Subterranean Ecology

Scientific Environmental Services

Goldsworthy Iron Ore Mining Operations

Cundaline and Callawa Mining Operations

Troglofauna Assessment

Prepared for *BHP Billiton Iron Ore*

October 2008

Goldsworthy Iron Ore Mining Operations: Cundaline and Callawa Mining Operations Troglofauna Assessment

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Project No. 58

Prepared for BHP Billiton Iron Ore

Prepared by: Subterranean Ecology

Date: October 2008

COVER: Pseudoscorpion *Indohya* SP01 (Hyidae). Image taken by Kate Muirhead, Copyright Subterranean Ecology Pty Ltd.

LIMITATIONS: This survey was limited to the requirements specified by the client and the extent of information made available to the consultant at the time of undertaking the work. Determination of in-pit and out-of-pit sites was based on information provided by BHP Billiton Iron Ore. Information not made available to this study, or which subsequently becomes available may alter the conclusions made herein.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF PLATES

LIST OF FIGURES

LIST OF ATTACHMENTS

EXECUTIVE SUMMARY

BHP Billiton Iron Ore Pty Ltd (BHPBIO) operates the Goldsworthy Iron Ore Mining Operations which are located approximately 200 kilometres (km) east of Port Hedland in the north of the Pilbara Region of Western Australia.

BHPBIO is planning on extending the mine life of the Goldsworthy Iron Ore Mining Operations by mining the Cundaline and Callawa deposits.

This report documents the results of a troglofauna survey conducted from December 2007 to April 2008 on the Cundaline and Callawa ridges. It also assesses the potential impacts on the planned Cundaline and Callawa satellite mining operations on troglofauna.

Principle findings and context were:

- Cundaline and Callawa deposits occur on discrete elevated ridge systems composed of the Nimingarra Iron Formation. The ridge systems are separated from each other by Eel Creek which forms an alluvial valley about 1 km wide, which may limit the distribution ranges for some populations and species of troglofauna.
- The morphological and preliminary genetic evidence suggests the possibility that some species, and populations, may be restricted in distribution to either the Cundaline Ridge or Callawa Ridge.
- The total sampling effort was 309 sample events from 226 bores, comprising 190 samples from in-pit areas and 119 samples from out-of-pit areas.
- The survey identified 29 putative troglomorphic morpho-species comprising millipedes (Diplopoda), centipedes (Chilopoda), symphylids (Symphyla), slaters (Isopoda), pseudoscorpions (Pseudoscorpionida), spiders (Araneae), harvestman (Opilionida), diplurans (Diplura), silverfish (Zygentoma), cockroaches (Blattodea), planthopper bugs (Hemiptera), and beetles (Coleoptera).
- A total of 22 morpho-species were collected on Callawa Ridge and 15 morpho-species were collected on Cundaline Ridge. Ten morpho-species were detected on both the Cundaline and Callawa ridges.
- Troglofauna habitat was evaluated from drill logs which recorded the majority of fissures, voids and cavities in the hardcapped zone lying to 30 metres (m) below ground surface, however cavities were recorded at depths of over 160 m below ground.
- On their respective ridges, most troglofauna species were collected from both in-pit and out-of-pit areas, consistent with the extent and continuity of geological habitat.
- Six morpho-species were only collected from in-pit areas (Haplodesmidae SP02, Symphyla SP01, Geophilidae SP01, Diplura SP01, Meenoplidae SP02 and Phalangodidae SP01), and a seventh morpho-species (*Indohya* SP01) was collected on both Cundaline and Callawa ridges, but was collected only from the in-pit area on the Cundaline Ridge. For these seven

morpho-species, it is considered probable, given the extent of the Nimingarra Iron Formation, that populations of each species are likely to occur outside the in-pit areas on each ridge.

- If any of the troglofauna species are restricted in distribution to either the Cundaline or Callawa ridges, they are unlikely to be threatened by the planned Cundaline and Callawa mining operations because of the large areas of contiguous habitat that will remain in the portions of each ridge that will not be impacted by mining.
- Habitat fragmentation is unlikely to be a conservation concern at Callawa Ridge as the proposed pit occupies a small corner of this large block-shaped landform. At Cundaline Ridge, habitat fragmentation may be an effect to consider, as the two proposed pits span a substantial portion of this narrow elongate landform, although habitat continuity is likely to be retained in the adjacent sections of unmined ridge.
- An interesting finding was the detection of troglofauna on the Yarrie Ridge adjacent to the Yarrie Mine, indicating that populations either persisted here during the mining activity, or recolonised from adjacent habitat after the mining disturbance ceased. This has important implications for understanding the impacts of mining on subterranean fauna and their ability to tolerate or recolonise after disturbance.

1 INTRODUCTION

BHP Billiton Iron Ore Pty Ltd (BHPBIO) operates Goldsworthy Iron Ore Mining Operations which are located approximately 200 kilometres (km) east of Port Hedland in the north of the Pilbara Region of Western Australia (Figure 1).

The iron ore deposits in this area are associated with the Goldsworthy Iron Ore Mining Operations and have been progressively mined since the mid 1960s. Current mining operations are centred at Yarrie and Cattle Gorge, with some mining at the Nimingarra and Sunrise Hill deposits (Figure 2).

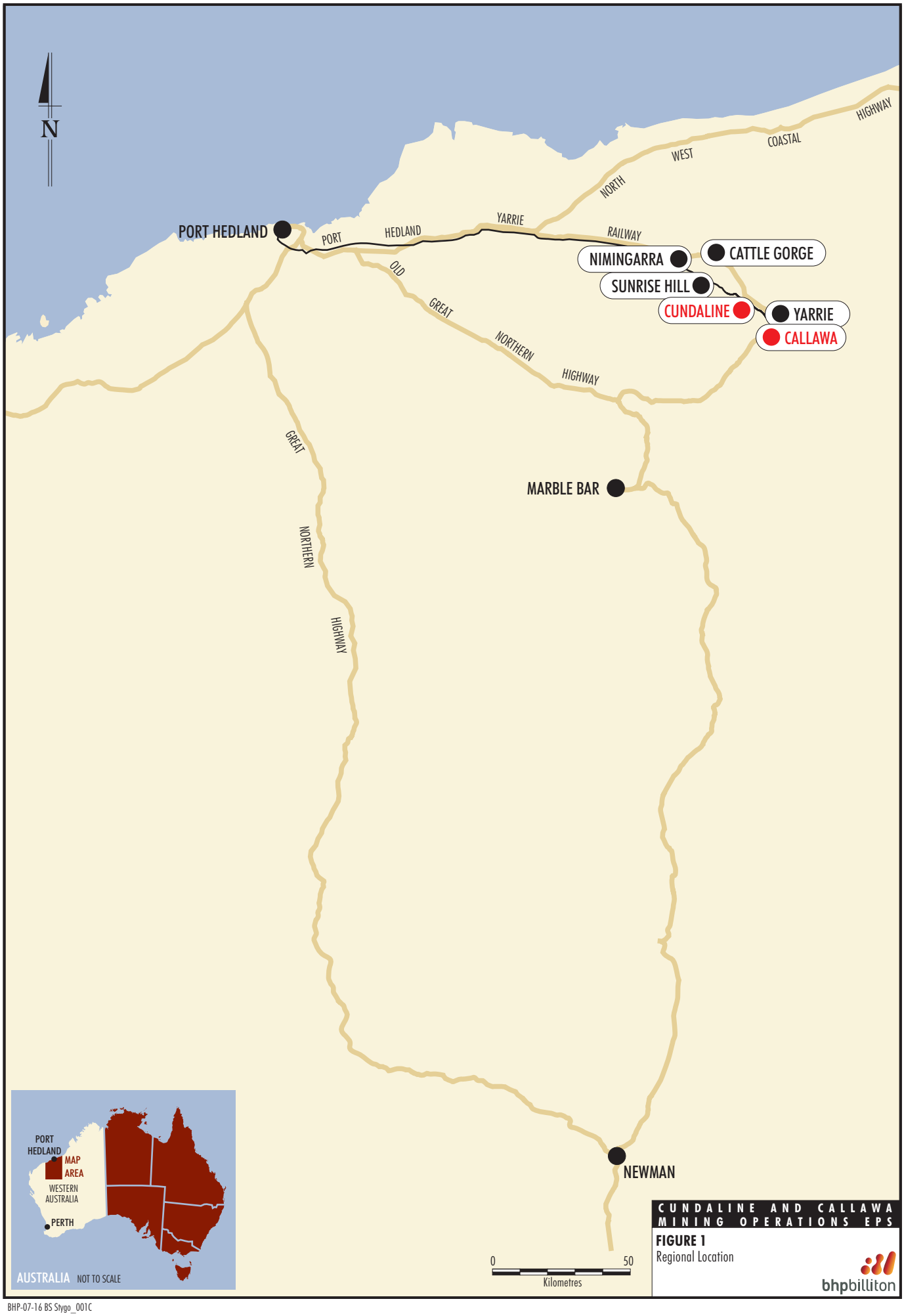
The approved mining areas at Goldsworthy Iron Ore Mining Operations are drawing towards the end of their mine life. However, BHPBIO has identified approximately 9.6 million tonnes of additional iron ore at the planned Cundaline and Callawa mining operations that would enable them to extend the mine life by up to five years. Mining at the Cundaline and Callawa deposits would use conventional open pit mining methods (Figures 3 and 4, respectively).

Troglofauna are subterranean invertebrates that have evolved morphological, physiological and behavioural adaptations that enable them to inhabit fissures and cavities present underground above the watertable (Gibert and Deharveng, 2002). Common morphological attributes used to identify a possible troglofauna species (troglomorph) are a significant reduction in or complete absence of eyes, pigmentation, and wings; the development of elongated appendages and/or setae present on various parts of the body; and often a more slender and less sclerotised body, especially compared to surface counterparts. Some species of troglofauna are obligate inhabitants (troglobites) of subterranean habitats, which may restrict their distribution to particular geological deposits.

This report documents the results of a troglofauna survey conducted from December 2007 to April 2008 at Cundaline and Callawa ridges.

The objectives of the study were to:

1) document the terrestrial subterranean fauna (troglofauna) present within the proposed mine pits at Cundaline and Callawa ridges, and surrounding out-of-pit areas located outside of the proposed mine pits; and
2) assess the conservation status of troglofauna species in relation to the proposed pits and mine layout at the planned Cundaline and Callawa mining operations.



CUNDALINE AND CALLAWA MINING OPERATIONS EPS

FIGURE 1
Regional Location

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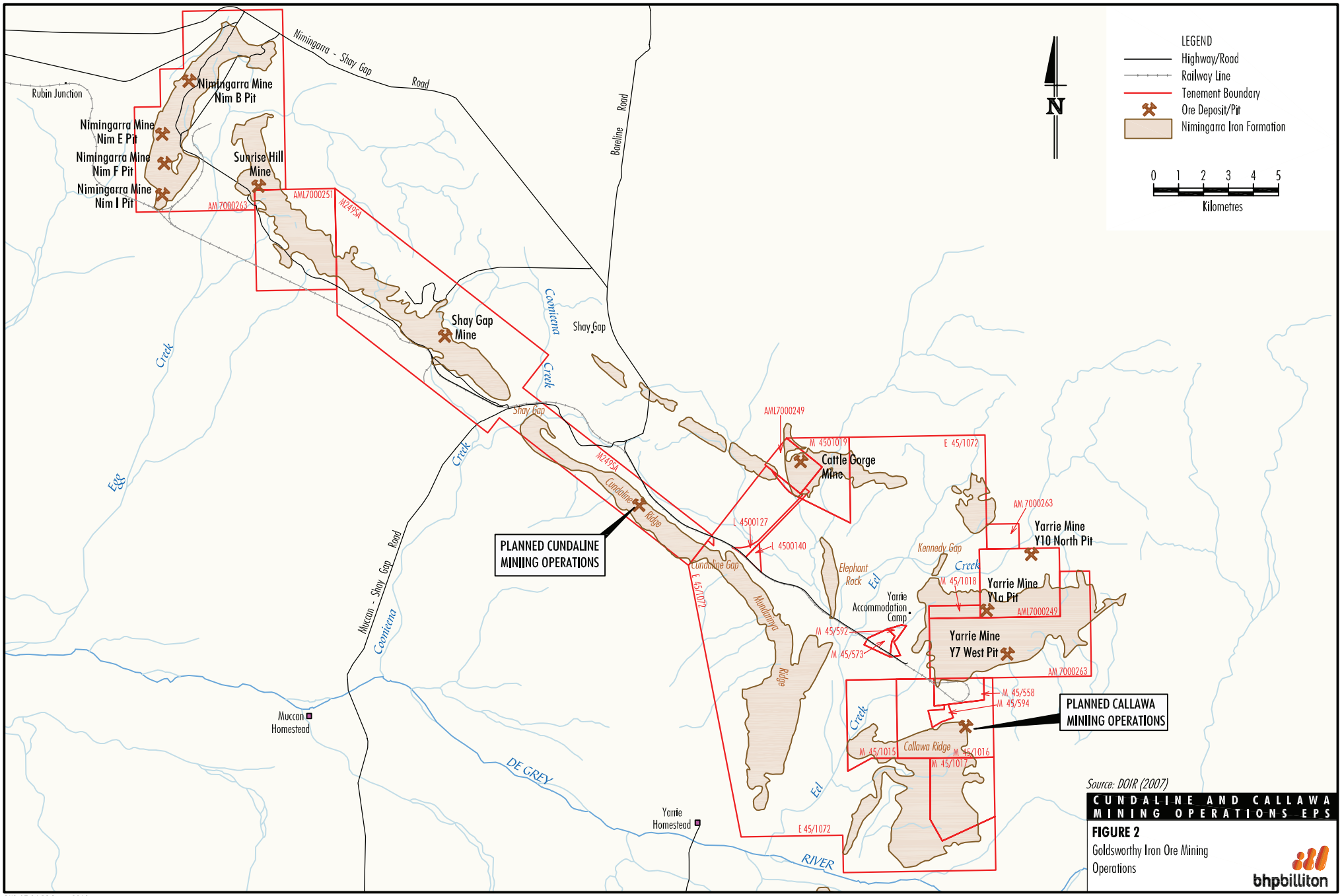

Source: DOIR (2007)

CUNDALINE AND CALLAWA MINING OPERATIONS EPS

FIGURE 2

Goldsworthy Iron Ore Mining Operations

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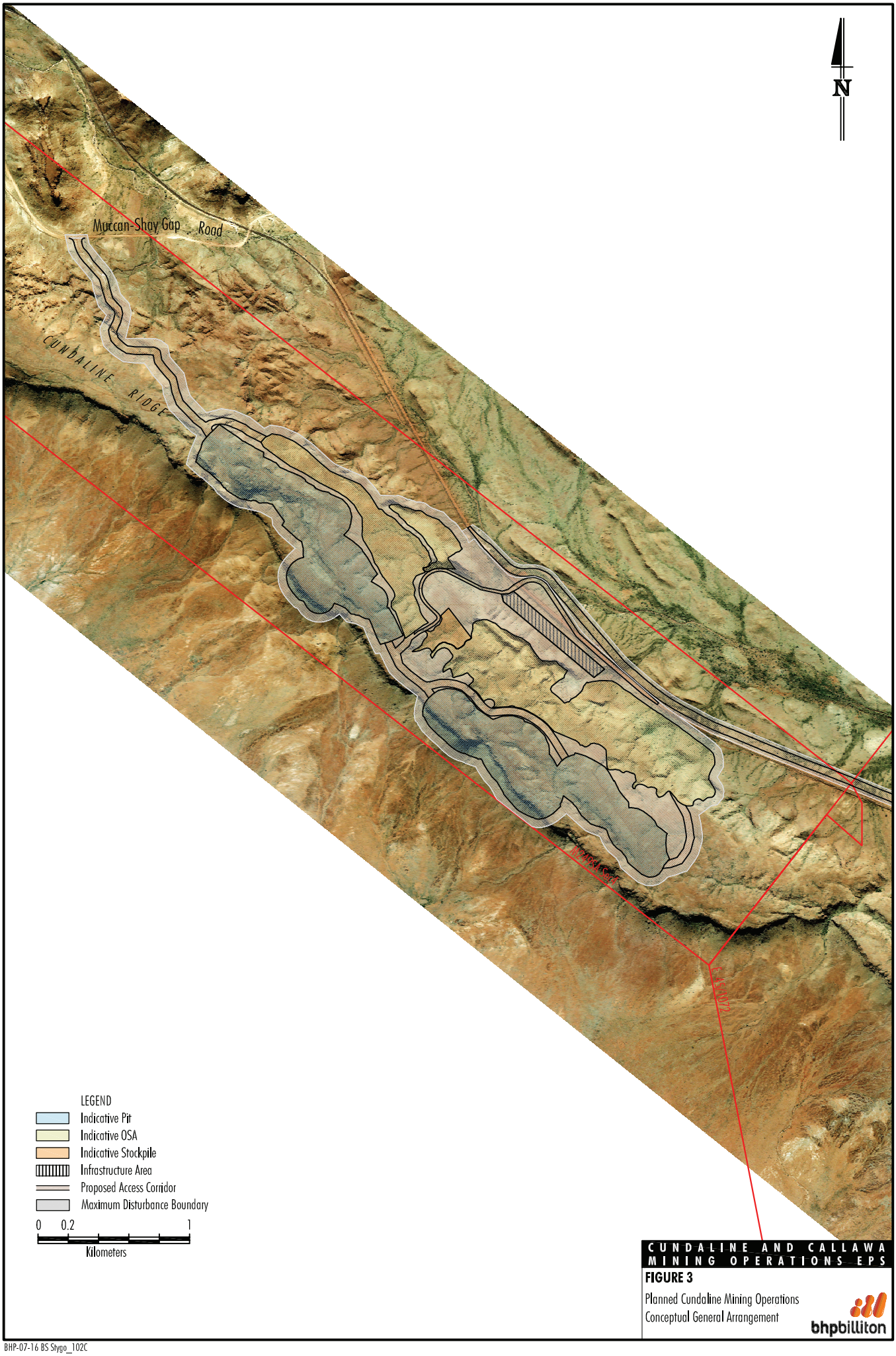

