Appendix S

Short Range Endemic Fauna Survey (Invertebrate Solutions 2019b)

Survey for Short Range Endemic Fauna for the North Kiaka Mine, Moora, Western Australia.

Report by Invertebrate Solutions
for GHD Pty Ltd on behalf of
Simcoa Operations Ltd

June 2019

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Report Number 2018ISJ1001_F01_20190619

Prepared for: GHD Pty Ltd on behalf of Simcoa Operations Ltd

Frontispiece: The scorpion *Lychas marmoreus* from the Project area.

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Executive Summary

Simcoa Operations Pty Ltd (Simcoa Operations) is proposing to construct and operate a quartzite quarry at the North Kiaka Project area (the Project), with processing and associated infrastructure at the adjacent existing Simcoa operations to the south. The proposed mine is located approximately 20 kilometres (km) north of Moora in the Wheatbelt region of Western Australia. Mining of the quartzite will occur above groundwater and will include a simple open cut operation with clearing and topsoil stockpiling, overburden drilling and blasting followed by conventional removal with truck.

Invertebrate Solutions has been requested by GHD Pty Ltd on behalf of Simcoa Operations Ltd to undertake a desktop assessment and field survey for short range endemic (SRE) invertebrates for the North Kiaka Mine.

The Desktop Study Area contains two Confirmed SRE species, a brine shrimp and a trapdoor spider, one Likely SRE species, a *Bothriembryon* land snail, and one Possible SRE species (one olpiid pseudoscorpion). The remainder of the species were found to be widespread.

The SRE field survey recorded 12 taxa of invertebrates from three classes, seven orders and 10 families that have the potential to contain SRE taxa. Of these 12 taxa recorded, eight (8) potential SRE invertebrate species were identified during subsequent analysis. There were two Confirmed SRE species recorded during the survey, a trapdoor spider (*Kwonkan wonganensis*?) and the millipede (*Antichiropus* sp. 'Moora'). Two species (the land snail *Bothriembryon sp. 'moora'* and the slater *Buddelundia* sp. '88') are considered to be Likely SRE species, whilst another four species are considered to be Possible SRE species. The Possible SRE species are classified as such primarily due to the groups being considered data deficient.

The Wheatbelt region has not be the subject of many previous systematic collections, especially considering its highly fragmented nature with only small portions of remnant vegetation remaining. compared with the Pilbara and even Midwest regions and so the distributions of some species are unknown apart from isolated historical records.

The development of the North Kiaka Mine is not anticipated to significantly impact any species recorded in this single season SRE survey. When the specific Project footprint and location of infrastructure areas is finalised these conclusions should be revisited to ensure they remain valid, however, due to the limited extent of any processing and infrastructure facilities, currently being proposed as part of the North Kiaka Mine, this assessment is not expected to alter.

The following recommendations are made with regard to the potential development of the North Kiaka Mine area:

- No further surveys for terrestrial SRE invertebrates are required to meet the EPA Technical guidance, sampling of short range endemic invertebrate fauna (EPA 2016).

1. Introduction

Simcoa Operations Pty Ltd (Simcoa Operations) is proposing to construct and operate a quartzite quarry at the North Kiaka Project area (the Project), with processing and associated infrastructure at the adjacent existing Simcoa operations to the south. The proposed mine is located approximately 20 kilometres (km) north of Moora in the Wheatbelt region of Western Australia.

Mining of the quartzite will occur above groundwater and will include a simple open cut operation with clearing and topsoil stockpiling, overburden drilling and blasting followed by conventional removal with truck.

Invertebrate Solutions has been requested by GHD Pty Ltd (GHD) on behalf of Simcoa Operations to undertake a desktop assessment and field survey for short range endemic (SRE) invertebrates for the North Kiaka Mine.

1.1 Purpose of this report

GHD has requested Invertebrate Solutions to undertake the following scope of works for the North Kiaka Mine area, Western Australia:

- Carry out a desktop review to inform the survey planning and report preparation, including identification of all SRE species likely to occur within the Project area;
- Undertake a SRE invertebrate survey to identify significant species in accordance with EPA Technical Guidance Sampling of short range endemic invertebrate fauna (EPA 2016);
- Identify to the lowest practical taxonomic unit all potential SRE specimens recorded during the field survey;
- Provide recommendations and any suggested requirements for further work to comply with relevant legislation; and
- Provide a written report containing the above items.

1.2 Project area

The proposed mine is located approximately 20 kilometres (km) north of Moora in the Wheatbelt region of Western Australia and is shown in Figure 1. The desktop study area comprised a rectangle of approximately 50 km sides bounded by the north west corner (30.281015°S, 115.807140°E) and the south east corner (30.771696°S, 116.286079°E) centred on the North Kiaka quartzite project.

