Bennelongia Environmental Consultants

Assessment of Troglofauna at OB32 East

Prepared for:

BHP Billiton Iron Ore

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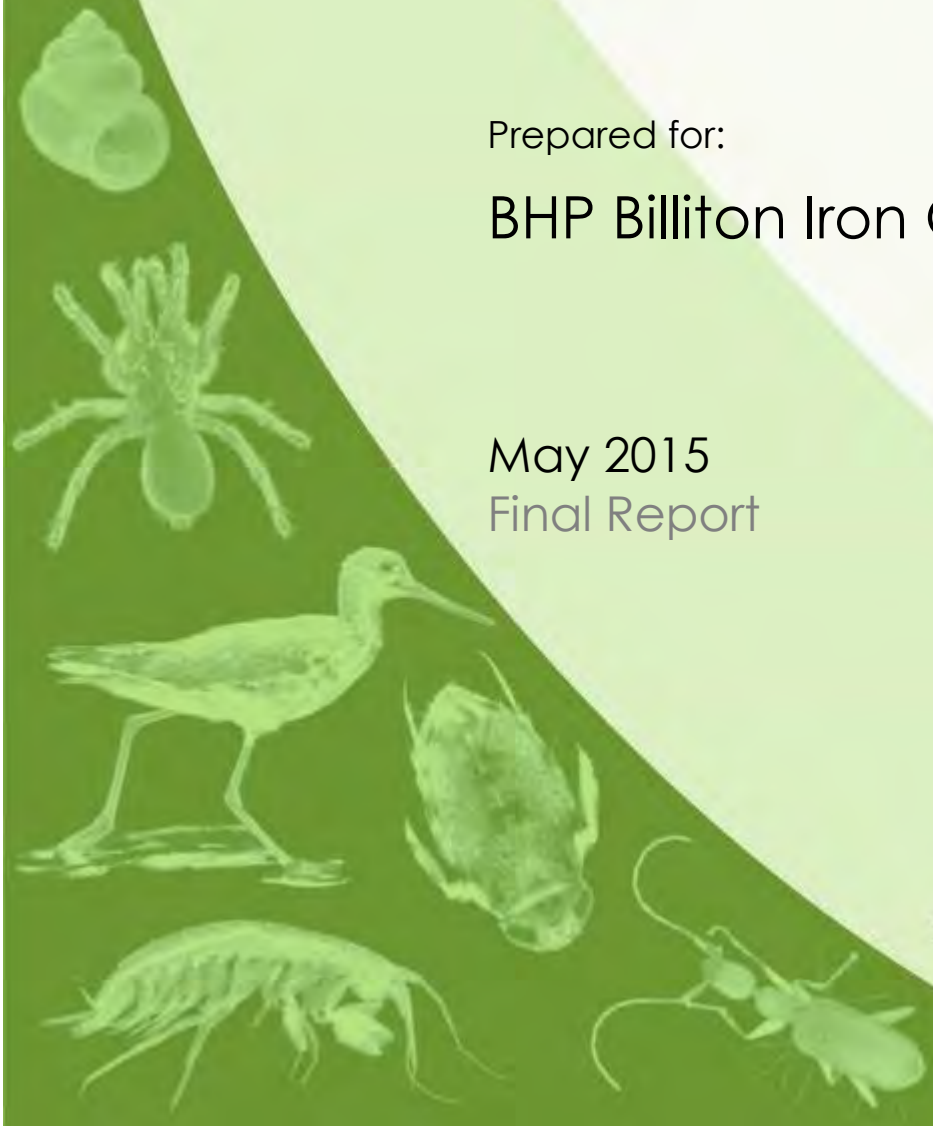
Final Report



Short-Range Endemics | Subterranean Fauna

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Assessment of Troglofauna at OB32 East

Bennelongia Pty Ltd
5 Bishop Street
Jolimont WA 6014

P: (08) 9285 8722
F: (08) 9285 8811
E: info@bennelongia.com.au

ABN: 55 124 110 167

Report Number: 234

Report Version	Prepared by	Reviewed by	Submitted to Client	
			Method	Date
Draft	Andrew Trotter	Stuart Halse	email	20 April 2015
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EXECUTIVE SUMMARY

Background

BHP Billiton Iron Ore is currently preparing a submission to the Environmental Protection Authority for the proposed development of the Orebody 32 East (OB32 East). OB32 East lies within BHP Billiton Iron Ore's Homestead project area, approximately 7 km north of Newman. Homestead is part of the Ophthalmia Range, which itself is an eastwards continuation of the better known Hamersley Range. The Ophthalmia Range hosts several iron ore deposits around the town of Newman.

BHP Billiton Iron Ore commissioned Bennelongia to undertake baseline troglofauna surveys at OB32 East and the immediate surrounds. The surveyed area encompassed the Development Envelope, including indicative mine pit, and is hereafter referred to as the Study Area. The results of troglofauna survey at the Study Area provided information to enable assessment of the threats to troglofauna associated with mining the OB32 East deposit.

Objective

The specific objectives of this assessment were:

(1) To describe the troglofauna communities present at OB32 East;

(2) To determine the conservation status of the troglofauna species present;

(3) To assess whether the conservation status of any troglofauna species is likely to be affected significantly by proposed mining at OB32 East.

Outcome

Troglofauna survey within the Study Area was conducted according to EPA guidelines with pit excavation considered to be the only activity threatening persistence of troglofauna species.

Survey of the Study Area collected 15 species belonging to 10 orders. The orders were Palpigradi, Isopoda, Polyxenida, Tetramerocerata, Cephalostigmata, Diplura, Thysanura, Hemiptera, Coleoptera and Diptera. The Study Area appears to have a similar troglofauna community to those previously identified in the Ophthalmia Range.

Three species of troglofauna are currently known only from within the indicative mine pit at OB32 East. They are Palpigradi sp. B17, nr *Andricophiloscia* sp. B17 and Pauropodidae sp. B32. All three species are considered likely to have ranges extending outside the mine pit because a high proportion of the other localized species have ranges that extend into surrounding areas. There appears to be good habitat connectivity between the indicative mine pit and surrounding areas and no geological barriers to cause a localized species to be restricted to the indicative mine pit.

Conclusion

When biological and geological information for the area is considered in conjunction with the relatively small size of the indicative mine pit (202 ha), there appears to be little threat to the persistence of troglofauna species as a result of mining at OB32 East.

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1. INTRODUCTION

BHP Billiton Iron Ore Pty Ltd (BHP Billiton Iron Ore) is currently preparing a submission to the Environmental Protection Authority (EPA) for the proposed development of the Orebody 32 East (OB32 East). OB32 East lies within BHP Billiton Iron Ore's Homestead project area, approximately 7 km north of Newman (Figure 1). Homestead is part of the Ophthalmia Range, which itself is an eastwards continuation of the better known Hamersley Range. The Ophthalmia Range hosts several iron ore deposits around the town of Newman.

The EPA usually requires that threats to subterranean fauna are considered when assessing proposed mine developments because subterranean fauna have very limited ranges. Their small ranges make subterranean species particularly vulnerable, as a group, to extinction as a result of anthropogenic activities (EPA 2013a). About 70% of stygofauna in the Pilbara meet the criterion for being short-range endemic (SRE) species (Eberhard *et al.* 2009) and the proportion of troglofauna that are SREs is likely to be even higher (Lamoreux 2004; Halse and Pearson 2014). Troglofauna were first recognised as occurring in significant numbers in the Pilbara when Biota (2006) collected them from pisolitic mesas of the Robe River Valley. Although there has not been a single regional-scale survey for troglofauna, such as the Pilbara Biodiversity Survey (McKenzie *et al.* 2009), there have now been many troglofauna surveys in the Pilbara for environmental impact assessments. Just some of these surveys have yielded 570 troglofauna species to date, nearly all undescribed, and the region is clearly rich in troglofauna at a global scale (Halse and Pearson 2014).

BHP Billiton Iron Ore commissioned Bennelongia to undertake a baseline troglofauna survey at OB32 East. The surveyed area, hereafter referred to as the Study Area, encompassed the Development Envelope which includes the indicative mine pit. The results of survey at the Study Area provide information to enable an assessment of the threats to troglofauna associated with mining the OB32 East deposit. The survey is part of a broadscale troglofauna survey program by BHP Billiton Iron Ore that began in November 2007 and involves more than 30 survey areas across the Pilbara (Figure 1). Information from other survey areas, particularly adjacent Orebody 24 (OB24), Orebody 25 (OB25), Homestead, and the nearby Orebody 18, Jimblebar and Mt Whaleback mines has been used to help assess the risk to troglofauna at OB32 East.

The specific objectives of this assessment were:

(1) To describe the troglofauna communities present at OB32 East;

(2) To determine the conservation status of the troglofauna species present;

(3) To assess whether the conservation status of any troglofauna species is likely to be affected significantly by proposed mining at OB32 East.

2. BACKGROUND

2.1. Troglofauna of the Pilbara

While the earliest work on troglofauna was focussed on their occurrence in caves, surveys during the past five years have shown that troglofauna are widespread in the landscape matrix of the Pilbara and are represented by many invertebrate groups, including isopods, palpigrads, spiders, schizomids, pseudoscorpions, harvestmen, millipedes, centipedes, pauropods, symphylans, diplurans, silverfish, cockroaches, bugs, beetles and fungus-gnats. Although abundance and diversity of troglofauna appear to be greater in the Pilbara than other parts of Western Australia, at the regional scale troglofauna are ubiquitous in vadose zone and they have been recorded from drill holes in the Kimberley (Harvey 2001), Cape Range (Harvey *et al.* 1993), Barrow Island (Biota 2005a), Mid-West (Ecologia 2008) and Yilgarn (Bennelongia 2009a), and South-West (Biota 2005b).

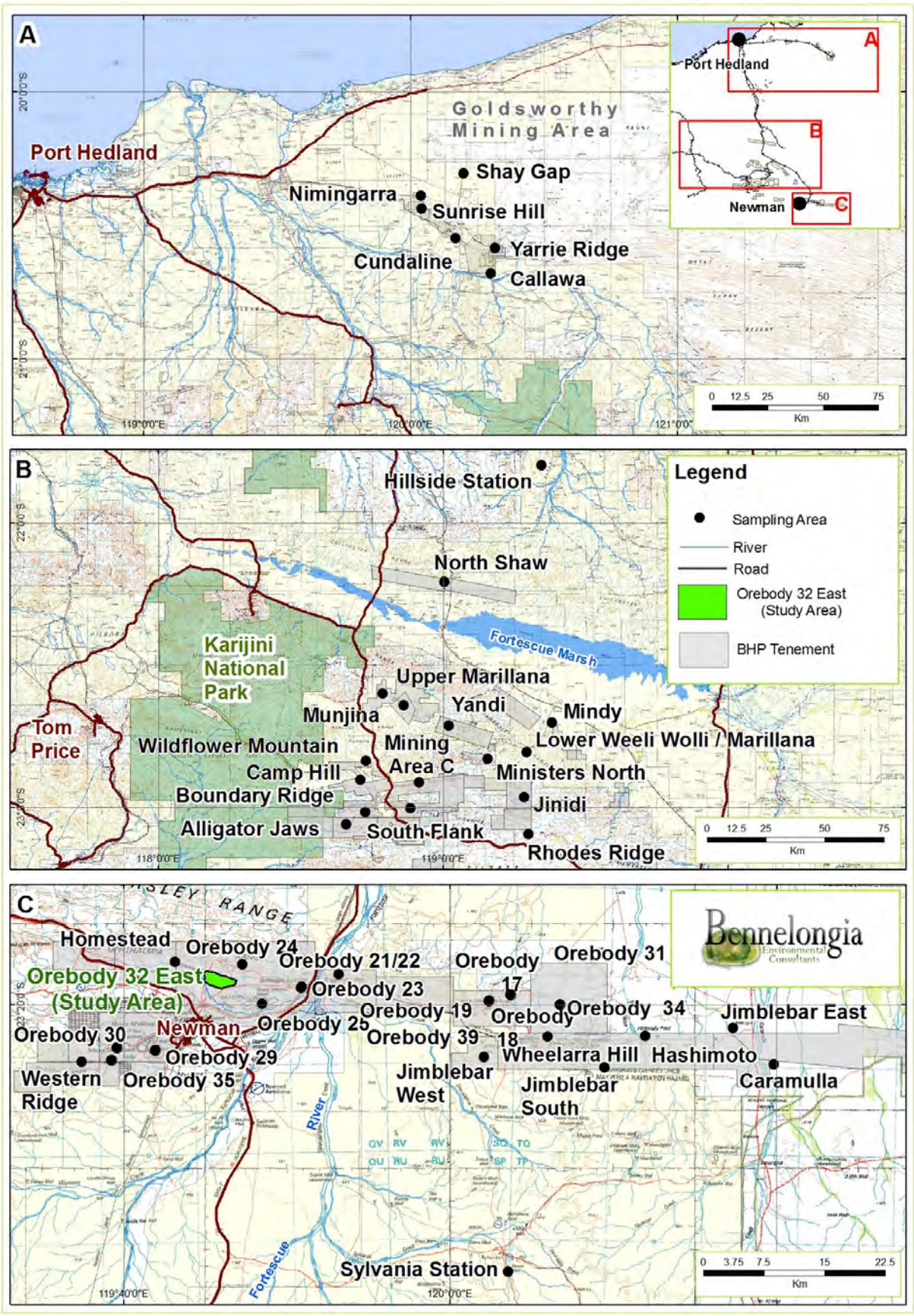

Figure 1. OB32 East in relation to other locations sampled during the BHP Billiton Iron Ore Regional Subterranean Fauna Sampling Program (RSFP).

Troglofauna habitat in the vadose zone is usually considered to extend from the lower layers of soil and sand at the ground surface down to the interface with groundwater (see Halse and Pearson 2014; also Juberthie *et al*. 1981 for a European perspective). Troglofauna occupy interstices, vugs, cavities and fissures within this realm, so their occurrence is closely linked to the structure of the rock or other layers present. If no fissures or voids are present, no troglofauna will occur. When subterranean spaces are present, the pattern of these spaces largely determines the abundance and distribution of troglofauna. Vertical connectivity with the surface is important for supplying carbon and nutrients to maintain populations of different species (plant roots are an important surface connection), while lateral connectivity of voids is crucial to underground dispersal. Geological features such as dykes may block off the continuity of habitat and act as barriers to dispersal, leading to species having highly restricted ranges. In other cases, small ranges may be an intrinsic characteristic of the species in subterranean habitats (Halse and Pearson 2014) despite no obvious habitat discontinuities and species sometimes may display metapopulation structure over scales of tens of metres (Sbordoni *et al*. 2000).

Troglofauna are typically classified as troglobite (obligate subterranean species), troglophile (subterranean species with either a life stage or some populations occurring above ground) and trogloxene (species with facultative occurrence below ground) (Sket 2008) although the lack of life history information for Pilbara troglofauna often makes it difficult to assign species to their correct classification.

Troglofauna are known to occur widely in the mineralised iron formations of the Pilbara (Bennelongia 2008a, b; 2009b, c; Biota 2006a). There is relatively little information about the occurrence of troglofauna outside mineralised habitats because mine development has been the primary reason for most of the sampling programs. However, it has been shown that troglofauna occur in calcrete and alluvium in the Pilbara (Edward and Harvey 2008; Rio Tinto 2008), Yilgarn (Barranco and Harvey 2008; Platnick 2008; Bennelongia 2009a) and elsewhere (Biota 2005a, b).

2.2. Geology of the Local Area

The landscape of Homestead, in which OB32 East is located, is dominated by flat plains and hills, with the larger hills being associated with outcropping Brockman Iron Formation.

The stratigraphic formations present at Homestead include (from oldest to youngest) the Jeerinah Formation, Marra Mamba Iron Formation, Wittenoom Formation, Mount Sylvia Formation, Brockman Iron Formation, Weeli Wolli Formation and the Woongarra Volcanics.

The Development Envelope at OB32 East is mostly hosted within the Mt Newman Member of the Marra Mamba Iron Formation. Overall, the OB32 area is considered to be structurally complex. A major WNW/ESE trending normal fault, named Ali's Fault, dissects the central section of OB32. Other major faults in the area include the Homestead Fault, which was observed in adjacent areas and the Whaleback Fault and associated splays.

The average depth to the top of the hardcap zone (i.e. weathered zone) at OB32 is 30 m. Hardcap has an average thickness of 13 m and is thicker to the north of OB32. Tertiary alluvials/detritals typically overlie the hardcap, but within the Study Area some of the Tertiary sediments are hardcapped. Three units of Tertiary detritals occur at OB32 (TD1, TD2 and TD3). The detritals mostly occur on the flat plains in the northern, southern and eastern sections of the deposit around the edge of the outcropping Marra Mamba Iron Formation. The detrital sequence has a depth of up to 60 m in the south and east of the area and has an average thickness of 15 m. TD1 is an iron rich unit, whereas TD2 consists of calcrete and clays, and TD3 is a shale unit with limited iron enrichment. Detrital cover is the deepest to the north of OB32 where it overlays hardcap (Penales 2013).

2.3. Study Site as Troglofauna Habitat

The mineralised Marra Mamba Iron Formation is recognised as troglofauna habitat in many parts of the Pilbara (Biota 2006, Bennelongia 2009b, c, 2010); however at OB32 East Marra Mamba Iron Formation does not appear to be vuggy, although examination of diamond drill cores showed it is fractured (T. Carroll, BHPBIO, Pers. Comm. 15.4.2015). On this basis, the stratum is not considered to be highly prospective for troglofauna. Likewise, although elsewhere in the Pilbara hardcap is typically one of the most prospective troglofauna habitats, it does not appear to have a vuggy texture in the Study Area (Figure 2). Accordingly, it is considered not to be highly prospective as troglofauna habitat (T. Carroll, BHPBIO, Pers. Comm. 15.4.2015).

Although troglofauna do occur in alluvium, Tertiary alluvials/detritals in the Pilbara are typically considered to be less prospective troglofauna habitat than mineralised ore. It is difficult to interpret the likely prospectivity of Tertiary alluvials/detritals in the Study Area based on their physical structure because in many cases this stratum is very friable and breaks down in the diamond core samples. Where competent, the stratum is not vuggy but is commonly fractured.

The Jeerinah Formation is usually not recognised as prospective for troglofauna, particularly at the depths at which it occurs at the Study Area. Volcanics are also not recognised as likely troglofauna habitat in Pilbara settings, while the Mount Sylvia Formation, Brockman Iron Formation and Weeli Wolli Formation are considered prospective because of the potential for weathering of iron components. Wittenoom Formation is also considered to be likely habitat for troglofauna owing to the dissolution potential of dolomite but sampling results have provided relatively little support for this conclusion.

Figure 2. Example of hardcap from the Study Area, demonstrating a lack of vugs.
Note that fractures are an artefact of the drilling process.

3. METHODS

Sampling was conducted according to the general principles laid out for subterranean fauna sampling in Environmental Assessment Guideline 12 and Guidance Statement 54A (EPA 2007, 2013).

3.1. Field and Laboratory Methods

Troglofauna samples were collected from uncased drill holes in the Study Area around OB32 East. Each sample from a drill hole consisted of the results of two separate collecting techniques that were applied to the hole. These techniques were trapping and scraping:

1. *Trapping*. Custom made cylindrical PVC traps (270 x 70 millimetres [mm], entrance holes side and top) were used for trapping. Traps were baited with moist leaf litter (sterilised by microwaving) and lowered on nylon cord to within several metres of the watertable or end of the bore. In every fourth hole a second trap was set mid-way down the bore. Holes were sealed while traps were set to minimise the ingress of surface invertebrates. Traps were retrieved eight weeks later and their contents (bait and captured fauna) were emptied into zip-lock bags and road freighted to the laboratory in Perth.
2. *Scraping*. Scrapes were collected immediately prior to setting traps. A troglofauna net (weighted ring net, 150 micrometre (µm) screen, various apertures according to diameter of the hole) was lowered to the bottom of the hole, or to the watertable, and scraped back to the surface along the walls of the hole. Each scrape comprised four sequences of lowering and retrieving with the aim of scraping all troglofauna present on the walls of the hole into the net. After each scrape, the contents of the net were transferred to a 125 millilitres (ml) vial and preserved in 100% ethanol. Scrape sampling usually yields more troglofauna than trapping.

After return to the laboratory, troglofauna were extracted from the leaf litter bait used in traps by placing the litter in Tullgren® funnels under incandescent lamps. The light and heat drives the troglofauna and other invertebrates out of the litter into the base of the funnel containing 100% ethanol (preservative). After about 72 hours, the ethanol and its contents were removed and sorted under a dissecting microscope. Litter from each funnel was also examined under a microscope for any remaining live or dead animals. Preserved scrapes were elutriated in the laboratory to separate animals from heavier sediment and screened into size fractions (250, 90 and 53 µm) to remove debris and improve searching efficiency. Samples were then sorted under a dissecting microscope.

All fauna picked from scrapes or extracted from bait were examined for troglomorphic characteristics (lack of eyes and pigmentation, well developed sensory organs, slender appendages, vermiform body). Surface and soil-dwelling animals were identified only to Order level. Troglofauna (troglobites and troglophiles but only rarely trogloxenes) were, as far as possible, identified to species/morphospecies level, unless damaged, juvenile or the wrong sex for identification. Identifications were made under dissecting and/or compound microscopes and specimens were dissected as necessary.

3.2. Troglofauna Survey

3.2.1. Sampling at the Study Area

Troglofauna sampling at the Study Area occurred over two sampling rounds. Round 1 was conducted as part of a wider survey in the Homestead-Eastern Ridge area during 2013. During Round 1, eight holes were each sampled twice over four visits to the Study Area. Fourteen samples were collected from within the indicative mine pit and two samples from outside of this area. Scraping and trap setting occurred on 7 April 2013 with traps collected 5-7 June 2013; and further scraping and trap setting occurred on 10-13 July 2013, with traps collected on 24 September 2013 (Figure 3 and Table 1). Round 2 sampling was undertaken during 2014 and 2015 specifically to increase the sample effort within the Study Area. Forty-seven samples were collected (27 within the indicative mine pit and 20 outside), with scraping and trap setting undertaken on 3-5 November 2014 and trap collection on 21-22 January 2015 (Figure 3 and Table 1). A list of bores sampled is given in Appendix 1.