CUNDALINE AND CALLAWA MINING OPERATIONS EPS

FIGURE 3

Planned Cundaline Mining Operations
Conceptual General Arrangement

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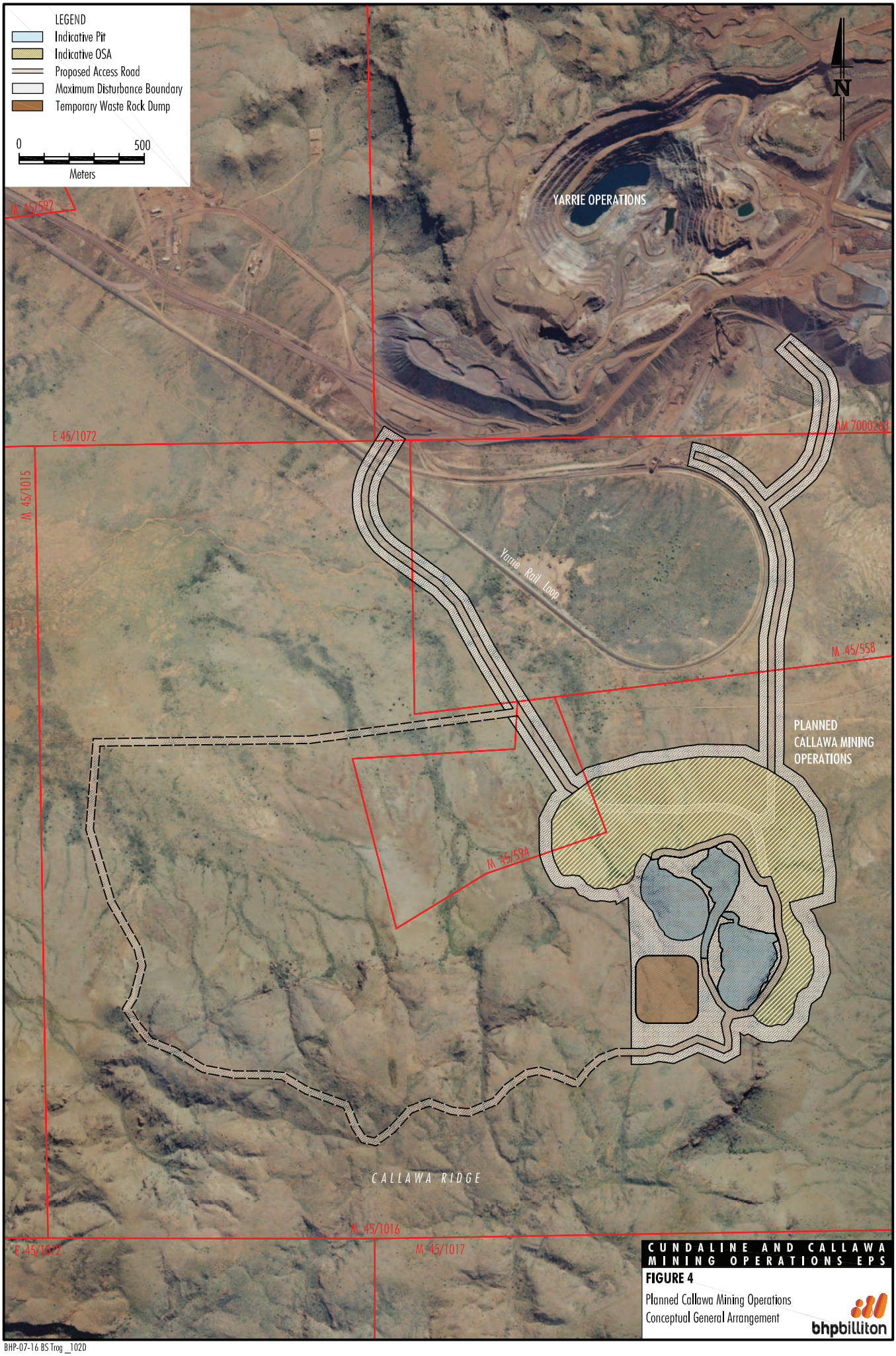


CUNDALINE AND CALLAWA MINING OPERATIONS EPS

FIGURE 4

Planned Callawa Mining Operations
Conceptual General Arrangement

bhpbilliton

BHP-07-16 BS Trog _102D

1.1 Regional Location

The Goldsworthy mining area is located within the catchment of the De Grey River. The De Grey River represents the most northern river system in the Pilbara before the expanse of the Great Sandy Desert begins (Figure 2).

All of the Goldsworthy iron ore deposits (including the Cundaline and Callawa deposits) occur on elevated ridge systems composed of the Nimingarra Iron Formation separated by alluvial valleys (Figure 2).

1.2 Local Topography

Both the Cundaline and Callawa deposits occur in elevated ridges of the Nimingarra Iron Formation rising approximately 150 metres (m) above the surrounding plains. Callawa Ridge runs over approximately 5 km in a north-south direction with a maximum width of approximately 4.8 km and comprises an area of approximately 1,800 hectares (ha) (Figures 2 and 4). The Cundaline Ridge joins Mundarmya Ridge to form an arc over 20 km long with a maximum width of approximately 3 km and covers an area of approximately 2,100 ha (Figures 2 and 3). The Callawa Ridge is 1 km to the east of the most southern point of the Cundaline-Mundarmya Ridge system. Separating the two ridge systems is Eel Creek which forms an alluvial valley. The distance between the proposed pit areas on Cundaline and Callawa ridges is approximately 13 km.

1.3 Troglofauna Habitat Characterisation

In accordance with Section 3.4 of EPA Guidance Statement No. 54a, BHPBIO has evaluated the geological information at Goldsworthy, in order to facilitate the assessment of the potential occurrence of troglofauna habitat. This geological information review is provided in Attachment 1 and the key points relevant to troglofauna habitat are described below.

The Goldsworthy area comprises a sequence of banded irons, sandstones, siltstones and tuffs. As discussed in Attachment 1, the iron ore mineralisation associated with the Cundaline and Callawa ridges is hosted within the Nimingarra Iron Formation, a steeply dipping sequence of Banded Iron Formation (BIF), ferruginous chert and shales (Figure 2). The Nimingarra Formation forms a prominent, semi-continuous fault-offset and folded group of ridges extending from the Callawa Ridge in the south to Nimingarra Ridge in the north, a strike length of approximately 60 km (Figure 2). The Nimingarra Iron Formation overlays the granites of the Muccan and Warrawagine batholiths.

Interrogation of the drill hole database shows that cavities extend throughout the Nimingarra Iron Formation to downhole depths of 160 m, however due in part to known weathering processes and also the lack of drilling data at depth in these areas, cavities are more prevalent at shallower depths associated with surficial weathering and development of hardcap and crustal deposits. Continuous weathering over the deposits has resulted in a carapace known as the ‘hardcap’ zone, which forms a semi-continuous horizon and hosts mineralisation across many of the ridges in the Goldsworthy area.

This zone can be extremely variable in texture and is known to contain more frequent voids and cavities. At the base of the hardcap zone there is often an extremely weathered, soft, saprolitic zone several metres thick. This is often seen in outcrop as an undercut where small caves and overhangs occur. While not common, large cavities on a scale of metres are occasionally observed during mining and drilling in this zone.

The Cundaline Deposit comprises a series of narrow lode-style orebodies over a strike length of approximately 9 km. There are four small lode deposits contained within the Lower and Middle BIF units of the Nimingarra Iron Formation, which dips steeply to the north-east. Several localised faults are noted throughout the deposits with a variety of orientations which offset stratigraphy and associated mineralisation. Examination of bore logs and geological mapping suggests there are minor variations between the composition and structure of the strata along strike, due to depositional variations and faulting and folding. However, these differences are minor, with the main variation being the depth of mineralisation and the extent of hardcap development. The hardcap zone reaches a depth of 30 m in the Cundaline Ridge. Interrogation of the drilling database indicates that vuggy cavities were identified to a depth of 160 m.

The Callawa deposit contains only one identified lode ore deposit on the north-east corner. This deposit is situated in the Lower or Middle member of the Nimingarra Iron Formation which dips shallowly to the west. This deposit contains post-mineralisation dolerite dykes that cross-cut mineralisation but have little offset and there are no other structural disruptions throughout the deposit to indicate faulting. The hardcap zone reaches a depth of 30 m in the Callawa Ridge. Interrogation of the drilling database indicates that vuggy cavities were identified to a depth of 60 m.

1.4 Previous Subterranean Faunal Studies

No previous sampling of subterranean fauna has been done at the Cundaline and Callawa ridges. However, Biota (2008a) collected some troglofauna (millipedes, pseudoscorpions and centipedes) as by-catch during sampling for stygofauna at the Yarrie Mine. Other subterranean surveys conducted in the northern Pilbara include Sulphur Springs (Subterranean Ecology 2007a) and the Ord Ranges (Subterranean Ecology 2007b). Troglofauna was detected at both sites, in particular a diverse assemblage in the Ord Ranges which is also situated in the Nimingarra Iron Formation.

BHPBIO is conducting a regional troglofauna sampling program for the Pilbara. The program has so far included troglofauna sampling at:

- Area C, located approximately 300 km south of Cundaline and Callawa ridges.
- Orebody 18, located approximately 330 km south of Cundaline and Callawa ridges.
- Orebody 24, located approximately 330 km south of Cundaline and Callawa ridges.

- Quarry 8, located approximately 95 km north of Area C.
- Boundary Ridge, located approximately 15 km west of Area C.

The preliminary results of the regional troglofauna sampling program, combined with the results of other troglofauna surveys in the Pilbara area show that troglofauna are diverse and widespread in suitable geological habitats across the region.

2 METHODOLOGY

The sampling methods used for this survey are consistent with the EPA's troglofauna sampling guidelines (EPA 2007) and the EPA Guidance Statement No. 54 and 54A (EPA 2003, 2007). The sample plan (Subterranean Ecology 2008a) conforms with BHPBIO's Regional Subterranean Fauna Study - Troglofauna Sampling Program Methodology (Biota 2008b) for the Pilbara that was endorsed by the Environmental Management Branch, Department of Environment and Conservation.

2.1 Sampling Design

Troglofauna sampling was undertaken in existing bores on the Cundaline and Callawa ridges. The number of out-of-pit samples was constrained by relatively few bores outside the proposed mine pit. This is a general problem because bores are drilled to define the resource area of mining interest, and consequently few bores are drilled beyond the proposed pit.

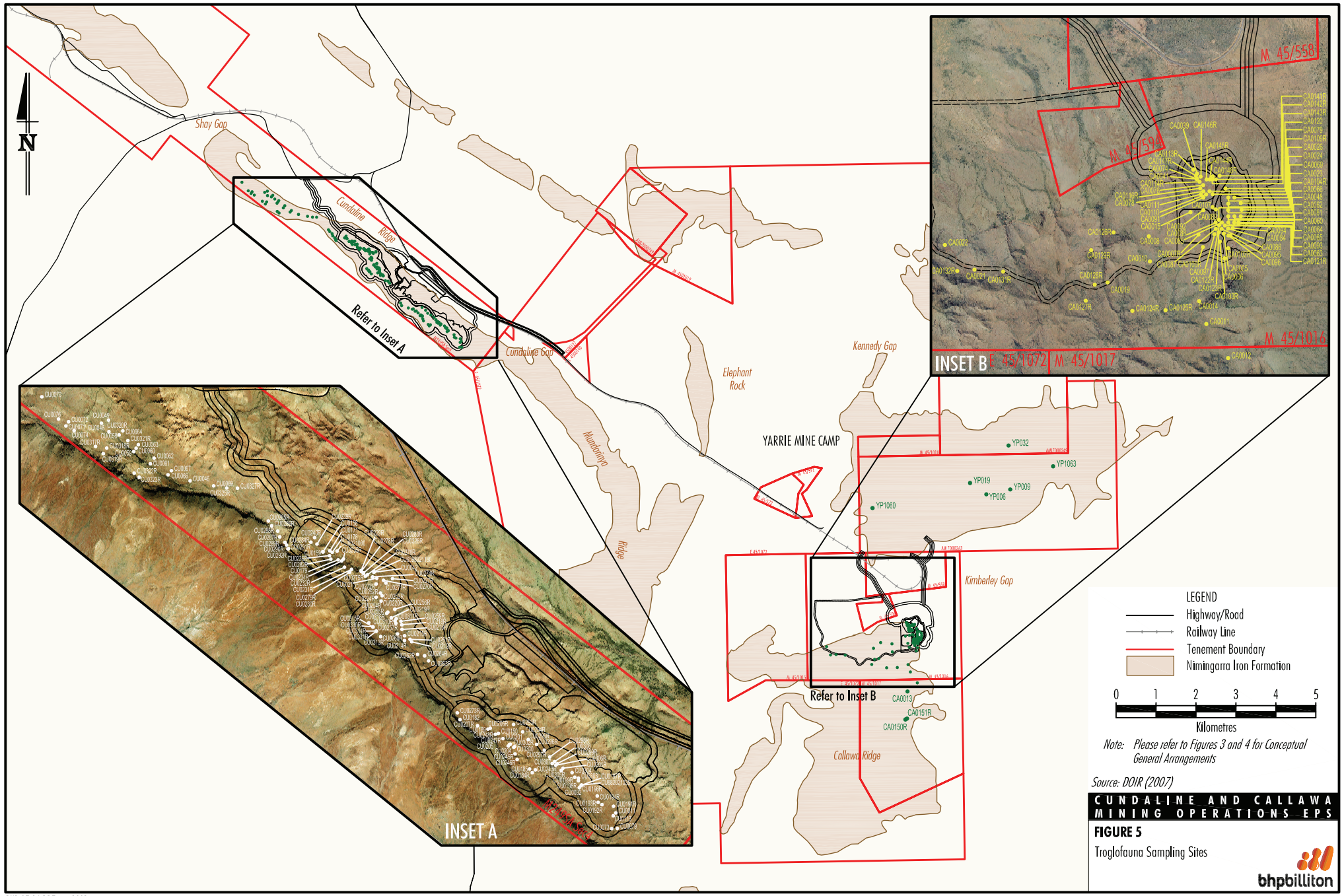
2.2 Sampling Effort

In the period from December 2007 to April 2008 two phases of troglofauna sampling were conducted. The total sampling effort was 309 sample events from 226 bores, comprising 190 samples from in-pit areas and 119 samples from out-of-pit areas (Table 1; Attachment 2). The majority of the sampling effort was concentrated in the Cundaline and Callawa deposits, where mining operations are proposed to occur. Bores that were not within the proposed pit areas were considered as Callawa out-of-pit and Cundaline out-of-pit areas. At Callawa Ridge, there were 33 suitable out-of-pit bores (Table 1). At Cundaline Ridge, there were 37 out-of-pit bores available (Table 1). Because of the limited number of out-of-pit bores at Cundaline Ridge and the close proximity of the proposed pits to each other that share the same geology, the same out-of-pit bores were used for the Cundaline Pit East and Pit West areas.

To provide a regional context, limited additional scraping and trapping was conducted at Yarrie Mine and Shay Gap Borefield (Table 1; Figures 2 and 5). The boreholes sampled at the Yarrie Mine occurred in the vicinity of the disused pit, and thus provided an opportunity to sample for troglofauna at a previously active mine. All of the sites sampled are listed in Attachment 2.

Table 1: Troglofauna sampling effort.

		Number of Holes Sampled	Number of Samples Taken	Phase 1: 12/12/07-28/02/08		Phase 2: 27/02-29/04/08	
				Trap	Scrape	Trap	Scrape
CALLAWA	IN-PIT	44	65	26	14	21	4
	OUT-OF-PIT	33	59	5	12	28	14
CUNDALINE	IN-PIT EAST	44	54	24	4	25	1
	IN-PIT WEST	59	71	29	8	31	3
	OUT-OF-PIT	37	51	5	8	36	2
YARRIE	YARRIE PIT	7	7	-	-	-	7
OUT-OF-PIT	SHAY GAP	2	2	-	-	-	2
	Total Overall	**226**	**309**	**89**	**46**	**141**	**33**



BHP-07-16 BS Trog _103D

2.3 Sampling Methods

Troglofauna was investigated using two different sampling techniques - mostly trapping and some scraping in accordance with the BHPBIO (2008) troglofauna sampling methodology. The first technique is the more traditional method employing litter traps that are suspended in boreholes following the procedure adopted by Biota (2006). The traps are comprised of 32 or 55 millimetre (mm) diameter PVC pipe cut to a length of 140 mm. The top of the trap consists of 10 mm aviary mesh to allow invertebrates to enter and colonise. The bottom end of the trap is capped with an appropriate sized PVC cap with a drill hole to allow any excess moisture to drain away to ensure the trap does not become and remain flooded. Each trap is prepared in the following way prior to installation in the field. Organic material is soaked in water prior to being irradiated in a microwave on high power for 10 minutes. This kills any invertebrates that may be present. The sterilised litter is then packed inside the traps ensuring that adequate interstitial spaces remain so ample micro-habitat is available for habitation by troglofauna. The organic litter used is sourced from the ground local to the survey area. Often for Pilbara surveys the material is mostly comprised of Spinifex and Acacia with some Eucalyptus plant debris. The packed traps are then sealed in zip lock bags to retain moisture and maintain sterile conditions. The litter traps are wetted again prior to installation in boreholes. Traps were left in place for at least six weeks or longer for each sample phase to allow adequate time for colonisation by fauna. When traps were recovered they were sealed in zip lock bags for transport to the laboratory. In the laboratory, fauna were extracted from the litter using Tullgren funnels and preserved in 100% ethanol.

The second technique, scraping, is a relatively new approach for collecting troglofauna, and is based on the net haul approach used for stygofauna. Scraping involves lowering an appropriate sized net to the base of the borehole or 1 m below the watertable and hauling the net up in a manner that maximises the nets contact with the wall surface with the aim of dislodging and collecting resident invertebrates. This process is usually repeated at least four times per borehole with the intention of sampling each side of a hole. Scraping for troglofauna may be conducted concurrently with stygofauna net hauling in uncased bores. Limited field time in this survey meant that scrape samples were only collected as part of stygofauna sampling, with each sample involving six net hauls. All haul samples were elutriated on site then transferred to a 30 millilitre (ml) vial and preserved in 100% ethanol.

2.4 Sample Sorting and Species Identification

All invertebrates collected were sorted and identified under a dissecting microscope using relevant available taxonomic resources. All specimens of each morpho-species were assigned a separate labelled vial and specimen tracking code. All associated and relevant morpho-species data and site data were recorded and analysed in an Excel spreadsheet.

Taxonomic groups known to contain troglobitic representatives were examined in more detail to determine if the specimens collected in this study were troglomorphic or non-troglomorphic forms. Potential troglobitic forms were distinguished by the possession of troglomorphic characters such as depigmentation, reduction or loss of eyes, elongation of appendages and sensory structures. Provisional troglobitic status (*viz*. troglomorphic) was assigned after comparison with the morphology of other close relatives in the group, and current knowledge on their distribution and ecology where known. Material was identified by Mr N. Stevens, Dr Stefan Eberhard, D. Cale and Dr T. Moulds. Where available, identifications were sought from specialist taxonomists, including Dr T. Weir (Commonwealth Scientific and Research Organisation [CSIRO], ANIC Canberra) (Coleoptera), Dr Pier Mauro Giachino (Italy) (Coleoptera), Dr Stefano Taiti (Instituo per lo Studio degli Ecosistemi – CNR Italy) (Coleoptera), Graeme Smith (Sydney University) (Zygentoma), Dr M. Harvey and Dr Volker Framenau (Western Australian Museum) (Araneae, Pseudoscorpionida), Fred Stone (Blattodea) (Bishop Museum, Hawaii). At the conclusion of the study, most specimens will be lodged at the Western Australian Museum. Subterranean Ecology will retain a voucher collection for future reference purposes.

2.5 DNA Genetic Testing

Representative specimens from eight different morpho-species that occur on both Cundaline and Callawa ridges were sent to Terrie Finston (University of Western Australia [UWA]) for molecular genetic analyses. The two main aims of the molecular analyses were:

1. to test the genetic robustness of identifications based on morphological characters; and
2. to investigate phylogeographic patterns in selected taxa, to assess the degree of genetic continuity, or discontinuity, between populations found on both Cundaline and Callawa Ridges.