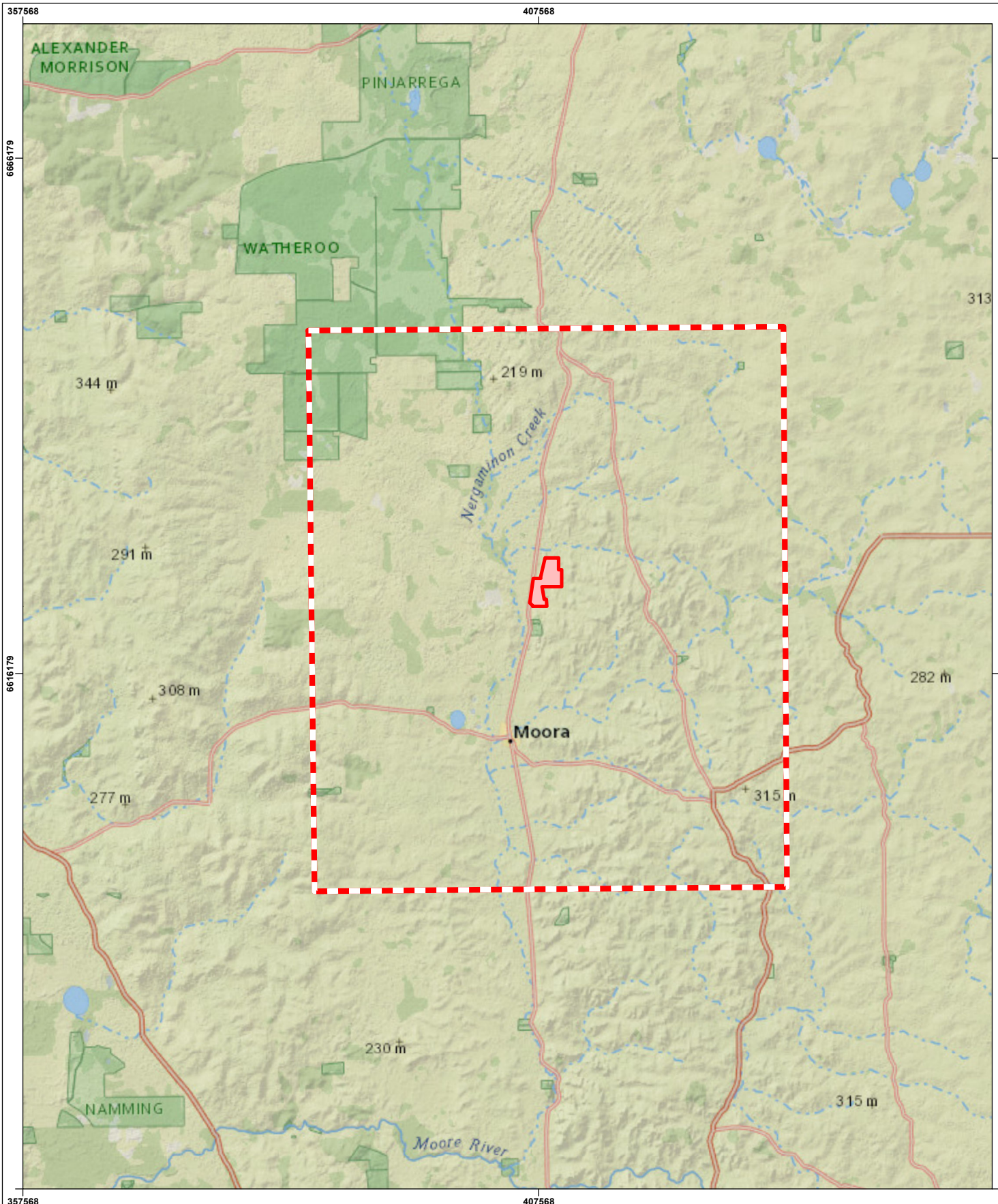
1.3 Survey Effort and Timing

Invertebrate Solutions completed a single season SRE survey at the North Kiaka Mine area in November 2018. This comprised five sites that were surveyed in conjunction with a vertebrate fauna trapping program and used the pitfall traps for collecting potential SRE invertebrates, along with 11 additional sites that were sampled using litter sifting and hand searching of appropriate microhabitats (Table 1, Appendix 1). The five pitfall trapping sites were also actively searched and had leaf litter samples collected for analysis.

Table 1 Locations sampled for SRE invertebrates

Sample Site	Easting	Northing	Habitat	Pitfall Trapping Nights	Pitfall Trap Date(s) Sampled	Active search
SIMSREP1	409062	6626327	Casuarina woodland	35	19 – 26 Nov	22/11/2018
SIMSREP2	408918	6625814	Casuarina woodland	35	19 – 26 Nov	21/11/2018
SIMSREP3	408934	6625444	Casuarina woodland	35	19 – 26 Nov	22/11/2018
SIMSREP4	408690	6626227	Mixed Xanthorea and Banksia sessilis	35	20 – 27 Nov	22/11/2018
SIMSREP5	408556	6626177	Mallee	35	20 – 27 Nov	21/11/2018
SIMSRE6	407934	6625304	York gum east slope	-	-	21/11/2018
SIMSRE7	408838	6626154	Banksia sessilis, Xanthorea south slope	-	-	21/11/2018
SIMSRE8	408610	6625586	Quartzite SE slope	-	-	21/11/2018
SIMSRE9	407881	6625580	York gum and Casuarina	-	-	21/11/2018
SIMSRE10	408888	6627072	Degraded – north end of pit	-	-	22/11/2018
SIMSRE11	408350	6625791	Casuarina woodland, south slope	-	-	22/11/2018
SIMSRE12	407032	6624874	Satellite pit	-	-	22/11/2018
SIMSRE13	408587	6626469	East slope	-	-	22/11/2018
SIMSRE14	409104	6625409	SE Slope	-	-	22/11/2018
SIMSRE15	409367	6625553	York Gum	-	-	22/11/2018
SIMSRE16	407098	6625303	Drainage	-	-	22/11/2018

A map showing the locations of the SRE sampling sites is shown in Figure 2.



Legend

- Dekstop Study Area
- Site Boundary

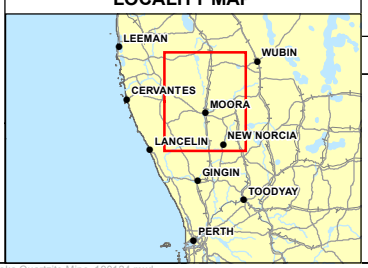
0 3.75 7.5 15 km

Scale: 1:500,000 @ A4

N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

LOCALITY MAP



- LOCALITY MAP SOURCED FROM LANDGATE 2006
- NATGEO WORLD MAP FROM OPEN SOURCE

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PROJECT ID	DATE
North Kiaka Quartzite Mine	24/01/2019

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 50

CREATED	CHECKED	APPROVED	REVISION
ENVIRONMAPS	TM	TM	0

Client: Simcoa Operations Ltd

Figure 1

Short Range Endemic Invertebrate Survey North Kiaka Quartzite Mine, Moora, WA

ENVIRONMAPS t: 0406 590 006 Environmental Mapping Solutions www.environmaps.com.au

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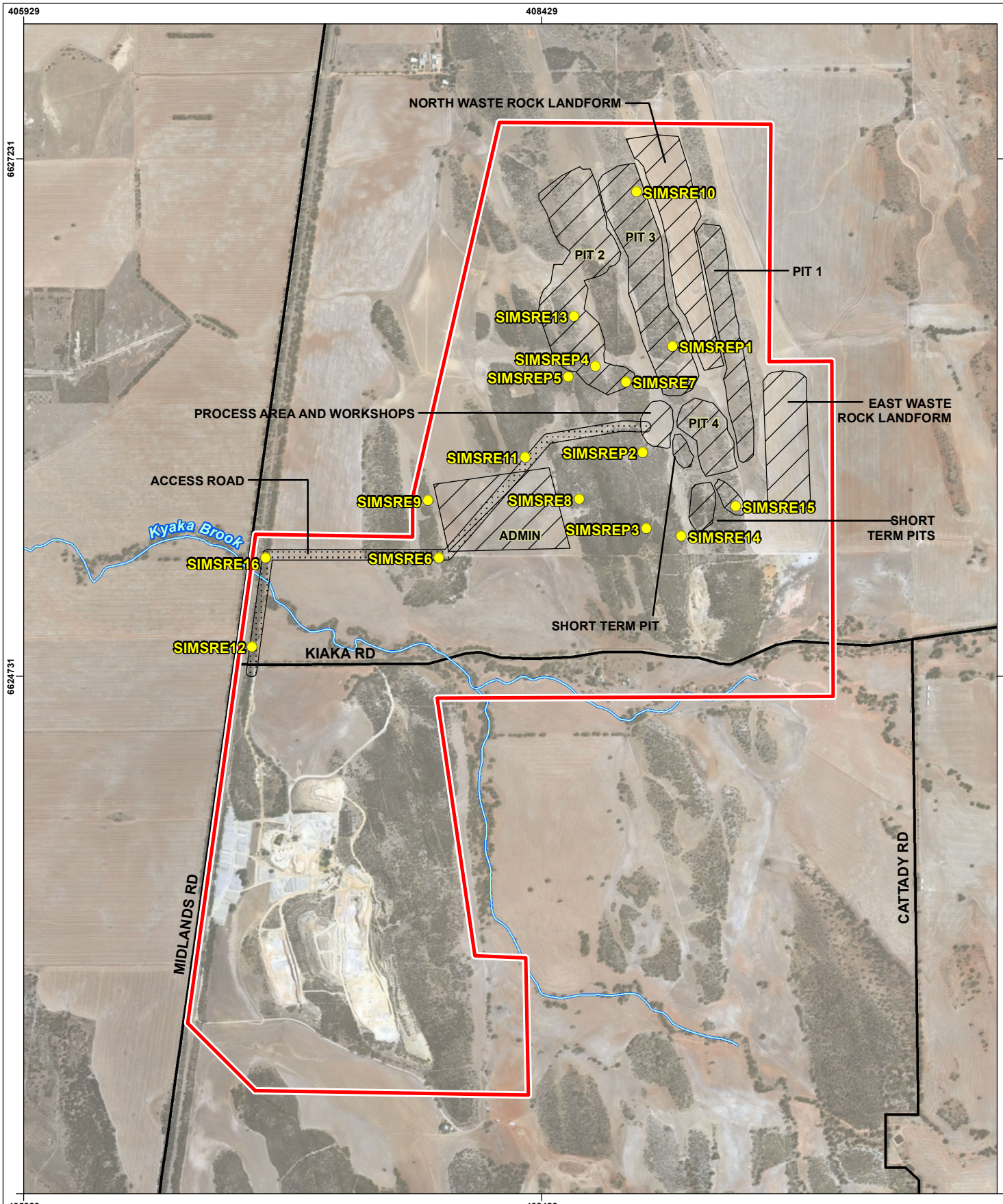