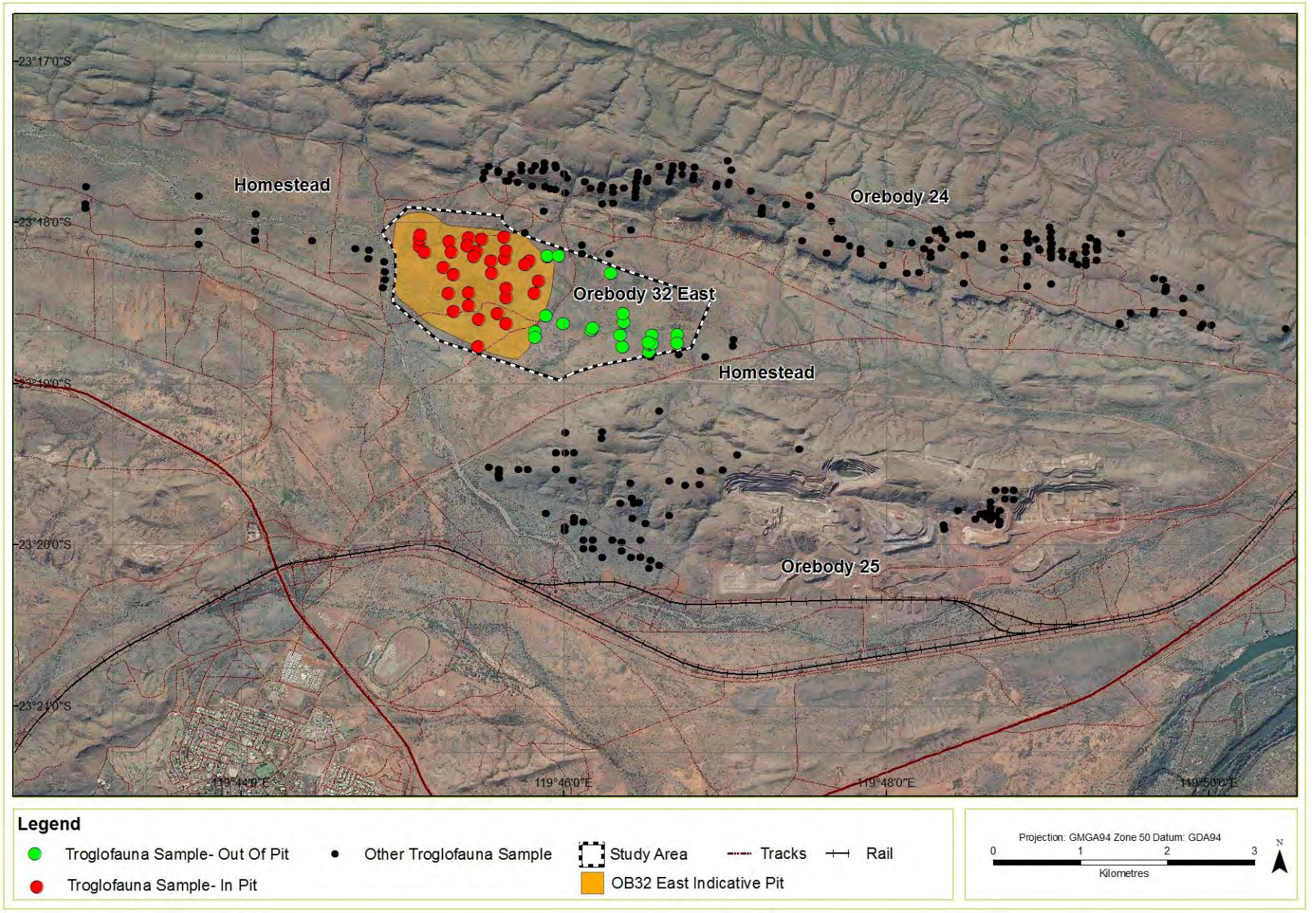

Figure 3. Drill holes sampled for troglofauna at OB32 East and the immediate surrounds.

3.2.2. Other Sampling

Troglofauna collected as by-catch during concurrent stygofauna sampling programs are included in survey results. These records provided additional information on species distributions.

Although not included in the survey results, data from surveys in the immediate vicinity at OB24, OB25 and Homestead was used to assess species ranges on a local-scale. Altogether, 461 samples have been collected from these localities. Thirty-five samples were collected at Homestead, 287 at OB24 and 139 at OB25 (Figure 3, Table 2). Note that some sampling at OB24 comprised only a scrape with no associated trap being set (Table 2). This has been taken into account when calculating the sample effort at each orebody. A scrape alone is considered to be 0.5 of a sample (Table 2).

Table 1. Troglofauna sampling in the Study Area

	Scrape	S Trap	D Trap	Samples
Round 1				
In-pit	14	10	4	**14**
Out-of-pit	2	2		**2**
Round 2				
In-pit	27	20	7	**27**
Out-of-pit	20	16	4	**20**

Table 2. Other troglofauna sampling in the vicinity of the Study Area.

Orebody	Scrape	S Trap	D Trap	Samples
Homestead	35	24	11	**35**
OB24	351	173	50	**287**
OB25	139	103	36	**139**

3.3. Personnel

Fieldwork was conducted by Jim Cocking, Dean Main, Grant Pearson and Jeremy Quartermaine. Sample sorting was done by Dean Main, Heather McLetchie, Jeremy Quartermaine, Jim Cocking, Lucy Gibson, Sean Bennett, Danilo Harms, Jane McRae and Mike Scanlon. Identifications were made by Jane McRae.

4. RESULTS

4.1. Occurrence and Abundance

Survey results in the Study Area yielded 144 troglofaunal animals belonging to 10 orders and 15 species (Table 3). This includes one arachnid order: Palpigradi (1 species). Crustaceans were represented by one order: Isopoda (4 species). Millipedes were represented by one order: Polyxenida (1 species). Pauropods were represented by one order: Tetramerocerata (2 species). Pseudocentipedes (symphylans) were represented by one order: Cephalostigmata (1 species). There were five orders of hexapods (Entognatha/Insecta): Diplura (1 species), Thysanura (2 species), Hemiptera (1 species), Coleoptera (1 species) and Diptera (1 species) (Table 3).

The community has similar composition and diversity to other parts of the Ophthalmia Range (Bennelongia 2008a, b, 2009b, 2011, 2014).

The millipede *Lophoturus madecassus* was the numerically dominant species (71 specimens) within the Study Area, with the beetle species *Ptinella* sp. B01 the next most abundant (35 specimens) (Figure 4). All other species were recorded in numbers of <10 specimens and five species were represented by one specimen (Figure 4).

Photographic examples of some of the troglofauna species collected at OB32 East are given (Figure 5).

Table 3. Troglofauna collected at the Study Area.
Species known only from the indicative mine pit at OB32 East are highlighted in grey.

Taxonomy	In-pit	Out-of-pit	Distribution	Range (km)
Arachnida				
Palpigradi				
Palpigradi sp. B17	7		Known only from OB32	0.5
Malacostraca				
Isopoda				
?*Buddelundia* sp. B01		1	Known only from single hole at OB32	-
nr *Andricophiloscia* sp. B17	2		Known only from single hole at OB32	-
Troglarmadillo sp. B38	1		Also known from Homestead	2.3
Troglarmadillo sp. B39		1	Also known from Homestead and OB24	11
Diplopoda				
Polyxenida				
Lophoturus madecassus	5	66	Cosmopolitan (Marquet and Conde 1950)	-
Pauropoda				
Tetramerocerata				
Decapauropus sp. B05	1		Also known from Mesa Gap	36
Pauropodidae sp. B32	1		Known only from single hole at OB32	
Symphyla				
Cephalostigmata				
Hanseniella sp. B19	7	1	Also known from OB25	4.5
Entognatha				
Diplura				
Japygidae `DPL002`	2		Also known from Alligator Jaws, Camp Hill, Caramulla, Governor Range, Hashimoto, Homestead, Jimblebar, Juna Downs Road, Jinidi, OB24, OB25, OB31, Rhodes Ridge, South Flank, Western Ridge, A Deposit, P1 Deposit, P4 Deposit, elsewhere in Pilbara (Bennelongia unpublished)	327
Insecta				
Thysanura				
Atelurinae sp. B02	1	2	Also known from Caramulla, Coondewanna, Governor Range, Hashimoto, Jimblebar, Juna Downs Road,	505

Taxonomy	In-pit	Out-of-pit	Distribution	Range (km)
			Jinidi, OB18, OB24, OB25, OB31, OB39, South Flank, Western Ridge, Wheelarra Hill, Yandi, elsewhere in Pilbara (Bennelongia unpublished)	
Trinemura sp. B26	6		Also known from Homestead	2.9
Hemiptera				
Meenoplidae sp.	1	2	Uncertain due to taxonomic resolution, probably Meenoplidae sp. B3 known from Hashimoto, Wheelarra Hill, Jimblebar East and Jimblebar West	NA
Coleoptera				
Ptinella sp. B01	22	13	Also known from P1 Deposit, Packsaddle West, elsewhere in the Pilbara (Bennelongia unpublished)	343
Diptera				
Sciaridae sp. B01		2	Also known from Alligator Jaws, Jimblebar South, Mindy, Jinidi, OB24, OB25, OB31, Rhodes Ridge, South Flank, Western Ridge, B Deposit, P4 Deposit, elsewhere in Pilbara (Bennelongia unpublished)	416

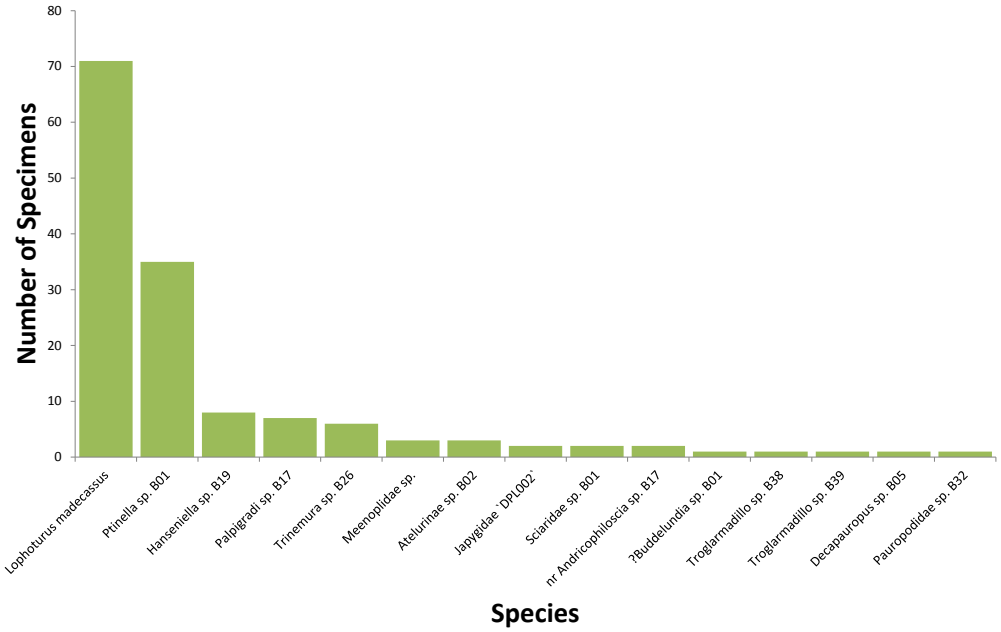

Figure 4. Capture abundance of troglofauna in the Study Area.

4.2. Ranges of Species Collected

Five of the 15 species of troglofauna known to occur at the Study Area are very widespread in the Pilbara or beyond; namely, *Lophoturus madecassus*, Japygidae `DPL002`, Atelurinae sp. B02, *Ptinella* sp. B01 and Sciaridae sp. B01 (Table 3). In addition, *Decapauropus* sp. B05 is known to have a linear range of 36 km in the Newman-Jimblebar area. Although Meenoplidae sp. is not identified to species level, the three animals are considered likely to be Meenoplidae sp. B03 which is known to be locally widespread in the Newman-Jimblebar area (Bennelongia 2009c).

The remaining eight species are known only from the Study Area or the near vicinity (Homestead, OB24, and OB25), namely, Palpigradi sp. B17, ?*Buddelundia* sp. B01, nr *Andricophiloscia* sp. B17, *Troglarmadillo* sp. B38, *Troglarmadillo* sp. B39, Pauropodidae sp. B32, *Hanseniella* sp. B19, and *Trinemura* sp. B26 (Table 3). Three of these species are known only from the indicative mine pit at OB32 East: Palpigradi sp. B17, nr *Andricophiloscia* sp. B17 and Pauropodidae sp. B32 (Figure 6).

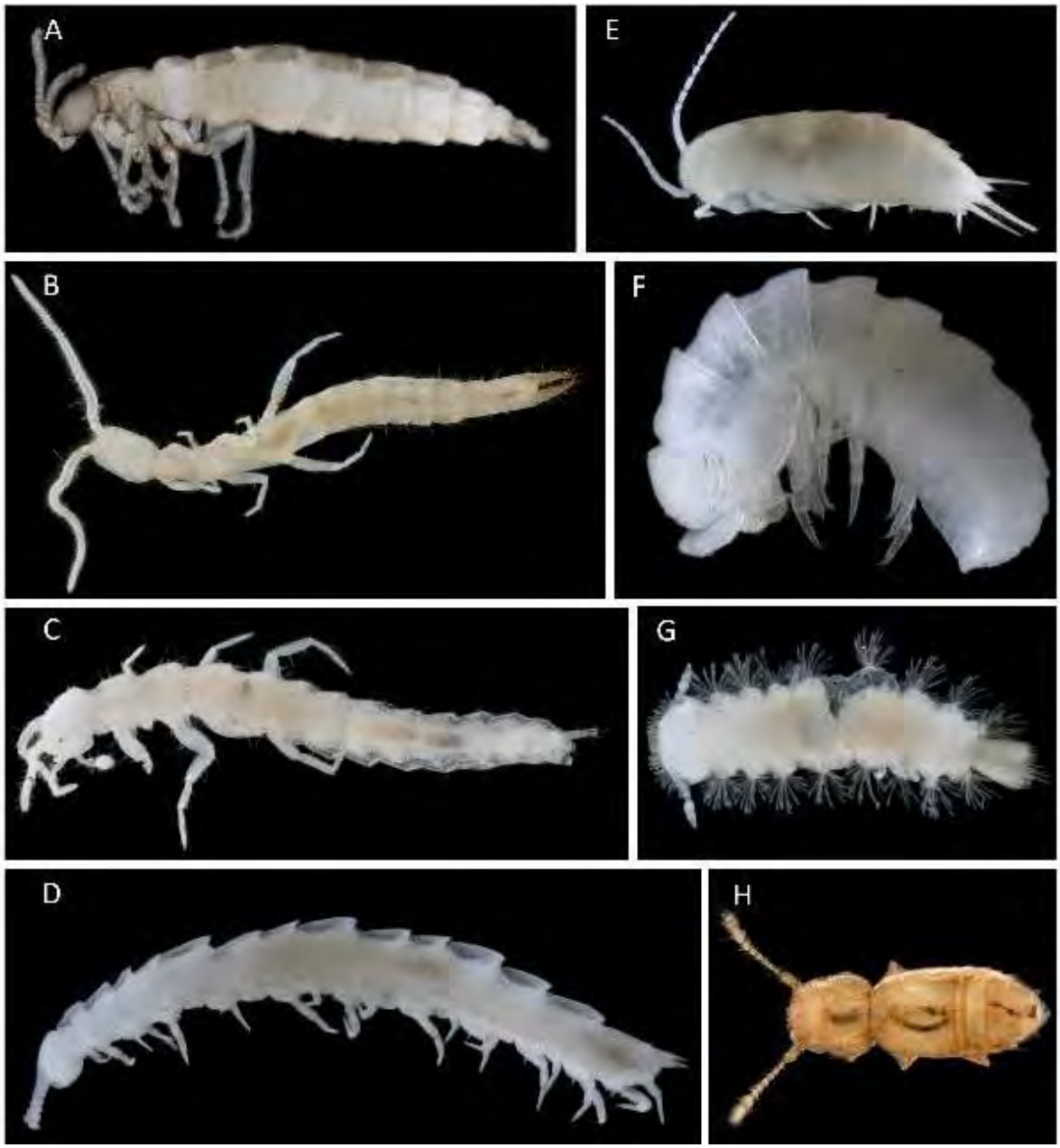

Figure 5. Troglofauna photographs:
(A) Sciaridae sp. B01 – Diptera; (B) Japygidae `DPL002` – Diplura; (C) Trinemura sp. B26 – Thysanura; (D) Hanseniella sp. B19 - Symphyla; (E) Atelurinae sp. B02 – Thysanura; (F) Troglarmadillo sp. B39 – Isopoda; (G) Lophoturus madecassus – Polyxenida; (H) Ptinella sp. B01 – Coleoptera.

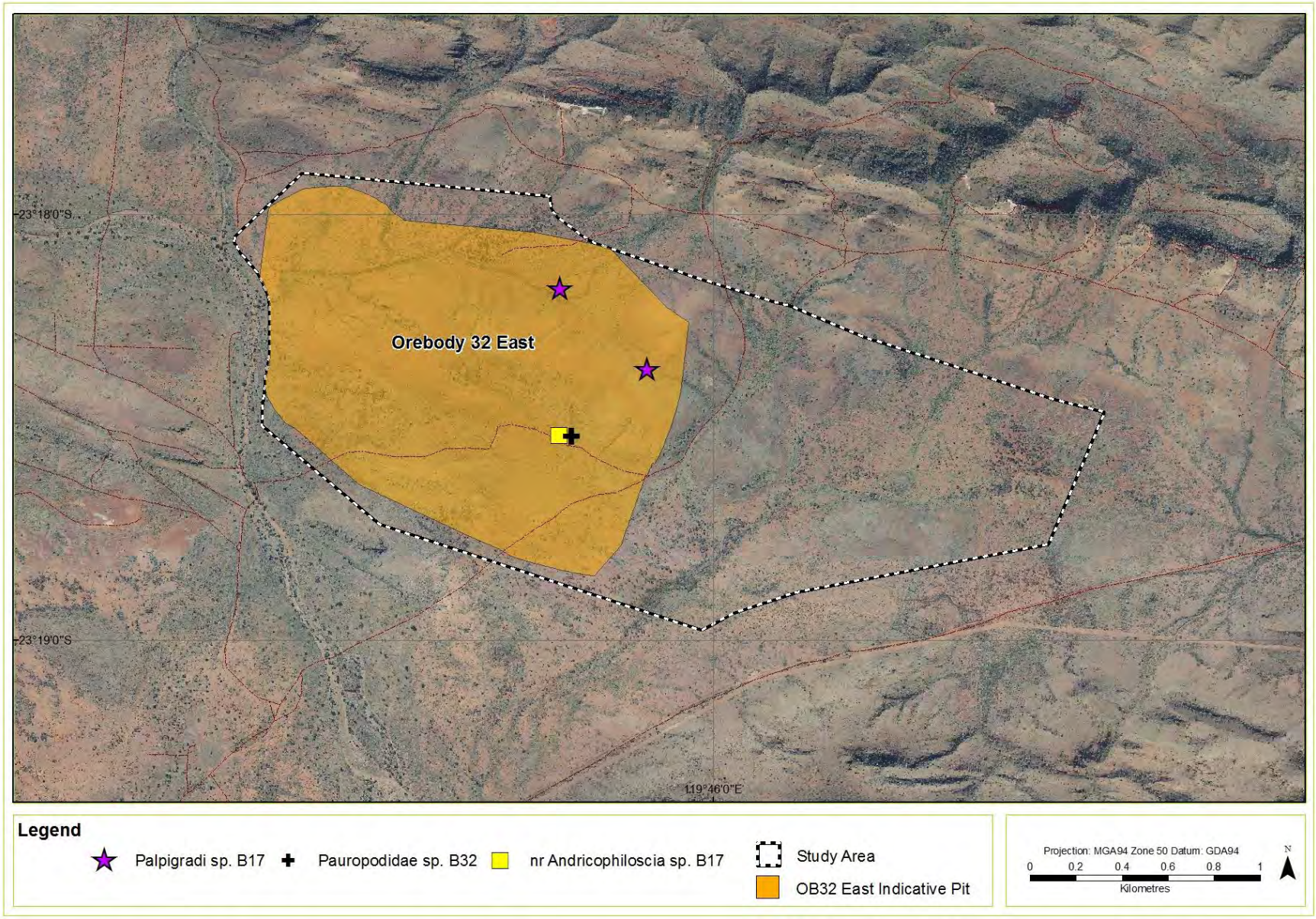

Figure 6. Troglofauna species known only from the indicative mine pit at OB32 East.

5. IMPACT EVALUATION

5.1. Potential Impacts of Mining on Troglofauna

Activities that cause direct habitat loss are considered to be the primary impacts with potential to lead to the extinction of troglofauna species. At OB32 East mining would remove troglofauna habitat only through pit excavation; however, this excavation is likely to present a significant threat to any troglofauna species with a range that is restricted to the indicative mine pit.

In most situations, activities that reduce the quality of subterranean fauna habitat (but not its occurrence) are considered more likely to reduce the population size of a troglofauna species than to cause its extinction (see Scarsbrook and Fenwick 2003; Masciopinto *et al*. 2006). Therefore, the threats associated with these activities are considered to be of secondary importance. These secondary threats are not considered further in text but are described briefly in Appendix 2.

5.2. Threats to Conservation of Troglofauna Species

The persistence of troglofauna species that have occurrences outside the indicative mine pit will not be threatened by the proposed mining at OB32 East. However, three troglofauna species are known only from indicative mine pit at OB32 East: Palpigradi sp. B17, nr *Andricophiloscia* sp. B17 and Pauropodidae sp. B32 (Figure 6). Understanding what the actual ranges of these species are likely to be is crucial in assessing any potential threat to them.

5.2.1. Inferred Ranges of Apparently Restricted Species

At present the understanding of factors controlling the distributions of individual troglofauna species in the Pilbara is poorly developed. Many troglofauna species are collected in low abundance in assessment surveys and it is difficult to distinguish between species with very restricted distributions that have been collected once or twice from across their small range and more widely distributed species collected from one small area within their larger range. There are many scenarios whereby the results of a sampling program may suggest that a quite widespread troglofauna species has a restricted range, especially when it is a low abundance species and, therefore, will be collected rarely and somewhat stochastically. Three of the scenarios are (see Magurran and Henderson 2003; Guisan *et al*. 2006):

- The survey area is much smaller than the species' range.
- The survey area is on the periphery of the species' range, which is mostly elsewhere.
- The sampling methods used did not catch the species effectively so that it was collected from only part of its area of occurrence within the survey area.

Bearing in mind the difficulty of determining the ranges of species, especially troglofauna, from geographically limited sampling programs, the likelihood of Palpigradi sp. B17, nr *Andricophiloscia* sp. B17 and Pauropodidae sp. B32 being restricted to the indicative mine pit is examined below. Conclusions about the likelihood of species having restricted ranges were based on what is known about closely related species from the Pilbara, together with a wider consideration of the ranges of other species in the same troglofauna community and the type of troglofauna habitat present.

Palpigradi sp. B17

Palpigradi sp. B17 is represented by specimens from two holes 0.5 km apart at OB32 East (Figure 6). One hole, (HST0037R) has been logged as Tertiary detritals from 0 - 30 m, West Angeles from 30 - 84 m (enrichment and shales) and dolomite from 84 - 90 m. Hardcap has been identified from 30 - 42 m down this hole and the water table depth has been logged at approximately 27 m. The second hole, (HST0428R) has been logged as West Angeles Member 0 - 30 m and dolomite from 30 - 45 m. Based on the habitat review (see Section 2.3), it is likely that Tertiary detritals and the West Angeles Member form the most likely habitat for Palpigradi sp. B17.

Bennelongia currently recognises 17 species of palpigrad in the Pilbara; two of these species Palpigradida sp. B01 and Palpigradida sp. B03 are considered widespread based on morphology (RSFP data). The other palpigrads collected by Bennelongia have been recorded at very low abundance and have very small known ranges, although these ranges may have been underestimated because of sampling issues associated with low abundance. Nevertheless, it is considered that some species are likely to be troglobitic and likely to be restricted in range, despite lacking strongly troglomorphic features (Halse and Pearson 2014). Palpigradi sp. B17 is treated as a potentially restricted troglobitic species based on the two records of the species being in close proximity.