The selected taxa exhibited a range of life history characteristics and a range of presumed dispersal capabilities, from taxa with low dispersal (e.g. millipedes) to taxa with high dispersal abilities (e.g. planthoppers).

3 RESULTS

3.1 Species Richness, Abundance and Distribution

Sampling conducted for this assessment yielded 263 troglofauna specimens from 12 major invertebrate groups including: millipedes (Diplopoda), centipedes (Chilopoda), symphylids (Symphyla), slaters (Isopoda), pseudoscorpions (Pseudoscorpionida), spiders (Araneae), harvestmen (Opilionida), diplurans (Diplura), silverfish (Thysanura), cockroaches (Blattodea), planthopper bugs (Hemiptera), and beetles (Coleoptera) (Table 2, Plates 1 to 12). A total of 29 putative morpho-species were identified (Table 2). The number of morpho-species recorded on each ridge included: Callawa Ridge (22 spp.), Cundaline (15 spp.), Yarrie (3 spp.). Ten morpho-species were collected on both the Callawa and Cundaline ridges during this survey (Tables 2 and 3, and Attachment 3). Very limited sampling on Yarrie ridge collected three morpho-species, of which one (Gnaphosidae SP01) was also collected on Callawa Ridge (Table 2). Two species, Diplura SP02 and *Nocticola* SP02, were collected on Yarrie Ridge but not detected on Callawa or Cundaline, where Diplura SP01 and *Nocticola* SP01 were collected.

Table 1. Troglomorphic taxa including abundance, distribution, and sample Method.

Order	Taxa	No. of Specimens and Boreholes (>1 in parenthesis)						Sampling Method	
		Callawa Ridge		Cundaline Ridge			Yarrie		
		Pit	Out-of-Pit	Pit East	Pit West	Out-of-Pit	Out-of-Pit	Trap	Scrape
Diplopoda	Haplodesmidae SP01	13(9)	33(16)	-	-	-	-	26	20
	Haplodesmidae SP02	-	-	1	-	-	-	1	-
	Polydesmida SP01	1	-	2	-	1	-	4	-
	Polyxenida SP01	-	-	-	-	1	-	1	
Symphyla	Symphyla SP01	-	-	2	-	-	-	2	-
Chilopoda	Geophilidae SP01	-	-	-	1	-	-	1	-
	Scolopendrida SP01	-	1	-	-	-	-	-	1
Isopoda	Armadillidiidae: *?Troglarmadillo* SP01[#]	3(2)	1	-	-	-	-	4	-
	Armadillidiidae: *?Troglarmadillo* SP02[#]	-	-	-	5(4)	1	-	5	1
Pseudoscorpionida	Hyidae: *Indohya* SP01	1	4(3)	2(2)	-	-	-	4	3
	Chthoniidae: Lagynochthonius leemouldi	4(3)	5(4)	-	-	2(2)	-	6	5
	Chthoniidae: Tyrannochthonius SP01	3(3)	2(2)	-	-	-	-	5	-
Araneae	Gnaphosidae SP01	-	6(2)	-	-	-	1	-	7
	Trochanteriidae SP01	-	4(3)	-	-	-	-	1	3
	Tetrablemmidae SP01	5(2)	1	-	-	3(3)	-	9	-
	Oonopidae: *Camptoscaphiella* SP01	-	2(2)	-	-	-	-	-	2
Opilionida	Phalongodidae SP01	1	-	-	-	-	-	-	-
Diplura	Diplura SP01	2(2)	-	1	-	-	-	3	-
	Diplura SP02	-	-	-	-	-	1	-	1
Zygentoma	Atelurinae: *Atelurodes* SP01	1	1	-	-	-	-	2	-
	Nicoletiinae: *Trinemura* SP01	2(2)	4(3)	-	-	5(3)	-	-	11
Blattodea	Nocticolidae: *Nocticola* SP01	5(3)	10(6)	8(4)	5(4)	14(4)	-	34	8
	Nocticola SP02	-	-	-	-	-	2(2)	-	2
Hemiptera	Meenoplidae SP01	4(3)	1	3	-	1	-	3*	6
	Meenoplidae SP02	2(2)	-	-	-	-	-	-	2
Coleoptera	Carabidae: *Illaphanus* SP01	1	1	-	-	1	-	1	2
	Coleoptera SP02	-	1	-	-	-	-	-	1
	Curculionidae SP01	1	4(3)	-	-	-	-	1	4
	Pselaphinae SP01	18(9)	20(10)	5(5)	8(5)	21(5)	-	67	5
Trog. Taxon total	***29***	**17**	**18**	**8**	**4**	**10**	**3**	**21**	**17**
							Number of specimens	**177**	**84**

Note: Shaded taxa recorded from out-of-pit sites.

* Specimens recovered from root mass material hauled up when trap was recovered. Therefore, although the specimens were not within the trap they are considered to have been collected by a trap sample.

[#] Recently, Dr Taiti has identified numerous new troglomorphic species in Western Australia that may belong to this genus. The generic placement remains uncertain until the taxonomy is revised in detail.

Table 3. Number of Troglomorphic Taxa Shared Among Sites

		Callawa Ridge		Cundaline Ridge			Yarrie Ridge
		Pit	Out-of-Pit	Pit (East)	Pit (West)	Out-of-Pit	Out-of-Pit
Callawa	Pit	**1**	-				
	Out-of-pit	13	**4**	-			
Cundaline	Pit (East)	6	4	**2**	-		
	Pit (West)	2	2	2	**1**	-	
	Out-of-pit	8	7	4	3	**1**	-
Yarrie	Out-of-pit	0	1	0	0	0	**2**

Note: bold number are collected from one site

The most abundant troglomorphic taxa were Pselaphinae SP01 (72), Haplodesmidae SP01 (46) and *Nocticola* SP01 (42) (Table 2 and Figure 6). Seven species were collected as single individuals (singletons), and all other species (except Symphyla SP01) were collected from at least two or more boreholes (Table 2).

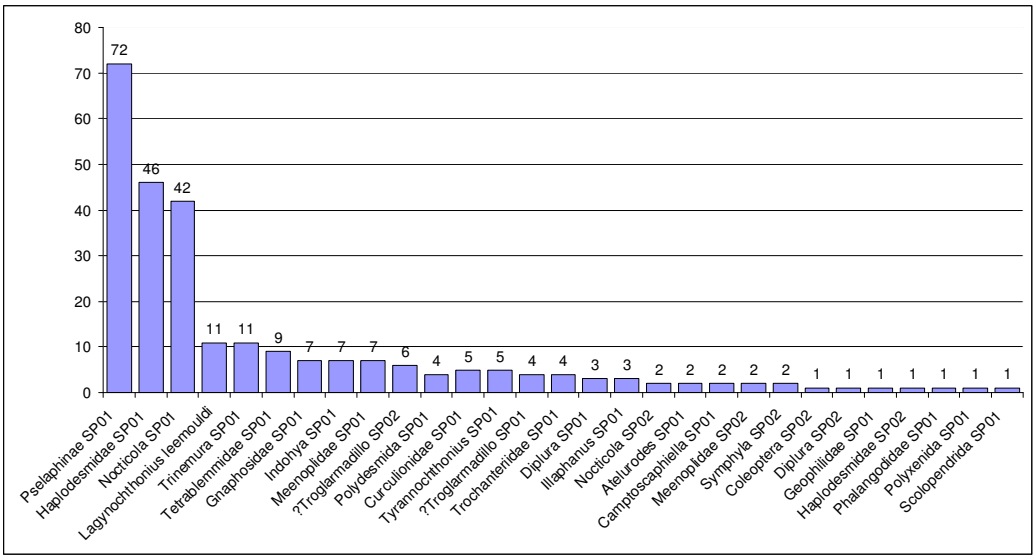


Figure 6: Abundance of troglomorphic morpho-species.

Plate 13. Tetrablemmidae SP01

Plate 14. Pseudoscorpion *Indohya* n. SP01

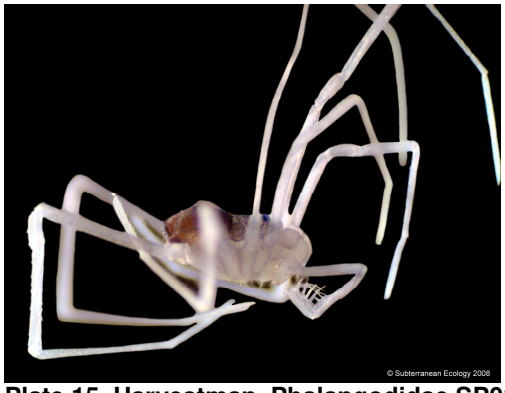


Plate 15. Harvestman, Phalangodidae SP01

Plate 16.Isopod, *Troglarmadillo (?)* sp.

Plate 17. Millipede, Haplodesmidae SP01

Plate 18. Centipede, Geophilidae SP01

Plate 19. Diplura SP01

Plate 20. Silverfish, *Trinemura* SP01

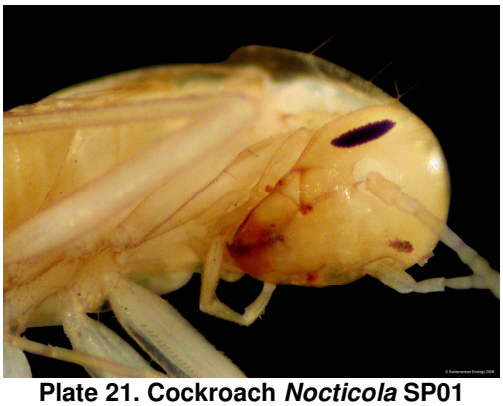


Plate 21. Cockroach *Nocticola* SP01

Plate 22. Beetle, *Illaphanus(?)*SP01

Plate 23. Weevil, Curculionidae SP01

Plate 24. Planthopper, Meenoplidae sp.

3.2 Arachnid Identifications

The Western Australian Museum (Harvey and Framenau 2008) provided identifications of arachnid specimens. *Lagynochthonius leemouldi* (Chthoniidae) was collected outside of proposed pit shells on both ridges, as currently delineated. *Lagynochthonius leemouldi* was recently described from a single female collected from subterranean habitats at Yarrie (Edward and Harvey 2008). This species is clearly troglobitic, as it completely lacks eyes and has elongated appendages (Harvey and Framenau 2008). *Tyrannochthonius* SP01 (Chthoniidae) located on the Callawa Ridge is also clearly troglobitic, as it completely lacks eyes and has elongated appendages (Harvey and Framenau 2008). Numerous other species of *Tyrannochthonius* are known to be troglobitic, and have been recorded from caves and boreholes in the Pilbara (Edward and Harvey 2008). Similarly, the hyid pseudoscorpion, *Indohya* SP01 collected from Cundaline and Callawa ridges is also clearly troglobitic (Harvey and Framenau 2008).

Two species of troglobitic spider were identified, *Camptoscaphiella* SP01 (Oonopidae), and a very interesting new species belonging to the family Tetrablemmidae, which was completely blind, and represents the first recorded troglomorphic member of this family. The tetrablemmid was collected from Cundaline and Callawa, from inside and outside pit areas, as currently delineated. *Camptoscaphiella* SP01 was collected from Callawa outside the proposed pit.

A single juvenile harvestman (Opilionida) was collected that fits the diagnosis for family Phalangodidae. The specimen was collected from in-pit area at Callawa (hole CAO39). It possessed small eye spots, but had elongated appendages and pallid colouration. It may represent a troglomorphic species, but adult specimens are required (Harvey and Framenau 2008). This family contains troglobitic representatives at Cape Range (Shear 2001), and other members of this family have been collected from subsurface habitats at Area C (Bennelongia 2008a) and Quarry 8 (Subterranean Ecology 2008b).

3.3 Isopod Identifications

A troglomorphic isopod belonging to the family Armadillidiidae is possibly assignable to the genus *Troglarmadillo*. This genus was erected by Wahrberg many years ago for a single species described from caves at Chillagoe, Queensland. Recently, Dr Taiti has identified numerous new troglomorphic species in Western Australia that may belong to this genus. The generic placement remains uncertain until the taxonomy is revised in detail. ?*Troglarmadillo* SP01 from Callawa Ridge was identified, based on morphology, as a different, but closely related, species to ?*Troglarmadillo* SP02 from Cundaline Ridge. On their respective ridges, both species were collected inside and outside proposed pit shells, as currently delineated.

3.4 Silverfish Identifications

Two species were recorded from Yarrie- a large undescribed troglomorphic nicoletiid species (*Trinemura* n. SP01) and an undescribed atelurine species

(nominally *Atelurodes* n. SP01) a family usually only collected in association with ants or termites (Smith 2008).

3.5 Cockroach Identifications

Two morpho-species of nocticolid cockroaches assignable to the genus *Nocticola,* were identified. *Nocticola* SP01 was recorded from the Cundaline and Callawa ridges, and *Nocticola* SP02 from Yarrie Ridge. *Nocticola* SP02 is only known from juvenile specimens but is distinguished from *Nocticola* SP01 by the complete absence of eyes. *Nocticola* SP01 clearly belongs to a new species characterised, inter alia, by a large, deeply indented tergal gland (Stone 2008). A similar, but distinct, species of *Nocticola* with deeply indented tergal gland is known from near Nullagine, and both these *Nocticola* spp. are distinct from *Nocticola* sp. collected from Area C (Stone 2008).

3.6 DNA Genetic Results

The results of DNA genetic studies by T. Finston (2008) are summarised below.

Millipedes: Haplodesmidae

The haplodesmid millipedes appear to be represented by at least two species (7% divergence) which are morphologically similar. One species was found on Callawa Ridge, Haplodesmidae SP01, and a second species, Haplodesmidae SP02, was found on Cundaline Ridge. Haplodesmidae SP01 was found on Callawa Ridge both inside and outside proposed pit shells. Haplodesmidae SP02 has only been collected once on Cundaline Ridge, and this was from inside a proposed pit (bore hole CU0247R).

Planthoppers: Meenoplidae SP01

The DNA data support the morphological identification of a single planthopper species, Meenoplidae SP01, occurring on both Cundaline and Callawa ridges. There was only a slight sequence divergence (0.6%) observed between the specimens that were examined from each ridge. Meenoplidae SP02 was not sequenced owing to insufficient material.

Slaters: Isopoda

There were technical difficulties in obtaining sequences from many of the specimens, which may be able to be rectified with further work that is currently progressing. However, sequences (290 base pair fragment of the 12s gene) obtained from three Cundaline specimens (LN1320, LN4996, LN4997) of ?*Troglarmadillo* SP02 were identical, confirming they are the same species. ?*Troglarmadillo* SP01 was not sequenced owing to insufficient material.

Beetles: Coleoptera

The DNA sequences obtained from Pselaphiinae SP01 were not successful, however two sequences were obtained from two specimens of *Illaphanus* SP01 (Carabidae) collected from the Cundaline and Callawa ridges. A 552 bp fragment was sequenced for the mitochondrial gene 16s for specimen LN1368, while a 449 base pair fragment of 16s was sequenced from LN6119 (CA0113). The two sequences were aligned and sequence divergence was calculated for the region of shared sequence. There was 11.7% sequence divergence between

the two specimens. This high level of sequence divergence suggests that they are two distinct species (T. Finston pers. comm. 2008). The taxonomic status of *Illaphanus* SP01 therefore remains a matter of ongoing determination.

Silverfish: Zygentoma

Eighteen specimens of silverfish from two subfamilies, the Ateluriinae and the Nicoletiinae, were sequenced for a 334 base pair fragment of the 12s mitochondrial gene.

The two specimens of *Trinemura* SP 1 (Nicoletiinae) form a single genetic group or clade. LN1020 (Callawa Ridge) differs from LN1093 (Cundaline Ridge) by 5.9% sequence divergence (uncorrected p-distance). The two specimens are clearly closely related, and share a common ancestor, but the level of sequence divergence suggests that the two populations have been isolated from one another for perhaps two million years or more, using the molecular clock for the mitochondrial gene COI (Finston 2008).

3.7 Comparison of Sampling Methods

Trapping and scraping collection methods enhanced the overall survey results. Trapping collected 21 taxa, and scraping collected 19 of the total 29 troglomorphic taxa recorded.

3.8 Variation between Sample Phases

The February sample phase collected fewer troglomorphic individuals than the April phase (90 compared to 173) but marginally more species (21 compared to 19) (Table 4). Generally, the more common and widespread species that were collected in both phases were more abundant during the April phase than the February phase (Attachment 4).

Table 4: Variation for all Sites Combined.

	December/February	April
Total # samples	135	174
Total # individuals	90	173
Total # species	21	19
# species exclusive to sample phase	9	8
# of individuals collected per sample	0.67	0.10
# of taxon records per sample	0.15	0.11

4 DISCUSSION

4.1 Diversity, Abundance and Sampling Efficiency

The Cundaline and Callawa Ridges were found to harbour a diverse troglofauna comprising at least 29 morpho-species. This can be compared to the species richness recorded in other well surveyed non-karstic Pilbara regions including the Robe Valley (~ 18 species.; Biota 2006), Ord Ranges (12 species; Subterranean Ecology 2007c), Ophthalmia range (10 species; Bennelongia 2008b), Jirrpalpar Range (~ 25 species; Bennelongia 2008a) and Packsaddle Range (15 species; Subterranean Ecology 2008c).

The frequency histogram of species abundance (Figure 6) exhibited the typical pattern of most ecological communities, with a few very abundant species and most species collected in low numbers. The high proportion of low abundance species is not uncommon in faunal surveys given that the detectability of a species is inversely related to the density of individuals present in the population falling within the survey area (Eberhard *et al*. 2005). On this survey, the overall capture rate of troglomorphs, was considerably higher (0.84 troglomorphs per sample) than some previous Pilbara studies where capture rates were between 0.05 and 0.25 troglomorphs per sample (Biota 2006; Subterranean Ecology 2007a,c). Other recent surveys in the Pilbara using trapping and scraping methods have also yielded high capture rates of 0.58 to 0.72 (Bennelongia 2008a; Subterranean Ecology 2008c). On this survey, the sampling efficiency and sampling effort (309 samples, 190 in-pit, 119 out-pit) is considered adequate to enable an assessment of troglofauna in relation to the proposed satellite mining operations at Cundaline and Callawa.

4.2 Conservation Assessment

The Cundaline and Callawa deposits occur on discrete elevated ridge systems separated by the alluvial valley of Eel Creek. This valley composed of Quaternary alluvium is approximately 1 km wide, and conceivably might pose a barrier to subterranean dispersal between ridges, thus contributing to isolation of populations, or species, in a manner analogous to that documented in the Robe Valley (cf. Biota 2006). During this survey one-third (12 species) of putative morpho-species were collected on both Cundaline and Callawa ridges, however, ten species were collected only on the Callawa Ridge and four species were collected only on the Cundaline Ridge. The apparent restriction of some species to a single ridge may be an artefact of the sampling because most species were collected in low numbers, and further sampling may show these species to occur on both ridges. However, the morphological and preliminary genetic evidence suggests the possibility that some species, and populations, may be restricted to a single ridge landform. The taxa concerned, for which some preliminary genetic data is available, include the haplodesmid millipedes, armadillid isopods, and nicoletiid silverfish. These taxa are discussed in more detail below.