Legend

- Site Boundary
- Mine Pits and Associated Infrastructure
- Watercourse
- Short Range Endemic Invertebrate Sampling Location

0 187.5 375 750
metres
Scale: 1:25,000 @ A4

N

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

LOCALITY MAP

- LOCALITY MAP SOURCED FROM LANDGATE 2006
- WORLD IMAGERY FROM OPEN SOURCE

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CREATED	CHECKED	APPROVED	REVISION
ENVIRONMAPS	TM	TM	0

Client: Simcoa Operations Ltd

Figure 2
Short Range Endemic Invertebrate Sampling Locations

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1.4 Introduction to SRE fauna

Short range endemic (SRE) invertebrates are species with restricted distributions. The isolation of invertebrates in specific habitats or bioregions leads to endemism at various spatial scales. The vast majority of invertebrates are capable of dispersing substantial distances at some phase of their life cycle. Some groups, however, are susceptible to short-range endemism which describes endemic species with restricted ranges, arbitrarily defined in Western Australia as less than 10,000 km^2 (100 km x 100 km) (Harvey, 2002). Taxa that have been more commonly found to contain SRE representatives include:

- Onychophorans (velvet worms);
- Crustaceans (Isopoda);
- Arachnids (mygalomorph spiders, pseudoscorpions, opiliones, scorpions, schizomids);
- Myriapods (millipedes and centipedes);
- Molluscs (land snails); and
- Insects (hemipterans, grasshoppers, butterflies).

SRE invertebrate fauna taxa are generally found in sheltered, relatively mesic environments such as isolated habitats (e.g. boulder piles, isolated hills, dense patches of vegetation, gullies) and can include microhabitats within these environments such as deep leaf litter accumulation, large logs, under bark, cave areas and springs and permanent water bodies.

Many processes contribute to taxa being susceptible to short range endemism. Generally, these factors are related to the isolation of a species which can include the ability and opportunity to disperse, life history, physiology, habitat requirements, and habitat availability. Taxa that exhibit short range endemism generally exhibit poor dispersal, low growth rates, low fecundity and reliance on habitat types that are discontinuous (Harvey, 2002). Taxa that reside within easily isolated habitats surrounded by physical barriers such as islands, mountains, aquifers, lakes and caves are also more susceptible to becoming SRE species often including additional taxa not otherwise generally forming SREs.

Taxa that exhibit short range endemism are particularly vulnerable to disturbance, either natural or anthropogenic, as they are reliant upon specialised and often restricted habitats (often moist) (Framenau, *et al*., 2008). Short range endemic taxa are unable to disperse to *refugia* when their habitats are threatened or destroyed, thus making them a priority for conservation efforts.

The allocation of short range endemism status can be difficult due to the often incomplete taxonomic framework of many invertebrate groups and the often frequent need for substantial revision to enable accurate identification. Short Range Endemic status is assigned using the categories described in Table 2, based upon the available information from the Western Australian Museum (WAM) database and discussion with appropriate taxonomic authorities for various invertebrate groups. Insufficient information exists for many invertebrate species due to specimens being juvenile, the wrong sex to allow identification, damaged, or inadequate taxonomic frameworks, precluding the assignment of SRE status.

Table 2 Short Range Endemic Status of Species

SRE Status	Definition
Confirmed	A confirmed SRE species. A known distribution of < 10,000 km^2 (after Harvey 2002). Taxonomy of the group is well known. The group is well represented in collections, or via comprehensive sampling.
Likely	Likely to be a SRE species based upon knowledge of the family/genus, where other closely related species show evidence of short range endemism. Where habitats containing the specimens show discontinuity within the landscape.
Possible	Based upon existing knowledge of the genus / family there is a possibility that the species may have a restricted range. Where habitats containing the specimens may show discontinuity within the landscape. Possible SRE species may be assigned one of the sub categories below: A. Data deficient i.e. new species, lack of distribution, taxonomic or collecting knowledge, juvenile specimens, wrong sex for identification B. Habitat indicators C. Morphology indicators D. Molecular evidence E. Research and expertise of WAM staff/taxonomic specialists
Widespread	Not a SRE, a wide ranging distribution of > 10,000 km^2

1.5 Conservation Legislation and Guidance Statements

Terrestrial SRE species are protected under state legislation via the newly enacted Biodiversity Conservation (BC) Act (2016) which came into force on 1st January 2019, replacing the outdated Wildlife Conservation (WC) Act (1950). The new BC Act is aligned with the federal Environment Protection and Biodiversity Conservation (EPBC) Act (1999). The assessment of SRE fauna for environmental impact assessment (EIA) is undertaken in Western Australia with regard to Technical Guidance – Sampling of short range endemic invertebrate fauna (EPA 2016).

At the State level, the BC Act provides a list of species that have special protection as species listed under Part 2 of Biodiversity Conservation Act, 2016. This notice is updated periodically by the Department of Biodiversity, Conservation and Attractions (DBCA) (formerly the Department of Parks and Wildlife (DPaW) and the current list (November 2018) includes numerous SRE species from the Wheatbelt, South Coast, Murchison and Pilbara regions. Included in the list are crustaceans, arachnids and myriapods that are considered to be "rare or likely to become extinct, as critically endangered fauna, or are declared to be fauna that is in need of special protection" (DPaW 2015). In addition to the specially protected fauna, DBCA also maintains a list of Priority fauna that are considered to be of conservation significance but do not meet the criteria for formal listing under the BC Act. The Priority fauna list is irregularly updated by DBCA and is now part of the BC Act.

The Biodiversity Conservation Act now provides the ability for the state government of Western Australia to formally list Threatened Ecological Communities (TECs), along with threatening processes.