Assessment of whether or not Palpigradi sp. B17 is restricted to the indicative mine pit can only be further advanced, based on a probabilistic approach, by using surrogates, i.e. likely habitat continuity and the distribution of other localised species (and hence likely troglobites) that occur close to Palpigradi sp. B17. This assessment is presented below under "Surrogate Data" for all three of the apparently restricted species.

nr *Andricophiloscia* sp. B17

nr *Andricophiloscia* sp. B17 is represented by two specimens from one hole (HST0213D) at OB32 East (Figure 6, Figure 7). Pauropodidae sp. B32 was collected from the same hole, which passes through Tertiary detritals from 0-20 m before intersecting the watertable. As Tertiary detritals is the only stratum present where nr *Andricophiloscia* sp. B17 was collected, it is assumed that this geology must represent habitat for the species, although other geologies may also inhabited elsewhere.

Troglofaunal philosciids are relatively rare in the Pilbara but some of the recorded species appear to have tightly restricted ranges. This species is likely to have a linear range of <10 km but the single record provides no information about its likely distribution in relation to the indicative mine pit. Further assessment of the likely range of this species is provided in the "Surrogate Data" section below.

Pauropodidae sp. B32

A single specimen of Pauropodidae sp. B32 was collected at OB32 East in hole HST0213D, which consisted of Tertiary detritals to the watertable (Figure 6, Figure 7). As with nr *Andricophiloscia* sp. B17 it is assumed that this geology must represent habitat for the species.

The taxonomy of pauropods in Australia is not well established (Scheller 2010, 2013) but some species in the Pilbara have extensive ranges, such as the circumtropical *Decapauropus tenuis* and Pauropodidae sp. B01 (known linear range of 143 km), while other species typically have smaller ranges in the order of 10 km or less (Halse and Pearson 2014). Many of the species collected in the Pilbara appear to be surface species or trogloxenes despite the aridity (U. Scheller personal communication) and wide ranges are not unexpected. Given that a related species (*Decapauropus* sp. B05) found at OB32 has a linear range extending 36 km to Mesa Gap, it is considered to be moderately likely that Pauropodidae sp. B32 does not have a tightly restricted range.

Surrogate Data

Both biological and geological data strongly suggest that the indicative mine pit is not isolated troglofauna habitat for Palpigradi sp. B17, nr *Andricophiloscia* sp. B17 and Pauropodidae sp. B32.

Four other species collected in the Study Area are considered likely to be troglobites and to have small ranges, namely the isopods ?*Buddelundia* sp. B01, *Troglarmadillo* sp. B38, symphylan *Hanseniella* sp. B19, and thysanuran *Trinemura* sp. B26 (Figure 8). Importantly, the latter three species are known from beyond the Study Area, *Troglarmadillo* sp. B38 is known from Homestead with a

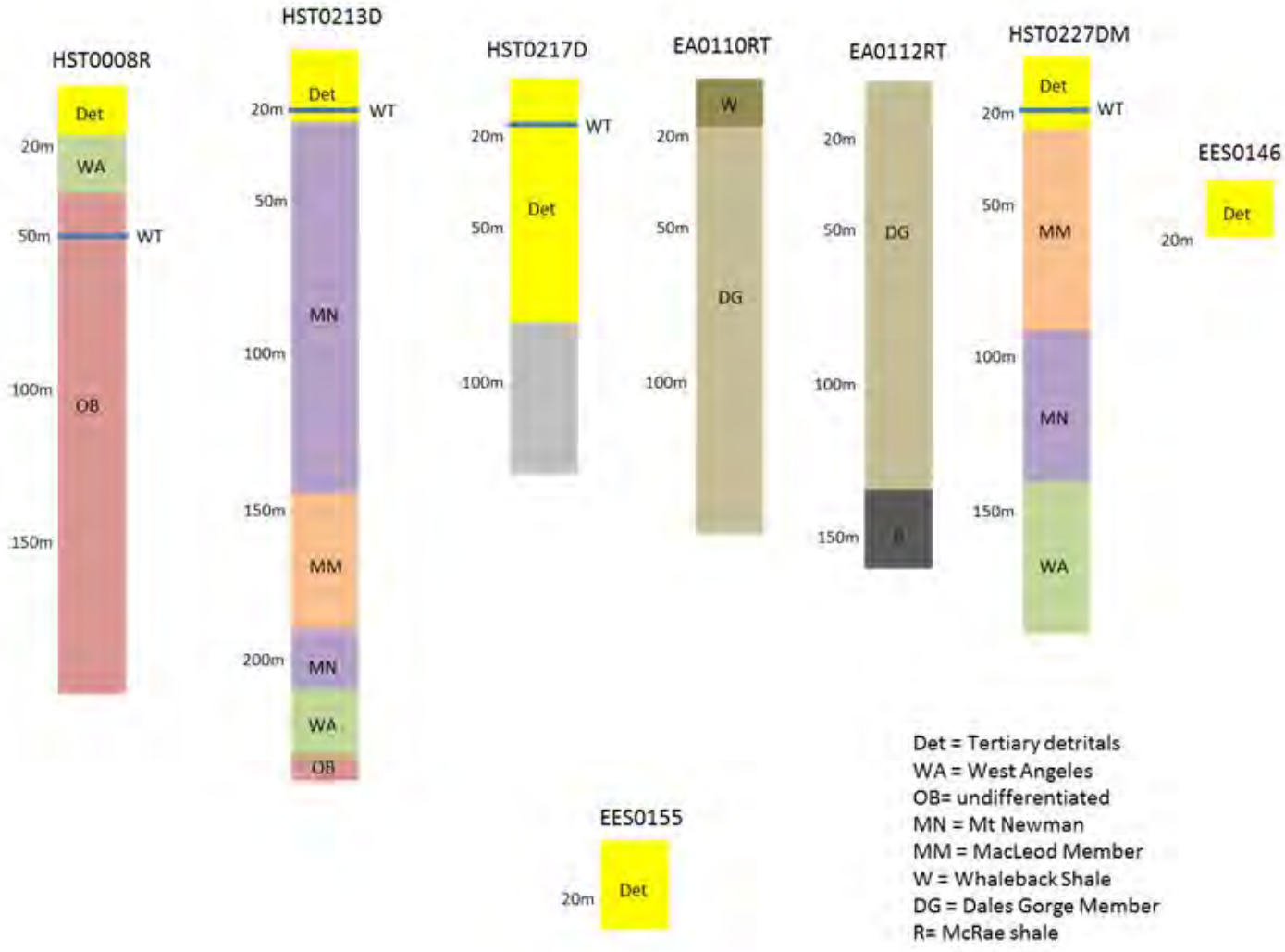

Figure 7. Stratigraphy of holes in which *Hanseniella* sp. B19 has been collected.

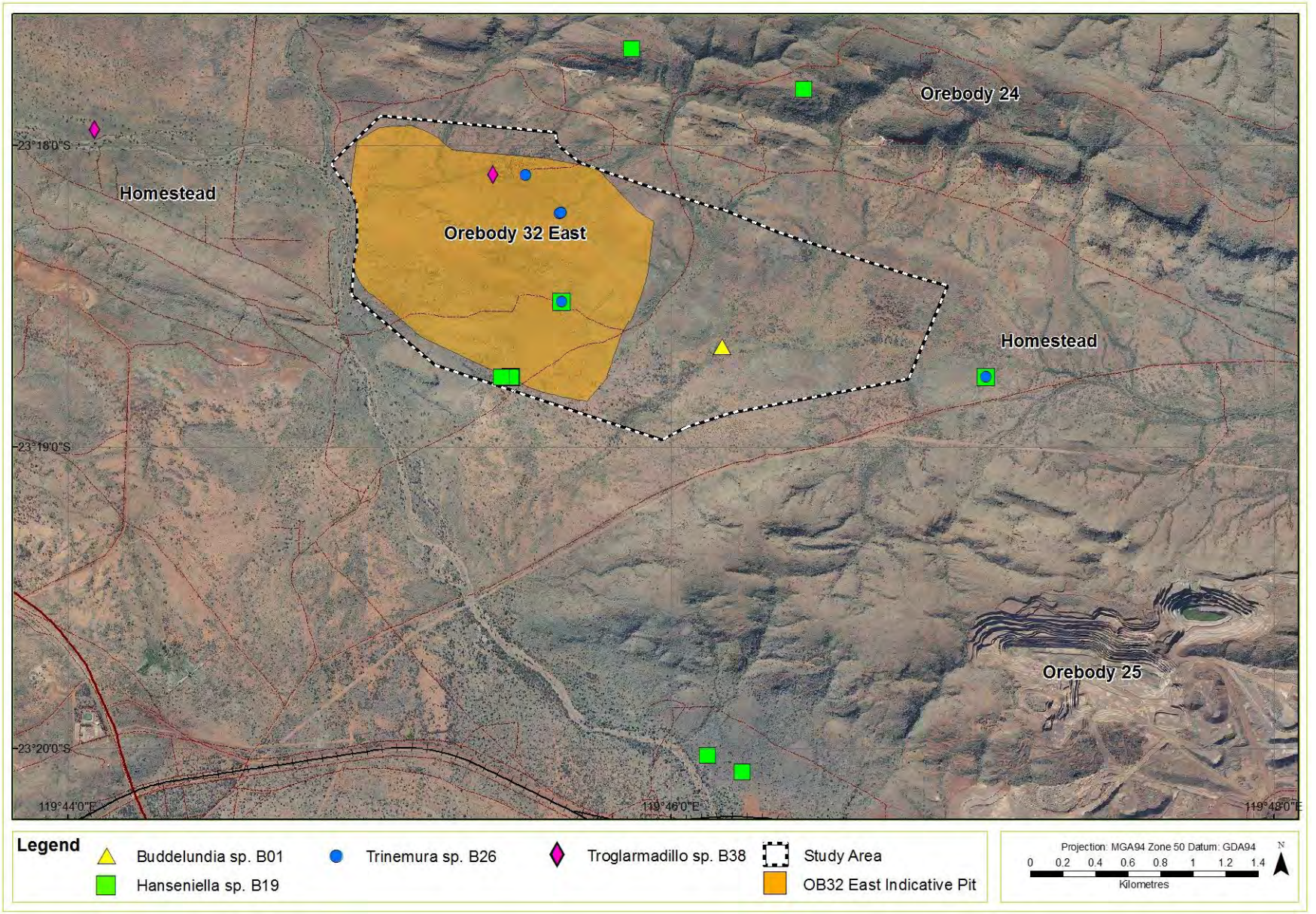

Figure 8. Other troglofauna species with localised distributions in the vicinity of OB32 East.

linear range of 2.3 km, *Hanseniella* sp. B19 is known from OB25 with a linear range of 4.5 km, and Trinemura sp. B26 is known from Homestead with a linear range of 2.9 km. It should be further noted that three of these species occur not only in the indicative mine pit but also as outside the Study Area and well beyond the indicative mine pit (Figure 8).

Building a picture of the habitat used by troglofauna in the Study Area is difficult because of the lack of obvious voids in the diamond drill cores but it is considered that the most suitable habitat probably occurs in the fracturing and friable components of the Tertiary alluvials/detritals. Given that Tertiary detritals is widespread in OB24, OB25 and Homestead area, it is likely that the three apparently restricted species, Palpigradi sp. B17, nr *Andricophiloscia* sp. B17 and Pauropodidae sp. B32 have moderately widespread local occurrence.

This pattern of moderately widespread local occurrence is shown by *Hanseniella* sp. B19, which occurs in the OB24, OB25 and Homestead area. *Hanseniella* sp. B19 co-occurs with nr *Andricophiloscia* sp. B17 and Pauropodidae sp. B32 in hole HST0213D where Tertiary detritals are the only habitat present above the watertable (Figures 6, 7, 8). Furthermore, *Hanseniella* sp. B19 also potentially occupies a number of other geologies across its range including; West Angeles Member, Whaleback Shale and Dales Gorge Member (Figure 8).

5.3. Development Impacts

When assessing the threat to troglofauna as a consequence of mining at OB32 East, it should be recognised that the indicative mine pit covers an area of only 202 ha. Troglofauna habitat within the local area is unlikely to contain major barriers to movement of species, such as the valleys between isolated mesas in the Robe Valley (Biota 2006a; Harvey *et al*. 2008). Furthermore, the presence of troglobitic species both within the indicative mine pit and elsewhere in the local area at Homestead, OB24 and OB25 strongly indicates habitat connectively extends beyond the area of commercial grade ore formations. It is likely that other specimens of Palpigradi sp. B17, nr *Andricophiloscia* sp. B17 and Pauropodidae sp. B32 occur in this local area beyond the indicative mine pit, despite the species probably having small ranges. Therefore, the proposed mining at OB32 East appears to pose little threat to the persistence of troglofauna species.

6. CONCLUSION

Troglofauna survey within the Study Area was conducted according to EPA guidelines with pit excavation considered to be the only activity threatening persistence of troglofauna species.

Survey of the Study Area collected 15 species belonging to 10 orders. The orders were Palpigradi, Isopoda, Polyxenida, Tetramerocerata, Cephalostigmata, Diplura, Thysanura, Hemiptera, Coleoptera and Diptera. The Study Area appears to have a similar troglofauna community to those previously identified in the Ophthalmia Range.

Three species of troglofauna are currently known only from within the indicative mine pit at OB32 East. They are Palpigradi sp. B17, nr *Andricophiloscia* sp. B17 and Pauropodidae sp. B32. All three species are considered likely to have ranges extending outside the mine pit because a high proportion of the other localised species have ranges that extend into surrounding areas. There appears to be good habitat connectivity between the indicative mine pit and surrounding areas and no geological barriers to cause a localised species to be restricted to the indicative mine pit.

When this biological and geological information is considered in conjunction with the relatively small size of the indicative mine pit (202 ha), there appears to be little threat to the persistence of troglofauna species as a result of mining at OB32 East.

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Appendix 1- Holes Sampled for Troglofauna within the Study Area

Drill Hole Code	Site Type	Latitude	Longitude
HOMUNK01	In-pit	-23.3128	119.7578
HST0152R	Out-of-pit	-23.3111	119.7695
HST0040R	In-pit	-23.3038	119.7605
HST0096R	In-pit	-23.303	119.7577
HST0042R	In-pit	-23.3035	119.7574
HST0131R	In-pit	-23.3025	119.7518
HST0132R	In-pit	-23.3017	119.7518
HST0045R	In-pit	-23.3013	119.7518
HST0180R	In-pit	-23.3073	119.7636
HST0428R	In-pit	-23.3061	119.7641
HST0425R	In-pit	-23.304	119.7631
HST0423R	In-pit	-23.3043	119.7626
HST0037R	In-pit	-23.3029	119.7607
HST0350R	In-pit	-23.304	119.7592
HST0353R	In-pit	-23.3052	119.7592
HST0137R	In-pit	-23.3078	119.7607
HST0122R	In-pit	-23.3068	119.7607
HST0185R	In-pit	-23.3104	119.7607
HST0454R	In-pit	-23.3094	119.7598
HST0063R	In-pit	-23.31	119.7578
HST0332R	In-pit	-23.3086	119.7569
HST0329R	In-pit	-23.3072	119.7569
HST0420R	In-pit	-23.3054	119.7553
EMP0115	In-pit	-23.3092	119.7553
HST0215DT	In-pit	-23.3073	119.7547
HST0380R	In-pit	-23.3046	119.7543
HST0442R	In-pit	-23.3016	119.7568
HST0448R	In-pit	-23.3017	119.7582
HST0310R	In-pit	-23.3024	119.7567
HST0130R	In-pit	-23.302	119.7548
HST0473R	In-pit	-23.3031	119.7523
HST0480R	In-pit	-23.303	119.755
HST0125RE	In-pit	-23.3015	119.7605
HST0033R	Out-of-pit	-23.3035	119.7649
HST0219D	Out-of-pit	-23.3034	119.765
HST0801R	Out-of-pit	-23.3052	119.7715
EXS0038	Out-of-pit	-23.3034	119.7662
HST0242D	Out-of-pit	-23.3096	119.7648
HST0212D	Out-of-pit	-23.3113	119.7637
HST0071R	Out-of-pit	-23.3118	119.7637
HST0225DM	Out-of-pit	-23.3105	119.7666
HST0227DM	Out-of-pit	-23.3109	119.7696
HST0230DM	Out-of-pit	-23.3129	119.7727
HST0075R	Out-of-pit	-23.3116	119.7725
EMP0097	Out-of-pit	-23.3103	119.7729
EMP0098	Out-of-pit	-23.3094	119.7728
EMP0130	Out-of-pit	-23.3117	119.7757
HST0084RD	Out-of-pit	-23.3134	119.7755
HST0229DM	Out-of-pit	-23.3126	119.7755
EMP0127	Out-of-pit	-23.3125	119.7757
HST0068R	Out-of-pit	-23.3115	119.7784
HST0069R	Out-of-pit	-23.3125	119.7784
HST0083RD	Out-of-pit	-23.3124	119.7754

Appendix 2 - Secondary Impact of Mining on Subterranean Fauna

Mining activities that may result in secondary impacts to subterranean fauna include:

1. *De-watering below troglofauna habitat*. The impact of a lowered water table on subterranean humidity and, therefore, the quality of troglofauna habitat is poorly studied but it may represent risk to troglofauna species in some cases. The extent to which humidity of the vadose zone is affected by depth to the watertable is unclear. Given that pockets of residual water probably remain trapped throughout de-watered areas and keep the overlying substrate saturated with water vapour, de-watering may have minimal impact on the humidity in the unsaturated zone. In addition, troglofauna may be able to avoid undesirable effects of a habitat drying out by moving deeper into the substrate if suitable habitat exists at depth. Overall, de-watering outside the proposed mine pits is not considered to be a significant risk to troglofauna.
2. *Percussion from blasting*. Impacts on both stygofauna and troglofauna may occur through the physical effect of explosions. Blasting may also have indirect detrimental effects through altering underground structure (usually rock fragmentation and collapse of voids) and transient increases in groundwater turbidity. The effects of blasting are often referred to in grey literature but are poorly quantified and have not been related to ecological impacts. Any effects of blasting are likely to dissipate rapidly with distance from the pit and are not considered to be a significant risk to either stygofauna or troglofauna outside the proposed mine pits.
3. *Overburden stockpiles and waste dumps*. These artificial landforms may cause localised reduction in rainfall recharge and associated inflow of dissolved organic matter and nutrients because water runs off stockpiles rather than infiltrating through them and into the underlying ground. The effects of reduced carbon and nutrient input are likely to be expressed over many years and are likely to be greater for troglofauna than stygofauna (because lateral movement of groundwater should bring in carbon and nutrients). The extent of impacts on troglofauna will largely depend on the importance of chemoautotrophy in driving the subterranean system compared with infiltration-transported surface energy and nutrients. Stockpiles are unlikely to cause species extinctions, although population densities of species may decrease under them.
4. *Aquifer recharge with poor quality water*. It has been observed that the quality of recharge water declines during, and after, mining operations as a result of rock break up and soil disturbance (i.e. Gajowiec 1993; McAuley and Kozar 2006). Impacts can be minimised through management of surface water and installing drainage channels, sumps and pump in the pit to prevent of recharge though the pit floor.
5. *Contamination of groundwater by hydrocarbons*. Any contamination is likely to be localised and may be minimised by engineering and management practices to ensure the containment of hydrocarbon products.

Bennelongia Environmental Consultants

ACN 124 110 167

Postal address
PO Box 384
Wembley WA 6913

Street address
64 Jersey Street
Jolimont WA 6014

Phone (08) 9285 8722
Fax (08) 9285 8811

Your reference
Our reference BEC14-01-J01, AJT

Sonya Brunt
BHP Billiton Iron Ore Pty Ltd
PO Box 7122
Cloisters Square WA 6850
sonya.brunt@BHPbilliton.com

Dear Sonya

Re: Response to comments from OEPA on OB32 Troglofauna Assessment

Comments from the OEPA

"Subterranean fauna (troglofauna) – a habitat map and information on the range of surrogate species, to support the habitat argument"

"Provide a figure showing the known extent of Tertiary Detritals (likely Troglofauna Habitat) and additional information and figures indicating the known range of surrogate species."

Response

Two main issues to be addressed were identified within the EPA comments:

1. identification of potential habitat in the form of Tertiary Detrital in the local area and the continuity of this habitat from within to outside of the proposed mine pit.
2. the known range of surrogate species in relation to the extent of Tertiary Detrital and the proposed mine pit.

Tertiary Detritals in the Local Area and Habitat Continuity

The Tertiary Detritals (alluvium and colluvium) are widespread in the area surrounding OB32, as depicted by the surface geology in Figure 1. Mapped surface geology shows continuity of potential troglofauna habitat (in the form of Tertiary Detritals) well beyond the proposed mine pit along the valley between OB24 and OB25 and westwards of OB32 as well. However, it should be recognised this depiction of the extent of the Tertiary Detritals is surficial and there is lateral and vertical heterogeneity in the depth and composition of Tertiary Detritals on a scale of tens to hundreds of metres in a repeated, albeit variable, pattern (Penales 2013). It is very unlikely that the fine-scale heterogeneity has created isolated troglofauna habitats but vagaries in actual habitat suitability (abundance of suitable subterranean spaces) means troglofauna are likely to have patchy distributions.

Importantly, within the Study Area (including the proposed mine pit) there are no landscape features that are considered significant enough to interrupt the continuity of troglofauna habitat and create a barrier to dispersal. There are no mesa-type formations or deep valleys present, few

breakaways or rocky outcrops and no dykes or significant faulting that are likely to limit the ranges of species.

Known Range of Surrogate Species

Three species collected in the OB32 Study Area are considered to be useful surrogates for determining the likely ranges of "the three potentially restricted species" at OB32. They are the isopod *Troglarmadillo* sp. B38 (which may be viewed as a taxonomic match for nr *Andricophiloscia* sp. B17), the symphylan *Hanseniella* sp. B19 (which can be considered to have similar biology to Pauropodidae sp. B32), and the thysanuran *Trinemura* sp. B26.

The three surrogate species are likely to be troglobitic (as are the potentially restricted species). However, *Troglarmadillo* sp. B38, *Hanseniella* sp. B19 and *Trinemura* sp. B26 have been collected more frequently in the area and are therefore likely to provide more accurate information about the ranges of troglobitic species in the Study Area than is available for the potentially restricted species, which have been collected only once (nr *Andricophiloscia* sp. B17, Pauropodidae sp. B32) or twice (Palpigradi sp. B17).

Troglarmadillo sp. B38 has a known linear range of 2.3 km, *Hanseniella* sp. B19 has a known linear range of 4.5 km, and *Trinemura* sp. B26 has a known linear range of 2.9 km (Figure 1). *Hanseniella* sp. B19 is potentially the best of the surrogates as it co-occurs with nr *Andricophiloscia* sp. B17 and Pauropodidae sp. B32 in hole HST0213D where Tertiary Detritals are the only habitat present above the watertable (Figure 1).

All three surrogate species have demonstrated occurrences both within and outside of the potential mine pit within the mapped Tertiary Detritals, as shown in Figure 1, although occurrences are often where banded iron formation is also present or in close proximity.

Conclusion

Analysis of geological data and information on the distribution of surrogate species suggest that the potentially restricted species (Palpigradi sp. B17, nr *Andricophiloscia* sp. B17 and Pauropodidae sp. B32) are likely to have ranges extending beyond the proposed mine pit. Hence, the proposed mine development appears likely to pose little threat to the persistence of the three species.