Two species of troglomorphic isopod were collected, one species from the Callawa Ridge, ?*Troglarmadillo* SP01, and a different but closely related species from the Cundaline Ridge, ?*Troglarmadillo* SP02. These two species are both different to ?*Troglarmadillo* collected from Area C (S. Taiti pers. comm.).

One species of haplodesmid millipede, Haplodesmidae SP01, was collected on Callawa Ridge and a second species, Haplodesmidae SP02, was found on Cundaline Ridge. If these are true sister species, then the DNA evidence (Finston 2008) is consistent with the low dispersal capabilities and high degree of local endemism generally observed in millipedes, and also consistent with patterns in cave dwelling paradoxosomatid millipedes at Cape Range where genetically distinct populations of *Stygiochiropus communis* were found on landform blocks separated by deep valleys (Humphreys and Adams 2001). An alternative possibility is that either one, or both, millipede species occur on both Cundaline and Callawa ridges. The second species appears to be quite rare (known only from one specimen) whereas the first species was collected in considerable abundance, but only on the Callawa Ridge. Haplodesmidae SP02 has only been collected once on the Cundaline Ridge, and this was from inside a proposed pit shell (bore hole CU0247).

The Nicoletidae is a widespread family of eyeless and unpigmented silverfish, normally collected in caves or soil (Paclt 1963). Troglobitic forms display larger size and elongated appendages. The genus *Trinemura* Silvestri, 1908 is known from cave and soil dwelling forms in Western Australia and the Northern Territory (Smith 1998a,b). *Trinemura* n SP01 collected from the Cundaline and Callawa ridges is the largest *Trinemura* species known. This species displays obvious troglomorphies (size and appendage elongation) and may be restricted to subterranean habitats (Smith 2008). The DNA sequence data from two specimens of *Trinemura* sp. 1, one from the Callawa Ridge and one from the Cundaline Ridge, was consistent with the identification of a single species based on morphological characters. The two specimens are clearly closely related, and share a common ancestor, but the level of sequence divergence (5.9%) suggests that the two populations have been isolated from one another for perhaps two million years or more, using the molecular clock for the mitochondrial gene COI (Finston 2008).

Harvey and Framenau (2008) consider two species of spider, *Camptoscaphiella* SP01 and Tetrablemmidae SP01, and three species of pseudoscorpions, (*Lagynochthonius leemouldi*, *Tyrannochthonius* SP01 and *Indohya* SP01) as short-range endemic species. Each of these species was collected from both in-pit and out-pit areas at Callawa or Cundaline, so these species are not considered to be a conservation risk in relation to the satellite mining operations, as currently proposed.

On their respective ridges, most troglofauna species were collected from both in-pit and out-of-pit areas, consistent with the extent and continuity of geological habitat. However, six morpho-species were only collected from in-pit areas (Haplodesmidae SP02, Symphyla SP01, Geophilidae SP01, Diplura SP01, Meenoplidae SP02 and Phalangodidae SP01) (Table 2). A seventh morpho-species, the pseudoscorpion *Indohya* SP01, was collected on both Cundaline and Callawa ridges, but was collected only from in-pit area on the Cundaline Ridge. Because *Indohya* SP01 is highly troglomorphic and a probable troglobite, it is possible that genetically discrete populations, or morphologically cryptic species, occur on each ridge. However, for these seven morpho-species it is considered likely given the extent of the Nimingarra Iron Formation, that populations of each species are likely to occur outside the in-pit areas on each ridge.

If any of the troglofauna species are restricted in distribution to a single ridge landform, they are unlikely to be threatened by the proposed mining because of the large areas of contiguous habitat that will remain in the portions of each ridge that will not be impacted by mining. Large expanses of out-of-pit area remain on each ridge, and these consist of similar geological habitat (Nimingarra Iron Formation) likely to support troglofauna.

Habitat fragmentation is unlikely to be a conservation concern at Callawa Ridge as the proposed pit occupies a small corner of this large block-shaped landform. At Cundaline Ridge, habitat fragmentation may be an effect to consider, as the two proposed pits span a substantial portion of this narrow elongate landform, although habitat continuity would presumably be retained in the adjacent sections of unmined ridge (Figure 2).

An interesting finding was the detection of troglofauna on the Yarrie Ridge adjacent to the Yarrie Mine, indicating that populations either persisted here during the mining activity, or recolonised from adjacent habitat after the mining disturbance ceased. This has important implications for understanding the impacts of mining on subterranean fauna and their ability to tolerate or recolonise after disturbance.

5 ACKNOWLEDGEMENTS

We would like to acknowledge the following taxonomists for identification of specimens: Dr T. Weir (CSIRO, ANIC Canberra) (Coleoptera), Dr Pier Mauro Giachino (Italy) (Coleoptera), Dr Stefano Taiti (Instituo per lo Studio degli Ecosistemi – CNR Italy) (Coleoptera), Graeme Smith (Sydney University) (Zygentoma), Dr M. Harvey and Dr Volker Framenau (Western Australian Museum) (Araneae, Pseudoscorpionida), Fred Stone (Blattodea) (Bishop Museum, Hawaii).

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ATTACHMENTS

Cundaline and Callawa Geological Review

Prepared by BHP Billiton Iron Ore

22 September 2008

In accordance with Section 3.4 of EPA Guidance Statement No. 54a, BHP Billiton (BHPBIO) has evaluated the geological information at Goldsworthy, in order to facilitate the assessment of the potential occurrence of troglofauna habitat. This review encompasses the Callawa and Cundaline deposits and surrounds. A description of the key findings of the review is provided below.

1. General Geology of the Goldsworthy Area

The Goldsworthy iron ore deposits are located at the northern margin of the Pilbara Craton, which comprises of large granitoid domes and batholiths separated by down-folded sequences of the Pilbara Supergroup sedimentary volcanic and intrusive rocks (Figure 1).

The Goldsworthy area and surrounds comprises a sequence of banded irons, sandstones, siltstones and tuffs as outlined in the stratigraphic column in Table 1 and presented in Figures 2a and 2b. The iron ore mineralisation associated with Cundaline and Callawa is hosted within the Nimingarra Formation, a steeply dipping sequence of banded-iron (BIF), ferruginous chert and shales (Figure 3).

The Nimingarra Formation forms a prominent, semi-continuous fault-offset and folded group of ridges extending from the Callawa Ridge in the south to Nimingarra Ridge in the north, a strike length of approximately 60 km (Figures 2a, 2b and 3). The Cundaline deposits occur in the mid-reach of the north-western trending limb (Figures 2a, 2b and 3).

The Nimingarra Formation consists of Lower, Middle, and Upper Member Banded Iron Formations (BIF) (Figures 4 and 5a to 5e). The Lower Member is characterised by thick bedded white and gray chert with only minor black chert and numerous interbedded shale units. The Middle and Upper Member BIF are typically thin bedded black and jaspilitic chert.

The Nimingarra Formation overlays the granites of the Muccan and Warrawagine batholiths (Table 1; Figures 4 and 5a to 5e).

The Cundaline Formation occurs on the northern side of the Cundaline Ridge, consisting of weathered shale and siltstone (Table 1; Figures 2a and 2b).

The plains between the ridges consist of Quaternary deposits (Table 1; Figures 2a and 2b).

Characteristics of the Nimingarra Banded Iron Formation

Lode ore found within the Nimingarra Formation is restricted mostly to the three hematite BIF units discussed previously, being best developed where structures and cross-cutting dolerite dykes provide a focus for mineralising fluids (Table 1).

The BIF host rock, precursor to ore, consists of finely bedded chert, iron oxides and silicates. The texture of this rock type is fine-grained and dense, with little or no intergranular pore space. Inter-bedded within the iron formation are shale and chert which can form bands up to 40 m thick. The shale and chert are similarly finely bedded and non-porous, however ore-forming weathering processes can alter BIF and other rock types to form voids and cavities. Chert and silica are leached out by meteoric water and may be replaced by iron hydroxides. The resultant rock consists mainly of iron oxides and iron hydroxides (hematite and goethite). Leaching of impurities increases the porosity of the rock and most of these iron ores will be permeable to water to some degree. Often pores are measured in scales of fractions of millimetres although occasionally larger (centimetre scale) voids will occur.

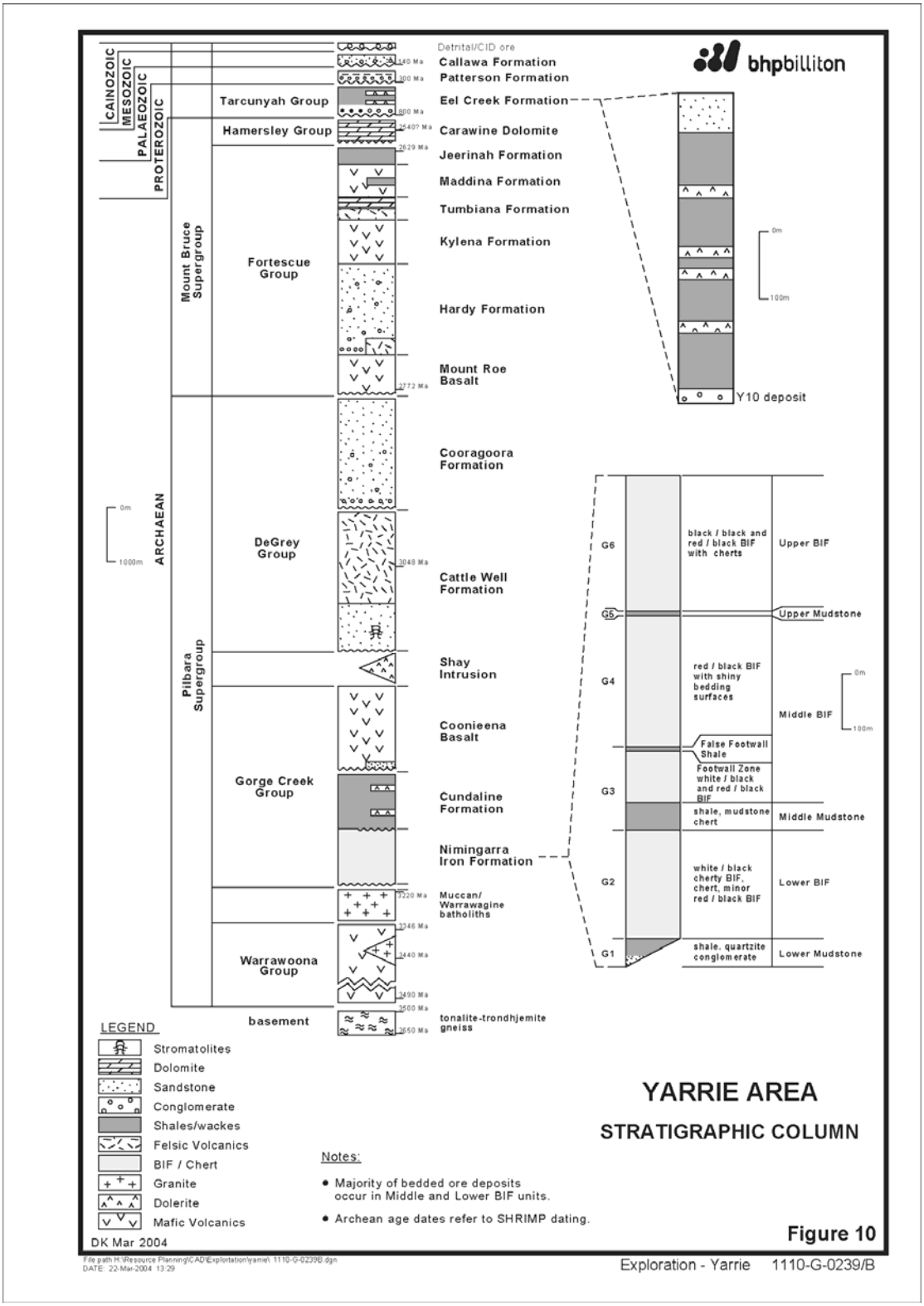

Table 1. Stratigraphy of the Yarrie Area (Kneeshaw, 2008)

Interrogation of the drill hole database shows that cavities extend throughout the Nimingarra Formation to downhole depths of 160 metres (m), however due in part to known weathering processes and also the lack of drilling data at depth in these areas, cavities are more prevalent at shallower depths associated with surficial weathering and development of hardcap (see section titled “Hardcap Zone”).

Several deformation and intrusive events have impacted on these rocks, causing folding and faulting at all scales. Faulting introduces discontinuities through which water can access otherwise non-porous rock. Continuous water flow through these faults can produce cavities which are often filled with secondary minerals such as silica or clay. Folding does little to change the porosity of the rocks. Intrusive dolerite dykes also cross-cut the stratigraphy, which creates further conduits through which water can flow.

Larger scale fault lines occur between the ridges as shown on Figure 3. These include the Elephant Rock Fault which defines the eastern edge of the Mundarinya Ridge; the Kennedy Gap Fault which occurs near Eel Creek, and a fault associated with the edge of Callawa Ridge.

Lode Mineralisation in the Cundaline and Callawa area (Figures 3 and 4a to 4e) is dominantly microplaty hematite, with goethite. Crustal hematite ore is also present formed by the near-surface leaching of the BIF).

Hardcap Zone

Continuous weathering over the deposits has resulted in a carapace known as the ‘hardcap’ zone, which forms a semi-continuous horizon and hosts mineralisation across many of the ridges in the Goldsworthy area. This zone can be extremely variable in texture and is known to contain more frequent voids and cavities (Plate 1). At the base of the hardcap zone there is often an extremely weathered, soft, saprolitic zone several metres thick. This is often seen in outcrop as an undercut where small caves and overhangs occur. While not common, large cavities on a scale of metres are occasionally observed during mining and drilling in this zone.

Plate 1. Example of the Hardcap Zone on the Callawa Ridge

2. Geology of the Callawa and Cundaline Ridges

Cundaline Ridge

The Cundaline deposit comprises a series of narrow lode-style orebodies over a strike length of approximately 9 km. There are four small lode deposits contained within the Lower and Middle BIF units of the Nimingarra Formation, which dips steeply to the north-east (Table 1; Figures 4a to 4e). These deposits are known as the 6 km, 10 km, 13 km and 14 km deposits. Several localised faults are noted throughout the deposits with a variety of orientations which offset stratigraphy and associated mineralisation.

Examination of bore logs and geological mapping suggests there are minor variations between the composition and structure of the strata along strike, due to depositional variations and faulting and folding. However, these differences are minor, with the main variation being the depth of mineralisation and the extent of hardcap development.

The hardcap zone reaches a depth of 30 m in the Cundaline area. Interrogation of the drilling database indicates that vuggy cavities were identified to a depth of 160 m.

Callawa Ridge

The Callawa deposit contains only one identified lode ore deposit on the north-east corner. This deposit is situated in the Lower or Middle member of the Nimingarra Formation which dips shallowly to the west (Table 1; Figure 3). This deposit contains post-mineralisation dolerite dykes that cross-cut mineralisation but have little offset and there are no other structural disruptions throughout the deposit to indicate faulting.

The hardcap zone reaches a depth of 30 m in the Callawa area. Interrogation of the drilling database indicates that vuggy cavities were identified to a depth of 60 m.

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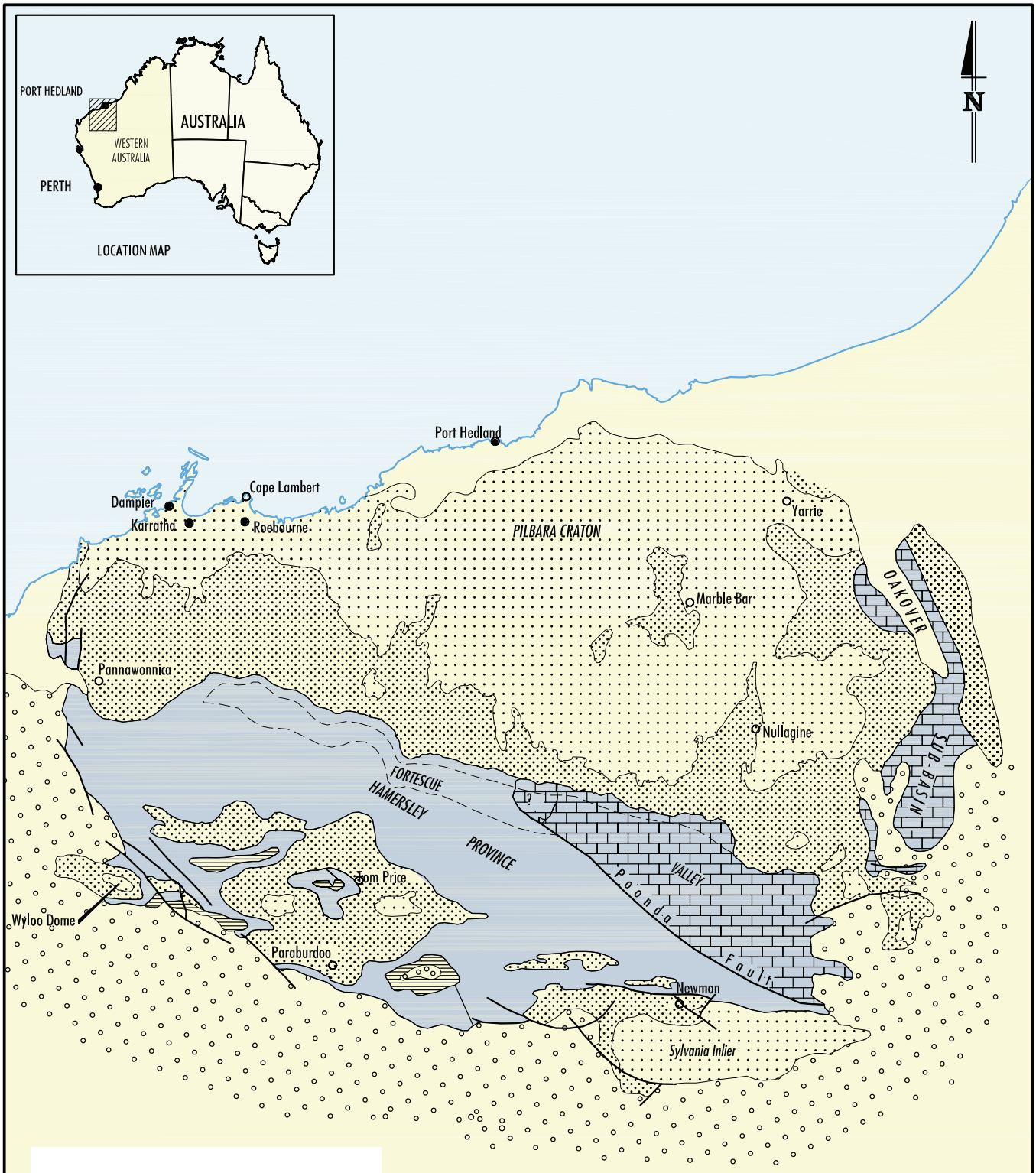