The federal EPBC Act protects both species and ecological communities. The most relevant listing for SRE fauna is the mygalomorph spider *Idiosoma nigrum* that occurs in the Wheatbelt region and is listed as Vulnerable.

1.6 Survey Staff Qualifications

Field sampling for invertebrates was undertaken by experienced ecologists and comprised of:

- Dr Timothy Moulds *BSc (Hons) Geol., PhD. Invert. Ecol.* (Invertebrate Solutions)

Sampling for SRE invertebrates was undertaken by Dr Tim Moulds. Invertebrate extraction, sorting and identification was completed by Dr Timothy Moulds. Survey work was undertaken under the collection licences issued by the Department of Parks and Wildlife:

- 08-003173-1; Licensee Dr Tim Moulds (Invertebrate Solutions); Valid from 19/11/2018.

1.7 Report Limitations and Exclusions

This study was limited to the written scope provided to the client by Invertebrate Solutions (30th July 2018) and in Section 1.1. This study was limited to the extent of information made available to Invertebrate Solutions at the time of undertaking the work. Information not made available to this study, or which subsequently becomes available may alter the conclusions made herein. Assessment of potential impacts to SRE fauna was based on proposed development plans provided by the client.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. Invertebrate Solutions has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by Invertebrate Solutions described in this report (this section and throughout this report). Invertebrate Solutions disclaims liability arising from any of the assumptions being incorrect.

Invertebrate Solutions has prepared this report on the basis of information provided by Simcoa Operations Ltd and others (including Government authorities), which Invertebrate Solutions has not independently verified or checked beyond the agreed scope of work. Invertebrate Solutions does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

Site conditions may change after the date of this report. Invertebrate Solutions does not accept responsibility arising from, or in connection with, any change to the site conditions. Invertebrate Solutions is also not responsible for updating this report if the site conditions change.

Species were identified to the lowest practical taxonomic level, taking into consideration that the taxonomic framework of many invertebrate groups is incomplete and often in need of substantial revision to enable accurate identification. Short Range Endemic status was assigned using the available information from the WAM database and discussion with appropriate taxonomic authorities for various invertebrate groups. Insufficient information exists for many invertebrate species due to specimens being juvenile, the wrong sex to allow identification, damaged, or inadequate taxonomic frameworks, precluding the assignment of SRE status.

Field surveys for SRE invertebrates require multiple seasonal surveys to fully record all species that may be present in an area, and in varying weather conditions. The current survey was undertaken over a single season and additional surveys at different times of the year may record additional species.

No access was available to the active mining areas located to the south of Kiaka Road due to safety issues regarding ongoing mining operations and blasting activities.

2. Methods

Invertebrate Solutions undertook the following tasks for the dual season SRE survey of the North Kiaka Mine area:

- SRE desktop assessment based upon Western Australian Museum Records;
- SRE survey of the Project Area (16 sites – 1 hour active searching and litter samples, five sites dry pitfall trapping in conjunction with a vertebrate fauna survey).

The survey program was undertaken with regard to the Technical Guidance – Sampling of short range endemic invertebrate fauna (EPA 2016).

2.1 SRE Desktop Methodology

A search of the WAM databases for Arachnids, Crustacea and Molluscs was undertaken for potential SRE taxa occurring in the Yalgoo region. In addition, other published reports for the area were examined. The desktop analysis was used to identify any potential SRE species that may occur in the Yalgoo region and target those taxa during the subsequent field survey of the Project area.

2.1.1 Likelihood of SRE invertebrate occurrence

The likelihood of SRE invertebrate species occurring in the Project area was assessed using a combination of regional and local botanical and landform information and database searches including:

- Analysis of published and unpublished reports concerning SRE invertebrate from the region.
- Botanical and vegetation mapping and other information available for the Study Area.
- Results of a Protected Matters Search from the Federal Government's Department of the Environment and Energy (DEE) website.
- Records of fauna held by the WAM.

Based on the analysis of all available information the Study Area was assigned a level of likelihood to support SRE invertebrates of either 'Very Low', 'Low', 'Moderate', 'High', or 'Definite'.

Table 3 SRE species likelihood of occurrence definitions

SRE Species Likelihood of occurrence	Definition
Definite	The species is confirmed to occur within the Project area
High	Habitat for the species is known to occur within the Project area and known records of the species are within 20 km
Moderate	Habitat for the species is known to occur within the Project area and known records of the species are within 50 km
Low	The species has been recorded from within 50 km, however, no habitat is present for the species within the Project area
Very low	No habitat exists for the species within the Project area and no records of the species are within 50 km or the distribution of the species is known well enough to exclude its presence within the Project area.

2.2 SRE Survey Methodology

The SRE survey was undertaken using a combination of sampling techniques and employed both systematic (timed active searching) and opportunistic (litter collection and transect) sampling. Sites were chosen to maximise SRE habitat including south-facing slopes, gullies, rocky outcrops, dense patches of trees and permanent water bodies.

2.2.1 Pitfall traps

At SRE sites 1 – 5 dry pitfall trapping for SRE invertebrates was undertaken in conjunction with the vertebrate fauna survey (Appendix 1). This involved the use of 5 x 20L plastic buckets buried in a line approximately 50 m in length with a drift fence of flywire placed along the centre line to direct invertebrates (and vertebrate fauna) into the pitfall traps. The pitfall traps were open for a minimum of seven nights at each site. These traps were checked once a day for invertebrates and more often for vertebrate fauna. Potential SRE invertebrates were collected using forceps, placing specimens into 70% ethanol.

2.2.2 Active searching

Active searching was undertaken at the five pitfall trapping locations and an additional 11 sites within and adjacent to the proposed disturbance areas, focusing on areas more likely to contain SRE fauna (Appendix 1). Active searching consisted of sifting of soil and/or leaf litter from suitable habitat areas within each site (millipedes and land snails); the raking of leaf litter (millipedes, land snails, centipedes, mygalomorph burrows); examination of vegetative material below logs and bark (pseudoscorpions, centipedes, millipedes), and an examination of (if present) areas of rock outcrops and associated rock piles.

A minimum of one half person hour active searching per site was undertaken.

2.2.3 Leaf Litter collection

Leaf litter was collected from each site surveyed and processed in Tullgren funnels for potential SRE fauna. Approximately 3L of leaf litter was collected from each site and stored in sealed plastic garbage bags.

2.2.4 Opportunistic collection

Various areas that may provide habitat for SRE invertebrates were also opportunistically sampled whilst undertaking other surveys in the survey area. This included searching for burrows of mygalomorph spiders and searching under tree bark and logs for potential SRE species.

2.3 Sorting and curation

Sorting for all SRE samples occurred in the Invertebrate Solutions laboratory using an Amscope 45x dissecting microscope and was undertaken by Dr Timothy Moulds. In the laboratory, fauna was extracted from SRE leaf litter samples using Tullgren funnels and preserved in 70% ethanol. Each taxon was identified to the lowest practical taxonomic rank using published keys and descriptions, and the numbers of each taxon recorded. Each identified taxon was kept in a separate labelled vial and assigned a specimen tracking code. Specimen and site collection data were recorded in an Excel spreadsheet. At the conclusion of the study, all specimens will be lodged at the Western Australian Museum.