Yours sincerely

Dr Stuart Halse
Bennelongia Pty Ltd

25 May 2015

Reference

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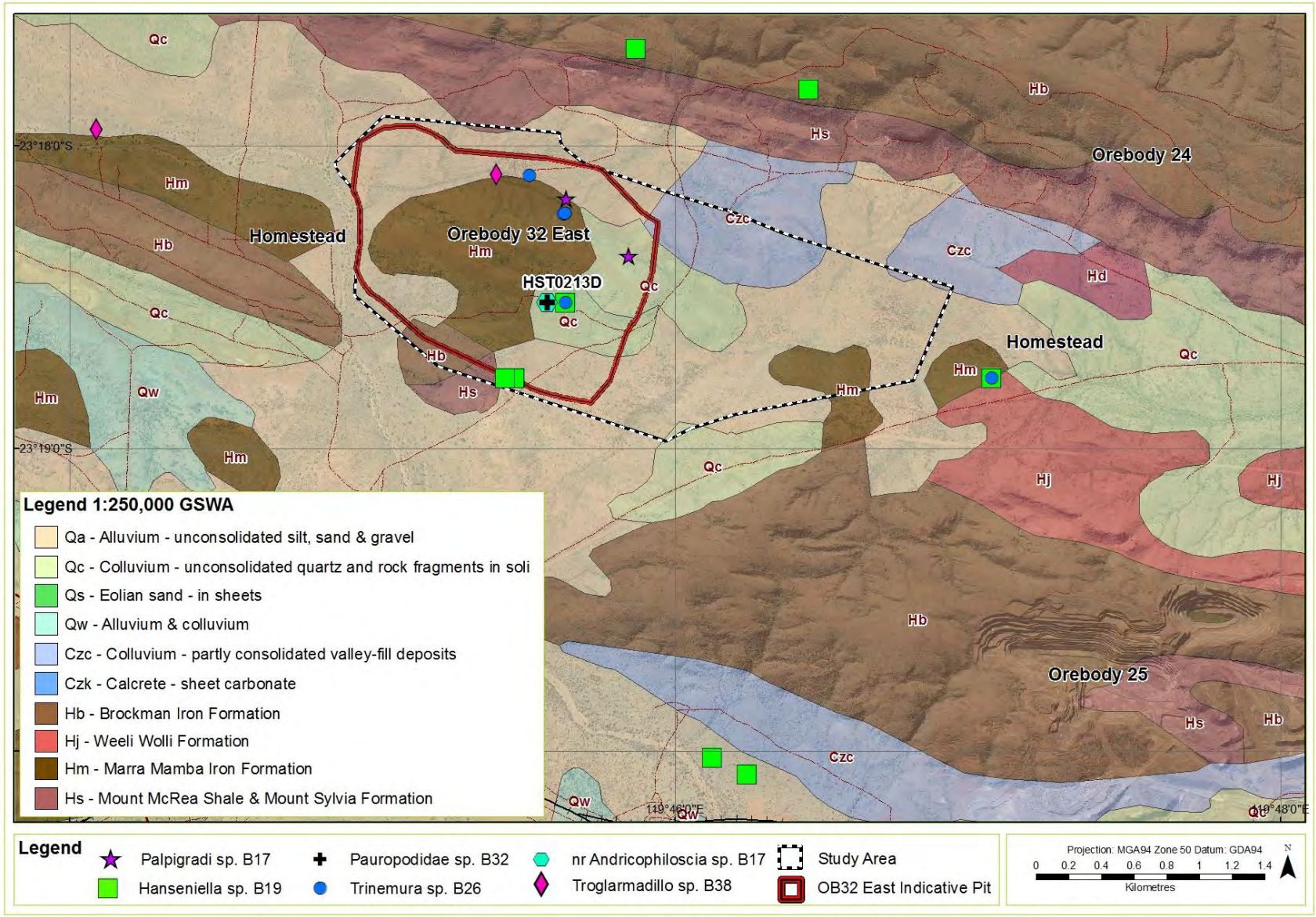

Figure 1. Surface geology in the OB32 Project Area (and surrounds) with known occurrences of restricted and surrogate species shown. Note that four species occur in hole HST0213D.

OREBODY 32E SURFACE WATER ENVIRONMENTAL IMPACT ASSESSMENT

OREBODY 32E SURFACE WATER ENVIRONMENTAL IMPACT ASSESSMENT

Prepared by:

RPS
38 Station Street, Subiaco WA 6008
PO Box 465, Subiaco WA 6904
T: 61 8 9211 1111
F: 61 8 9211 1122
E: water@rpsgroup.com.au
W: rpsgroup.com.au

Our ref: 1720B/003c
Date: 7 May 2015

Prepared for:

BHP Billiton Iron Ore
Level 30
125 St Georges Terrace
Perth WA 6000

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	Name	Position	Signature	Date
Author	Rhod Wright	Principal Civil / Water Engineer		07/5/2015
Reviewer	V Piper	Senior Principal Water Resources Engineer		07/5/2015

Disclaimer

EXECUTIVE SUMMARY

BHP Billiton Iron Ore Pty Ltd (BHP Billiton Iron Ore) is seeking approval to construct and operate the Orebody 32E (OB32E) mining infrastructure facilities at Eastern Ridge in the Pilbara. OB32E is located on a small hill between Eastern Ridge and Ophthalmia Range..

Currently, the OB32E development area is undisturbed by mining operations. The planned operations comprise an open hard rock pit with mining above the water table, as well as extensions to existing approved Overburden Storage Areas (OSA's), and placement of overburden in existing and new mined-out pits (i.e. in-fill dumping); as well as progressive construction of haul roads and light vehicle access roads linking the open pit, OSA's and mine infrastructure.

This report has been prepared as a surface water environmental summary to accompany a referral to the Environmental Protection Authority (EPA).

The OB32E project is adjacent to Homestead Creek in the Upper Fortescue River catchment.

Surface water quality in the Homestead Creek / Eastern Ridge area and adjacent creek systems may be characterised as fresh. No significant changes to surface water drainage or quality are anticipated due to the OB32E development.

OB32E project is located within the Homestead Creek catchment. The proposed OB32E pit lies predominately on a hill standing about 45m above the surrounding terrain. The planned pit development area naturally drains from the ridge top in all directions.

Potential surface water impacts associated with mining operations at the OB32E mine site include:

- Interruption of existing surface water flow patterns;
- Increased risk of erosion and sedimentation from disturbed areas; and
- Contamination of surface water by chemicals or hydrocarbons.

Surface water flood protection measures at OB32E are required to protect the pit from potential flooding.

Sediment basins will be used to control surface water sediment, and will be constructed down slope of all disturbed mine infrastructure.

The planned mining development works will cause the loss of catchment area contributing runoff to the downstream drainage system, and may have an impact on the downstream environment. Runoff volume is likely to decrease from areas containing pits, OSAs and catchments blocked or trapped by these works.

The loss of catchment area contributed by the OB32E development is estimated at about 0.4% of the 302km² Homestead Creek catchment at its junction with the Fortescue River. When combined with other planned and existing mines, the total effective catchment loss is 1165ha, which represents about 4% of the Homestead Creek catchment or 0.25% of the Fortescue River catchment at Ethel Gorge.

This potential runoff volume reduction is not considered significant to the overall hydrological systems downstream, particularly when considering the natural seasonal variations in catchment runoff.

From an environmental perspective, key surface water management objectives and principles have been incorporated into the planning of OB32E project through assessment of the potential impacts from the proposed development.

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TABLES

FIGURES (compiled at end of report)

1. INTRODUCTION

1.1 Project Description

BHP Billiton Iron Ore Pty Ltd (BHP Billiton Iron Ore) is seeking approval to construct and operate the Orebody 32E (OB32E) mining infrastructure facilities in their mining tenements at Eastern Ridge in the Pilbara Region of Western Australia. The proposed OB32E development is located about 6km north-east of Newman town as shown in Figure 1.

OB32E is located on a small hill between Eastern Ridge and Ophthalmia Range. BHP Billiton Iron Ore currently mines two other nearby deposits, the OB25 deposit on Eastern Ridge and OB24 deposit in Ophthalmia Range. Both of these mines consist of open pits, processing and train loading capacity. BHP Billiton Iron Ore's Newman Port Hedland Railway passes south of OB32E.

Currently, the OB32E development area is undisturbed by mining operations (except for exploration activities). The planned operations comprise an open hard rock pit with mining above the water table, as well as extensions to existing approved OSA's, and placement of overburden in existing and new mined-out pits (i.e. in-fill dumping); as well as progressive construction of haul roads and light vehicle access roads linking the open pit, OSA's and mine infrastructure.

The existing OB24 or OB25 processing plant, train loop and load out will be used (refer Figure 2).

1.2 Objectives and Purpose of Report

This report is an Environmental Impact Assessment (EIA) to describe the proposal, the potential for surface water environmental impacts from the development, and how these potential impacts will be managed in relation to surface water issues.

It identifies these potential environmental impacts to ensure the development plan is environmentally responsive and presents management recommendations and strategies for key factors.

The report has been prepared as a surface water environmental summary to accompany a referral to the Environmental Protection Authority (EPA).

1.3 Environmental Approvals Process

EIA is a formalised process designed to provide information to the EPA, regulatory authorities and the community regarding proposed developments that have the potential to impact on natural (and social) environments. As a part of Western Australia's environmental approval process, the *Environmental Protection Act 1986* provides the primary process for the EPA to carry out an EIA of development proposals that it considers are likely to have significant effects on the surrounding environment.

The objectives of the Act include the protection of the environment, and the prevention, control and abatement of pollution and environmental harm. It is an offence under the Act to cause pollution or environmental harm, and these are regulated under the Act in a variety of ways, such as an EIA and authorisation of significant proposals under Part IV of the Act (refer Environmental Assessment Guidelines 1 [EAG1]).

The EPA states that:

> "The onus is on proponents to demonstrate through their environmental impact assessment documentation that the proposal or scheme, if implemented, can meet the EPA's objective for each relevant environmental factor" (refer EAG 8).

In principle, the proponent needs to demonstrate that best practicable measures have been taken in planning and designing the project to avoid, and where this is not possible, to minimise impacts on the environment. The unavoidable impacts should be found to be environmentally acceptable, taking into account cumulative impacts which have already occurred in the region, and encompass the principles of sustainability.

2. BASELINE HYDROLOGY

2.1 Climate

Western Australia (WA) has three broad climate divisions. The northern / Pilbara area is characterised by an arid-tropical climate receiving summer rainfall. Cyclones can occur during this period, bringing heavy rain.

The south-west corner has a Mediterranean climate, with long, hot summers and wet winters. The remainder is mostly arid land or desert climates.

2.2 Temperature

The Pilbara climate is arid and experiences two main seasons: hot summers and mild and dry winters. The mean maximum temperatures average 36-37 Celsius (°C) from November to April, rising to highs of 50°C. Temperatures over the May to October period are milder, with mean maximum temperatures averaging 28-29°C and cooler nights, particularly in inland desert regions, reflected in the mean minimums of around 6-9°C in July, dropping to lows of 0°C.

The nearest Bureau of Meteorology (BOM) climate station to the OB32E area is at Newman Aero (Site Number 007176). The average monthly temperatures at Newman are given in Table 2.1

Table 2.1: Newman - Average Monthly Temperatures

Average Temperature	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Maximum [ºC]	39	37	35	32	27	23	23	26	30	35	37	38
Minimum [ºC]	25	24	22	17	12	7	6	8	12	18	21	24

2.3 Rainfall and Evaporation

Rainfall in the Pilbara is generally low (270-400mm per annum) and variable throughout the year. The annual average rainfall for Newman is 326mm (BOM, Newman Aero, Site Number 007176). Annual variability is high with recorded rainfall varying between 153mm (1976) and 619mm (1999).

On average, the driest months are August to October, while January / February are the wettest months. Average monthly rainfall for Newman is shown in Table 2.2.

Table 2.2: Newman - Average Monthly Rainfall and Evaporation

Average Rainfall/Evap	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Rainfall [mm]	67	75	39	19	17	15	15	7	4	6	12	39
Evaporation [mm]	461	369	343	290	193	173	176	193	264	377	424	466

Rainfall is greatest during summer, resulting from moist tropical storms from the north which bring sporadic and drenching thunderstorms. With the exception of these large events, rainfall can be erratic and localised due to thunderstorm activity - rainfall from a single site may not be representative of the spatial variability of rainfall over a wider area. High summer temperatures and humidity seldom occur together, giving the Pilbara its very dry climate.

The Pilbara coastline lies within the most tropical cyclone-prone region of the Australian coast (Broome to Exmouth). On average, two tropical cyclones cross this stretch of coastline each year, mainly from January to March, and capable of producing very destructive winds.

During May and June, cold fronts move easterly across WA, sometimes reaching the Pilbara region, producing light winter rains.

The mean annual Class A pan evaporation rate at Newman is about 3733mm (Department of Agriculture, 1987), which exceeds mean annual rainfall by around 3400mm. Average monthly pan evaporation rates for Newman are shown in Table 2.2. These evaporation rates vary from a minimum of 173mm in June to a maximum of 466mm in December. Evaporation rates in the Eastern Ridge area would be similar.

Design rainfall intensity data for the Eastern Ridge area are given in Table 2.3 ("Australian Rainfall and Runoff", Institution of Engineers Australia, 1987). These data provide for various rainfall durations and average exceedance probability (AEP) and can be used for runoff volume assessments and waterway designs.

Table 2.3: Eastern Ridge - Average Rainfall Intensities [mm/hr]

Rainfall Duration	20% AEP*	10% AEP	5% AEP	2% AEP	1% AEP
1 hour	32.9	38.5	45.5	55.0	62.4
6 hours	9.7	12.0	14.8	18.9	22.3
9 hours	7.3	9.2	11.5	14.8	17.6
12 hours	6.0	7.6	9.6	12.5	14.9
24 hours	3.7	4.7	5.9	7.8	9.3
48 hours	2.2	2.8	3.6	4.7	5.6
72 hours	1.6	2.0	2.6	3.4	4.1

* Note that 1% AEP is equivalent to 100 year Average Recurrence Interval (ARI) i.e. AEP Ξ 100/ARI

2.4 Streamflow

Streamflow in the Pilbara region is typically correlated with rainfall, with the majority of streamflow occurring during the summer months. Streamflow in the smaller flow channels is typically short in duration, and ceases soon after the rainfall passes. In the larger river channels and catchments, runoff can persist for several weeks and possibly months following major rainfall events, such as those resulting from tropical cyclones.

Streamflow gauging stations are widely spaced in the Pilbara region. Near Eastern Ridge, a gauge is located on the Fortescue River near Newman (Department of Water [DoW] Station 708011, catchment area 2,822km^2). Available gauging data from 1980 indicates an average annual runoff volume of 5.4% of the Newman annual rainfall. However the variability of annual runoff is high, with annual runoff varying from 0-15% of the Newman average rainfall.

Due to relative catchment sizes, streamflow data recorded at this station does not necessarily represent the runoff characteristics in the Eastern Ridge area. Homestead Creek flows through the Eastern Ridge area and has a much smaller catchment area of 302km² at its Fortescue River junction.

Peak streamflow discharges from ungauged catchments in the Pilbara region can be estimated using empirical techniques, such as those recommended in "Australian Rainfall and Runoff".

2.5 Climate Change

2.5.1 Definition

Climate change is generally defined as a change in average, long term, global weather patterns. It commonly suggests increases in temperature, greater or lesser precipitation at any given location, and occurrences of extreme weather events (Department of the Environment climate change website).

2.5.2 Temperature

Australia's climate has warmed since national records began in 1910, especially since 1950, and the frequency of hot days and nights has increased. Since 1910, daytime maximum temperatures have warmed by 0.8°C and overnight minimum temperatures have warmed by 1.1°C. Generally the Pilbara region has become warmer, with more hot days and less cold nights.

Modelling predicts about 1°C (above 1990 temperatures) average warming across Australia 2030; with warming of 0.7-0.9°C in coastal areas and 1.0-1.2°C inland. By 2070, average warming is expected to be between 2.2-5.0°C across Australia, depending on the emissions scenario adopted or endorsed.

2.5.3 Rainfall

Australian average annual rainfall has increased since national records began in 1900, largely due to increases in rainfall from October to April, and most markedly across the northwest. Rainfall is highly variable which makes it difficult to identify significant trends over time; however some rainfall changes are discernible. Rainfall trends in the Pilbara have also shown a substantial increase since 1950 (which implies increased runoff in river and creek systems).

By contrast, declining rainfall in the southwest of WA has been statistically significant over the recent period, and has occurred as a series of step changes. The decline in this region has also been characterised by a lack of very wet winters.

Global climate models show uncertainty in regard to future Pilbara rainfall trends, but predict a decrease in the total number of tropical cyclones, but a likely increase in the proportion of cyclones in the more intense categories. By 2030 there may be a 60% increase in intensity of the most severe storms, and a 140% increase by 2070. Hence more extreme storm events and flash flooding are predicted, along with more frequent and severe droughts.

3. EXISTING ENVIRONMENT

3.1 Fortescue River System

The OB32E project is adjacent to Homestead Creek in the Upper Fortescue River catchment, as shown in Figure 1. The Fortescue Marsh is a closed system with a total catchment area of ~29,700km^2 into which the upper Fortescue River and several large creeks, including Homestead Creek, drain. The Goodiadarrie Hills at the downstream (western) end of the Fortescue Marsh effectively separates the Fortescue River into two river systems. The lower Fortescue River, downstream from the Marsh, drains in a general north-westerly direction to the ocean at Cape Preston, south of Karratha.

The Fortescue Marsh is an extensive intermittent wetland (about 100km long, 10km wide). The marsh bed has an elevation of about RL400m, with the Chichester Plateau and Hamersley Range on either side. Following significant rainfall, runoff from the various catchments drains to the marsh. A major flood event may be sufficient to flood the whole marsh area, while for smaller runoff events, isolated pools form on the marsh opposite the main drainage inlets.

Surface water runoff to the marsh has low salinity and turbidity, though the turbidity typically increases significantly during flood peaks. Water stored on the marsh slowly dissipates through evaporation and seepage. Evaporation increases salinity in the ponded water and as the flooded areas recede, traces of surface salt can be seen. The ponded water is believed to seep into the valley floor alluvial deposits, and water becomes increasingly more saline over time due to evaporation. Groundwater below the marsh is believed to be saline to hypersaline.

3.2 Homestead Creek

Homestead Creek is a significant ephemeral tributary of the Fortescue River. The creek rises about 20km west of Newman in the Ophthalmia Range and drains east, passing west and south of the OB32E deposit and then along the southern side of Eastern Ridge, crosses the Marble Bar Road and ultimately discharges into the Fortescue River 3km downstream of Ophthalmia Dam. The Homestead Creek catchment is about 302km² at the Fortescue River, and enters the Fortescue River just upstream of Ethel Gorge.

3.3 Existing Surface Water Quality

Based on the water quality sampling conducted by the DoW and BHP Billiton Iron Ore, the pH at the Fortescue River, and Homestead and Whaleback Creeks (shown on Figure 2) is neutral and typically pH6-8.

Total Dissolved Solids (TDS, a measure of salinity) can be highly variable depending on volume of streamflow and the volume of flow preceded the water sample date. Salinity at the Fortescue River (Newman) gauging station typically varies from 20-100 mg/L TDS after a major flow event, with an average of about 40 mg/L. Salinities at Homestead and Whaleback Creeks show higher levels, at around an average of 100 to 150 mg/L TDS, potentially due to lower streamflow volumes or less frequent flushing events.

The water may be characterised as fresh, with TDS typically <500mg/L.

4. SURFACE WATER HYDROLOGY

4.1 General

The OB32E project is located within the Homestead Creek catchment. Homestead Creek is a large creek with a formed channel typically about 20m wide near Eastern Ridge, but commonly wider, with a mobile (sand/ gravel) bed. The creek has a typical bed slope of about 0.3%.

The proposed OB32E pit lies predominately on a hill standing about 45m above the surrounding terrain, and located between Eastern Ridge and Ophthalmia Range. The ground surface elevations at the proposed pit vary from about RL545-590m. The planned pit development area naturally drains from the ridge top in all directions (refer Figure 3).

Run-off from the Ophthalmia Range drains towards the northern side of the proposed pit area. This run-off collects in a watercourse at the northern toe of the OB32E ridgeline and drains in a westerly direction into Homestead Creek.

The western end of the pit area lies within the Homestead Creek floodplain, which will potentially be impacted by flooding in Homestead Creek;

Drainage from the eastern and southern sides of the proposed pit area is away from the pit footprint.

Other mining operations are located nearby:

- Orebody 24 (OB24) located in the Ophthalmia Range 3km east of OB32E. Surface water from this mine drains into the valley between Ophthalmia Range and Eastern Ridge, and then mostly west into Homestead Creek;
- Orebody 25W - located on Eastern Ridge 1.5km south east of OB32E. Surface water from this planned development drains into the same valley.

Surface water run-off from both these developments does not impact the planned OB32E development.

5. POTENTIAL MINE SITE IMPACTS AND MITIGATION MEASURES

5.1 Potential Impacts from Mining Activities

Potential surface water impacts associated with mining operations at the OB32E mine site include:

Interruption of existing surface water flow patterns

- The construction of an open pit, and extended existing OSAs, stockpiles and service infrastructure will interrupt surface water flow patterns. This has the potential to reduce (and in some cases increase) the surface water runoff volumes. This is discussed below.

Increased risk of erosion and sedimentation from disturbed areas

- Rainfall and surface water runoff from mining areas has the potential to significantly increase erosion and transmit sediment laden water to the environment / natural drainage systems, if appropriate management measures are not implemented; the main potential sediment sources are the existing OSA's and stockpiles, as well as other existing and new disturbance areas;
- Diversion channels or flood bunds placed around infrastructure may concentrate sheet flow and potentially increase local flow velocities and therefore soil erosion.

Contamination of surface water by chemicals or hydrocarbons

- Spillage of chemicals or hydrocarbons from storage and / or transfer areas is possible, if appropriate control measures and operating procedures are not used.

5.2 Interruption of Existing SW Flow Patterns and Run-Off Loss to Downstream Environment

5.2.1 Flood Protection Measures

The pit is impacted by surface water at the following locations:

- The 100 year ARI flow event in Homestead Creek near OB32E is about 500m³/s. Although the creek is generally dry outside of seasonal rainfall events, the proposed pit lies within the floodplain of Homestead Creek;
- Run-off from the Ophthalmia Range drains towards the north side of the proposed pit. Runoff from the Ophthalmia Range will be directed downstream and not lost from the catchment. The Ophthalmia Range runoff is generated from a relatively large catchment of approximately 4km^2 and needs active diversion;
- Surface water runoff from adjacent catchments at the south eastern corner of the pit footprint. The catchment is minimal and only requires "passive" bunding to prevent nuisance flows into the pit.

Surface water flood protection measures such as guide banks / bunds and channel bund combinations, are required to protect the OB32E pit from potential flooding (refer Figure 4).

5.2.2 Runoff Loss - General

The planned mining development will cause loss of catchment area and therefore runoff to the downstream drainage systems, and may have an impact on the downstream environment. Runoff volume is likely to decrease from areas containing pits, OSAs and catchments blocked or trapped by these works.

- Locally, within pit areas, internal stormwater runoff will collect at the pit base and typically be removed by sump pumping. Overall, loss of runoff volume from a pit is estimated at a maximum 50% of the pre-development runoff volume. If the pit is left open at closure however, then 100% loss has been assumed;

- On the top surfaces of an OSA, perimeter bunding will contain stormwater and prevent runoff down the sides of the OSA and into the downstream environment. Overall, loss of runoff volume from and OSA development is estimated at a maximum 50% of the pre-development runoff volume.

These estimates account for the losses to the downstream environment from non-recovered runoff from a pits or OSA.