CUNDALINE AND CALLAWA MINING OPERATIONS EPS

FIGURE 1

Regional Geology

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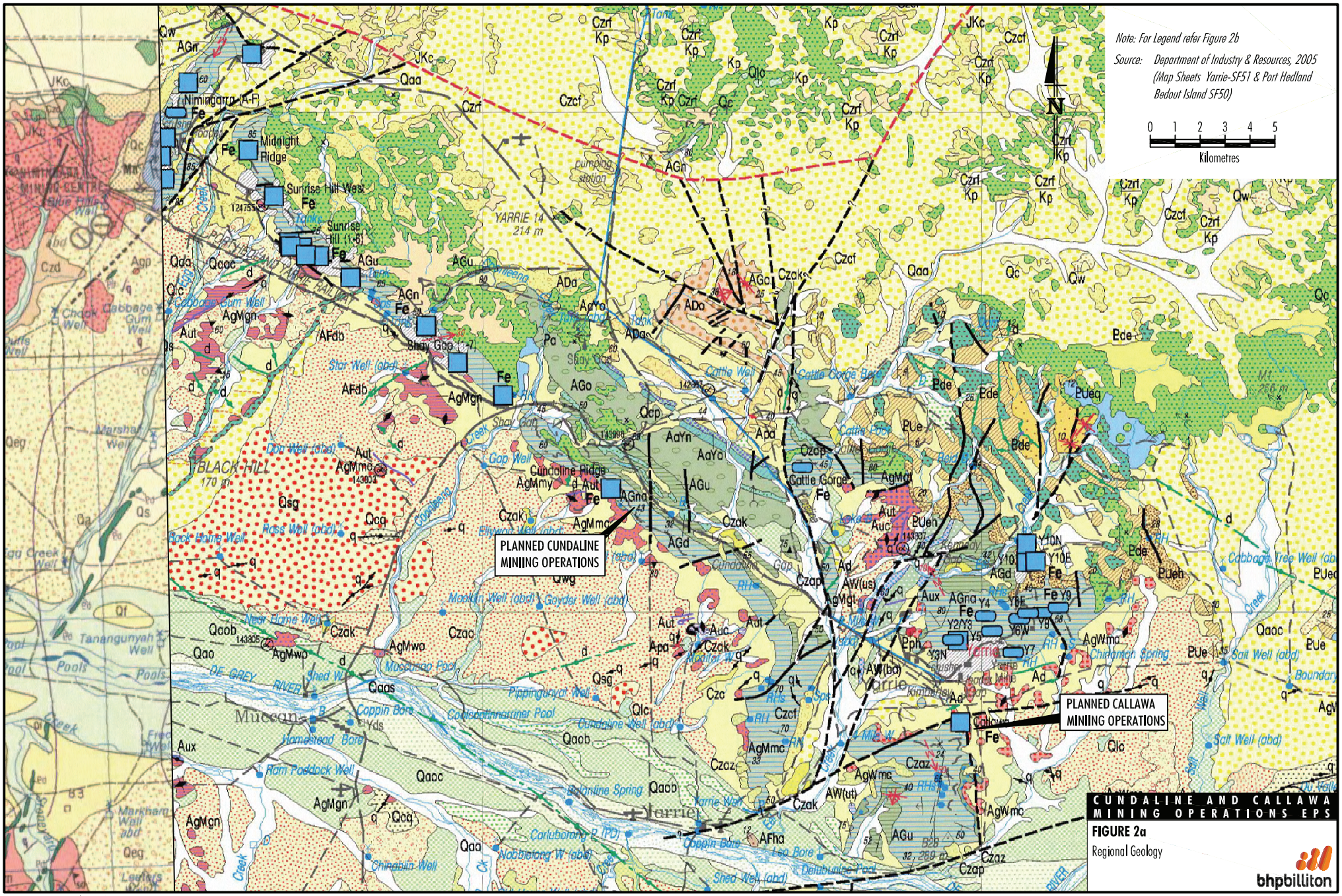

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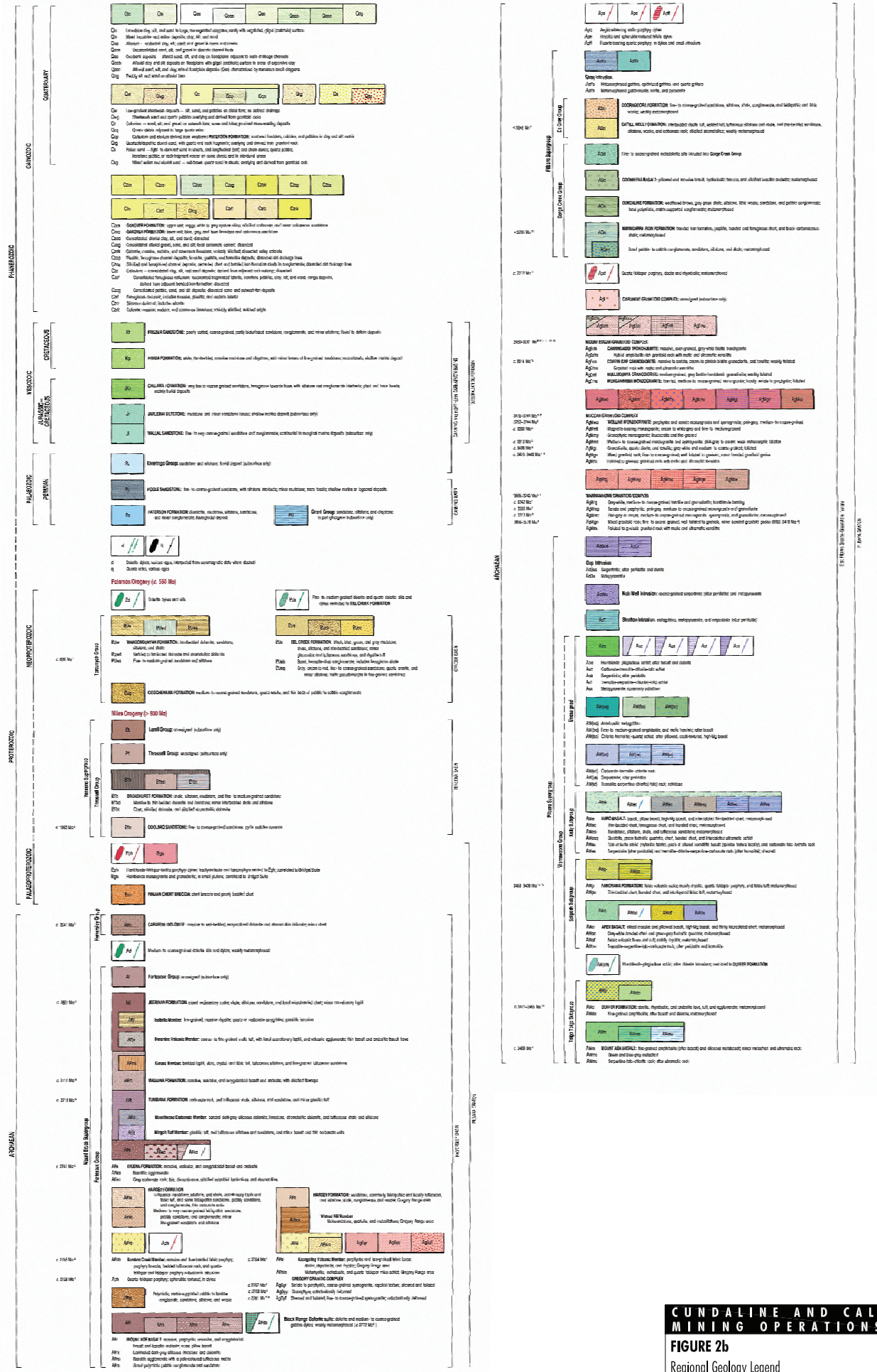

CUNDALINE AND CALLAWA MINING OPERATIONS EPS

FIGURE 2b

Regional Geology Legend

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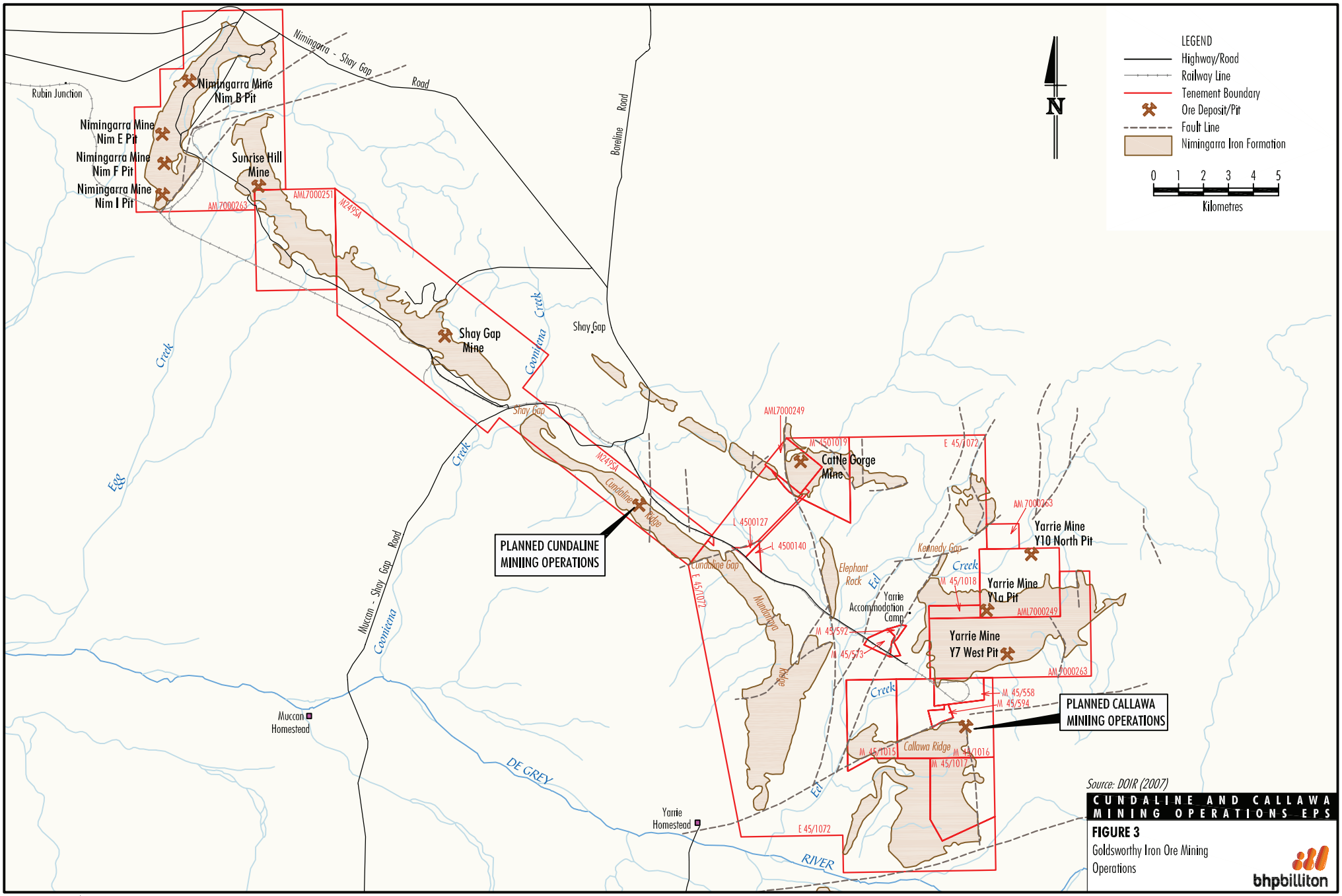

CUNDALINE AND CALLAWA MINING OPERATIONS EPS

FIGURE 3
Goldsworthy Iron Ore Mining Operations

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BHP-07-16 BS Trog Attach _104B

RL 300 m

RL 200 m

RL 100 m

MIDDLE MEMBER BIF

GRANITE INTRUSIVE

MIDDLE MEMBER BIF

GRANITE INTRUSIVE

218800 mE

218900 mE

219000 mE

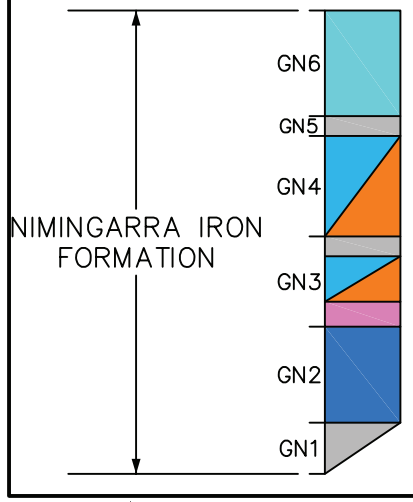
219100 mE

219200 mE

219300 mE

LEGEND

STRATIGRAPHY



- Upper BIF
- Upper Mudstone
- Middle BIF
- Middle Mudstone
- Lower BIF
- Lower Mudstone

ORE / ROCK TYPES

- Banded Iron Formation
- Lode Ore
- Crustal Ore
- Dolerite Intrusive
- Granite Intrusive
- Middle Member Footwall Mudstone

- Hard Cap
- Final Pit Profile
- Drill Hole Location

1:1500

0 30 60 m

30

CUNDALINE AND CALLAWA MINING OPERATIONS EPS

FIGURE 4

Callawa - North Lode Deposit

Geological Section - 7715350 mN

bhpbilliton

BHP-07-16 BS Trog Attach _10SC

RL 200 m

RL 150 m

RL 100 m

RL 50 m

GRANITE INTRUSIVE

LOWER MEMBER BIF

MIDDLE MEMBER BIF

UPPER MEMBER BIF

20800 mN

21000 mN

21200 mN

LEGEND

STRATIGRAPHY

NIMINGARRA IRON FORMATION

GN6 — Upper BIF

GN5 — Upper Mudstone

GN4 — Middle BIF

GN3 — Middle Mudstone

GN2 — Lower BIF

GN1 — Lower Mudstone

ORE / ROCK TYPES

- Banded Iron Formation
- Lode Ore
- Crustal Ore
- Dolerite Intrusive
- Granite Intrusive
- Middle Member Footwall Mudstone

- Hard Cap
- Final Pit Profile
- Drill Hole Location

1:1500

0 30 60 m

30

CUNDALINE AND CALLAWA MINING OPERATIONS EPS

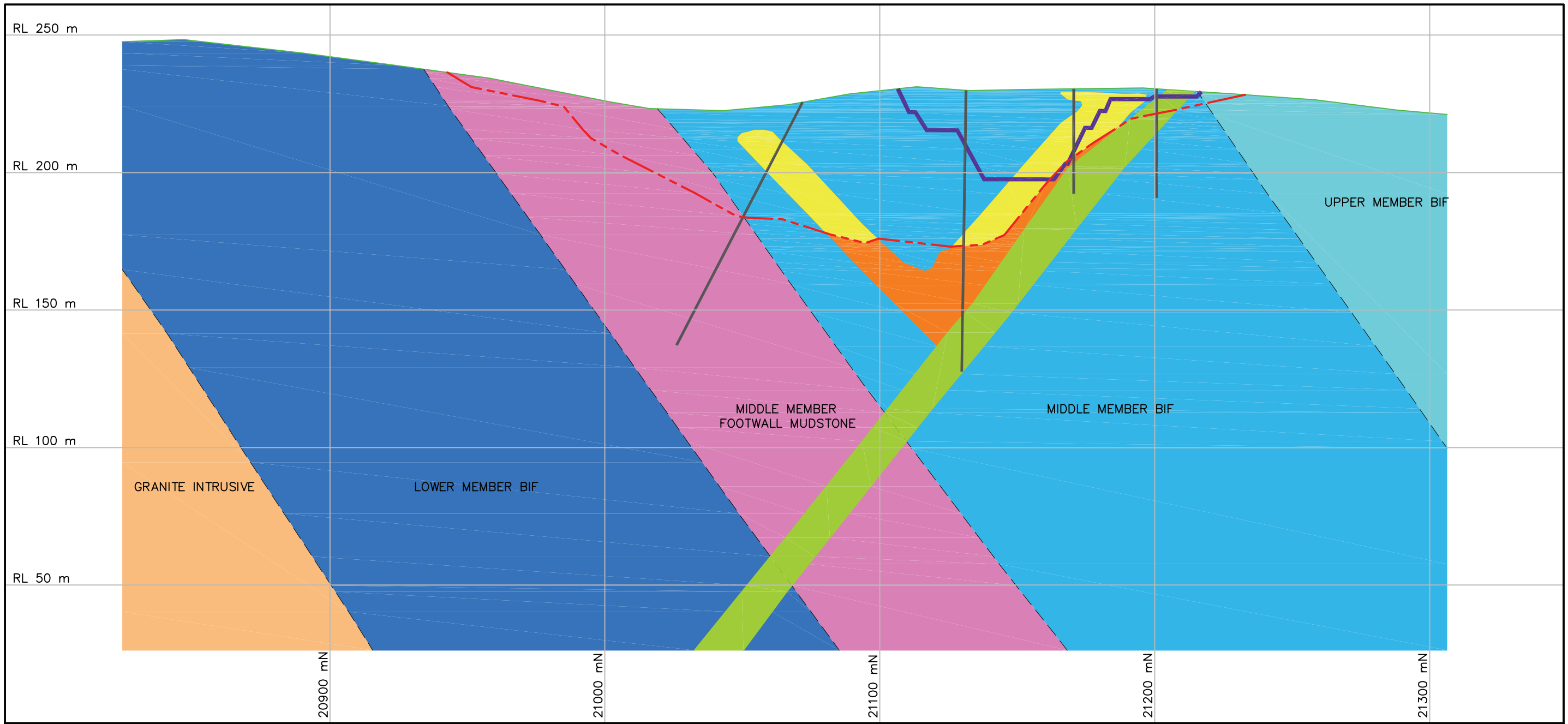
FIGURE 5a

Cundaline - 10k West

Geological Section - 65620 mE

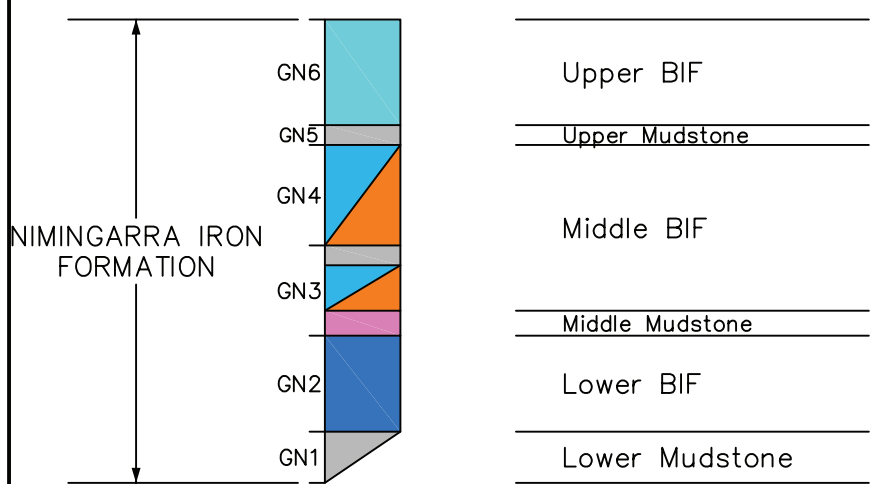
bhpbilliton

BHP-07-16 BS Trog Attach _106C



LEGEND

STRATIGRAPHY



ORE / ROCK TYPES

- Banded Iron Formation
- Lode Ore
- Crustal Ore
- Dolerite Intrusive
- Granite Intrusive
- Middle Member Footwall Mudstone