2.4 Taxonomy and Nomenclature

Identification of collected invertebrate material was undertaken by Dr Timothy Moulds. Invertebrate groups collected that have no SRE representatives such as ants and flying insects were not identified or reported. The presence of winged adults in most insect groups suggests that they are more capable dispersers and, therefore, less likely to have a restricted range.

The level of specimen identification achievable is dependent on the level of taxonomic knowledge and expertise available. The majority of the taxonomic expertise relating to SRE taxa resides with the staff of the Western Australian Museum, while some groups are also worked on by researchers within other government departments and academic institutions. Taxonomic treatments are available for some invertebrate groups, but not all. The EPA expects that invertebrates collected for identification will be identified to the lowest taxonomic level possible. Ideally, this is to the species level, but there will be limits due to the nature of specimens and the availability of taxonomic keys.

2.5 Short Range Endemic Status

Taxonomic groups known to contain SRE representatives were examined in more detail to determine if the specimens collected in this study are potentially restricted forms. SRE status will be assigned after comparison with the morphology of other close relatives in the group and current knowledge on their distribution and ecology, where known. Identifications of isopods was undertaken by Dr Simon Judd (Edith Cowan University). Identification of land snails was undertaken by Dr Stephanie Clarke (Invertebrate Identification NSW) and Mr Corey Whisson (Western Australian Museum)

3. Results

3.1 SRE Invertebrates of the Wheatbelt region

Whilst there are few systematic surveys for SRE species within the Wheatbelt region of Western Australia, the area has been the subject of numerous invertebrate collections by researchers from the Western Australian Museum and Universities over the past 80 years or more. This has resulted in a reasonable understanding of the regions fauna within a highly fragmented agricultural landscape. The highly conservation significant *Idiosoma nigrum* (Vulnerable EPBC Act) is now known to be restricted to the central northern Wheatbelt (Rix et al. 2018), along with several other conservation significant mygalomorph spiders from various portions of the Wheatbelt including Idi*osoma dandaragan,* although none are known to occur within the desktop study area.

There are no SRE surveys in the vicinity of Moora or the Project Area. The previous studies in the region are almost exclusively related to ad hoc surveys of remnant vegetation, usually nature reserves with little in the way of broad scale systematic data available, although the recent work on the mygalomorph spider fauna of Western Australia has greatly increased our knowledge of some specific families and genera compared with the general SRE fauna. Many species remain to be properly documented and the taxonomy of many groups remains unresolved.

3.2 Desktop SRE Assessment

A search of the WAM databases for potential SRE taxa occurring in the Desktop Study Area centred on the Project area to the north of Moora was undertaken (WAM 2018a, b, c). The desktop study area comprised a rectangle of approximately 50 km sides bounded by the north west corner (30.281015°S, 115.807140°E) and the south east corner (30.771696°S, 116.286079°E) centred on the North Kiaka quartzite project. The results of these were filtered for groups that potentially contain SRE species as shown in Table 4. Definitions for SRE status are found in Table 2.

The Desktop Study Area contains two Confirmed SRE species, a brine shrimp and a trapdoor spider, one Likely SRE species, a *Bothriembryon* land snail, and one Possible SRE species (one olpiid pseudoscorpion). The remainder of the species were found to be widespread.

Table 4 Desktop records from WAM of potential SRE Invertebrates in the Moora area

Higher Order	Genus and species	SRE Status and notes	Likelihood of occurrence
Gastropoda			
Heterobranchia: Bothriembryontidae	*Bothriembryon `Walebing` n.sp.*	Likely	Moderate
Crustacea:			
Diplostraca: Limnadiidae	*Paralimnadia hyposalina*	Confirmed	Low
Arachnida: Mygalomorphae			
Actinopodidae	*Missulena granulosa*	Widespread	-
	Missulena hoggi	Widespread	-
	Missulena occatoria	Widespread	-
Idiopidae	*Bungulla riparia*	Confirmed	Moderate
Nemesiidae	*Aname mainae*	Widespread	-
Arachnida: Pseudoscorpiones:			
Chernetidae	*Troglochernes dewae*	Widespread	-
Olpiidae	*Genus indet.*	Possible (A)	-[1]
Arachnida: Scorpiones			
Buthidae	*Lychas 'splendens'*	Widespread	-
Urodacidae	*Urodacus armatus*	Widespread	-
	Urodacus novaehollandiae	Widespread	-
Chilopoda:			
Scolopendridae	*Cormocephalus aurantiipes*	Widespread	-
	Cormocephalus turneri	Widespread	-
	Ethmostigmus rubripes	Widespread	-
	Scolopendra morsitans	Widespread	-
Geophilida: Oryidae	*Orphnaeus brevilabiatus*	Widespread	-

[1]All olpiid pseudoscorpions are considered Possible SRE species due to an incomplete taxonomic framework (refer section 4.1 for full details).

3.3 SRE Field Survey

The SRE field survey recorded 12 taxa of invertebrates from three classes, seven orders and 10 families that have the potential to contain SRE taxa (Table 5). Two species (the mygalomorph spider *Kwonkan wonganensis?* and the millipede *Antichiropus sp. 'Moora')* were identified as Confirmed SRE species. Two species (the land snail *Bothriembryon sp. 'moora'* and the slater *Buddelundia* sp. '88') are considered to be Likely SRE species, whilst another four species are considered to be Possible SRE species. The Possible SRE species (refer Table 2) are classified as such primarily due to the groups being considered data deficient. Specimen abundance and tracking numbers are provided in Appendix 2.

The Wheatbelt region has not be the subject of many previous systematic collections, especially considering its highly fragmented nature with only small portions of remnant vegetation remaining. compared with the Pilbara and even Midwest regions and so the distributions of some species are unknown apart from isolated historical records.

Table 5 Invertebrates recorded during the field survey and examined for SRE status

Higher Order	Genus and species	Sites recorded	SRE Status
Gastropoda:			
Stylommatophora: Bothriembryontidae	*Bothriembryon 'Moora' n.sp.*	SIMSRE2, SIMSRE4	Likely
Crustacea: Isopoda:			
Armadillidae	*Buddelundia opaca*	SIMSRE2, SIMSRE7,	Possible (A)
	Buddelundia sp. '88'	SIMSRE1, SIMSRE4, SIMSRE8, SIMSRE13, SIMSRE14, SIMSRE16,	Likely
Arachnida:			
Mygalomorphae: Nemesiidae	*Kwonkan wonganensis?*	SIMSREP5	Confirmed
Pseudoscorpiones: Olpiidae	*Beierolpium sp.*	SIMSRE15	Possible (A)
	Indolpium sp.	SIMSRE12	Possible (A)
Scorpiones: Buthidae	*Lychas marmoreus*	SIMSRE1, SIMSRE3, SIMSRE6, SIMSRE13	Widespread
Chilopoda:			
Scolopendromorpha: Scolopendridae	*Arthrorhabdus mjobergi*	SIMSRE1, SIMSRE2, SIMSRE3, SIMSRE4	Widespread
Geophilomorpha: Chilenophilidae	*Ribautia sp.*	SIMSRE13	Possible (A)
Geophilomorpha: Oryidae	*Orphnaeus brevilabiatus*	SIMSREP2,SIMSRE11, SIMSRE13,SIMSRE16	Widespread
Diplopoda:			
Julida: Julidae	*Ommatoiulus moreletii*	SIMSRE3	Widespread
Paradoxosomatidae	*Antichiropus 'Moora' n.sp.*	SIMSRE2, SIMSRE7	Confirmed

4. Discussion

4.1 SRE Invertebrate Assessment

The Desktop Study Area contains two Confirmed SRE species, a brine shrimp and a trapdoor spider, one Likely SRE species, a *Bothriembryon* land snail, and one Possible SRE species (one olpiid pseudoscorpion). The remainder of the species were found to be widespread.