Runoff volumes from some infrastructure areas (e.g. roofs, hardstands, access roads) may increase, whereas from other infrastructure development areas (e.g. ponds, depressions and interrupted flow areas) runoff volumes may be reduced. Overall runoff volumes from these areas are considered to be effectively unchanged by the planned works.

5.2.3 Assessment of Run-off Loss in the Homestead Creek Catchment

An assessment has been made of the maximum loss of catchment area from the existing and planned mines in the Homestead Creek catchment area upstream of its confluence with the Fortescue River. These catchment losses are due to the pit and OSA / stockpile areas that currently contribute run-off to downstream drainage systems (i.e. Homestead Creek).

An approximate estimate of the existing and planned relevant pit and OSA / stockpile areas for the proposed OB32E mine and others are provided in the table below. It has been assumed that pits are not backfilled, but remain open at closure, and therefore a 100% loss has been assumed.

Table 5.1: Areas Impacted by Mining in Homestead Creek Catchment

Location	Development Area (ha)	Adopted Runoff Loss	Catchment Area Loss Estimate (ha)	% Loss of Homestead Ck Ac
OB32E (future pit)	108	100%	108	0.4%
OB25W (future pit & associated external pit catchment area)	81	100%	81	0.3%
OB25 (existing operations) - Pits	320	100%	320	1.1%
OB25 (existing operations) - OSA & stockpiles	400	50%	200	0.7%
OB24 (existing & future operations) - Pits	320	100%	320	1.1%
OB24 (existing & future operations) - OSA & stockpiles	350	50%	175	0.6%
Total	1579		1204	4.0%

The effective catchment loss due to the proposed OB32E pit is 0.4% of the Homestead Creek catchment.

The total effective catchment loss of 1204ha corresponds to about 4% of the Homestead Creek catchment. This effective catchment loss of the Fortescue River at Ethel Gorge (catchment area about 4,872km²) corresponds to 0.25%; or for the Fortescue Marsh Catchment Area of 29,700km^2, as shown in Figure 1, about 0.04%.

This potential runoff volume reduction is not considered significant to the overall hydrological systems downstream, particularly when considering the natural seasonal variations in catchment runoff.

5.3 Management Objectives, Standards and Guidelines

Stormwater management, surface water discharges and activities that discharge to the environment are regulated under the Environmental Protection Act. The EPA applies the following objective (refer EAG 8) in its assessment of the 'Hydrological Processes' and the 'Inland Waters Environmental Quality' factors:

- To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance, are protected;
- To maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected.

Applicable guidelines and standards include ANZECC / ARMCANZ Guidelines, WA Water Quality Protection Guidelines, and the State Water Quality Management Strategy.

5.4 Sediment Basins

Sediment basins are a means to control surface water sediment, and will be located at low points in the drainage system down slope of disturbed areas; and formed by a combination of excavation and earth bunds. Sediment basins will be used in conjunction with erosion minimisation strategies, such as vegetated batters, coarse sheeting and engineered drainage systems.

The basins collect internal dirty runoff and treat the water to remove sediments to acceptable levels prior to release to the natural environment. Bunds, drainage diversion works and sedimentation basins will be constructed, or in existing infrastructure areas modified as required, to direct water from disturbed areas to the basins.

The final locations and layouts for the diversion bunds and sediment basins will be determined in association with the detailed mine plans.

5.5 Predicted Outcomes due to the Development of OB32E

No significant changes to surface water drainage or quality are anticipated due to the OB32E development.

Potential impacts from the minesite will be minimised. Reduction in surface water runoff volume due to the OB32E development will be minimal, as most runoff will be redirected and distributed downstream, however some run-off loss will be incurred. Runoff volumes from upstream flowpaths diverted around the planned mine development works remain largely unchanged by the planned works.

The potential for increases in surface water sediment loading downstream will be minimal, due to appropriately designed diversion structures and sediment basin interceptors (where appropriate).

Therefore, consistent with the EPA objective for Hydrological Processes and Inland Waters Environmental Quality, it is anticipated that the alterations to surface runoff and drainage should not have an adverse impact on the surface water regime and the existing ecosystems.

However monitoring will be undertaken downstream of the OB32E development to establish surface water quality parameters. Water quality samples would be monitored opportunistically to ensure no substantial differences in water quality.

6. SUMMARY OF IMPACTS AND MANAGEMENT MEASURES

The table below summarises the potential environmental impacts associated with the project, identifies the key management – based measures and objectives (EAG 11) that will be implemented to avoid or mitigate impacts, and describes the predicted outcomes once management measures have been implemented. On this basis, the proposal is not expected to have a significant impact on the environment.

Table 6.1: Summary of Impacts and Management Measures

Objectives and Scope of Work	Project Component / Potential Impacts	Proposed Mitigation and Management Measures	Predicted Outcomes
To maintain the hydrological regimes of groundwater and surface water so that existing and potential uses, including ecosystem maintenance, are protected. To maintain the inland waters environmental quality of groundwater and surface water, sediment and biota, so that the environmental values, both ecological and social, are protected.	Interruption to existing surface water flow patterns. Reduction of surface water runoff volume / quality in the environment downstream. Impact on downstream dependent vegetation communities. Discharge of chemicals, including hydrocarbons, etc. Pooling of water, growth of invasive vegetation in low-lying areas.	Limit clearing, provide adequate buffer zones between areas of disturbance and natural drainage lines. Divert upstream surface water flows around structures, into downstream water courses so natural (clean) runoff water originating outside the development site does not mix with internal (disturbed) site runoff. Construction on or near natural flow paths planned for the dry season where practicable. Chemical and hydro-carbon stores located away from, or bunded off from, external surface water surface water flows. Disturbance minimised to achieve the design function and as necessary for safe working conditions. Vehicle movements kept to the minimum necessary and existing tracks used where possible. Sediment laden surface water runoff from disturbed areas and stockpiles / dumps captured by bunding the perimeter of infrastructure areas, and treatment in sediment basins. Waste dumps dished to dissipate runoff by evaporation / seepage, and to reduce runoff and erosion down the face. Appropriate battering of the face and contour drains to minimise sheet water flows and benefit growth of vegetation. Construct access roads with a camber, table drains and regular turnouts to discharge the water into the natural surrounds. Place structures that must be located in floodplains, away from main flow channels; Locate sediment basins at drainage low points to control erosion and the deposition of sediment downstream. Use water preferentially for dust suppression, or other processes on site prior to discharge.	No significant changes to surface water flow patterns drainage or quality is expected. Minimal reduction in surface water runoff volume as most runoff redirected down-stream. Insignificant changes in surface flow volume (when compared with overall runoff). Minimal potential for increase in surface water sediment loading with appropriately designed diversion structures and sediment basin interceptors Maintenance of existing surface water hydrological regime so that existing and potential uses, including ecosystem maintenance, are protected.

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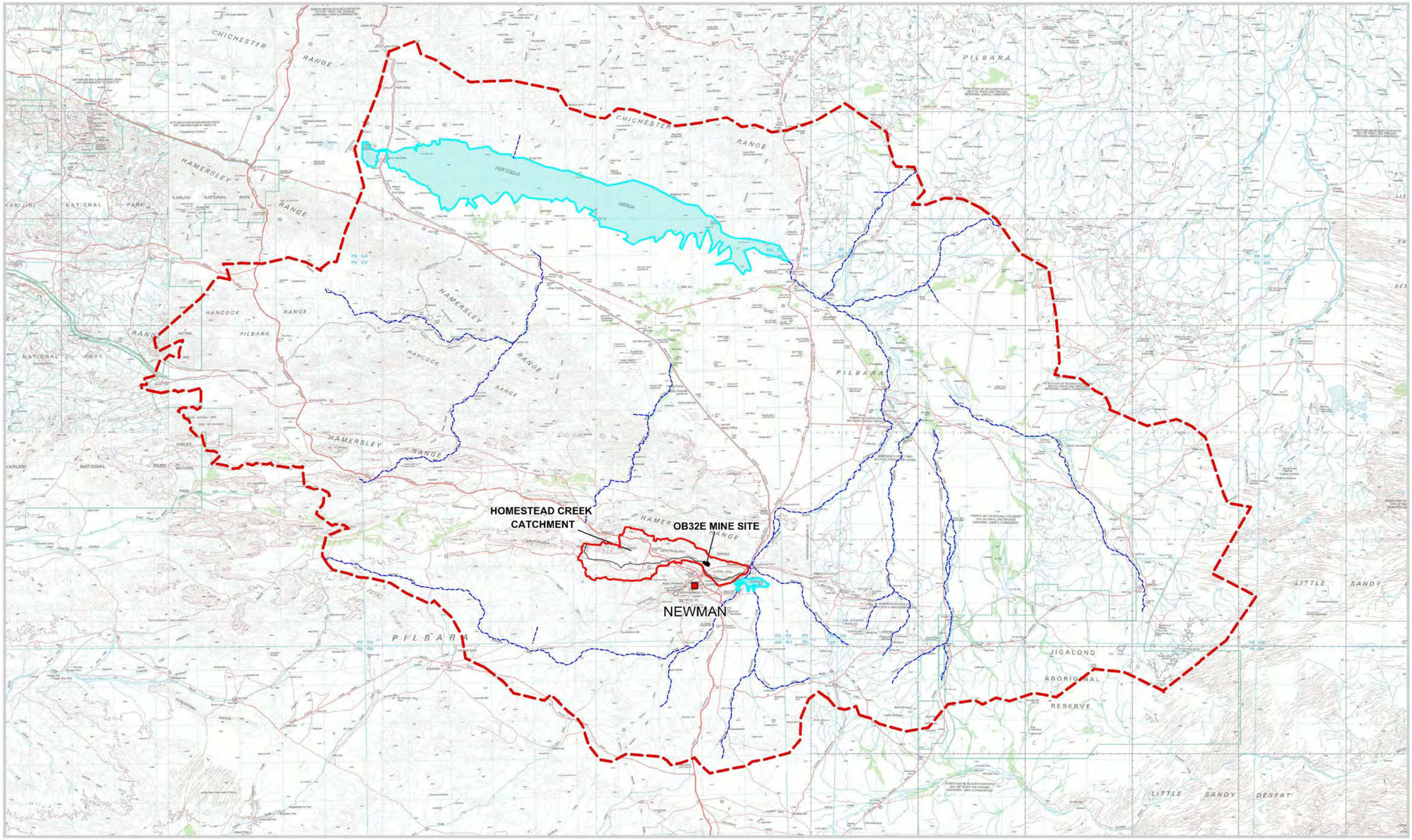
FIGURES



LOCATION MAP

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Kilometres

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GDA 1994 Zone 51

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DRAWN:	JT	REVISION:	B
DATE:	05/05/2015	JOB NO:	1720B

Location: F:\Jobs\1720B\Spatial_Data\MapInfo\Workspaces\Figure 1

LEGEND

- Fortescue Marsh Catchment Boundary
- Homestead Creek Catchment Boundary
- Creeks
- Drainage Basin

RPS

FIGURE 1

OREBODY 32E

REGIONAL LOCATION PLAN

Total Homestead Creek Catchment
at Fortescue River
Area = 302km2

Homestead Creek

OB32E

OB24

OB23

EASTERN RIDGE

OB25

Whaleback Creek

WHALEBACK

NEWMAN

Fortescue River

Ethel
Gorge

Ophthalmia Dam

Fortescue River

LOCATION MAP

DERBY
Project
NEWMAN
KALGOORLIE
PERTH
ALBANY

N

0 2 4

Kilometres

Scale: 1:120,000 @A3

GDA 1994 Zone 50

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DRAWN:	JT	REVISION:	C
DATE:	07/05/2015	JOB NO:	1720B

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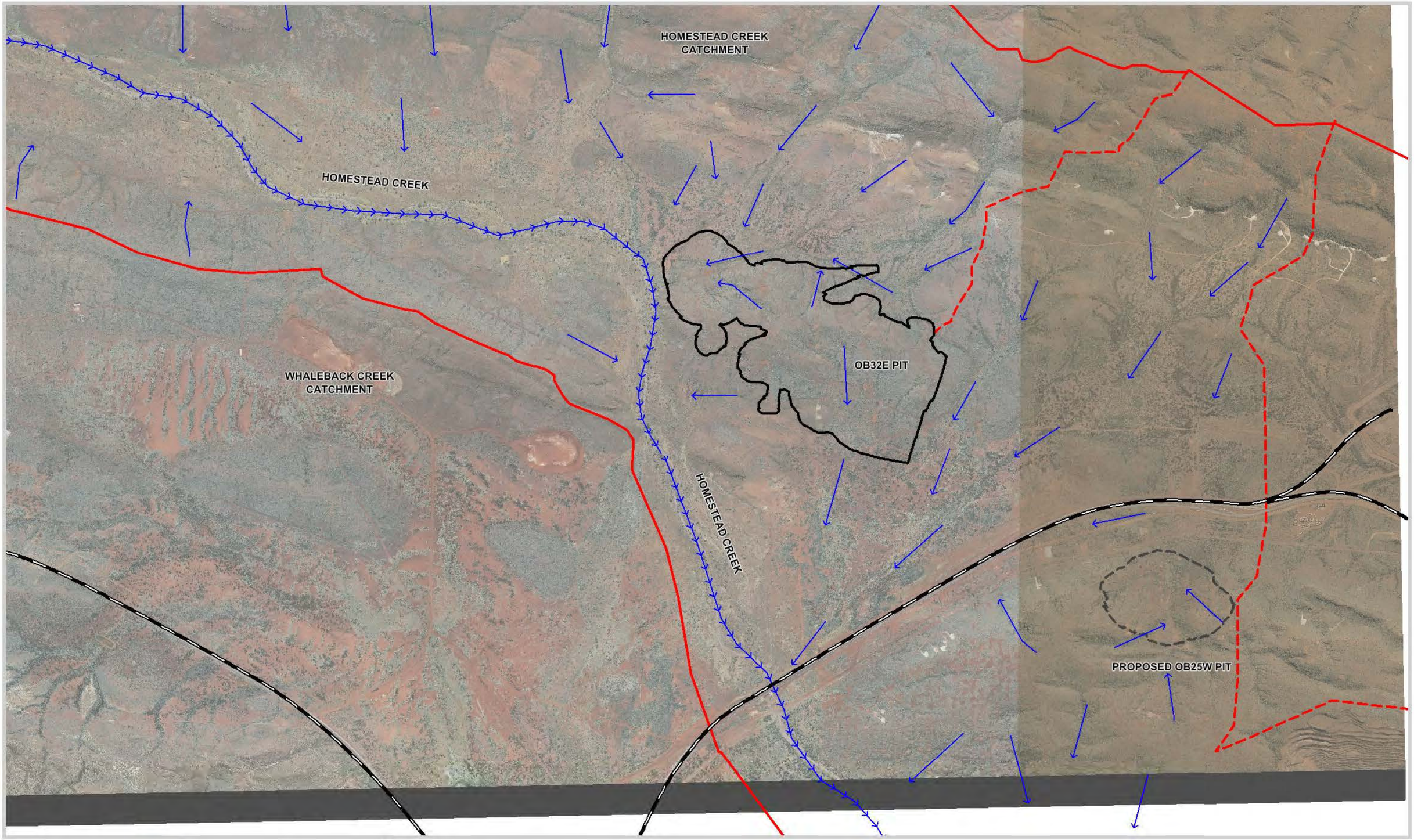
LEGEND

- Pit Outline
- Catchment Boundary / Divide
- Subcatchment
- Creek Flow
- Flow paths
- Fortescue River

RPS

FIGURE 2

OREBODY 32E
PROJECT LOCATION PLAN



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GDA 1994 Zone 50

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DRAWN:	JT	REVISION:	a
DATE:	30/09/14	JOB NO:	1720B

LEGEND

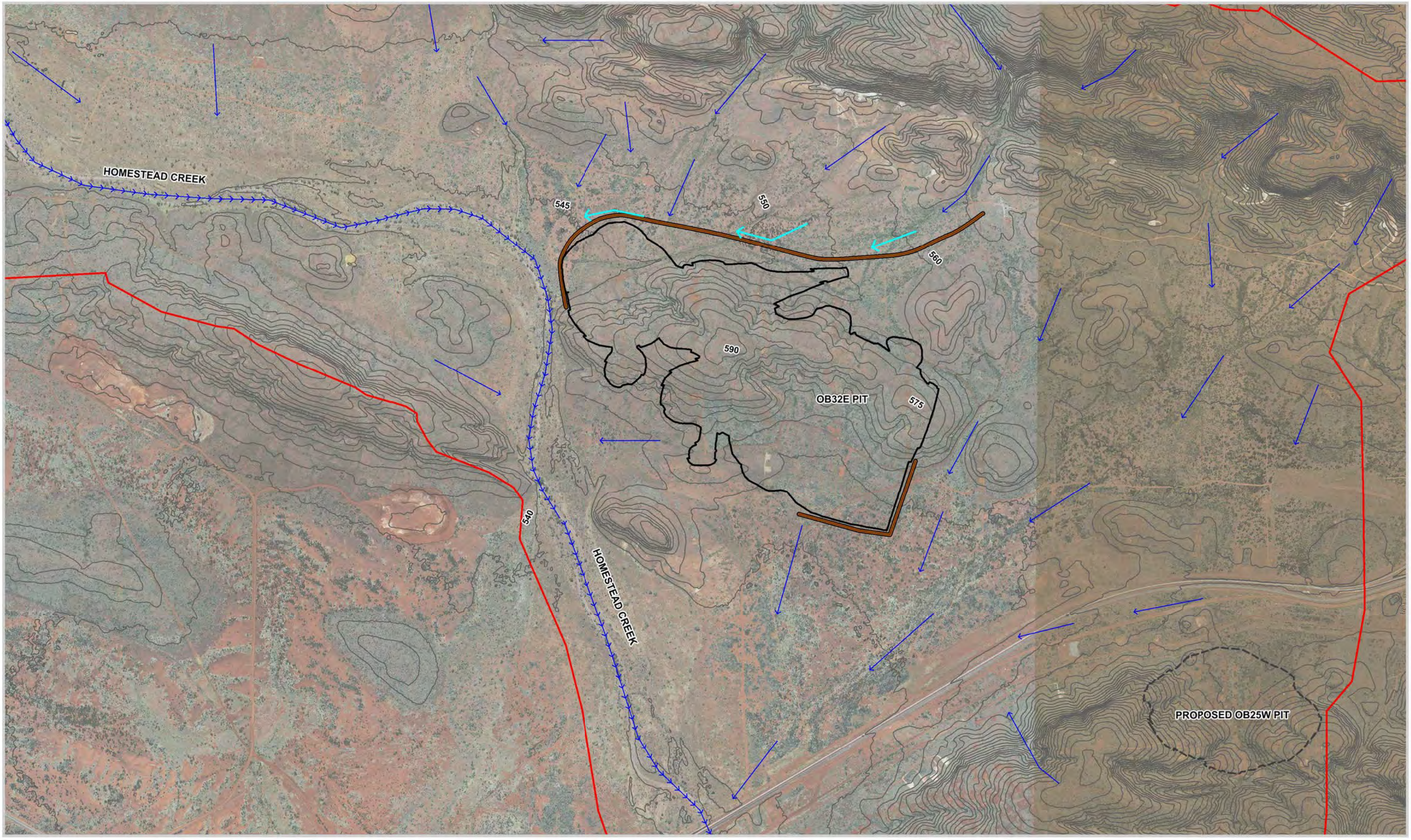
- Pit Outline
- Catchment Boundary
- Subcatchment
- Flowpath
- Creek Flow
- Railway

Location: F:\Jobs\1720B\Spatial_Data\MapInfo\Workspaces\EIA Figures 2 - 4

RPS

FIGURE 3

OREBODY 32E
SURFACE WATER IMPACT



LOCATION MAP

N

0 300 600

Metres

Scale: 1:15,000 @A3

GDA 1994 Zone 50

AUTHOR:	JT	REPORT NO:	003
DRAWN:	JT	REVISION:	B
DATE:	05/05/15	JOB NO:	1720B

Location: F:\Jobs\1720B\Spatial_Data\MapInfo\Workspaces\EIA Figures 2 - 4

LEGEND

- Pit Outline
- Catchment Boundary / Divide
- Flowpath
- Homestead Creek
- Flood Bund
- Contour (5m)
- Diverted Flow

RPS

FIGURE 4

OREBODY 32E
SURFACE WATER MANAGEMENT

Western Australia Iron Ore

bhpbilliton
resourcing the future

Regional Land and Biodiversity Management Plan

Department: Environment

Draft Version 2

Draft Version 2 (May 2015)

4.95cm

Item	Detail
Project name	Regional Land and Biodiversity Management Plan
Prepared by	BHP Billiton Iron Ore – George Watson
Reviewed by	BHP Billiton Iron Ore – Stephen White
Approved for release by	BHP Billiton Iron Ore – Gavin Price
Status/version number	Draft Revision 1 (20 March 2015) – first draft submitted to the Environmental Protection Authority as part of a Section 38 referral for the Proposal Orebody 31 Iron Ore Mine Projec t Draft Revision 2 (8 May 2015) – incorporating updates to Appendix 1 of this plan in relation to a Orebody 31 Scoping Document response to the Office of the Environmental Protection Authority
Date saved	08/05/2015

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1. Introduction

1.1. Purpose

BHP Billiton Iron Ore Pty Ltd (BHP Billiton Iron Ore) is one of the world's leading iron ore producers, with operations in Australia and Brazil. Its principal iron ore operations are located in the Pilbara region of Western Australia, which currently comprises seven mining operations, over 1000 kilometres (km) of rail and port facilities in Port Hedland. The company manages almost 1.5 million hectares of tenure in the Pilbara region (including pastoral leases), which is approximately 8% of the total land area of the Pilbara.

A number of conservation significant vegetation communities and flora species occur within the area managed by BHP Billiton Iron Ore. From time to time these species and or communities, may be impacted as a result of BHP Billiton Iron Ore's activities, and will require specific management to reduce the significance of any potential impact. Native flora and vegetation is protected under both Western Australian (WA) State and Commonwealth legislation.

This management plan (the Plan) has been prepared to provide a consistent and standard approach to the management of significant flora and vegetation communities within all BHP Billiton Iron Ore Western Australian (WAIO) tenements. It has been developed in consideration of the legal requirements relevant to native flora and vegetation (Section 4) and BHP Billiton requirements (Section 3). This Plan complies with the requirements of the relevant Acts administered by the State and Federal government and BHP Billiton Iron Ore guiding principles.

Further, this Plan considers guidance documents developed by the State and Federal governments, including recovery plans, threat abatement plans and conservation advice. It largely complies with these guidelines but may deviate from these where they conflict with BHP Billiton Iron Ore internal safety policies, or are not practical for implementation in the Pilbara environment.

1.2. Objective of this Plan

The Plan provides a consistent approach to the management of conservation significant flora and vegetation across all of BHP Billiton Iron Ore's Western Australian (WAIO) operations. The objective of this Plan is to, where practicable, avoid and mitigate impacts to significant flora species and vegetation communities, where they occur within BHP Billiton Iron Ore's area of influence, by:

- prescribing standardised systems and processes to avoid conservation significant flora species and vegetation communities;
- detailing the management actions and strategies that will be implemented to mitigate potential impacts to significant flora species and vegetation communities during the planning, construction and operation of BHP Billiton Iron Ore mines, projects and associated infrastructure; and
- outline the monitoring, inspection, reporting, and management plan review programs that will be implemented in a consistent manner during the life of BHP Billiton Iron Ore's projects.