- Hard Cap
- Final Pit Profile
- Drill Hole Location

1:1500 0 30 60 m

30

CUNDALINE AND CALLAWA MINING OPERATIONS EPS

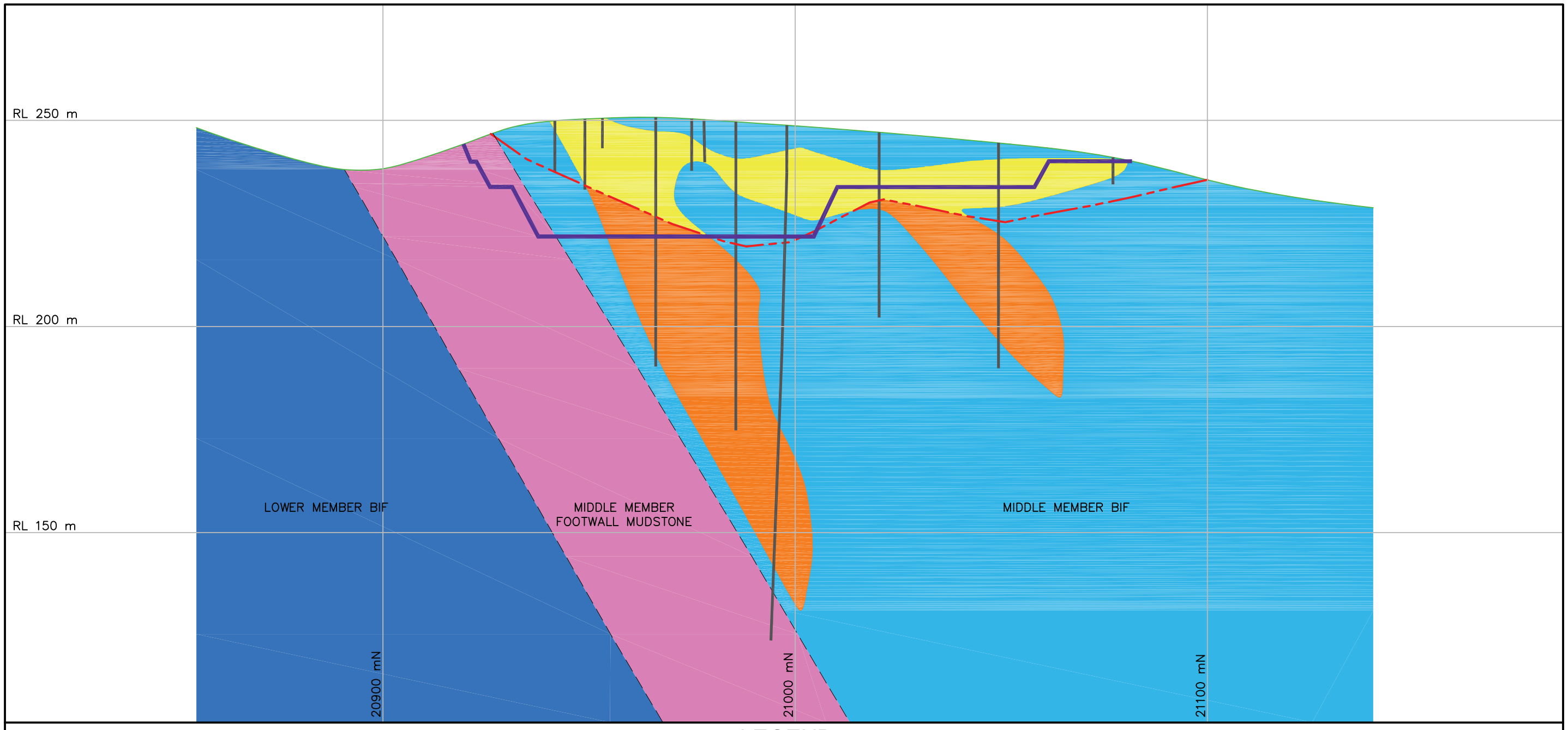
FIGURE 5b

Cundaline - 10k East

Geological Section - 66000 mE

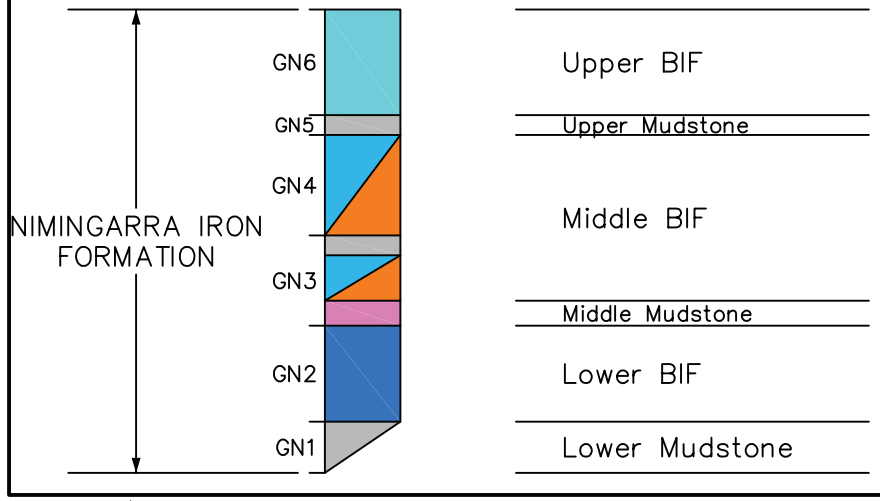
bhpbilliton

BHP-07-16 BS Trog Attach _107C



LEGEND

STRATIGRAPHY



ORE / ROCK TYPES

- Banded Iron Formation
- Lode Ore
- Crustal Ore
- Dolerite Intrusive
- Granite Intrusive
- Middle Member Footwall Mudstone

- Hard Cap
- Final Pit Profile
- Drill Hole Location

1:1000 0 20 40 m
20 10

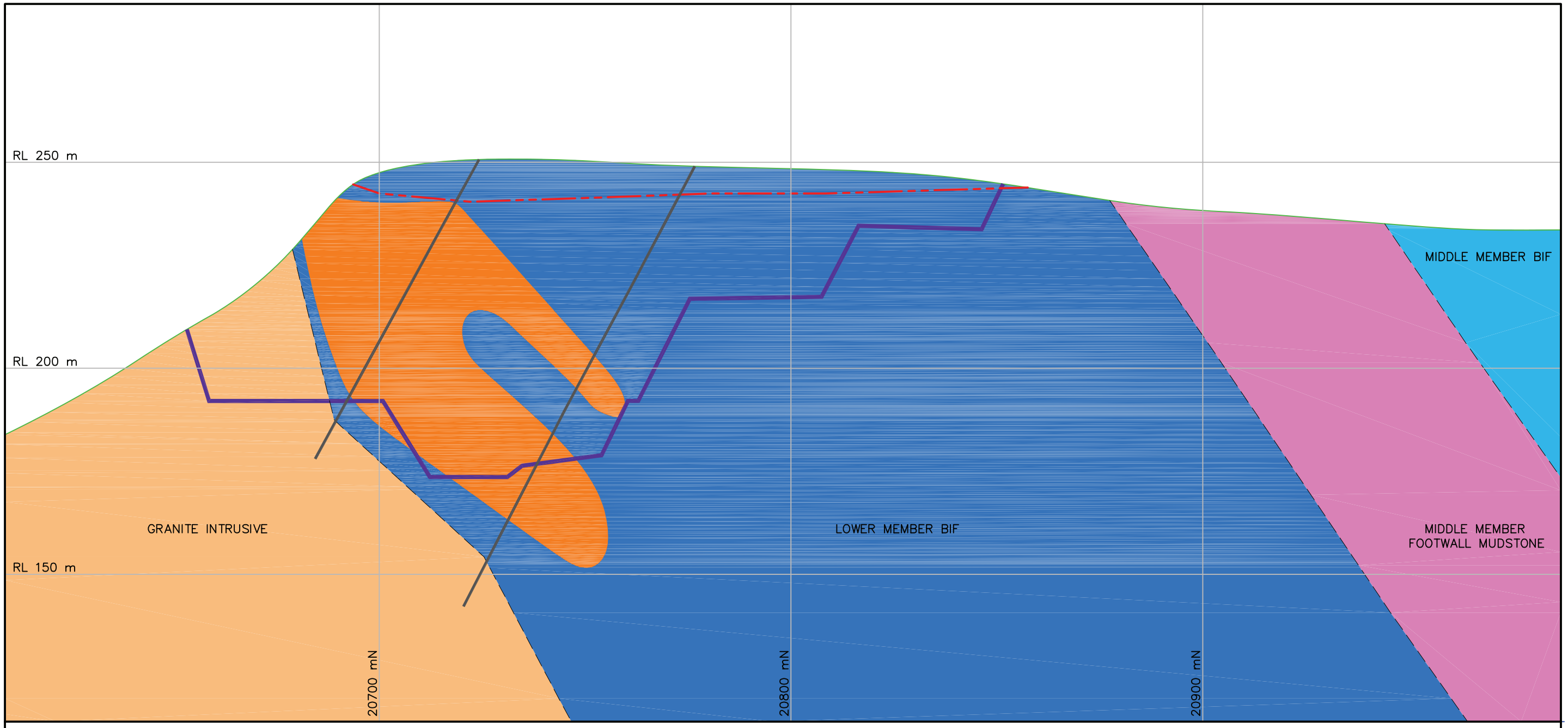
CUNDALINE AND CALLAWA MINING OPERATIONS EPS

FIGURE 5c

Cundaline - 10k East
Geological Section - 66300 mE

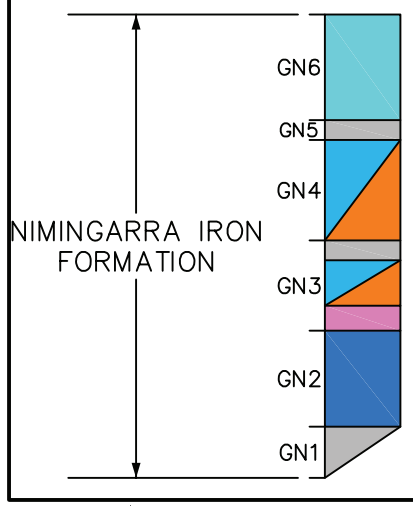
bhpbilliton

BHP-07-16 BS Trog Attach _108C



LEGEND

STRATIGRAPHY



- Upper BIF
- Upper Mudstone
- Middle BIF
- Middle Mudstone
- Lower BIF
- Lower Mudstone

ORE / ROCK TYPES

- Banded Iron Formation
- Lode Ore
- Crustal Ore
- Dolerite Intrusive
- Granite Intrusive
- Middle Member Footwall Mudstone

- Hard Cap
- Final Pit Profile
- Drill Hole Location

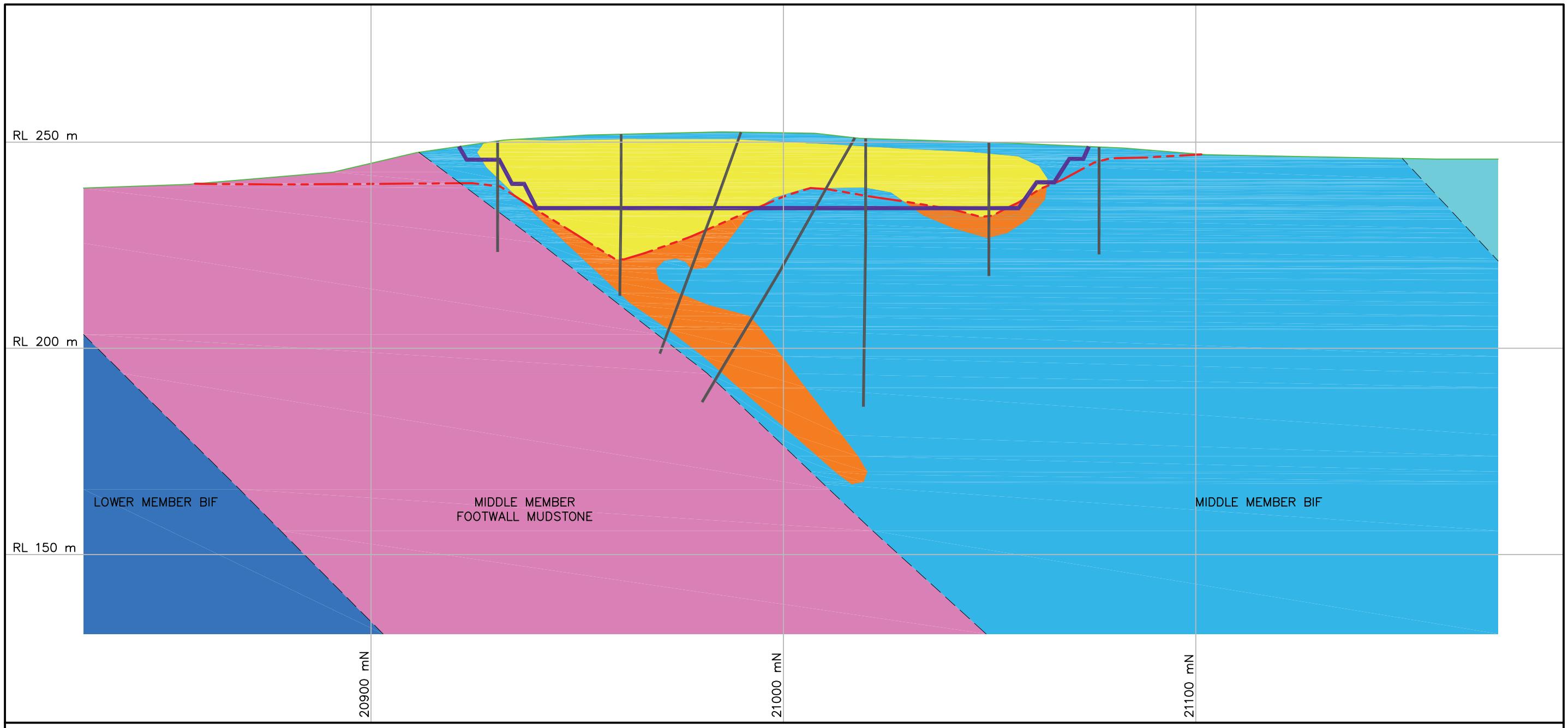
1:1000 0 20 40 m
20 10

CUNDALINE AND CALLAWA MINING OPERATIONS EPS

FIGURE 5d
Cundaline - 13k East
Geological Section - 67760 mE

bhpbilliton

BHP-07-16 BS Trog Attach _109C



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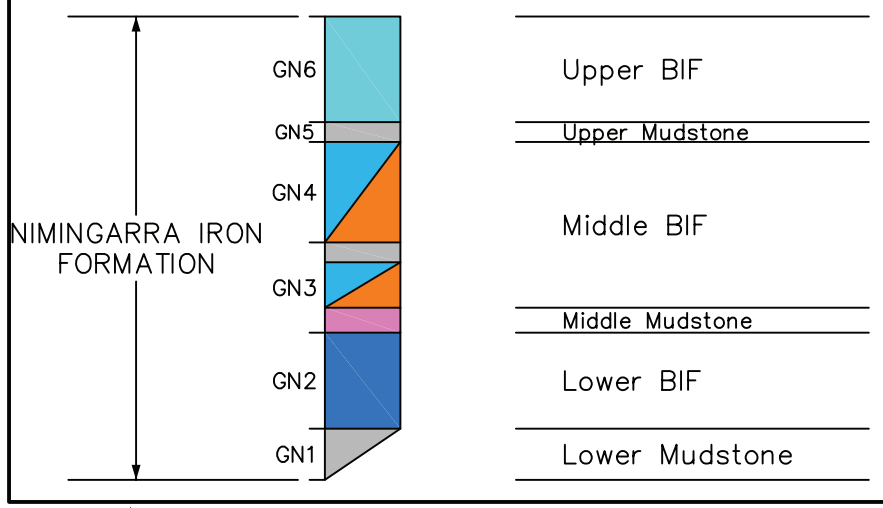
STRATIGRAPHY



ORE / ROCK TYPES

- Banded Iron Formation
- Lode Ore
- Crustal Ore
- Dolerite Intrusive
- Granite Intrusive
- Middle Member Footwall Mudstone

- Hard Cap
- Final Pit Profile
- Drill Hole Location

1:1000 0 20 40 m
20 10

CUNDALINE AND CALLAWA MINING OPERATIONS EPS

FIGURE 5e
Cundaline - 14k East
Geological Section - 69050 mE

bhpbilliton

BHP-07-16 BS Trog Attach _110C

Attachment 2: List of all Sites Sampled at Callawa Ridge, Cundaline Ridge, Shay Gap Borefield and Yarrie Ridge.

Zone	Borehole Information			Sampling			
	Borehole #	Eastings GDA94 Ref. 51	Northings GDA94 Ref. 51	*Troglofauna*			
				Phase 1: 12/12/07-28/02/08		Phase 2: 29/02-28/04/08	
				Trap	Scrape	Trap	Scrape
Callawa Pit	CA0005	219302	7715072	PIT CA			
Callawa Out-of-pit	CA0006	219308	7714874	OUT-OF-PIT CA	OUT-OF-PIT CA	OUT-OF-PIT CA	OUT-OF-PIT CA
Callawa Out-of-pit	CA0007R	219099	7715063			OUT-OF-PIT CA	
Callawa Out-of-pit	CA0008	218700	7715050			OUT-OF-PIT CA	OUT-OF-PIT CA
Callawa Out-of-pit	CA0010	218709	7714849		OUT-OF-PIT CA		OUT-OF-PIT CA
Callawa Out-of-pit	CA0011	219162	7714346		OUT-OF-PIT CA	OUT-OF-PIT CA	OUT-OF-PIT CA
Callawa Out-of-pit	CA0012	219336	7714073		OUT-OF-PIT CA	OUT-OF-PIT CA	OUT-OF-PIT CA
Callawa Out-of-pit	CA0013	219090	7713856			OUT-OF-PIT CA	
Callawa Out-of-pit	CA0014	219104	7714529		OUT-OF-PIT CA	OUT-OF-PIT CA	OUT-OF-PIT CA
Callawa Out-of-pit	CA0015	219035	7715243			OUT-OF-PIT CA	
Callawa Out-of-pit	CA0019	218370	7714681		OUT-OF-PIT CA	OUT-OF-PIT CA	OUT-OF-PIT CA
Callawa Out-of-pit	CA0021	217301	7714782		OUT-OF-PIT CA	OUT-OF-PIT CA	OUT-OF-PIT CA
Callawa Out-of-pit	CA0022	217064	7714980		OUT-OF-PIT CA	OUT-OF-PIT CA	OUT-OF-PIT CA
Callawa Pit	CA0023	219337	7715311		PIT CA	PIT CA	PIT CA
Callawa Pit	CA0024	219337	7715360			PIT CA	
Callawa Pit	CA0026	219387	7715361			PIT CA	
Callawa Pit	CA0039	219087	7715554	PIT CA			
Callawa Pit	CA0041	219084	7715509	PIT CA			
Callawa Pit	CA0048	219336	7715261			PIT CA	
Callawa Pit	CA0060	219337	7715211	PIT CA			
Callawa Pit	CA0061	219387	7715211	PIT CA			
Callawa Pit	CA0062	219437	7715211			PIT CA	
Callawa Pit	CA0063	219337	7715161	PIT CA			
Callawa Pit	CA0064	219386	7715161		PIT CA	PIT CA	
Callawa Pit	CA0065	219419	7715160			PIT CA	
Callawa Pit	CA0066	219445	7715262			PIT CA	
Callawa Pit	CA0069	219437	7715316		PIT CA	PIT CA	PIT CA
Callawa Pit	CA0074	219086	7715511	PIT CA			
Callawa Pit	CA0076	219136	7715461	PIT CA			
Callawa Pit	CA0078	219137	7715411		PIT CA	PIT CA	PIT CA
Callawa Pit	CA0079	219187	7715411		PIT CA	PIT CA	
Callawa Pit	CA0084	219336	7715111	PIT CA	PIT CA		
Callawa Pit	CA0085	219286	7715161	PIT CA			
Callawa Pit	CA0086	219283	7715109	PIT CA	PIT CA		
Callawa Out-of-pit	CA0087	219238	7715109			OUT-OF-PIT CA	
Callawa Out-of-pit	CA0088	219236	7715161	OUT-OF-PIT CA			
Callawa Out-of-pit	CA0089	219238	7715266			OUT-OF-PIT CA	
Callawa Pit	CA0091	219138	7715361			PIT CA	
Callawa Out-of-pit	CA0092	219137	7715261			OUT-OF-PIT CA	
Callawa Pit	CA0093	219419	7715154			PIT CA	
Callawa Pit	CA0094	219374	7715114	PIT CA			
Callawa Pit	CA0095	219353	7715057	PIT CA			
Callawa Pit	CA0096	219337	7715057	PIT CA			

Attachment 2 (Continued) List of all Sites Sampled at Callawa Ridge, Cundaline Ridge, Salt Well, Shay Gap Borefield and Yarrie Pit.