The SRE field survey recorded eight (8) potential SRE invertebrate species from the North Kiaka Mine area. There were two Confirmed SRE species recorded during the survey, a trapdoor spider (*Kwonkan wonganensis*?) and the millipede (*Antichiropus* sp. 'Moora'). Two species (the land snail *Bothriembryon sp. 'moora'* and the slater *Buddelundia* sp. '88') are considered to be Likely SRE species, whilst another four species are considered to be Possible SRE species. The Possible SRE species are classified as such primarily due to the groups being considered data deficient.

Table 6 Potential SRE invertebrates recorded during the field survey and from desktop analysis.

Higher Order	Genus and species	Site	SRE Status
Gastropoda:			
Stylommatophora: Bothriembryontidae	*Bothriembryon 'Moora' n.sp.*	SIMSRE2, SIMSRE4	Likely
	Bothriembryon `Walebing` n.sp.	Desktop only	Likely – Moderate Likelihood
Crustacea::			
Diplostraca: Limnadiidae	*Paralimnadia hyposalina*	Desktop only	Confirmed – Low Likelihood
Isopoda: Armadillidae	*Buddelundia opaca*	SIMSREP2, SIMSRE7,	Possible (A)
	Buddelundia sp. 88	SIMSREP1, SIMSREP4, SIMSRE8, SIMSRE13, SIMSRE14, SIMSRE16	Likely
Arachnida:			
Idiopidae	*Bungulla riparia*	Desktop only	Confirmed – Moderate Likelihood
Mygalomorphae	*Kwonkan wonganensis?*	SIMSREP5	Confirmed
Pseudoscorpiones: Olpiidae	*Beierolpium sp.*	SIMSRE15	Possible (A)
	Indolpium sp.	SIMSRE12	Possible (A)
Chilopoda:			
Geophilomorpha: Chilenophilidae	*Ribautia sp.*	SIMSRE13	Possible (A)
Diplopoda:			
Paradoxosomatidae	*Antichiropus'Moora' n.sp.*	SIMSRE2, SIMSRE7	Confirmed

4.1.1 Gastropoda: Bothrienbryontidae

Bothriembryon 'Moora' n. sp.

The land snail specimens recorded during the field survey are representatives of an undescribed species of *Bothriembryon* from the northern Wheatbelt (Corey Whisson, Western Australian Museum, pers comm. March 2019). The taxa is considered a Likely SRE species, primarily due to the highly fragmented nature of the remnant vegetation in the region reducing available habitat and area of occurrence for the species. The records form the North Kiaka Project area occur both within and outside of proposed impact areas (refer Figure 2). The taxa most likely occurs throughout the vegetated areas of the Project area and consideration should be given to minimise the clearing of native vegetation to reduce impacts to this Likely SRE species.

Bothriembryon 'Walebing' n. sp.

The land snail *Bothriembryon* 'Walebing' n. sp. identified during the desktop assessment is known from a single record near the locality of Walebing, some 40km to the south east of the Project area. It differs from the specimens recorded during the field survey by the radial whorls across the shell (Corey Whisson, Western Australian Museum, pers comm. March 2019). The taxa is considered a Likely SRE species, primarily due to the highly fragmented nature of the remnant vegetation in the region reducing available habitat and area of occurrence for the species. Following the field survey it is not considered likely that this species occurs within the North Kiaka Project area.

4.1.2 Crustacea

Diploctracea: Limnadiidae: Paralimnadia hyposalina

This is a species of clam shrimp that occurs in salt and clay pans to the west of Commberdale (Timms 2016), that is the locality immediately to the north of the North Kiaka Project area. This species is known only from a series of salt pans in this area, however, these are not likely to be the subject of any impacts from the development of the project and thus no impacts are anticipated to occur to the endemic clam shrimp.

Isopoda: Armadillidae

The taxonomic framework of slaters in Australia is extremely poorly making assessment of SRE status for this fauna difficult. The armadillid isopods from the Australian genus *Buddelundia* are extremely diverse in arid Australia with over 150 putative species identified in collections, primarily from Western Australia, but requires taxonomic revision at a family level making the proper identification of species difficult (Dalens 1992; Judd and Perina 2013).

Buddelundia opaca

Two specimens are tentatively determined as *B. opaca*. This species is known principally from rocky areas of the Northern Jarrah Forest Sub Bioregion. The specimens collected from Moora are at the northern limit of the its distribution (Judd 2019). There are some minor morphological differences between the specimens examined here and those found in the Jarrah forest proper. Many of the specimens collected in the northern part of its distribution are old and the taxon needs to be

revised, preferably with new material. The species appears to be restricted to rocky habitat types. The species should be considered a Possible SRE species.

Buddelundia sp. 88

This species was collected from five sites. The specimens collected match a single specimen collected about 150 km north of the North Kiaka Project area. This specimen is much smaller than the material recorded in the current study and maybe a juvenile, but highly likely it is the same taxon (Judd 2019). These are the only records for Buddelundia sp. 88. Since it is restricted it should be considered a Likely SRE, however, it is noted that due to a lack of collecting in the Wheatbelt that it is likely that the taxon occurs elsewhere in remnant vegetation within the region (Judd 2019).

4.1.3 Arachnida

Mygalomorphae: Idiopidae: Bungulla riparia

Bungulla riparia has a relatively restricted distribution in the southern Geraldton Sandplains bioregion of south-western Australia, from Lesueur National Park, south to Mount Misery, west of Moora (Rix et al. 2018). Burrows of female specimens have previously been located from creek banks (Main 1957), whilst male specimens were collected in mid- to late autumn (Rix et al. 2018). No specimens of this species were recorded during the field survey and it is outside of the known distribution and thus no significant impacts to this species are anticipated by the development of the North Kiaka project.

Mygalomorphae: Nemesiidae: Kwonkan wonganensis?

This mygalomorph spider is known only from the Wongan Hills Nature Reserve, some 65 km to the south east of the North Kiaka Project (Main 1977). The species was described from adult female specimens only, whilst the specimens recorded from North Kiaka are adult males the similarities of the other primary characteristics appear to be very similar, including eye position, and spination of the chelicerae. The specimens from Wongan Hills were dug from their distinctive burrows, made of small pebbles of which the habitat at North Kiaka is favourable. This designation is a tentative identification unless genetic evidence is obtained. If the specimens from North Kiaka were subsequently shown not to be *Kwonkan wonganensis*, they would be an undescribed species that should still be considered an SRE species due to the highly fragmented nature of the remnant vegetation of the Wheatbelt and the limited powers of dispersal of mygalomorph spiders.