Where specific management measures are required that are localised to a particular operation or situation, and are in addition to, or above and beyond, the measures outlined, these will be detailed in Appendix 1 for that operation or project. Where there is any contradiction between the management measures applicable to a site-specific EMP (as required and approved under a Ministerial Statement) and those outlined in this plan, the site specific management measures shall apply.

2. Environmental Management Framework

The Iron Ore Health, Safety and Environment (HSE) Management System is hierarchical, as illustrated in Figure 1. This management plan sits at the Asset level of the management system, and aims to align with the Biodiversity Management Standard, Regional Management Strategies and the requirements of the BHP Billiton Charter and Group Level Documents (GLD's) as described in Sections 1.2.1 and 1.2.2 below.

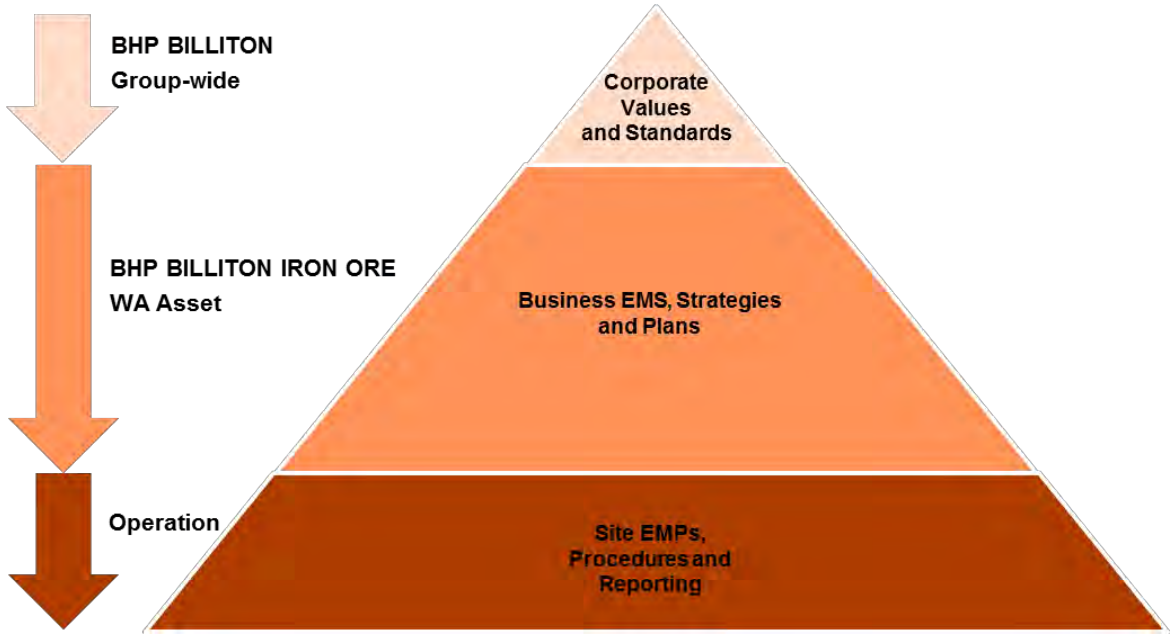


Figure 1: BHP Billiton Iron Ore's Health Safety & Environment Management Pyramid

2.1.1. BHP Billiton Charter

The BHP Billiton Charter explains BHP Billiton's mission statement and core values. This Plan has been prepared to address the following core values:

- Putting health and safety first, being environmentally responsible and supporting our communities.
- Doing what is right and doing what we say we will do.
- Embracing openness, trust, teamwork, diversity and relationships that are mutually beneficial.
- Achieving superior business results by stretching our capabilities.
- Focusing our efforts on the things that matter most.
- Defining and accepting responsibility and delivering on our commitments.

2.1.2. BHP Billiton Iron Ore Policy and Standards

The BHP Billiton Iron Ore Policy and Standards explained in BHP Billiton's Group Level Documents (GLDs) outline the company's environmental commitments.

This document is guided by the WAIO Biodiversity Management Standard and Regional Management Strategies which describe a regional approach to biodiversity management. A regional approach to management provides the benefits of standardisation and consistency in management across all WAIO sites. The approach is outcomes based and adaptive in nature, taking on board the concept of continual improvement.

The Group Level Document (GLD 009) relates to Environment and includes land and biodiversity management. Requirements of GLD 009 relevant to the management of conservation significant flora and vegetation are:

- Identify and map key features and define the area of influence.
- Establish the baseline or reference conditions for land, biodiversity, water resources and air within the area of influence.
- Document the type and extent of actual and reasonably foreseeable environmental impacts associated with our activities within the area of influence.
- Assess the risks of our activities with actual and reasonably foreseeable environmental impacts within the area of influence.

- Define and obtain authorisation for target environmental outcomes for land, biodiversity, water resources and air consistent with the assessed risks and impacts.
- Implement controls demonstrating application of the mitigation hierarchy (avoid, minimise and rehabilitate environmental impacts, prior to applying compensatory actions) to manage the identified risks and achieve target environmental outcomes.
- Monitor the design and operational effectiveness of these controls.
- Maintain a disturbance approval process that meets regulatory requirements and takes into account stakeholder expectations and potential impacts to areas of important biodiversity and/or ecosystems.
- Maintain a rehabilitation plan that supports Life of Asset and closure plans, and rehabilitates disturbed areas no longer required for operational purposes consistent with the pre-disturbance land use or alternate land use developed taking into account regulatory requirements and stakeholder expectations.
- Do not explore or extract resources within or adjacent to the boundaries of International Union for Conservation of Nature (IUCN) Protected Areas Categories I to IV unless authorisation is obtained and a plan implemented that meets regulatory requirements, takes into account stakeholder expectations and contributes to the values for which the protected area is listed.
- Do not operate where there is a risk of direct impacts to ecosystems which could result in the extinction of an IUCN Red List Threatened Species in the wild.

2.2. Project Environmental Aboriginal Heritage Review (PEAHR)

BHP Billiton Iron Ore has a Project Environmental Aboriginal Heritage Review (PEAHR) process to manage the implementation of its environmental, Aboriginal heritage, land tenure and legal obligations prior to and during land disturbance activities. Additionally, the PEAHR procedure provides a mechanism whereby technical and professional advice can be provided to the business regarding environmental issues, land access and Aboriginal heritage planning and management issues. The PEAHR system is accessible to all employees and consists of an electronic workflow process linked to a geographical information system.

The objectives of the PEAHR process are to:

- Identify the significant environmental, Aboriginal heritage and legal aspects of proposed activities;
- Ensure that, through appropriate environmental Aboriginal heritage and land access planning and management, BHP Billiton Iron Ore activities comply with all legal and other obligations;
- Avoid, minimise and mitigate the number and nature of environmental, Aboriginal heritage and land tenure events and ensure the environmental performance of BHP Billiton Iron Ore operations; and
- Provide a mechanism for continuous improvement.

3. Legal Framework

Native flora is protected under the WA *Wildlife Conservation Act 1950* (WC Act), the *Environmental Protection Act 1986* (EP Act), and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), which are administered by the WA Department of Parks and Wildlife (DPaW), the WA Department of Environmental Regulation (DER), and the Commonwealth Department of the Environment (DoE), respectively.

For the purposes of this Plan, conservation significant flora is;

- native flora that has been gazetted and listed under the Western Australian *Wildlife Conservation Act 1950* as Threatened Flora and declared as Rare Flora (DRF) by the WA state Minister for the Environment;
- flora listed under the Commonwealth's *Environmental Protection and Biodiversity Conservation Act 1999;*
- flora listed under the threatened categories (Vulnerable, Endangered and Critically Endangered on the IUCN Red List; and
- native flora that is rare and poorly known, and which have been assigned a priority status (Priority Flora) by DPaW for consideration for declaration as 'rare flora'.

For the purposes of this Plan, conservation significant vegetation is:

- vegetation that forms a defining component of declared Threatened Ecological Communities (TEC's);
- vegetation communities listed under the *Environment Protection and Biodiversity Conservation Act 1999 as threatened communities;*
- vegetation that forms a defining component of Priority Ecological Communities (PEC's) as defined by DPaW; and
- vegetation as a component of Environmentally Sensitive Areas (ESA's) as defined in *the Environmental Protection Act 1986.*

3.1. *Environmental Protection Act* 1986

The WA *Environmental Protection Act 1986* provides for the establishment of the Environmental Protection Authority (EPA), which has the objective of overseeing the prevention, control and abatement of pollution and environmental harm, and the conservation, preservation, protection, enhancement and management of the environment. The EPA has developed policies to assist with achieving its objective. These include policies on the use of the precautionary principle, consideration of intergenerational equity, the conservation of biological diversity and ecological integrity, and waste minimisation. The EPA also provides advice to the public and the WA Minister for Environment on the environmental protection aspects of any proposal brought to it.

Part IV of the *EP Act* establishes provisions for the EPA to carry out Environmental Impact Assessments (EIA) in WA. Where relevant, the EPA issues and directs proponents to comply with Guidance Statements that contain the EPA's minimum requirements for the protection of elements of the environment such as flora and fauna. Guidance Statement 51 – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004) requires proponents to assess flora and vegetation of conservation significance in their EIA.

The EPA's position on the clearing of native vegetation in WA is broadly described in Position Statement 2 – Environmental Protection of Native Vegetation in Western Australia. (EPA 2000)

Part V Division 2 of the EP Act establishes provisions for the clearing of native vegetation. Prior to the clearing of any native vegetation under Part V of the EP Act a Native Vegetation Clearing Permit (NVCP) must be obtained. NVCPs are assessed against the clearing principles set out in Schedule 5 of the Act. Clearing principles C and D prevent the clearing of the native vegetation if the vegetation it includes is necessary for the continued existence of, rare flora, or it is necessary for the maintenance of, a threatened ecological community. A NVCP application that is seriously at variance with the clearing principles will not be granted unless, in the opinion of the CEO of the government department administering the Act, there is a good reason for doing so.

Section 51(B) of the EP Act enables the WA Minister for Environment to declare an Environmentally Sensitive Area (ESA). Vegetation clearing exemptions do not apply within an ESA and all clearing requires a permit and consultation with the Department of Parks and Wildlife.

3.2. *Wildlife Conservation Act*, 1950

The WA *Wildlife Conservation Act 1950* provides for the conservation and protection of flora and fauna. Rare or endangered flora species are identified as 'threatened flora' and declared to be Rare Flora (DRF) for the purposes of the Act (i.e. "flora that is likely to become extinct or is rare or otherwise in need of special protection"). Threatened flora species that are declared rare by the WA Minister for Environment are listed in the Wildlife Conservation (Rare Flora) Notice, which is updated regularly and published in the State Government Gazette.

The WC Act requires licenses to be issued for the taking of protected and rare flora.

3.3. *Environment Protection and Biodiversity Conservation Act*, 1999

"The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places defined in the Act as matters of national environmental significance" (DOE 2014). The EPBC Act provides for the listing of nationally threatened native species and ecological communities. The list is divided into groups according to conservation status and updated regularly by the Federal, Threatened Species Scientific Committee.

3.4. International Union for the Conservation of Nature

"The IUCN Global Species Programme working with the IUCN Species Survival Commission (SSC) assesses the conservation status of species, subspecies, varieties, and even selected subpopulations on a global scale, in order to highlight taxa threatened with extinction. The IUCN Red List of Threatened Species™ provides taxonomic, conservation status and distribution information on plants, fungi and animals that have been globally evaluated using the IUCN Red List Categories and Criteria." (IUCN 2014). BHP Billiton's environmental management system, as it relates to conservation significant species, is informed by the IUCN's assessment of threatened species, and categorisation of these in the Red List of Threatened Species.

3.5. Conservation Codes and Categories

The conservation status of a species or community, informs the extent and type of management actions applied within this plan. Conservation significance is categorised through 'codes' or categories applied by relevant management agencies responsible for the conservation of flora and vegetation at a state, federal and global scale. The conservation codes for threatened and priority flora used by WAIO are as described by DPaW in '*Conservation Codes for Western Australian Flora and Fauna*'.

Species and communities of national environmental significance listed under the EPBC Act are categorised under Section 179 of the Act. Nominated additions to the list are assessed by the Threatened Species Scientific Committee annually and listed in the DoE's Species Profile and Threats Database.

Table 1: Conservation categories for flora described under the EPBC Act

CATEGORY	DESCRIPTION
Extinct	A species is extinct if there is no reasonable doubt that the last member of the species has died.
Extinct in the Wild	A species is categorised as extinct in the wild if it is only known to survive in cultivations, in captivity, or as a naturalised population well outside its past range; or if it has not been recorded in its known/expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered	The species is facing an extremely high risk of extinction in the wild and in the immediate future.
Endangered	The species is likely to become extinct unless the circumstances and factors threatening its abundance, survival, or evolutionary development cease to operate; or its numbers have been reduced to such a critical level, or its habitats have been so drastically reduced, that it is in immediate danger of extinction.
Vulnerable	Within the next 25 years, the species is likely to become endangered unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate.
Conservation Dependent	The species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

The IUCN has developed a framework for the classification of species according to their risk of extinction (Figure 2). The IUCN Red List Categories and Criteria, Version 3.1 was published in 2008, and informs decisions by the IUCN for the inclusion of species on the '*Red List*' and their appropriate classification. The WA Department of Parks and Wildlife have adopted this framework in the classification of species under the Wildlife Conservation Act.

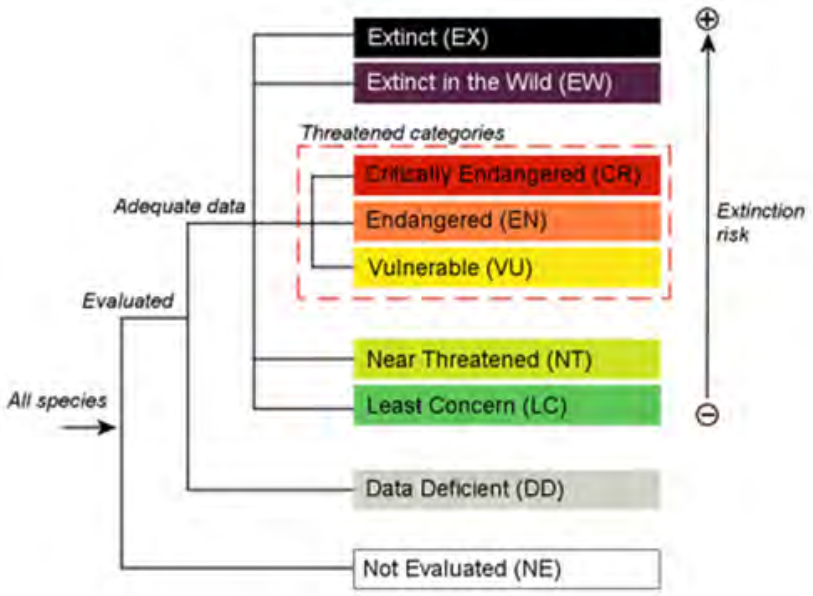


Figure 2: Structure of categories from IUCN Red List Categories and Criteria, Version 3 (2012)

The Department of Parks and Wildlife have developed priority codes for species that may be threatened or near threatened but for which there is little data to enable the species to be assessed for listing under the Rare Flora Notice. Flora listed on the Priority Flora List are categorised under a Priority1, 2 or 3 and are prioritised for evaluation of conservation status to enable their consideration for threatened flora listing. “Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened list for other than taxonomic reasons, are placed in Priority 4.” (DPaW 2014)

Threatened and priority ecological communities have been defined, categorised and listed by DPaW according to a set of established criteria. The DPaW paper titled Definitions, Categories and Criteria for Threatened and Priority Ecological Communities (DPaW 2010) provides guidance on the application of threats and conservation significance at a community level.

4. Conservation Significant Pilbara Flora and Vegetation.

The effective management of flora and vegetation on WAIO operational areas is dependent upon a comprehensive knowledge and understanding of the species and communities that occur within WAIO's area of influence.

BHP Billiton Iron Ore's operations in the Pilbara fall within Beard's Fortescue Botanical District. Beard mapped the vegetation of the Pilbara at a broad scale of 1:1,000,000. Beards mapping was assessed by Shepherd *et al.* (2001) who provided updated boundaries and split some vegetation units to account for clearing in the intensive land use zone. The vegetation of the district is heavily influenced by landform, geology and fire and has an added complexity with the influence of surface and ground water. Floristically the district is characterised by arid zone flora of Poaceae, Malvaceae, *Amaranthaceae and Fabaceae* including *Hibiscus*, *Senna*, *Sida*, *Ptilotus* and *Acacia* . The Pilbara is an important transition zone between the tropical grasslands of the north and the Acacia woodlands to the south, resulting in many range extensions and outlying populations of species.

The Department of Agriculture has conducted flora and vegetation inventory and condition surveys of the Pilbara (van Vreeswyk *et al.* 2004) using an integrated survey method involving the land system approach to rangeland description evaluation. A total of 102 land systems were defined in the Pilbara at scale of 1:250,000 (van Vreeswyk *et al.* 2004). Land systems are broadly used to provide context and to inform impact assessment and management. Vegetation condition within BHP Billiton Iron Ore's tenements is largely good to excellent, except where these co-occur with pastoral activity and associated high stock activity around water points, and dense introduced pastoral grasses i.e. Buffel Grass (*Cenchrus ciliaris*).

To date, in excess of 160 baseline flora and vegetation surveys have been commissioned by WAIO within its area of influence. The WAIO biodiversity geodatabase currently contains greater than 11,000 records for almost 200 significant plant species, including 3 Threatened Flora, 64 Priority 1, 32 Priority 2, 80 Priority 3 and eight Priority 4 flora. There are in excess of 7,200 records for close to 60 introduced weed species. Seven of these weed species are listed as Declared Pests under the *Biosecurity and Agriculture Management Act 2007* (BAM Act). The location of these records both on and off WAIO tenements in the Pilbara, inform the management of our operations.

'An ecological community is a naturally occurring group of plants, animals and other organisms interacting in a unique habitat' (DEC 2007). Distinct communities that are under threat from a range of processes and are limited in their distribution are assessed and listed by the State or Commonwealth. The DPaW maintain a register of Threatened and Priority Ecological Communities for WA. Registers are reviewed by the West Australian Threatened Species Scientific Committee and amendments made annually. There are presently no declared threatened vegetation communities within WAIO's area of influence. There are however 9 PEC's comprised of 7 Priority 1, and two Priority 3 communities.

Table 2: **Conservation significant vegetation communities within WAIO's area of influence** (derived from DPaW, 2014)

DPaW No/	Community	Priority
1	West Angelas Cracking-Clays Open tussock grasslands of *Astrebla pectinata, A. elymoides, Aristida latifolia*, in combination with *Astrebla squarrosa* and low scattered shrubs of *Sida fibulifera*, on basalt derived cracking-clay loam depressions and flowlines.	P1
2	Weeli Wolli Spring community. Weeli Wolli Spring's riparian woodland and forest associations are unusual as a consequence of the composition of the understorey. The sedge and herbfield communities that fringe many of the pools and associated water bodies along the main channels of Weeli Wolli Creek have not been recorded from any other wetland site in the Pilbara. The spring and creekline are also noted for their relatively high diversity of stygofauna and this is probably attributed to the large-scale calcrete and alluvial aquifer system associated with the creek. The valley of Weeli Wolli Spring also supports a very rich microbat assemblage including a threatened species	P1
12	Brockman Iron cracking clay communities of the Hamersley Range. Rare tussock grassland dominated by Astrebla lappacea (not every site has presence of Astrebla) in the Hamersley Range, on the Brockman land system. Tussock grassland on cracking clays- derived in valley floors and, depositional floors. This is a rare community and the landform is rare. Known from near West Angeles, Newman, Tom Price and boundary of Hamersley and Brockman Stations.	P1
17	Freshwater claypans of the Fortescue Valley. Freshwater claypans downstream of the Fortescue Marsh - Goodiadarrie Hills on Mulga Downs Station.	P1

DPaW No/	Community	Priority
18	Fortescue Marsh (Marsh Land System) Fortescue Marsh is an extensive, episodically inundated samphire marsh at the upper terminus of the Fortescue River and the western end of Goodiadarrie Hills. It is regarded as the largest ephemeral wetland in the Pilbara. It is a highly diverse ecosystem with fringing mulga woodlands (on the northern side), samphire shrublands and groundwater dependant riparian ecosystems. It is an arid wetland utilised by waterbirds and supports a rich diversity of restricted aquatic and terrestrial invertebrates. It is the recorded locality for night parrot and bilby and several other threatened vertebrate fauna. It also provides habitat for endemic Eremophila species, populations of priority flora and several near endemic and new to science' samphires.	P1
21	Coolibah-lignum flats: *Eucalyptus victrix* over Muehlenbeckia community. Woodland or forest of *Eucalyptus victrix* (coolibah) over thicket of *Muehlenbeckia florulenta* (lignum) on red clays in run-on zones. Associated species include *Eriachne benthamii*, *Themeda triandra, Aristida latifolia, Eulalia aurea and Acacia aneura.*	
	• Coolibah and mulga (*Acacia aneura*) woodland over lignum and tussock grasses on clay plains (Coondewanna Flats and Wanna Munna Flats)	P3
	• Coolibah woodlands over lignum (*Muehlenbeckia florulenta*) over swamp wandiree (Lake Robinson is the only known occurrence)	P1
	• Coolibah woodland over lignum and silky browntop (*Eulalia aurea*) (two occurrencesknown on Mt Bruce Flats)	P1
25	Vegetation of sand dunes of the Hamersley Range/Fortescue Valley (previously 'Fortescue Valley Sand Dunes'). These red linear iron-rich sand dunes lie on the Divide Land system at the junction of the Hamersley Range and Fortescue Valley, between Weeli Wolli Creek and the low hills to the west. A small number are vegetated with *Acacia dictyophleba* scattered tall shrubs over *Crotalaria cunninghamii, Trichodesma zeylanicum var. grandiflorum* open shrubland. They are regionally rare, small and fragile and highly susceptible to threatening processes.	P3

Note: The Ethel Gorge TEC is not listed as this is a stygobiont community and outside the scope of this Plan.