Zone	Borehole Information			Sampling			
	Borehole #	Eastings GDA94 Ref. 51	Northings GDA94 Ref. 51	*Troglofauna*			
				Phase 1: 12/12/07-28/02/08		Phase 2: 29/02-28/04/08	
				Trap	Scrape	Trap	Scrape
Callawa Out-of-pit	CA0097	219226	7715067			OUT-OF-PIT CA	
Callawa Out-of-pit	CA0100R	219134	7714963		OUT-OF-PIT CA	OUT-OF-PIT CA	OUT-OF-PIT CA
Callawa Out-of-pit	CA0102R	219338	7714954		OUT-OF-PIT CA	OUT-OF-PIT CA	OUT-OF-PIT CA
Callawa Out-of-pit	CA0103R	219270	7715008			OUT-OF-PIT CA	
Callawa Out-of-pit	CA0104R	219261	7715183	OUT-OF-PIT CA			
Callawa Pit	CA0107	219211	7715284		PIT CA	PIT CA	PIT CA
Callawa Pit	CA0109R	219212	7715387			PIT CA	
Callawa Pit	CA0110	219160	7715386			PIT CA	
Callawa Pit	CA0111	219117	7715388			PIT CA	
Callawa Pit	CA0113R	219057	7715585	PIT CA	PIT CA		
Callawa Pit	CA0114R	219107	7715487	PIT CA			
Callawa Pit	CA0116R	219112	7715435	PIT CA			
Callawa Pit	CA0120	219316	7715433			PIT CA	
Callawa Pit	CA0121R	219310	7715137	PIT CA	PIT CA		
Callawa Out-of-pit	CA0122R	219265	7715138	OUT-OF-PIT CA			
Callawa Out-of-pit	CA0123R	219262	7715083	OUT-OF-PIT CA			
Callawa Out-of-pit	CA0124R	218568	7714451		OUT-OF-PIT CA	OUT-OF-PIT CA	OUT-OF-PIT CA
Callawa Out-of-pit	CA0125R	218834	7714457			OUT-OF-PIT CA	
Callawa Out-of-pit	CA0126R	218417	7715081			OUT-OF-PIT CA	
Callawa Out-of-pit	CA0127R	218194	7714533			OUT-OF-PIT CA	
Callawa Out-of-pit	CA0128R	218266	7714661			OUT-OF-PIT CA	
Callawa Out-of-pit	CA0129R	218238	7714939			OUT-OF-PIT CA	
Callawa Out-of-pit	CA0131R	217531	7714767		OUT-OF-PIT CA	OUT-OF-PIT CA	OUT-OF-PIT CA
Callawa Out-of-pit	CA0132R	217163	7714772			OUT-OF-PIT CA	
Callawa Pit	CA0141R	219268	7715536	PIT CA	PIT CA	PIT CA	
Callawa Pit	CA0142R	219238	7715507	PIT CA			
Callawa Pit	CA0143R	219209	7715507	PIT CA	PIT CA		
Callawa Pit	CA0144R	219189	7715506	PIT CA	PIT CA	PIT CA	
Callawa Pit	CA0145R	219163	7715506	PIT CA			
Callawa Pit	CA0146R	219116	7715529	PIT CA	PIT CA	PIT CA	
Callawa Pit	CA0147R	219079	7715536	PIT CA			
Callawa Pit	CA0148R	219212	7715530	PIT CA			
Callawa Out-of-pit	CA0150R	219035	7713156			OUT-OF-PIT CA	
Callawa Out-of-pit	CA0151R	219076	7713178			OUT-OF-PIT CA	OUT-OF-PIT CA
Cundaline Out-of-pit	CU0046	203845	7725800			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0048	202997	7726351			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0049	203065	7726381			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0058	203166	7726239			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0059	203307	7726080			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0060	203329	7726112		OUT-OF-PIT CU	OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0061	203465	7725963			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0062	203501	7726017		OUT-OF-PIT CU	OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0063	203350	7726146		OUT-OF-PIT CU	OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0064	203201	7726277			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0066	203634	7725858			OUT-OF-PIT CU	

Attachment 2 (Continued) List of all Sites Sampled at Callawa Ridge, Cundaline Ridge, Salt Well, Shay Gap Borefield and Yarrie Pit.

Zone	Borehole Information			Sampling			
	Borehole #	Eastings GDA94 Ref. 51	Northings GDA94 Ref. 51	*Troglofauna*			
				Phase 1: 12/12/07-28/02/08		Phase 2: 29/02-28/04/08	
				Trap	Scrape	Trap	Scrape
Cundaline Out-of-pit	CU0067	203666	7725897			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0069	204070	7725752			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0070	202428	7726604			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0071	202658	7726325			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0072	202683	7726365			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0074	202737	7726282			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0076	202587	7726390			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0285R	204593	7725416			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0286R	204625	7725370		OUT-OF-PIT CU	OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0287R	204702	7725264		OUT-OF-PIT CU	OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0288R	204683	7725319			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0317R	202940	7726129			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0318R	203048	7726114			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0319R	203015	7726060			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0320R	203069	7726270			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0321R	203250	7726184			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0322R	203311	7725874			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0323R	203358	7725834			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0325R	204195	7725731			OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0327R	204298	7725729		OUT-OF-PIT CU	OUT-OF-PIT CU	
Cundaline Pit East	CU0011	207916	7722624			PIT EAST	
Cundaline Pit East	CU0032	207566	7722865	PIT EAST			
Cundaline Pit East	CU0073	207877	7722474			PIT EAST	
Cundaline Out-of-pit	CU0079	207930	7722476	OUT-OF-PIT CU			
Cundaline Pit East	CU0113	207891	7722596			PIT EAST	
Cundaline Pit East	CU0150	206792	7723384	PIT EAST			
Cundaline Pit East	CU0182	206426	7723516			PIT EAST	
Cundaline Pit East	CU0184R	207117	7723009			PIT EAST	
Cundaline Pit East	CU0185	207091	7723044			PIT EAST	
Cundaline Pit East	CU0191R	207894	7722688		PIT EAST	PIT EAST	
Cundaline Pit East	CU0192R	207784	7722703			PIT EAST	
Cundaline Pit East	CU0193R	207746	7722725			PIT EAST	
Cundaline Pit East	CU0194R	207739	7722786			PIT EAST	
Cundaline Pit East	CU0196R	207585	7722886	PIT EAST			
Cundaline Pit East	CU0197R	207589	7722890	PIT EAST			
Cundaline Pit East	CU0198R	207558	7722933	PIT EAST		PIT EAST	
Cundaline Pit East	CU0199R	207523	7722965	PIT EAST			
Cundaline Pit East	CU0201R	207411	7723052		PIT EAST		
Cundaline Pit East	CU0204	206940	7723251	PIT EAST			
Cundaline Pit East	CU0205	206888	7723264	PIT EAST			
Cundaline Pit East	CU0243R	207147	7723036		PIT EAST	PIT EAST	PIT EAST

Attachment 2 (Continued) List of all Sites Sampled at Callawa Ridge, Cundaline Ridge, Salt Well, Shay Gap Borefield and Yarrie Pit.

Zone	Borehole Information			Sampling			
	Borehole #	Eastings GDA94 Ref. 51	Northings GDA94 Ref. 51	*Troglofauna*			
				Phase 1: 12/12/07-28/02/08		Phase 2: 29/02-28/04/08	
				Trap	Scrape	Trap	Scrape
Cundaline Pit East	CU0245R	206953	7723188	PIT EAST		PIT EAST	
Cundaline Pit East	CU0246R	206973	7723135			PIT EAST	
Cundaline Pit East	CU0247R	206837	7723334	PIT EAST			
Cundaline Pit East	CU0248R	206764	7723376	PIT EAST		PIT EAST	
Cundaline Pit East	CU0273R	206400	7723581			PIT EAST	
Cundaline Pit East	CU0293R	206938	7723470			PIT EAST	
Cundaline Pit East	CU0294R	207025	7723399			PIT EAST	
Cundaline Pit East	CU0295R	207079	7723326			PIT EAST	
Cundaline Pit East	CU0296R	207158	7723279			PIT EAST	
Cundaline Out-of-pit	CU0297R	207232	7723224			OUT-OF-PIT CU	
Cundaline Pit East	CU0298R	207283	7723158			PIT EAST	
Cundaline Pit East	CU0299R	207357	7723094	PIT EAST			
Cundaline Pit East	CU0300	206947	7723258	PIT EAST			
Cundaline Pit East	CU0301	206900	7723279	PIT EAST			
Cundaline Pit East	CU0302R	206908	7723281	PIT EAST		PIT EAST	
Cundaline Pit East	CU0303	207558	7722957	PIT EAST			
Cundaline Pit East	CU0304	207498	7723009	PIT EAST			
Cundaline Pit East	CU0305R	207394	7723030		PIT EAST	PIT EAST	
Cundaline Pit East	CU0306R	207342	7723080	PIT EAST			
Cundaline Pit East	CU0307	207308	7723095	PIT EAST			
Cundaline Pit East	CU0308	207330	7723114	PIT EAST			
Cundaline Pit East	CU882021 035	207589	7722890	PIT EAST			
Cundaline Pit West	CU0021	205630	7724869		PIT WEST	PIT WEST	
Cundaline Pit West	CU0042	205602	7724926			PIT WEST	
Cundaline Pit West	CU0158	205116	7725120			PIT WEST	
Cundaline Pit West	CU0159	205114	7725122			PIT WEST	
Cundaline Pit West	CU0171	205181	7725132	PIT WEST			
Cundaline Pit West	CU0178	205204	7725116	PIT WEST			
Cundaline Pit West	CU0179	205261	7725045	PIT WEST			
Cundaline Pit East	CU0189	206693	7723426	PIT EAST		PIT EAST	
Cundaline Pit East	CU0206R	206715	7723434	PIT EAST		PIT EAST	
Cundaline Pit East	CU0207R	206594	7723458	PIT EAST			
Cundaline Pit West	CU0212R	205964	7724261			PIT WEST	
Cundaline Pit West	CU0214R	205895	7724273			PIT WEST	
Cundaline Pit West	CU0215R	205896	7724318			PIT WEST	
Cundaline Pit West	CU0216R	205871	7724379			PIT WEST	
Cundaline Pit West	CU0218R	205870	7724423			PIT WEST	
Cundaline Pit West	CU0219R	205769	7724490	PIT WEST			
Cundaline Pit West	CU0220R	205736	7724544	PIT WEST			
Cundaline Pit West	CU0224R	205625	7724687			PIT WEST	
Cundaline Pit West	CU0227R	205780	7724864		PIT WEST	PIT WEST	PIT WEST
Cundaline Pit West	CU0229R	205480	7724942	PIT WEST	PIT WEST		
Cundaline Pit West	CU0230R	205408	7724982	PIT WEST			
Cundaline Pit West	CU0231R	205389	7724953	PIT WEST			

Attachment 2 (Continued) List of all Sites Sampled at Callawa Ridge, Cundaline Ridge, Salt Well, Shay Gap Borefield and Yarrie Pit.

Zone	Borehole Information			Sampling			
	Borehole #	Eastings GDA94 Ref. 51	Northings GDA94 Ref. 51	*Troglofauna*			
				Phase 1: 12/12/07-28/02/08		Phase 2: 29/02-28/04/08	
				Trap	Scrape	Trap	Scrape
Cundaline Pit West	CU0232R	205321	7724974	PIT WEST			
Cundaline Pit West	CU0234R	205295	7725034	PIT WEST			
Cundaline Pit West	CU0235R	205312	7725052	PIT WEST		PIT WEST	
Cundaline Pit West	CU0236R	205178	7725084	PIT WEST	PIT WEST		PIT WEST
Cundaline Pit West	CU0239R	205058	7725195			PIT WEST	
Cundaline Pit West	CU0240R	205036	7725257			PIT WEST	
Cundaline Pit West	CU0252R	205664	7724727			PIT WEST	
Cundaline Pit West	CU0253R	205681	7724701			PIT WEST	
Cundaline Pit West	CU0254R	205672	7724650			PIT WEST	
Cundaline Pit West	CU0255R	205725	7724532	PIT WEST			
Cundaline Pit West	CU0256R	205803	7724571	PIT WEST			
Cundaline Pit West	CU0257R	205812	7724437	PIT WEST			
Cundaline Pit West	CU0259R	205861	7724457			PIT WEST	
Cundaline Pit West	CU0260R	205828	7724336			PIT WEST	
Cundaline Pit West	CU0261R	205948	7724285			PIT WEST	
Cundaline Pit West	CU0262R	206020	7724140			PIT WEST	
Cundaline Pit West	CU0263R	206125	7724078			PIT WEST	
Cundaline Pit West	CU0264R	206088	7724127			PIT WEST	
Cundaline Pit West	CU0270R	205695	7724849			PIT WEST	
Cundaline Pit West	CU0271R	205717	7724822		PIT WEST	PIT WEST	
Cundaline Pit West	CU0272R	205625	7724813			PIT WEST	
Cundaline Pit West	CU0274R	205590	7724880		PIT WEST	PIT WEST	
Cundaline Pit West	CU0275R	205522	7724888			PIT WEST	
Cundaline Pit West	CU0276R	205540	7724901		PIT WEST	PIT WEST	
Cundaline Pit West	CU0278R	205481	7724934	PIT WEST			
Cundaline Pit West	CU0279R	205408	7724985	PIT WEST			
Cundaline Pit West	CU0280R	205444	7724974	PIT WEST			
Cundaline Pit West	CU0282R	205191	7725050	PIT WEST			
Cundaline Pit West	CU0284R	205000	7725213			PIT WEST	
Cundaline Out-of-pit	CU0289R	204751	7725211	OUT-OF-PIT CU	OUT-OF-PIT CU	OUT-OF-PIT CU	OUT-OF-PIT CU
Cundaline Out-of-pit	CU0290R	204768	7725186	OUT-OF-PIT CU		OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0291R	204786	7725151	OUT-OF-PIT CU		OUT-OF-PIT CU	
Cundaline Out-of-pit	CU0292R	204781	7725150	OUT-OF-PIT CU	OUT-OF-PIT CU	OUT-OF-PIT CU	OUT-OF-PIT CU
Cundaline Pit West	CU0310R	205805	7724461	PIT WEST			
Cundaline Pit West	CU0311R	205816	7724483	-PIT WEST			
Cundaline Pit West	CU0313R	205668	7724310	PIT WEST			
Cundaline Pit West	CU0314R	205625	7724363	PIT WEST			
Cundaline Pit West	CU0315R	205593	7724403	PIT WEST	PIT WEST		PIT WEST
Cundaline Pit West	CU0316R	205554	7724442	PIT WEST			
Cundaline Pit West	CU0328R	205446	7724977	PIT WEST			
Cundaline Pit West	CU0330R	205595	7724401	PIT WEST			
Cundaline Pit West	CU0331R	205627	7724361	PIT WEST			
Cundaline Pit West	CU6598021180	205607	7724931			PIT WEST	
Cundaline Pit West	CU9021080	205250	7725128	PIT WEST			

Attachment 2 (Continued) List of all Sites Sampled at Callawa Ridge, Cundaline Ridge, Shay Gap Borefield and Yarrie Pit.