All the adult male specimens recorded were from pitfall traps so the detailed location of the population within the landscape is unknown although female mygalomorph spiders can only live in remnant vegetation that has limited fire regimes and is protected from grazing, so is likely to be the restricted to vegetated rocky outcrop areas in the local region. The taxa most likely occurs throughout the rocky vegetated portions of the Project area and consideration should be given to minimise the clearing of native vegetation to reduce impacts to this Confirmed SRE species.

Pseudoscorpionida: Olpiidae spp.

The taxonomy of the Olpiidae is poorly known and, until further taxonomic resolution has been obtained, all species are considered to be Possible SRE species in Western Australia due to a

deficiency in data. Molecular sequencing of Pilbara and other Western Australian specimens is currently being undertaken by the Western Australian Museum and these data will be used in the future to determine if species are widespread or restricted in distribution. It must be stated, however, there is considerable difference between molecular and morphological data, with generic and species boundaries highly uncertain making meaningful results unlikely, except in the medium to long term.

4.1.4 Diplopoda

Paradoxosomatidae: *Antichiropus. 'Moora' n. sp.*

Millipedes from the genus *Antichiropus* all have limited powers of dispersal and conservative ecological requirements (Car et al. 2013). In addition, the above-ground activity of most *Antichiropus* species are limited to a very small window of opportunity when there is sufficient moisture for them to forage and mate during wetter winter months (Car et al. 2013). *Antichiropus* species are, consequently, short-range endemics with very small distributions *sensu* Harvey 2002.

The millipede *Antichiropus* sp. 'Moora' was collected as dead specimens from two sites near the centre of the North Kiaka Project area. One of these sites is outside of existing mining areas whilst the other is situated on the south eastern edge of Pit 2 (Figure 2). Antichiropus millipedes require adult male specimens for complete identification to species level, however, due to the location of this record, and that virtually all other species within this genus show often highly restricted distributions these specimens are considered to be a Confirmed SRE species. The taxa most likely occurs throughout the rocky vegetated portions of the Project area and consideration should be given to minimise the clearing of native vegetation to reduce impacts to this Confirmed SRE species.

4.1.5 Chilopoda:

Geophilomorpha: Chilenophilidae: *Ribautia* sp. 'IS01'

The taxonomy of the Chilenophilidae is poorly known and until further taxonomic resolution has been obtained all species are considered to be Potential SRE species in Western Australia due to a deficiency in data. The genus *Ribautia* has 10 species described from both the east and west coasts of Australia. The species recorded from the North Kiaka Project area is likely a described species, however the poor original descriptions and lack of specimens precludes an identification beyond generic level. It is highly unlikely that this soil dwelling species is restricted to the Project area, and most likely occurs widely through the Wheatbelt and adjacent coastal areas but there are few records of the genus for comparison in collections. The population is not considered to be subject to any significant impact from the development of the North Kiaka Project.

5. Conclusions and Recommendations

The Desktop Study Area contains two Confirmed SRE species, a brine shrimp and a trapdoor spider, one Likely SRE species, a *Bothriembryon* land snail, and one Possible SRE species (one olpiid pseudoscorpion). The remainder of the species were found to be widespread.

The SRE field survey recorded 12 taxa of invertebrates from three classes, seven orders and 10 families that have the potential to contain SRE taxa. Of these 12 taxa recorded, eight (8) potential SRE invertebrate species were identified during subsequent analysis. There were two Confirmed SRE species recorded during the survey, a trapdoor spider (*Kwonkan wonganensis*?) and the millipede (*Antichiropus* sp. 'Moora'). Two species (the land snail *Bothriembryon sp. 'moora'* and the slater *Buddelundia* sp. '88') are considered to be Likely SRE species, whilst another four species are considered to be Possible SRE species. The Possible SRE species are classified as such primarily due to the groups being considered data deficient.

The Wheatbelt region has not be the subject of many previous systematic collections, especially considering its highly fragmented nature with only small portions of remnant vegetation remaining. compared with the Pilbara and even Midwest regions and so the distributions of some species are unknown apart from isolated historical records.

The development of the North Kiaka Mine is not anticipated to significantly impact any species recorded in this single season SRE survey. When the specific Project footprint and location of infrastructure areas is finalised these conclusions should be revisited to ensure they remain valid, however, due to the limited extent of any processing and infrastructure facilities, currently being proposed as part of the North Kiaka Mine, this assessment is not expected to alter.

5.1 Recommendations

The following recommendations are made with regard to the potential development of the North Kiaka Mine area:

- No further surveys for terrestrial SRE invertebrates are required to meet the EPA Technical guidance, sampling of short range endemic invertebrate fauna (EPA 2016).

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Appendix 1

SRE Site locations and habitats

SIMSRE 1 409062E 6626327N Casuarina woodland	
SIMSRE 2 408918E 6625814N Mixed *Xanthorea* and *Banksia sessilis*	

SIMSRE 3 408934E 6625444N Casuarina woodland	
SIMSRE 4 408690E 6626227N Mixed *Xanthorea* and *Banksia sessilis*	

SIMSRE 5 408556E 6626177N Mallee	
SIMSRE 6 407934E 6625304N York gum east facing slope	

SIMSRE 7 408838E 6626154N *Banksia sessilis*, *Xanthorea* south facingslope	
SIMSRE 8 408610E 6625586N Quartzite south east facing slope	

SIMSRE 9 407881E 6625580N York gum and Casuarina	
SIMSRE 10 408888E 6627072N Degraded – north end of pit	

SIMSRE 11 408350E 6625791N Casuarina woodland, south facing slope	
SIMSRE 12 407032E 6624874N Sheoak woodland, Satellite pit	

SIMSRE 13 408587E 6626469N East facing slope	
SIMSRE 14 409104E 6625409N Mixed low woodland on east facing slope	

SIMSRE 15 409367E 6625553N York Gum	
SIMSRE16 407098E 6625303N York Gum on drainage line	