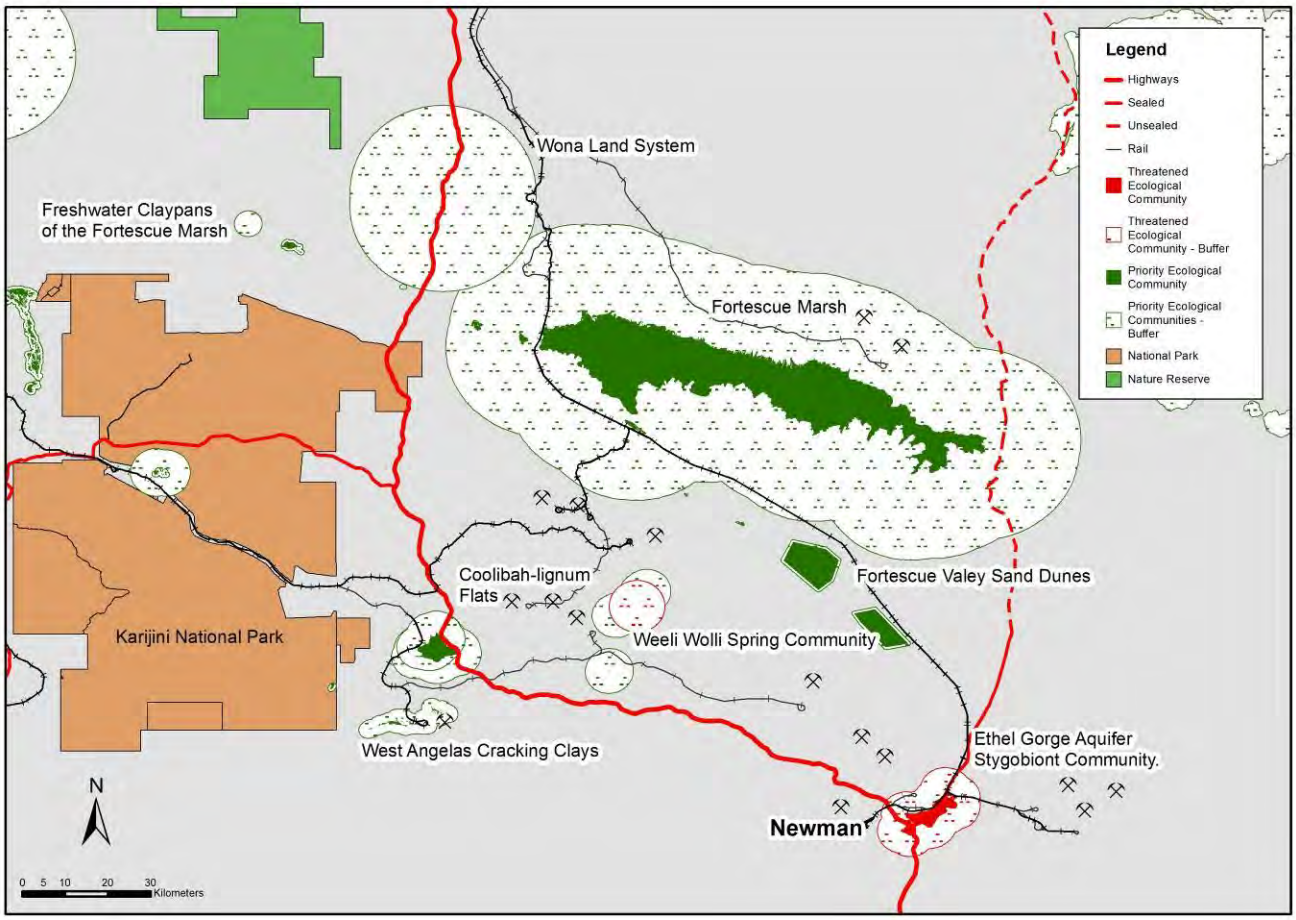


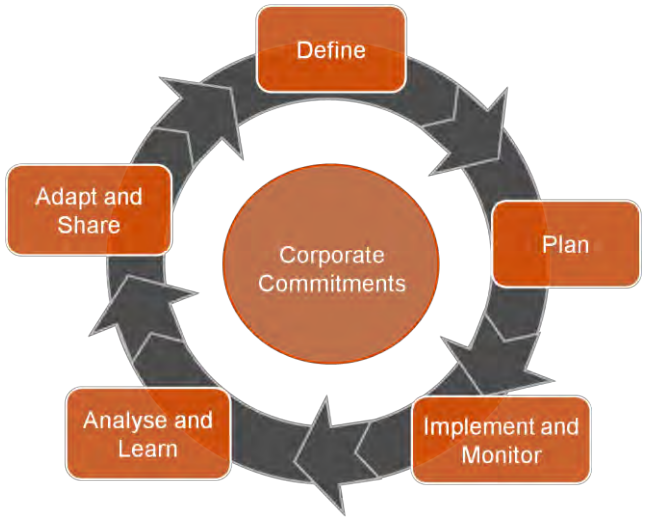
Figure 3: Location of conservation significant communities within WAIO's area of influence

5. Management

5.1. Adaptive Management Framework

WAIO applies an adaptive management framework to implementing management measures identified in this plan. Adaptive management is a structured, iterative process to decision making. An integral component is the application of the mitigation hierarchy (avoid, minimise and rehabilitate environmental impacts, prior to applying offsets).

The framework embeds a cycle of monitoring, reporting and implementing change where required. It allows an evaluation of the management controls so that they are progressively improved and refined, or alternative solutions adopted, to ensure the outcome-based objectives are achieved.



5.2. Assessing Threats to Conservation Significant Flora and Vegetation

BHP Billiton Iron Ore undertakes a risk management process, guided by GLD 17 (Risk Management) that defines the risks and threats to environmental factors and identifies management controls that can be applied to mitigate the risk of impacts to environmental factors.

The risk management process used for environmental risk is described below:

1. Establish Context:
    - Defines the parameters within which risks must be managed and sets the scope for the risk management process.
2. Risk Assessment:
    - Risk identification (comprehensive list of environment risks).
    - Risk analysis (determine cause and existing preventative and mitigating controls).
3. Risk Control:
    - Risk evaluation (select, implement and monitor the effectiveness of specific risk controls).
    - Risk treatment (assign, implement and monitor action plans for further mitigation of environment risks to as low as reasonably practicable).
4. Risk Monitoring and Review:
    - Monitor, review and update (review progress and developments, check actions effectiveness, identify new risks).
5. Risk Communication and Reporting.
    - Reviews of the Operation / Project Environment Risk Registers are communicated to any applicable Risk Owner(s).

'Conservation significant flora and vegetation' is an environmental factor considered in this process of environmental impact assessment, undertaken to support the referral of projects for state and Commonwealth environmental approval. Any potential threats to conservation significant species from a project are identified and considered during this process.

The potential threats to conservation significant flora and vegetation from mining activities in the Pilbara are relatively well understood. Potential cumulative impacts to conservation significant flora and vegetation as a result of non-mining factors i.e pastoralism, community infrastructure have been considered in the development of this plan.

The principal threats to conservation significant flora and vegetation, and the application of these in the context of WAIO's operations and area of influence are described in Table 3.

Table 3 : Potential threats to conservation significant flora and vegetation associated with WAIO activities

Identified Threat	Application to WAIO Operational Activities

Identified Threat	Application to WAIO Operational Activities
Weeds	• Mining activity across WAIO has the potential to introduce and spread invasive weed species by transporting contaminated soil and seeds, either directly or contained within dirt or soil on machinery. • Weeds alter the characteristics of TEC's, by out competing individual species, changing fire patterns and increasing erosion. • Weeds can directly compete with conservation significant species for environmental resources.
Altered water regimes	• Dewatering associated with mining below groundwater levels reduces the water table and potentially impacts on flora and vegetation that may be dependent on existing groundwater levels. • The discharge of water to ephemeral streams for extended periods, and in an arid climate can alter the composition of communities associated with these systems and create an unnatural dependency on the water being discharged. • The quality of water discharged into environments has the potential to impact directly on species and or communities. • The discharging of water to surface and through 'Managed Aquifer Recharge' (MAR) has the potential to water log soils and directly impact individuals and communities. • Increasing the availability of water in an arid climate can promote weed growth and encourage their competition with species and communities.
Fire	• Flora and vegetation in the Pilbara is adapted to natural fire regimes. Mining activities have the potential to change the frequency of fire by actively extinguishing fires and or by causing them. This may result in fire in certain parts of the landscape being too frequent or in other parts being not frequent enough and overly intense when they do occur. • Changed fire regimes can encourage weeds at a landscape level. • Altered fire regimes can change the ecological characteristics of communities.
Vegetation Clearing	• Mining operations can directly impact on flora and vegetation communities through the clearing of vegetation, including for; overburden storage areas, pits, transport, laydown and work areas etc.
Dust	• There may be a number of processes through which iron ore dust could impact the functioning of plants. The limited studies in this area from the Pilbara indicate that despite differing circumstance's and dust loads, there appears to be little physiological impact to plants. • Indirect physiological impacts to conservation significant flora and vegetation associated with vegetation dust loading are considered to be low.

5.3. Management Objectives

WAIO is focused on outcome based management objectives. In regards to conservation significant flora and vegetation, WAIO seeks to maintain representation, diversity, viability and ecological function at the species, population and community level.

To achieve this outcome we will apply a suit of management actions in an adaptive management framework to ensure that we:

- Avoid clearing conservation significant species and or communities within regulator approved clearing areas to the extent that it is reasonably practicable
- Ensure no unauthorised disturbance occurs
- Do not increase weed distribution as a result of our activities
- Protect the diversity and distribution of significant flora species and vegetation communities within our area of influence
- Limit the impact of fire to significant flora and vegetation
- Manage impacts to conservation significant flora and vegetation as a result of our changes to the hydrological regime

5.4. Management Actions

5.4.1. Project Environmental and Aboriginal Heritage Review (PEAHR)

The Project Environment and Aboriginal Heritage Review (PEAHR) is an internal procedure designed to identify the environmental, aboriginal heritage and land tenure legal requirements that are required, prior to any land disturbance. A PEAHR approval is required prior to any land clearing activity.

BHP Billiton Iron Ore project managers wishing to undertake land clearing activities must first lodge a PEAHR application via the web based PEHAR application system. Each application is assessed by Environment and Heritage Advisors responsible for the area in which the clearing is to be conducted. Assessors of each PEAHR ensure that the required approvals and licenses are in place and that the appropriate management measures and conditions are being applied. Assessors will also apply the management hierarchy and recommend conditions and limitations where appropriate and reasonable. The PEAHR application and the recommendations of the assessing environmental advisor are then reviewed by a Team Lead or Superintendent and a PEAHR permit is authorised.

In reviewing and approving PEHAR applications and applying management measures WAIO will apply the ALARP (As Low As Reasonably Practicable) principle, as discussed by Jones-Lee Aveen (2011). This includes the clearing of conservation significant flora and vegetation within approved clearing boundaries. The assessing environmental advisor will avoid clearing conservation significant flora and vegetation until it is no longer reasonably practicable to do so. Avoidance of removal of conservation significant flora species and vegetation will be achieved through the application of exclusion zones or buffers as detailed in Table 4. Approval will be sought for removal of conservation significant flora and vegetation species where avoidance is not possible.

Table 4: Buffers to be applied around flora within specific conservation categories

Conservation Category	Buffer	Rational
Threatened Flora (DRF)	50 m	Contemporary buffer applied by regulators for all threatened species under normal circumstances and for ESA's as recognised by the EP Act.
Newly Discovered Species	50 m	Until reviewed by scientific committees and taxonomists, take a precautionary approach and treat as for DRF
Priority 1	50 m	Accounting for the lack of knowledge of the species, treated as for DRF.
Priority 2	10 m	A 10 meter buffer provides sufficient safeguard to ensure clearing does not directly impact on the ecological resources required by individual plants.
Priority 3	10 m	
Priority 4	10 m	

5.4.2. Flora and Vegetation Survey

BHP Billiton Iron Ore has been undertaking baseline biological surveys on most of its Pilbara tenements since the 1990s. Comprehensive baseline and targeted flora and vegetation surveys are undertaken to support environmental impact assessment (EIA) and management. WAIO Guidelines for Vegetation and Flora Surveys WIN-ENV-LAND NW-008 have been developed to ensure compliance with the EPA's guidance statement 51 (Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in WA) and enable consistent and comparable results across its operations and between surveys.

Ordinarily, baseline surveys are conducted at a tenement scale. This ensures a regional understanding of flora and vegetation communities which enables informed management in a regional context and an assessment at a projects level of impact and area of influence beyond its direct footprint. Baseline surveys are reviewed on a 5 yearly basis to ensure they remain current and applicable for management. In these reviews, survey timing, methodology, and extent are considered against contemporary standards. The results of the survey are considered against taxonomic and conservation significance changes over the past 5 years and the potential for future operational activity in the area.

Targeted surveys may be undertaken to update baseline information or to resolve particular survey or study gaps. Targeted surveys may also be undertaken prior to approved land clearing if there is an identified risk of DRF, or Priority 1 species occurring in the impact area.

To provide a consistent vegetation map across our tenements at a 1:20,000 scale, WAIO periodically consolidates the vegetation mapping developed during baseline surveys (Figure 4). This has been enabled by the consistent methodology provided in the WAIO Guidelines. Consistent mapping of flora and vegetation across WAIO tenements provides a valuable tool to enable management decisions in a regional context and considering cumulative impacts to flora and vegetation communities. Targeted surveys are undertaken on a needs basis to clearly map and better understand threatened and priority ecological communities as defined by DPaW.

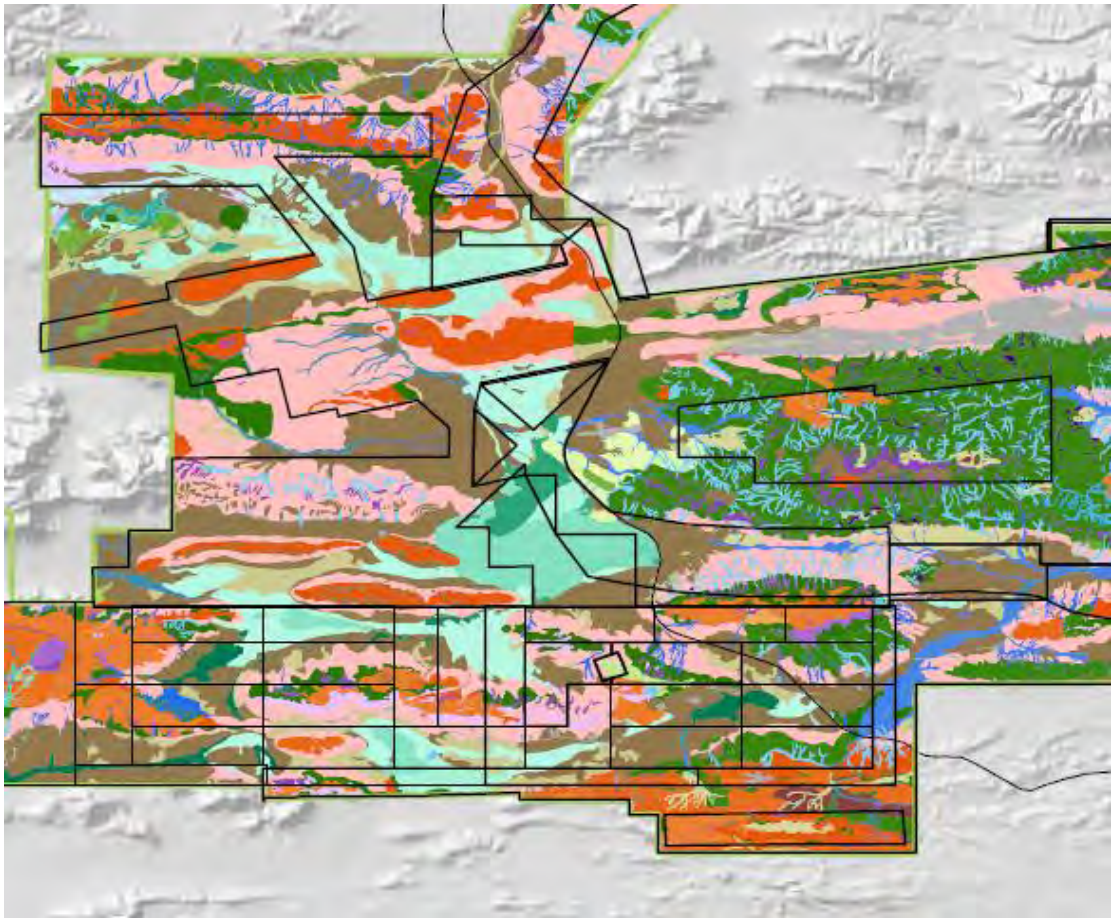


Figure 4: **Regional Vegetation Mapping – Central Pilbara (Onshore 2014)**

5.4.3. Data Capture and Management

Survey data is captured in a standard format (Biological Survey Spatial Data Requirements SPR-IEN-EMS-015) and using a prescribed template (FRM-IEN-EMS-002). The data is quality assured and checked by WAIO ecologists and loaded into a geodatabase where the data is published and made available for business systems and processes, including web based mapping (ioMaps), the PEAHR works approval system, and for environmental approvals.

Flora and vegetation datasets are updated as required following any notification of changes to taxonomy or significance classifications. Formal reviews of taxonomy and conservation significant status are undertaken six monthly. Taxonomy is maintained from data provided by the Western Australian Herbarium and includes only species appearing in the WA Herbarium Census of WA Plants Database. The conservation significant status for each recorded species or conservation significant community is maintained against published lists generated by the relevant scientific committees of the IUCN, DoE, and DPaW.

5.4.4. Conservation significant flora and vegetation Information for sites

Operational staff can access current information on the conservation significant flora occurring on their site by using the information tool in ArcGIS or ioMaps. These tools open attributes attached to each record which provides information about the conservation status of the species, its scientific name, when it was discovered, and some of the physical aspects of the location at which it occurs. A direct link to the report for the survey during which it was discovered is also provided and provides further information if needed.

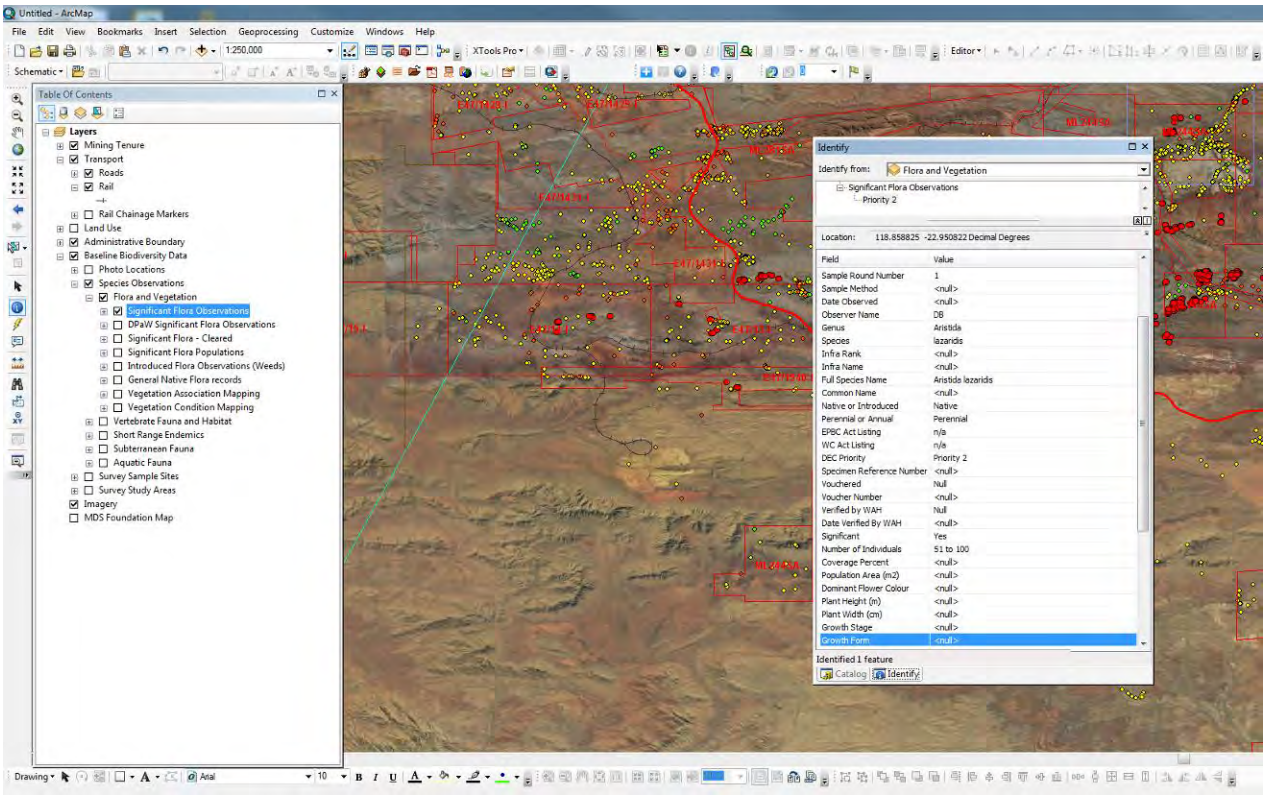


Figure 5: Example of records accessed via the BHP Billiton Iron Ore Biodiversity GIS Layer on ArcGIS providing site specific data to operational staff

Further information on specific conservation significant flora can be accessed through the WA Herbariums FloraBase website. This is the most current scientific information available on the taxonomy of WA's flora. The Department of Parks and Wildlife also provide recovery and interim recovery plans for certain threatened flora and vegetation communities. These plans are available from the DPaW website.

Vegetation communities are mapped as part of our baseline vegetation assessments and provided to operational staff via a specific ArcGIS layer. Conservation significant vegetation is mapped and provided to operational staff in the Key Assets layer. The community boundary is mapped and so too is a buffer as provided and maintained by DPaW. Details of each community can be found in the attributes by using the identify tool. Further information on conservation significant vegetation communities can be found on DPaWs Threatened Species and Communities Web page

5.4.5. Groundwater and Surface Water Management

Management requirements for water dependent ecosystems and communities are established within Regional Water Resource Management Plans (RWRMP). These plans incorporate the technical considerations, assumptions and adaptive management that underlie the broader Pilbara Water Resource Management Strategy (PWRMS). Plans are broadly catchment based and take into consideration hub and site specific water resource management requirements and the ecological requirements for identified ecological receptors.

Conservation significant vegetation communities that are dependent on a hydrological regime that may be impacted by WAIO operations will be considered within RWRMP's. Plans will assess all existing ecological information on the community and baseline flora data, current and future conditions of groundwater, soil moisture and surface water to develop 'eco-hydrological' models for the area. These models will inform the required adaptive management to enable the achievement of outcome-based objectives.

Regional Water Resource Management Plans consider the following aspects:

- Hydrological changes (baseline, current and future conditions of groundwater, soil moisture and surface water) resulting from WAIO groundwater abstraction and surface water diversion.
- The receiving conservation significant flora or vegetation communities, their identified value and hydrological dependency (groundwater, soil moisture and/or surface water).
- Potential impacts (predicted & actual) to conservation significant flora or vegetation communities.
- Required risk-based adaptive management techniques that are feasible (tested and practicable) to mitigate potential impacts to acceptable levels during operations and closure.

Hydrological conditions can be impacted by more than one mining operation, depending on the surface water and groundwater hydrological interconnectivity at the catchment scale. Regional Water Resource Management Plans and catchment scale eco-hydrological studies provide baseline assessments and predictive models, which will be updated iteratively to inform cumulative impact assessments and adaptive management within our area of influence.

5.4.6. Monitoring

WAIO operates in natural systems that are complex and poorly understood. The adaptive management approach provides a framework that enables the business to learn more about the response of these complex systems to our management actions and to minimise impact to conservation significant flora and vegetation through continuous improvement.

Where WAIO operations are likely to have an indirect impact on conservation significant flora or vegetation an integrated monitoring program may be required to meet the identified outcomes for the species or community. Monitoring programs will be developed where necessary, based on clear objectives. Objectives will be focused on achieving the outcomes identified and will then inform the design of the monitoring program.

Monitoring programs will be designed in consideration of the following:

- **The defined relationship with the identified impact**.
  A clear assessment of how our activity is likely to impact the species or community at the operation, including whether impacts are short-term or long-term, reversible or irreversible, and/or minor or major;

- **Cost effective and practical application in meeting the objectives of the program**.
  Only monitoring that will materially contribute to the adaptive management of the species or community, and enable an appropriate management response to identified change shall be implemented;

- **Have early warning capabilities.**
  An early warning indicator allows enough time to instigate an appropriate management response where required. A monitoring program that does not enable an effective response is only valuable in identifying or measuring the response to change and does not mitigate against the impact of this change;

- **Consider the 'lag' effects between changing physical factors and a species or community response.**
  Some indicators, such as vegetation responses to changed hydrology, may be slow, and limited in enabling an appropriate management response. In these instances predicted responses based on previous research or monitoring may need to be applied to known levels of change at the receptor. Management actions will need to be applied in response to trigger levels that limit the risk of impacting the species or community to ALARP;

- **Have multiple indicators.**
  Consider multiple indicators that, will reduce the likelihood of missing a critical link and an unacceptable impact occurring. An adaptive management framework enables the refining of triggers and indicators over time to best limit the risk of impacting the species or community to ALARP.

