low mixed Acacia shrubs to 0.5m, over mature spinifex hummocks to 0.35m, with creeper present.

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
22	Beach Ficus Thicket	100	5-10cm	5	80	>10yrs	Marine derived grey-white sands

Thicket of *Ficus* sp on rock pile

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
23	Beach *Ficus* Thicket	100	5-10cm	5	80	>10yrs	Marine derived grey-white sands

Dense Acacia to 2.0m over medium relatively dense *Acacia* shrubs to 1.0m over grasses.

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
24	Dune	100	5-10cm	5	80	>10yrs	Marine derived grey-white sands

Dense Acacia to 2.0m over medium relatively dense Acacia shrubs to 1.0m over grasses.

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
25	Dune	100	5-10cm	5	80	>10yrs	Marine derived grey-white sands

Dense Acacia to 2.0m over medium relatively dense Acacia shrubs to 1.0m over grasses.

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
26	Dune	100	5-10cm	5	80	>10yrs	Marine derived grey-white sands

Dense Acacia to 2.0m over medium relatively dense Acacia shrubs to 1.0m over grasses.

Site	Habitat and Description	Leaf Litter (%)	Leaf Litter Depth (cm)	Bare Earth (%)	Canopy Cover (%)	Fire History	Soils
27	Dune	100	5-10cm	5	80	>10yrs	Marine derived grey-white sands

Dense Acacia to 2.0m over medium relatively dense Acacia shrubs to 1.0m over grasses.

APPENDIX 2: ANKETELL POINT RAIL ALINGMENT AND PORT PROJECTS SRE SITE GPS COORDINATES

	Datum:	WGS-84 (50 K)			
	Name	Easting (UTM)	Northing (UTM)	Latitude	Longitude
1	Site 01	515159	7715311	20° 39 ' 41.27" S	117° 8 ' 43.93" E
2	Site 02	512055	7712277	20° 41 ' 20.05" S	117° 6 ' 56.72" E
3	Site 03	509495	7713536	20° 40 ' 39.16" S	117° 5 ' 28.23" E
4	Site 04**(N01)	508702	7713004	20° 40 ' 56.46" S	117° 5 ' 0.8" E
5	Site 05	508277	7713222	20° 40 ' 49.39" S	117° 4 ' 46.13" E
6	Site 06	502661	7716254	20° 39 ' 10.81" S	117° 1 ' 31.97" E
7	Site 07	502014	7715904	20° 39 ' 22.19" S	117° 1 ' 9.63" E
8	Site 08	501308	7715693	20° 39 ' 29.06" S	117° 0 ' 45.22" E
9	Site 09	497711	7714476	20° 40 ' 8.65" S	116° 58 ' 40.89" E
10	Site 10	498926	7715635	20° 39 ' 30.97" S	116° 59 ' 22.91" E
11	Site 11	502788	7713811	20° 40 ' 30.26" S	117° 1 ' 36.4" E
12	Site 12	502735	7713725	20° 40 ' 33.09" S	117° 1 ' 34.54" E
13	Site 13	508321	7705688	20° 44 ' 54.47" S	117° 4 ' 47.78" E
14	Site 14	508647	7706685	20° 44 ' 22.02" S	117° 4 ' 59.02" E
15	Site 15	509122	7707366	20° 43 ' 59.86" S	117° 5 ' 15.43" E
16	Site 16	509037	7707498	20° 43 ' 55.56" S	117° 5 ' 12.5" E
17	Site 17	506749	7707039	20° 44 ' 10.54" S	117° 3 ' 53.4" E
18	Site 18	508154	7707341	20° 44 ' 0.69" S	117° 4 ' 41.95" E
19	Site 19**(N06)	507858	7707252	20° 44 ' 3.59" S	117° 4 ' 31.72" E
20	Site 20	507621	7709679	20° 42 ' 44.65" S	117° 4 ' 23.51" E
21	Site 21	512442	7710343	20° 42 ' 22.94" S	117° 7 ' 10.14" E
22	Site 22	497728	7714626	20° 40 ' 3.79" S	116° 58 ' 41.5" E
23	Site 23	499137	7715635	20° 39 ' 30.97" S	116° 59 ' 30.19" E
24	Site 24	498561	7715205	20° 39 ' 44.95" S	116° 59 ' 10.27" E
25	Site 25	499625	7715590	20° 39 ' 32.42" S	116° 59 ' 47.05" E
26	Site 26	499952	7715764	20° 39 ' 26.75" S	116° 59 ' 58.34" E
27	Site 27	500575	7715813	20° 39 ' 25.17" S	117° 0 ' 19.9" E
28	Night 01**(S04)	508702	7713004	20° 40 ' 56.46" S	117° 5 ' 0.8" E
29	Night 02	502964	7713539	20° 40 ' 39.13" S	117° 1 ' 42.46" E
30	Night 03	509595	7715175	20° 39.764 ' S	117° 05.527 ' E
31	Night 04	502017	7716204	20° 39 ' 12.45" S	117° 1 ' 9.71" E

	Datum:	WGS-84 (50 K)			
	Name	Easting (UTM)	Northing (UTM)	Latitude	Longitude
32	Night 05	508049	7707855	20° 43 ' 43.97" S	117° 4 ' 38.33" E
33	Night 06**(S19)	507858	7707252	20° 44 ' 3.59" S	117° 4 ' 31.72" E
34	Night 07	508228	7706815	20° 44 ' 17.8" S	117° 4 ' 44.53" E
35	958 Aname 01	497739	7714554	20° 40 ' 6.12" S	116° 58 ' 41.87" E
36	958 Aname 02	502735	7713725	20° 40 ' 33.09" S	117° 1 ' 34.54" E