Zone	Borehole Information			Sampling			
	Borehole #	Eastings GDA94 Ref. 51	Northings GDA94 Ref. 51	*Troglofauna*			
				Phase 1: 12/12/07-28/02/08		Phase 2: 29/02-28/04/08	
				Trap	Scrape	Trap	Scrape
Shay Gap Borefield	OB1	207551	7752183				OUT-OF-PIT YARRIE
Shay Gap Borefield	PB4	207727	7152852				OUT-OF-PIT YARRIE
Yarrie Range	YP006	221063	7718793				OUT-OF-PIT YARRIE
Yarrie Range	YP009	221662	7718916				OUT-OF-PIT YARRIE
Yarrie Range	YP019	220655	7719076				OUT-OF-PIT YARRIE
Yarrie Range	YP027	221044	7719417				OUT-OF-PIT YARRIE
Yarrie Range	YP032	221620	7720016				OUT-OF-PIT YARRIE
Yarrie Range	YP1060	218214	7718448				OUT-OF-PIT YARRIE
Yarrie Range	YP1063	2227340	7719494				OUT-OF-PIT YARRIE

Attachment 3: Total Faunal Results of all Troglomorphic Taxa Collected per Bore

Deposit	Borehole #	Taxon	spmn #	Sampling Method	Specimen Reference no.	Date
Callawa Out-of-pit	CA0006	Scolopendrida SP01	1	scrape	seLN1653	27/02/08
Callawa Out-of-pit	CA0006	Haplodesmidae SP01	1	scrape	seLN1650	27/02/08
Callawa Out-of-pit	CA0006	*Trinemura* SP01	2	scrape	seLN1652	27/02/08
Callawa Out-of-pit	CA0006	Haplodesmidae SP01	1	scrape	seLN2300	26/04/08
Callawa Out-of-pit	CA0008	Trochanteriidae SP01	1	trap	seLN2339	24/04/08
Callawa Out-of-pit	CA0008	Haplodesmidae SP01	1	trap	seLN2336	24/04/08
Callawa Out-of-pit	CA0008	*Nocticola* SP01	1	trap	seLN2337	24/04/08
Callawa Out-of-pit	CA0008	Pselaphinae SP01	1	trap	seLN2335	24/04/08
Callawa Out-of-pit	CA0008	*Tyrannochthonius* SP01	1	trap	seLN2338	24/04/08
Callawa Out-of-pit	CA0008	Trochanteriidae SP01	2	scrape	seLN2269	25/04/08
Callawa Out-of-pit	CA0011	*Nocticola* SP01	1	trap	seLN2317	24/04/08
Callawa Out-of-pit	CA0011	Gnaphosidae SP01	1	scrape	seLN2292	26/04/08
Callawa Out-of-pit	CA0011	*Camptoscaphiella* SP01	1	scrape	seLN2293	26/04/08
Callawa Out-of-pit	CA0011	Curculionidae SP01	1	scrape	seLN2285	26/04/08
Callawa Out-of-pit	CA0011	Haplodesmidae SP01	4	scrape	seLN2284	26/04/08
Callawa Out-of-pit	CA0011	*Trinemura* SP01	1	scrape	seLN2287	26/04/08
Callawa Out-of-pit	CA0011	*Nocticola* SP01	1	scrape	seLN2290	26/04/08
Callawa Out-of-pit	CA0011	*Indohya* SP01	1	scrape	seLN2288	26/04/08
Callawa Out-of-pit	CA0011	*Lagynochthonius leemouldi*	1	scrape	seLN2289	26/04/08
Callawa Out-of-pit	CA0012	Pselaphinae SP01	1	scrape	seFN60	26/02/08
Callawa Out-of-pit	CA0012	*Camptoscaphiella* SP01	1	scrape	seLN2298	26/04/08
Callawa Out-of-pit	CA0012	Curculionidae SP01	2	scrape	seLN2294	26/04/08
Callawa Out-of-pit	CA0012	Haplodesmidae SP01	2	scrape	seLN2295	26/04/08
Callawa Out-of-pit	CA0012	*Nocticola* SP01	3	scrape	seLN2296	26/04/08
Callawa Out-of-pit	CA0012	Coleoptera SP02	1	scrape	seLN1358	26/02/08
Callawa Out-of-pit	CA0012	Meenoplidae SP01	1	scrape	seLN2297	26/04/08
Callawa Out-of-pit	CA0014	Haplodesmidae SP01	1	trap	seLN2271	24/04/08
Callawa Out-of-pit	CA0014	Pselaphinae SP01	1	trap	seLN2330	24/04/08
Callawa Out-of-pit	CA0019	Haplodesmidae SP01	1	scrape	seFN765	26/02/08
Callawa Out-of-pit	CA0019	*Lagynochthonius leemouldi*	1	scrape	seFN765	26/02/08
Callawa Out-of-pit	CA0019	*Atelurodes* SP01	1	trap	seLN2321	24/04/08
Callawa Out-of-pit	CA0022	Haplodesmidae SP01	1	scrape	seLN1019	17/12/07
Callawa Out-of-pit	CA0022	*Nocticola* SP01	1	scrape	seLN1018	17/12/07
Callawa Out-of-pit	CA0022	*Lagynochthonius leemouldi*	1	scrape	seLN1017	17/12/07
Callawa Out-of-pit	CA0022	Curculionidae SP01	1	scrape	seLN1648	27/02/08
Callawa Out-of-pit	CA0022	Tetrablemmidae SP01	1	trap	seLN2367	24/04/08
Callawa Out-of-pit	CA0022	Gnaphosidae SP01	5	scrape	seLN2267	25/04/08
Callawa Out-of-pit	CA0022	Trochanteriidae SP01	1	scrape	seLN2268	25/04/08
Callawa Out-of-pit	CA0022	Haplodesmidae SP01	1	scrape	seLN2264	25/04/08
Callawa Out-of-pit	CA0022	*Indohya SP01*	2	scrape	seLN2265	25/04/08
Callawa Out-of-pit	CA0022	*Lagynochthonius leemouldi*	2	scrape	seLN2266	25/04/08
Callawa Pit	CA0023	Tetrablemmidae SP01	2	trap	seLN2374	23/04/08
Callawa Pit	CA0023	Haplodesmidae SP01	1	trap	seLN2373	23/04/08
Callawa Pit	CA0023	Pselaphinae SP01	1	trap	seLN2372	23/04/08
Callawa Pit	CA0023	*Lagynochthonius leemouldi*	2	trap	seLN2371	23/04/08
Callawa Pit	CA0023	Meenoplidae SP02	1	scrape	seLN5300	28/02/08
Callawa Pit	CA0023	Meenoplidae SP01	2	scrape	seLN2281	26/04/08
Callawa Pit	CA0024	Tetrablemmidae SP01	3	trap	seLN2325	23/04/08
Callawa Pit	CA0024	*Atelurodes* SP01	1	trap	seLN2324	23/04/08

Attachment 3 (Continued): Total Faunal Results of all Troglomorphic Taxa Collected per Bore

Deposit	Borehole #	Taxon	spmn #	Sampling Method	Specimen Reference no.	Date
Callawa Pit	CA0024	Curculionidae SP01	1	trap	seLN2322	23/04/08
Callawa Pit	CA0024	Pselaphinae SP01	4	trap	seLN2323	23/04/08
Callawa Pit	CA0026	Haplodesmidae SP01	3	trap	seLN2369	23/04/08
Callawa Pit	CA0026	Pselaphinae SP01	1	trap	seLN2368	23/04/08
Callawa Pit	CA0026	*Lagynochthonius leemouldi*	1	trap	seLN2370	23/04/08
Callawa Pit	CA0039	Phalongodidae SP01	1	trap	seLN1362	27/02/08
Callawa Pit	CA0062	Haplodesmidae SP01	1	trap	seLN2341	23/04/08
Callawa Pit	CA0064	Haplodesmidae SP01	1	trap	seFN1425	23/04/08
Callawa Pit	CA0064	Pselaphinae SP01	1	trap	seLN2356	23/04/08
Callawa Pit	CA0065	*Nocticola* SP01	1	trap	seLN2318	23/04/08
Callawa Pit	CA0066	Haplodesmidae SP01	1	trap	seLN2360	23/04/08
Callawa Pit	CA0069	Meenoplidae SP01	1	scrape	seLN1655	28/02/08
Callawa Pit	CA0074	*?Troglarmadillo SP01*	2	trap	seFN1048	27/02/08
Callawa Pit	CA0084	Polydesmida SP01	1	trap	seLN1332	27/02/08
Callawa Pit	CA0086	*Tyrannochthonius* SP01	1	trap	seLN1355	27/02/08
Callawa Out-of-pit	CA0087	Haplodesmidae SP01	7	trap	seLN2359	23/04/08
Callawa Out-of-pit	CA0089	Pselaphinae SP01	3	trap	seLN2340	23/04/08
Callawa Out-of-pit	CA0092	Haplodesmidae SP01	1	trap	seFN1535	23/04/08
Callawa Pit	CA0093	Haplodesmidae SP01	2	trap	seLN2365	23/04/08
Callawa Pit	CA0093	*Nocticola* SP01	2	trap	seLN2366	23/04/08
Callawa Pit	CA0096	Haplodesmidae SP01	1	trap	seLN1364	27/02/08
Callawa Pit	CA0096	Pselaphinae SP01	1	trap	seFN564	27/02/08
Callawa Out-of-pit	CA0102R	*Illaphanus* SP01	1	scrape	seLN2277	26/04/08
Callawa Out-of-pit	CA0103R	Pselaphinae SP01	2	trap	seLN2329	23/04/08
Callawa Out-of-pit	CA0104R	*?Troglarmadillo SP01*	1	trap	seFN571	27/02/08
Callawa Pit	CA0113R	*Illaphanus* SP01	1	trap	seLN1368	27/02/08
Callawa Pit	CA0113R	Pselaphinae SP01	1	trap	seFN1041	27/02/08
Callawa Pit	CA0113R	*Tyrannochthonius* SP01	1	trap	seLN1366	27/02/08
Callawa Pit	CA0113R	*Indohya* SP01	1	trap	seLN1367	27/02/08
Callawa Pit	CA0120	Pselaphinae SP01	4	trap	seLN2350	23/04/08
Callawa Pit	CA0121R	*?Troglarmadillo SP01*	1	trap	seLN1359	27/02/08
Callawa Out-of-pit	CA0124R	Haplodesmidae SP01	1	scrape	seLN1009	17/12/07
Callawa Out-of-pit	CA0124R	Haplodesmidae SP01	2	trap	seLN2352	24/04/08
Callawa Out-of-pit	CA0124R	*Nocticola* SP01	1	trap	seLN2353	24/04/08
Callawa Out-of-pit	CA0124R	Pselaphinae SP01	2	trap	seLN2351	24/04/08
Callawa Out-of-pit	CA0124R	*Indohya* SP01	1	trap	seLN2354	24/04/08
Callawa Out-of-pit	CA0124R	*Tyrannochthonius* SP01	1	trap	seLN2355	24/04/08
Callawa Out-of-pit	CA0124R	Haplodesmidae SP01	6	scrape	seLN2271	25/04/08
Callawa Out-of-pit	CA0124R	*Trinemura* SP01	1	scrape	seLN2272	25/04/08
Callawa Out-of-pit	CA0125R	Pselaphinae SP01	3	trap	seLN2357	24/04/08
Callawa Out-of-pit	CA0127R	Haplodesmidae SP01	2	trap	seLN2364	24/04/08
Callawa Out-of-pit	CA0127R	Pselaphinae SP01	4	trap	seLN2363	24/04/08
Callawa Out-of-pit	CA0128R	Haplodesmidae SP01	1	trap	seFN1518	24/04/08
Callawa Out-of-pit	CA0128R	Pselaphinae SP01	2	trap	seFN1518	24/04/08
Callawa Pit	CA0141R	Pselaphinae SP01	3	scrape	seLN997	16/12/07
Callawa Pit	CA0141R	Diplura SP01	1	trap	seLN1311	20/02/08
Callawa Pit	CA0144R	*Trinemura* SP01	1	scrape	seLN1020	16/12/07
Callawa Pit	CA0144R	*Tyrannochthonius* SP01	1	trap	seLN1357	20/02/08
Callawa Pit	CA0145R	Diplura SP01	1	trap	seLN1363	27/02/08
Callawa Pit	CA0146R	Haplodesmidae SP01	2	scrape	seLN1023	16/12/07

Attachment 3 (Continued): Total Faunal Results of all Troglomorphic Taxa Collected per Bore

Deposit	Borehole #	Taxon	spmn #	Sampling Method	Specimen Reference no.	Date
Callawa Pit	CA0146R	*Trinemura* SP01	1	scrape	seLN1022	16/12/07
Callawa Pit	CA0146R	Pselaphinae SP01	2	trap	seFN980	20/02/08
Callawa Pit	CA0146R	Haplodesmidae SP01	1	trap	seLN2333	24/04/08
Callawa Pit	CA0146R	*Nocticola* SP01	2	trap	seLN2332	24/04/08
Callawa Pit	CA0146R	*Lagynochthonius leemouldi*	1	trap	seLN2334	24/04/08
Callawa Out-of-pit	CA0150R	Pselaphinae SP01	1	trap	seLN2361	24/04/08
Callawa Out-of-pit	CA0151R	*Nocticola* SP01	1	scrape	seLN2319	24/04/08
Callawa Out-of-pit	CA0151R	*Nocticola* SP01	1	trap	seLN2319	24/04/08
Cundaline Pit East	CU0032	*Nocticola* SP01	4	trap	seLN1330	25/02/08
Cundaline Out-of-pit	CU0049R	Pselaphinae SP01	1	trap	seLN2396	23/04/08
Cundaline Out-of-pit	CU0059R	Tetrablemmidae SP01	1	trap	seLN2389	23/04/08
Cundaline Out-of-pit	CU0059R	*Lagynochthonius leemouldi*	1	trap	seLN2390	23/04/08
Cundaline Out-of-pit	CU0060R	*?Troglarmadillo* SP02	1	scrape	seLN1247	18/12/07
Cundaline Out-of-pit	CU0060R	*Trinemura* SP01	1	scrape	seLN1249	18/12/07
Cundaline Out-of-pit	CU0061R	Polydesmida SP01	1	trap	seLN2387	23/04/08
Cundaline Out-of-pit	CU0061R	Polyxenida SP01	1	trap	seLN2388	23/04/08
Cundaline Out-of-pit	CU0061R	*Nocticola* SP01	6	trap	seLN2386	23/04/08
Cundaline Out-of-pit	CU0061R	*Nocticola* SP01	5	trap	seLN2398	23/04/08
Cundaline Out-of-pit	CU0061R	Pselaphinae SP01	14	trap	seLN2383	23/04/08
Cundaline Out-of-pit	CU0061R	Pselaphinae SP01	3	trap	seLN2399	23/04/08
Cundaline Out-of-pit	CU0062R	*Trinemura* SP01	1	scrape	seLN1248	15/12/07
Cundaline Out-of-pit	CU0062R	Tetrablemmidae SP01	1	trap	seLN2393	23/04/08
Cundaline Out-of-pit	CU0062R	*Nocticola* SP01	2	trap	seLN2392	23/04/08
Cundaline Out-of-pit	CU0063R	Tetrablemmidae SP01	1	trap	seLN2395	23/04/08
Cundaline Out-of-pit	CU0063R	*Lagynochthonius leemouldi*	1	trap	seLN2400	23/04/08
Cundaline Out-of-pit	CU0079	Pselaphinae SP01	1	trap	seFN1011	23/02/08
Cundaline Pit East	CU0113	Pselaphinae SP01	1	trap	seLN2381	22/04/08
Cundaline Pit West	CU0171	Geophilidae SP01	1	trap	seLN1317	25/02/08
Cundaline Pit West	CU0178	*?Troglarmadillo* SP02	2	trap	seLN1320	25/02/08
Cundaline Pit West	CU0179	*?Troglarmadillo* SP02	1	trap	seFN1026	24/02/08
Cundaline Pit West	CU0179	*Nocticola* SP01	2	trap	seLN1365	24/02/08
Cundaline Pit West	CU0179	Pselaphinae SP01	1	trap	seFN1026	24/02/08
Cundaline Pit East	CU0191R	Pselaphinae SP01	1	scrape	seFN745	24/02/08
Cundaline Pit East	CU0198R	Symphyla SP01	2	trap	seFN988	23/02/08
Cundaline Pit East	CU0198R	Diplura SP01	1	trap	seFN988	23/02/08
Cundaline Pit East	CU0199R	*Indohya* SP01	1	trap	seLN1316	23/02/08
Cundaline Pit East	CU0206R	Polydesmida SP01	2	trap	seLN1329	23/02/08
Cundaline Pit East	CU0207R	Pselaphinae SP01	1	trap	seLN1361	23/02/08
Cundaline Pit West	CU0230R	*?Troglarmadillo* SP02	1	trap	seFN1027	24/02/08
Cundaline Pit West	CU0234R	*Nocticola* SP01	1	trap	seLN1370	24/02/08
Cundaline Pit West	CU0234R	Pselaphinae SP01	1	trap	seFN1028	24/02/08
Cundaline Pit East	CU0247R	Haplodesmidae SP02	1	trap	seLN1309	23/02/08
Cundaline Pit West	CU0256R	Pselaphinae SP01	1	trap	seFN1034	24/02/08
Cundaline Pit West	CU0257R	Pselaphinae SP01	4	trap	seLN1322	24/02/08
Cundaline Pit West	CU0260R	*Nocticola* SP01	1	trap	seLN2376	22/04/08
Cundaline Pit West	CU0282R	*Nocticola* SP01	1	trap	seLN1369	24/02/08
Cundaline Out-of-pit	CU0292R	*Illaphanus* SP01	1	scrape	seLN1248	14/12/07
Cundaline Out-of-pit	CU0292R	*Nocticola* SP01	1	scrape	seFN757	25/02/08
Cundaline Out-of-pit	CU0292R	Meenoplidae SP01	1	scrape	seLN1253	14/12/07

Attachment 3 (Continued): Total Faunal Results of all Troglomorphic Taxa Collected per Bore

Deposit	Borehole #	Taxon	spmn #	Sampling Method	Specimen Reference no.	Date
Cundaline Pit East	CU0294R	*Nocticola* SP01	1	trap	seLN2378	22/04/08
Cundaline Pit East	CU0305R	*Nocticola* SP01	1	scrape	seFN746	24/02/08
Cundaline Pit East	CU0306R	Pselaphinae SP01	1	trap	seLN1318	23/02/08
Cundaline Pit East	CU0306R	*Indohya* SP01	1	trap	seLN1319	23/02/08
Cundaline Pit East	CU0307	*Nocticola* SP01	2	trap	seLN1314	23/02/08
Cundaline Pit East	CU0307	Pselaphinae SP01	1	trap	seLN1315	23/02/08
Cundaline Pit East	CU0307	Meenoplidae SP01	3	trap	seLN1313	23/02/08
Cundaline Pit West	CU0310R	Pselaphinae SP01	1	trap	seFN1015	24/02/08
Cundaline Pit West	CU0313R	*?Troglarmadillo* SP02	1	trap	seFN1024	24/02/08
Cundaline Out-of-pit	CU0317R	Pselaphinae SP01	2	trap	seLN2377	23/04/08
Cundaline Out-of-pit	CU0327R	*Trinemura* SP01	3	scrape	seFN761a	25/02/08
Yarrie Range	YP006	*Nocticola* SP02	1	scrape	seLN2313	27/04/08
Yarrie Range	YP009	Diplura SP02	1	scrape	seLN2314	27/04/08
Yarrie Range	YP019	Gnaphosidae SP01	1	scrape	seLN2311	27/04/08
Yarrie Range	YP032	*Nocticola* SP02	1	scrape	seLN2316	27/04/08

Attachment 4: Variation in species richness and abundance between phases.

		FEB	APRIL
Diplopodea	Haplodesmidae SP01	7	39
	Haplodesmidae SP02	1	-
	Polydesmida SP01	3	1
	Polyxenida SP01	-	1
Symphyla	Symphyla SP02	2	-
Chilopoda	Geophilidae SP01	1	
	Scolopendrida SP01	1	
Isopoda	*Armadilliidae: ?Troglarmadillo* SP01	4	-
	Armadilliidae: ?Troglarmadillo SP02	6	-
Opilionida	Phalangodidae SP01	1	
Araneae	Gnaphosidae SP01	-	7
	Trochanteriidae SP01	-	4
	Tetrablemmidae SP01	-	9
	Oonopidae: *Camptoscaphiella* SP01	-	2
Pseudoscorpionida	Hyidae: *Indohya* SP01	3	4
	Chthoniidae: *Lagynochthonius leemouldi*	2	9
	Chthoniidae: *Tyrannochthonius* SP01	3	2
Diplura	Diplura SP01	3	-
	Diplura SP02	-	1
Thysanura	Atelurinae: *Atelurodes* SP01	-	2
	Nicoletiinae: *Trinemura* SP01	9	2
Hemiptera	Meenoplidae SP01	4	3
	Meenoplidae SP02	2	-
Coleoptera	Carabidae: *Illaphanus* SP01	2	1
	Coleoptera SP02	1	-
	Curculionidae SP01	1	4
	Pselaphinae SP01	21	51
Blattodea	Nocticolidae: *Nocticola* SP01	13	29
	Nocticolidae: *Nocticola* SP02	-	2
	TOTAL # INDIVIDUALS	90	173
	TOTAL # SAMPLES	135	174
	TOTAL # SPECIES	21	19
# OF INDIVIDUALS COLLECTED PER SAMPLE		0.65	0.99
# OF SPECIES RECORDS PER SAMPLE		0.15	0.11