5.4.7. Reporting

BHP Billiton Iron Ore publicly reports its environmental compliance performance annually in accordance with standard approval conditions via an Annual Environment Report. BHP Billiton reports its Group-wide sustainability performance in the BHP Billiton Annual Sustainability Report.

5.4.8. Rehabilitation

Rehabilitation at sites is undertaken in accordance with the WAIO Rehabilitation Standard and site specific Mine Closure Plans (MCP). Conservation significant flora and vegetation is considered when developing mine closure plans and their related completion criteria.

The success of rehabilitation in the Pilbara is critically dependent on maintenance of the availability of scarce biophysical resources required for long-lived perennial plants. These resources, including topsoil and surface water drainage are given close consideration when developing mine closure plans and in rehabilitation planning.

The use of conservation significant flora in rehabilitation will be considered on a case by case basis, and identified as a management action in site based rehabilitation and closure plans. The principle objective of rehabilitation however is that it must be safe and stable, and, within the limits of the altered post-mining environment. Rehabilitation aims to establish a native Pilbara ecosystem that provides for low intensity grazing, protection of water quality and conservation.

Where possible WAIO undertakes progressive rehabilitation. Progressive rehabilitation involves planning the rehabilitation during the initial mine planning phase and ensuring that where possible, rehabilitation occurs concurrently with other operations as land becomes available for final landform; thereby reducing the total area open and increasing opportunities for ongoing learning and improvement.

5.5. Management Summary Table

Table 5: Summary of environmental management components

OEPA Objective	WAIO Management Objective	Management Action	Monitoring Requirements	Indicatiors and/or Trigger Criteria	Reporting Requirements	Potential Contingency Actions
To maintain representation, diversity, viability and ecological function at the species, population and community level.	• Avoid clearing conservation significant species and or communities within regulator approved clearing areas.	• Ensure comprehensive baseline and targeted surveys are current for each operational site. • Project review through PEAHR process (Section 6.5.1) considering alternatives to clearing. • Application of buffers where appropriate. • Apply conditions within permits to take. • Retain topsoil for redistribution in rehabilitation. • Pre-clearing PEAHR inspections. • Flagging of individuals where appropriate in field.	• Clearing commitments and conditions monitored within a management system. (CMO database) • Periodic, Group and WAIO GLD and process audits. • Rehabilitation monitoring.	• Known conservation significant species cleared under approval.	• Species cleared reported as per the requirements of regulators.	• Rehabilitation conducted in accordance with WAIO Rehabilitation Standard. • Local topsoil retained for use in rehabilitation. • All clearance of known occurrences of conservation significant species recorded in GIS. •
	• Ensure no increase in weed distribution attributable to BHP Billiton Iron Ore activities	• Weed hygiene inspections of ground-engaging equipment prior to arriving at site • Weed mapping as part of baseline assessments. • Weed surveys	• Declared weed populations monitored. • Maintain contemporary knowledge of weed species and management techniques in the Pilbara	• An increase in weed distribution identified • New weed species identified.	• Notification to regulatory authority upon identification of a new weed species on sites or in the Pilbara. • Weed control and survey activity reported in Annual Environment Report	• Weed control programme implemented as required • Records shared through Herbarium and Florabase.

OEPA Objective	WAIO Management Objective	Management Action	Monitoring Requirements	Indicators and/or Trigger Criteria	Reporting Requirements	Potential Contingency Actions
	• Protect the diversity and distribution of significant flora species and vegetation communities on our tenements	• PEAHR approval must be in place prior to land disturbance. • Operational personnel educated and aware of PEAHR requirements. • Maintenance of comprehensive GIS including data on; approval boundaries, identified conservation . significant species, and communities. • Improve scientific knowledge of Priority species and communities. • Develop and annually review a WAIO Biodiversity Strategy. • Regional vegetation mapping.	• 5 - yearly review of baseline biodiversity surveys to determine if further surveys are required. • Capture of data on significant species/community cleared • Regional assessment indicating possible occurrence of species or communities.	• New significant species, or vegetation community found • Elevation of significant status of known occurrences of species or communities.	• notification to the regulatory authority upon identification of new significant species or vegetation community (Rare Flora Report Form) • Provide relevant new data to the regulatory authority on known species or communities. • Collaborate with the WA Herbarium on taxonomy of new species.	• Rehabilitation of impacted areas. • Local topsoil retained for use in rehabilitation. • Targeted Surveys. • Manage non- mining related impacts to reduce cumulative 'pressure' on ecosystem function
	• Limit the impact of fire to Conservation significant flora and vegetation communities.	• Avoid accidental ignition of fire through works planning safety management systems i.e. hot works permits. • Limit spread of wildfire through the execution of BHPBIO Fire Management Plan. • Maintain an emergency management and reporting system	• Identify and monitor bushfires occurring on, or with the potential to spread to WAIO tenements. • Fire Weather and Fire danger indices.	• Bushfire occurring on, or with the potential to impact BHP Billiton Tenure.	• Report all bushfires to the appropriate authority.	• Respond to fire emergencies in accordance to WAIO Fire Management Plan and in association with the responsible management authority.
	• Avoid and manage the potential impact of dust on conservation significant flora and vegetation.	• Implement standard dust control measures. • Apply adaptive management targeting dust source	• Monitor the generation of dust from significant sources.	• Unexpected visual decline in conservation significant flora or vegetation health beyond natural variation.	• Report any identified impacts to conservation significant flora or vegetation attributable to dust, annually within the AER.	• Investigate identified impacts associated with dust loading and recommend management action changes to the satisfaction of the CEO of the DPaW. • Apply changes

6. Research

WAIO will continue to undertake research into relevant significant species and communities as required. Research and Development (R and D) planning and budgeting will consider recommendations and priorities identified within the relevant species recovery plans or conservation advice in addition to business priorities and requirements. Specific research commitments are described in Appendix 1.

Support for the WA Herbarium in cataloguing and promoting Pilbara flora will continue to be a priority.

7. Audit and Review

BHP Billiton undertakes periodic audits of businesses management systems to ensure compliance with standards and the application of established systems and processes. This includes GLD 009 and the PEAHR system amongst others. WAIO undertake periodic internal audits as part of its drive for continual improvement. Internal audits are commonly subject focussed, narrow and dive deeply into particular management aspects. Layered audits are undertaken more regularly in the field by site environmental staff and are designed to review and set standards, reinforce positive performance and identify system issues and opportunities in environment management systems at a site level.

This multi layered approach assesses ongoing performance against established standards and systems, identifies and addresses management gaps, and drives continuous improvement. The established audit and review process will ensure the application of management procedures for the management of conservation significant flora and vegetation within WAIO's area of influence will be consistently and effectively applied.

This document will be reviewed when required for new developments. or following any significant change to BHPB Iron Ores' systems and or procedures, and then at a frequency of no more than 5 years from the previous revision.

8. Responsibilities

Position Title	Role	Description of Task
Environment Managers	Approval	• Approval of the Plan • Preparation and approval of any subsequent versions of the Plan that are required to support an environmental approval • Sign off of annual reporting
Environmental Superintendents/ Team Leads	Accountability	• Implementation of the management plan, including provision of funding • Preparation and approval of any subsequent versions of the Plan, not required to support an approval
Superintendent Ecology and/ or Principal Ecologists	Advice	• Technical review and development of the plan • Liaison with relevant stakeholders
Environmental Advisors	Implementation	• Implementation of the plan • Reporting against conditions, via the Annual Environment Report • Information dissemination to site personnel

9. Definitions and Abbreviations

Term	Description
ºC	degrees Celsius
ALARP	As Low As Reasonably Practicable. This principle involves effective recognition of the fact that, while in most circumstances risk can be reduced, beyond some point, the cost (in financial, time and effort) of further risk-reduction is grossly disproportional to the potential derived benefits. It is at this point that the level of potential impact for the given management response is considered to be ALARP (Lee and Aven, 2011).
ArcGIS	A comprehensive system that allows people to collect, organise, manage, analyse, communicate and distribute geographic information. This system is used by BHP Billiton Iron Ore using the ESRI ArcMAP platform.
BAM Act	Biosecurity and Agriculture Management Act 2007
BSL	Below Surface Level

Term	Description
BHPB	BHP Billiton Pty Ltd
CEO	Chief Executive Officer
DEC	Department of Environment and Conservation (WA)
DER	Department of Environment Regulation
DoE	Department of the Environment (Federal)
DPaW	Department of Parks and Wildlife WA (formally DEC)
DRF	Declared Rare Flora
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities (Federal)
EIA	Environmental impact assessment
EPA	Environmental Protection Authority
EP Act	*Environmental Protection Act 1986* (WA)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Clth)
ESA	Ecologically sensitive area
g	grams
GIS	Geographic information system
GLD	BHP Billiton Group level document
GPS	Global positioning system
ha	hectare
HSE	Health, Safety and Environment
IBRA	Interim Biogeographic Regionalisation for Australia
IUCN	International Union for Conservation of Nature
km	kilometre
km/hr	kilometres per hour
m	metre
mm	millimetre
MAR	Managed Aquifer Recharge
MCP	Mine Closure Plan – Previously referred to as Rehabilitation and Closure Management Plans
NVCP	Native Vegetation Clearing Permit
OEPA	Office of the Environment Protection Authority.
PEAHR	Project Environment and Aboriginal Heritage Review
PEC	Priority Ecological Community
PWRMS	WAIO's - Pilbara Water Resource Management Strategy
R and D	Research and Development
RWRMP	WAIO – Regional Water Resource Management Plan.
SSC	Species Survival Commission
TEC	Threatened Ecological Community
VHA	Vegetation Health Assessment.
WA	Western Australia
WAIO	Western Australian Iron Ore – BHP Billiton Iron Ore operations in Western Australia.
WC Act	*Wildlife Conservation Act 1950* (WA)

10. References

The following guidelines developed by the State and Commonwealth environmental regulation departments are applicable to the management of Conservation Significant Flora and Vegetation in the Pilbara:

Department of Environment and Conservation (1995). *Department of Conservation and Land Management Policy Statement No. 29: Translocation of threatened flora and fauna*.

Department of Environment and Conservation (2007) *Conserving Threatened Ecological Communities,* Brochure: DEC Threatened Species and Communities Branch.

Department of Parks And Wildlife (2014) *Priority Ecological Communities for Western Australia Version 21*

Brearley, D (2014) *Consolidation of Regional Vegetation Mapping: BHP Billiton Iron Ore*.

Environmental Protection Authority (2002). *EPA Position Statement No. 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection*.

Jones-Lee M, Aven T, (2011) *ALARP – What Does it Really Mean*, Reliability Engineering and System Safety, Volume 96, Issue 8, August 2011

Carwardine J, Nicol S, van Leeuwen S, WaltersB, Firn J, Reeson A, Martin TG, Chades I (2014) *Priority threat management for Pilbara species of conservation significance*, CSIRO Ecosystems Sciences, Brisbane.

Shepherd, D., Beeston, G and Hopkins, A. (2001) Native Vegetation in Western Australia. Extent, Type and Status. *Resource Management Technical Report 249*. Department of Agriculture, South Perth.

Department of Environment and Conservation (1995). *Department of Conservation and Land Management Policy Statement No. 29: Translocation of threatened flora and fauna*.

van Vreeswyk, A.M.E, Payne, A.L, Leighton, K.A. and Hennig, P. (2004) An inventory and condition survey of the Pilbara region, Western Australia. Western Australian Department of Agriculture Technical Bulletin No. 92.

Western Australian Herbarium (1998–). FloraBase—the Western Australian Flora. Department of Parks and Wildlife. https://florabase.dpaw.wa.gov.au/.

ADDITIONAL SUPPORTING INFORMATION REGARDING THE APPLICATION OF OFFSETS FOR THE OREBODY 32 EAST ABOVE WATER TABLE MINE PROJECT REFERRAL

The Orebody 32 East Above Water Table Mine Project Referral (the Proposal) is the second BHP Billiton Iron Ore Pty Ltd (BHP Billiton Iron Ore) Proposal to be referred to the Environmental Protection Authority (EPA) following the release of the *Offsets Guideline* (WA Government, 2014)[1]. To date, no active BHP Billiton Iron Ore mine operation has been conditioned for offsets under a Ministerial Statement.

A BHP Billiton Iron Ore Offsets Strategy is currently being developed and will continue to develop throughout this year in parallel to the EPA's update of the *Offsets Guideline* 'to include further information on the use of metrics in determining offsets and on the determination and application of offsets for cumulative impacts' (WA Government, 2014 p. 3), through avenues such as established strategic working groups.

This correspondence has been compiled to:

a) explain how BHP Billiton Iron Ore has completed the required Offsets Template for the Proposal; and
b) explain work currently underway to answer the questions in the required *Offsets Template Form.* This work will be addressed within an *Impact Reconciliation Procedure* for the Proposal and will also be presented as necessary for discussion at strategic working group meetings.

Completed Offsets Template Form for the Orebody 32 Above Water Table Iron Ore Mine Project

The required *Offsets Template Form* is completed and attached to this document. Following application of the Mitigation Hierarchy outlined in the *Offsets Guideline* (WA Government, 2014). BHP Billiton Iron Ore has divided proposed native vegetation clearing this into two types of 'clearing domains'. These are:

- mine pit; and
- infrastructure (this includes, for example, haul roads and stockpiles, etc.).

In the case of this Proposal, BHP Billiton Iron Ore understands that, in accordance with the *Offsets Guideline* (WA Government, 2014), offsets will be applied to the proposed clearing of 'Good-to-Excellent' vegetation.

Notwithstanding this, it is noted that BHP Billiton Iron Ore has been undertaking rehabilitation activities since the 1970's. Considerable work has been undertaken in recent years to compile and interpret rehabilitation monitoring data. The data indicates that several domains can be rehabilitated back to a comparable 'Good-to-Excellent' condition. At the appropriate time, BHP Billiton Iron Ore will present relevant information to the OEPA and other decision-making authorities.

BHP Billiton Iron Ore's view on its rehabilitation practices as listed in the attached completed *Offsets Template Form* for this Proposal is briefly explained below.

[1] Following the recent submission of the BHP Billiton Iron Ore Pty Ltd Orebody 31 Iron Ore Mine Project on 20 March 2015

Orebody 32 Clearing Domains

Mine Pit – 220 ha

The ‘worst-case’ scenario for the Proposal is that the mine pit will not be backfilled. Therefore, BHP Billiton Iron Ore acknowledges that the mine pit will be subject to offsets based on the ‘worst-case’ scenario.

Infrastructure, roads and associated stockpile areas – 130 ha

BHP Billiton Iron Ore is currently reviewing and compiling a range of monitoring data which is expected to demonstrate that these clearing domains can be rehabilitated back to a comparable ‘Good-to-Excellent’ condition. At the time of submission of this Proposal, however, BHP Billiton Iron Ore acknowledges that clearing for these purposes will be subject to offsets based on the limited amount of publically available data at the present time.

Continuous improvement in rehabilitation at BHP Billiton Iron Ore

BHP Billiton Iron Ore acknowledges the journey it is currently on with regard to continuous improvement in rehabilitation. BHP Billiton Iron Ore believes that there are valuable opportunities available to showcase success in rehabilitating selected clearing domains back to a ‘Good-to-Excellent’ condition, thus reducing residual impacts as a result of native vegetation clearing in the Pilbara region in the future. These successes would provide learning and sharing opportunities across the industry to a range of proponents and we look forward to discussing these further at the appropriate time.

Orebody 32 East Above Water Table Mine Project

Existing environment/ Impact	*Mitigation*			*Significant Residual Impact*	*Offset Calculation Methodology*				
	Avoid and minimise	*Rehabilitation Type*	*Likely Rehab Success*		*Type*	*Risk*	*Likely offset success*	*Time Lag*	*Offset Quantification*
220 hectares of 'Good-to-Excellent' vegetation to be cleared for: a pit area.	The worst-case scenario is that the mine pit will not be back-filled.	Site-specific approach.	Can the environmental values be rehabilitated/Evidence? No. Various closure scenarios are being investigated, however, worst case is the pit will not be backfilled. The Proponent would like the EPA to note that there are comparable sites whereby mine batters have been successfully rehabilitated. The Proponent proposes to compile case-studies and present to the EPA as part of discussions via working strategy groups and/or in relation to future developments.	Extent 220 hectares Quality Degraded Conservation Significance Nil Land Tenure Pastoral Lease or Unallocated Crown Land. Time Scale Permenant According to the agreed significance framework, residual impact is considered to be significant because: 220 hectares of 'Good-to-Excellent' vegetation in the Pilbara Hamersley IBRA sub-region will be cleared and potentially not rehabilitated.	Monetary offsets contribution to the Pilbara Offsets Strategic Fund	N/A	Suggested Ministerial Conditions are provided in the Orebody 32 East Above Water Table Iron Ore Referral Supporting Document	Permanent	$750 per hectare of 'Good-to-Excellent' vegetation cleared within the Hamersley IBRA subregion.
130 ha hectares of 'Good-to-Excellent' vegetation to be cleared for: haul road, stockpiles and ancillary purposes.	Avoid/minimise - Use existing infrastructure such as workshops, offices, etc. at adjacent Orebody 24 and Orebody 25.	130 hectares rehabilitated back to 'Good-to-Excellent'.	Can the environmental values be rehabilitated/Evidence? Yes. BHP Billiton Iron Ore has successes in rehabilitaing a range of low-impact disturbances of a comparable nature and timeframe at various Pilbara operations. Further information is contained within a memo attached to this spreadsheet. Operator experience in undertaking rehabilitation? Yes, please refer to the memo attached to this spreadsheet. What is the type of vegetation being rehabilitated? Hummock and Tussock Grassland frequenting with Acacia. Time lag? 12 years post closure. Credibility of the rehabilitation proposed (evidence of demonstrated success) Please refer to the memo attached to this spreadsheet for discussion and a brief overview of recent successes in the rehabilitation of comparable low impact clearing. The Proponent would like the EPA to note that extensive rehabilitation monitoring data is currently being compiled to demonstrate the credibility of its rehabilitation. The Proponent proposes to compile case studies for presentation to the EPA in future.	Extent 130 hectares Quality The Proponent has had successes in rehabilitating 'low impact' clearing disturbance back to a similar pre-mining condition. Conservation Significance Nil Land Tenure Pastoral Lease or Unallocated Crown Land. Time Scale 12 years post closure According to the agreed significance framework, residual impact is considered to be significant because: 130 hectares of 'Good-to-Excellent' vegetation in the Pilbara Hamersley IBRA region will be cleared and based on recent comparable successes, it may potentially be rehabilitated back to a comparable pre-mining condition.	Monetary offsets contribution to the Pilbara Offsets Strategic Fund	N/A	Suggested Ministerial Conditions are provided in the Orebody 32 East Above Water Table Iron Ore Referral Supporting Document	12 years post closure	$750 per hectare of 'Good-to-Excellent' vegetation cleared within the Hamersley IBRA subregion.

Key Environmental Factor	**Flora and Vegetation**
EPA Objective	To maintain representation, diversity, viability and ecological function at the species, population and community level.
BHP Billiton Iron Ore Objective	To restore, conserve and promote terrestrial biodiversity, to ensure healthy and enduring landscapes.
Assessment (in summary)	The Proposal contains no Threatened Flora, Priority Flora, TECs or PECs and all taxa have been recorded in adjacent tenements. The vegetation within the Development Envelope has been rated as Good to Excellent condition.
Management Objective	The proponent shall ensure that implementation of the Proposal maintains the representation, diversity, viability and ecological function of conservation significant flora and vegetation.
Recommended Condition	The proponent shall ensure that implementation of the Proposal maintains the representation, diversity, viability and ecological function at the species, population and community level. **Regional Land and Biodiversity Management Plan – Flora and Vegetation** The Proponent shall implement a Regional Land and Biodiversity Management Plan – Flora and Vegetation. 1. The Regional Land and Biodiversity Management Plan required by condition X shall: (1) when implemented, manage the implementation of the proposal to meet the requirements of condition X-1; and (2) be to the requirements of the CEO. 2. Revisions to the standard commitments of the Regional Land and Biodiversity Management Plan – Flora and Vegetation may be endorsed by the CEO on the advice of the Department of Parks and Wildlife. 3. The proponent shall implement revisions of the standard commitments of the Regional Land and Biodiversity Management Plan required by condition X.

Key Environmental Factor	**Offsets**
EPA Objective	To counterbalance any significant residual environmental impacts or uncertainty through the application of offsets.
Assessment (in summary)	The Proposal will directly impact up to 350 ha of 'Good-to-Excellent' vegetation within the Pilbara's Fortescue IBRA sub-regions.
Management Objective	**Offsets** X-1 In view of the significant residual impacts and risks as a result of implementation of the proposal, the proponent shall contribute funds for the clearing of native vegetation, in accordance with the *Offsets Guideline* (Western Australian Government, 2014) or its updates. This

	funding shall be provided to a government-established conservation offset fund or an alternative offset arrangement providing an equivalent outcome as determined by the Minister. X-2 The proponent's contribution to the strategic regional conservation initiative shall be paid biennially, the first payment due in the second year following the commencement of ground disturbance. The amount of funding will be made in accordance with the approved Impact Reconciliation Procedure required by condition X-3: X-3 The proponent shall prepare and submit an Impact Reconciliation Procedure to the satisfaction of the CEO.

Key Environmental Factor	**Rehabilitation and Decommissioning**
EPA Objective	To ensure that premises are closed, decommissioned and rehabilitated in an ecologically sustainable manner, consistent with agreed outcomes and land uses, and without unacceptable liability to the State.
BHP Billiton Iron Ore Objective	Create a safe, stable, non-polluting and sustainable landscape that is consistent with key stakeholder agreed social and environmental values and aligned with creating optimal business value.
Assessment (in summary)	BHP Billiton Iron Ore is obliged under its the tenure requirements of the Mining Lease, issued under the *Iron Ore (Mount Newman) Agreement Act 1964* ensure that premises are closed, decommissioned and rehabilitated in an manner consistent with current government standards and without unacceptable liability to the State. To support this requirement, BHP Billiton Iron Ore is currently preparing a hub-based Mine Closure Plan for the Eastern Ridge Mine Hub, which will consolidate and supersede existing plans and also incorporate the deposit under this Proposal.
Measurable outcome	The proponent shall ensure that premises associated with the Proposal are closed, decommissioned and rehabilitated in an ecologically sustainable manner and without unacceptable liability to the State. **Implement a Mine Closure Plan** The proponent shall develop and implement a Mine Closure Plan. 1. The Mine Closure Plan required by condition X shall: (1) when implemented, manage the implementation of the proposal to meet the requirements of condition X-1; (2) be prepared in accordance with the Guidelines for Preparing Mine Closure Plans, May 2015 (Department of Mines and Petroleum and Environmental Protection Authority) or its revisions; and (3) be to the requirements of the CEO on advice of the Department of Mines and Petroleum. 2. The proponent shall submit the Mine Closure Plan to the CEO unless otherwise agreed by the CEO. 3. Revisions to the Mine Closure Plan may be approved by the CEO on the advice of the Department of Mines.

	4. The proponent shall implement revisions of the Mine Closure Plan required by condition X.