Appendix 2

Specimen abundance and tracking codes

Phylum/ Subphylum	Class	Order	Family	Genus and sp	SRE Status	Abundance	Site	Date	Collection Method	Tracking number	Identified by
Mollusca	Gastropoda	Heterobranchia	Bothriembryontidae	*Bothriembryon 'Moora' n.sp.*	Likely	1	SIMSREP4	21/11/2018	Active searching and litter sifting	ISTN409	Corey Whisson
Mollusca	Gastropoda	Heterobranchia	Bothriembryontidae	*Bothriembryon 'Moora' n.sp.*	Likely	1	SIMSREP2	21/11/2018	Active searching and litter sifting	ISTN481	Corey Whisson
Crustacea:	Malacostraca	Isopoda	Armadillidae	*Buddelundia opaca*	Possible (a)	1	SIMSRE7	21/11/2018	Active searching and litter sifting	ISTN408	Simon Judd
Crustacea:	Malacostraca	Isopoda	Armadillidae	*Buddelundia sp. 88*	Likely	1	SIMSREP1	19/11/2018	Pitfall dry	ISTN470	Simon Judd
Crustacea:	Malacostraca	Isopoda	Armadillidae	*Buddelundia opaca*	Possible (a)	4	SIMSREP2	19/11/2018	Pitfall dry	ISTN401	Simon Judd
Crustacea:	Malacostraca	Isopoda	Armadillidae	*Buddelundia sp. 88*	Likely	3	SIMSREP4	20/11/2018	Pitfall dry	ISTN474	Simon Judd
Crustacea:	Malacostraca	Isopoda	Armadillidae	*Buddelundia sp. 88?*	Likely	1	SIMSRE16	22/11/2018	Active searching and litter sifting	ISTN415	Simon Judd
Crustacea:	Malacostraca	Isopoda	Armadillidae	*Buddelundia sp. 88*	Likely	1	SIMSRE14	22/11/2018	Active searching and litter sifting	ISTN414	Simon Judd
Crustacea:	Malacostraca	Isopoda	Armadillidae	*Buddelundia sp. 88*	Likely	1	SIMSRE8	21/11/2018	Active searching and litter sifting	ISTN407	Simon Judd
Crustacea:	Malacostraca	Isopoda	Armadillidae	*Buddelundia sp. 88*	Likely	1	SIMSRE13	22/11/2018	Active searching and litter sifting	ISTN479	Simon Judd
Chelicerata	Arachnida	Aranaeomorphae	Zoodariidae	*sp.*	Widespread	1	SIMSREP1	19/11/2018	Pitfall dry	ISTN468	T Moulds
Chelicerata	Arachnida	Mygalomorphae	Nemesiidae	*Kwonkan wonganensis?*	Confirmed	1	SIMSREP5	20/11/2018	Pitfall dry	ISTN404	T Moulds
Chelicerata	Arachnida	Mygalomorphae	Nemesiidae	*Kwonkan wonganensis?*	Confirmed	1	SIMSREP5	20/11/2018	Pitfall dry	ISTN475	T Moulds
Chelicerata	Arachnida	Mygalomorphae	Nemesiidae	*Kwonkan wonganensis?*	Confirmed	1	SIMSREP5	20/11/2018	Pitfall dry	ISTN577	T Moulds
Chelicerata	Arachnida	Scorpionida	Buthidae	*Lychas marmoreus*	Widespread	2	SIMSREP1	19/11/2018	Pitfall dry	ISTN469	T Moulds
Chelicerata	Arachnida	Scorpionida	Buthidae	*Lychas marmoreus*	Widespread	1	SIMSREP1	19/11/2018	Pitfall dry	ISTN573	T Moulds
Chelicerata	Arachnida	Scorpionida	Buthidae	*Lychas marmoreus*	Widespread	1	SIMSREP3	19/11/2018	Pitfall dry	ISTN472	T Moulds
Chelicerata	Arachnida	Scorpionida	Buthidae	*Lychas marmoreus*	Widespread	1	SIMSREP3	19/11/2018	Pitfall dry	ISTN575	T Moulds
Chelicerata	Arachnida	Scorpionida	Buthidae	*Lychas marmoreus*	Widespread	1	SIMSRE6	22/11/2018	Pitfall dry	ISTN405	T Moulds
Chelicerata	Arachnida	Scorpionida	Buthidae	*Lychas marmoreus*	Widespread	1	SIMSRE13	22/11/2018	Active searching and litter sifting	ISTN478	T Moulds
Chelicerata	Arachnida	Pseudoscorpionida	Olpiidae	*Beierolpium sp.*	Possible (a)	1	SIMSRE15	22/11/2018	Leaf Litter tullgren funnel	ISTN418	T Moulds
Chelicerata	Arachnida	Pseudoscorpionida	Olpiidae	*Indolpium sp.*	Possible (a)	1	SIMSRE12	22/11/2018	Leaf Litter tullgren funnel	ISTN419	T Moulds
Myriapoda	Chilopoda	Scolopendromorpha	Scolopendridae	*Arthrorhabdus mjobergi*	Widespread	2	SIMSREP1	19/11/2018	Pitfall dry	ISTN402	T Moulds
Myriapoda	Chilopoda	Scolopendromorpha	Scolopendridae	*Arthrorhabdus mjobergi*	Widespread	2	SIMSREP1	19/11/2018	Pitfall dry	ISTN574	T Moulds
Myriapoda	Chilopoda	Scolopendromorpha	Scolopendridae	*Arthrorhabdus mjobergi*	Widespread	1	SIMSREP3	19/11/2018	Pitfall dry	ISTN400	T Moulds
Myriapoda	Chilopoda	Scolopendromorpha	Scolopendridae	*Arthrorhabdus mjobergi*	Widespread	2	SIMSREP3	19/11/2018	Pitfall dry	ISTN471	T Moulds
Myriapoda	Chilopoda	Scolopendromorpha	Scolopendridae	*Arthrorhabdus mjobergi*	Widespread	1	SIMSREP3	19/11/2018	Pitfall dry	ISTN576	T Moulds
Myriapoda	Chilopoda	Scolopendromorpha	Scolopendridae	*Arthrorhabdus mjobergi*	Widespread	1	SIMSREP4	20/11/2018	Pitfall dry	ISTN403	T Moulds
Myriapoda	Chilopoda	Scolopendromorpha	Scolopendridae	*Arthrorhabdus mjobergi*	Widespread	1	SIMSREP2	21/11/2018	Active searching and litter sifting	ISTN411	T Moulds
Myriapoda	Chilopoda	Geophilida	Oryidae	*Orphnaeus brevilabiatus*	Widespread	1	SIMSRE16	22/11/2018	Active searching and litter sifting	ISTN476	T Moulds
Myriapoda	Chilopoda	Geophilida	Oryidae	*Orphnaeus brevilabiatus*	Widespread	1	SIMSRE11	22/11/2018	Active searching and litter sifting	ISTN412	T Moulds
Myriapoda	Chilopoda	Geophilida	Oryidae	*Orphnaeus brevilabiatus*	Widespread	2	SIMSRE13	22/11/2018	Active searching and litter sifting	ISTN413	T Moulds
Myriapoda	Chilopoda	Geophilida	Chilenophilidae	*Ribautia sp. IS01*	Possible (a)	1	SIMSRE13	22/11/2018	Active searching and litter sifting	ISTN477	T Moulds
Myriapoda	Chilopoda	Geophilida	Oryidae	*Orphnaeus brevilabiatus*	Widespread	1	SIMSREP2	21/11/2018	Active searching and litter sifting	ISTN480	T Moulds
Myriapoda	Diplopoda	Julida	Julidae	*Ommatoiulus moreletii*	Widespread	1	SIMSREP3	19/11/2018	Pitfall dry	ISTN473	T Moulds
Myriapoda	Diplopoda	Polydesmida	Paradoxosomatidae	*Antichiropus sp. 'Moora'* (F)	Confirmed	1	SIMSRE2	21/11/2018	Active searching and litter sifting	ISTN410	Cathy Car
Myriapoda	Diplopoda	Polydesmida	Paradoxosomatidae	*Antichiropus sp. 'Moora'* (F)	Confirmed	1	SIMSRE7	21/11/2018	Active searching and litter sifting	ISTN406	Cathy Car

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