10. Assessment of impact on terrestrial fauna

10.1 Relevant environmental objectives, policies, guidelines, standards and procedures

10.1.1 EPA objective

The EPA applies the following objectives to the assessment of proposals that may affect fauna:

To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement of knowledge.

To maintain biological diversity that represents the different plants, animals and microorganisms, the genes they contain and the ecosystems they form, at the levels of genetic diversity, species diversity and ecosystem diversity.

10.1.2 EPA statements and guidelines

EPA Position Statement No. 3

EPA Position Statement No. 3 (EPA 2002a) discusses the principles the EPA would apply when assessing proposals that may have an effect on biodiversity values in Western Australia.

EPA Guidance Statement No. 20

EPA Guidance Statement No. 20 (EPA 2009) provides guidance on standards and protocols for surveys of short-range endemic (SRE) fauna, particularly those undertaken for the Environmental Impact Assessment of Proposals.

EPA Guidance Statement No. 56

EPA Guidance Statement No. 56 (EPA 2004d), provides guidance on standards and protocols for terrestrial fauna surveys, particularly those undertaken for the Environmental Impact Assessment of Proposals.

10.1.3 Regulatory framework

State protection

In a legislative context, the preservation and conservation of fauna is covered primarily by the following Western Australian legislation:

- *Wildlife Conservation Act 1950* (WA) (WC Act)
- *Conservation and Land Management Act 1984* (WA).

In Western Australia, rare or endangered species are protected by the Wildlife Conservation (Specially Protected Fauna) Notice 2008, under the WC Act. Schedules 1 and 4 in this Notice are relevant to this assessment, providing a listing of those species protected by this Notice.

The DEC (Nature Conservation Division) Priority Fauna List also nominates conservation species from Priority One to Five. The potential impacts of a proposal on Priority listed species should be managed to prevent the species becoming threatened under the IUCN criteria.

Australian Government protection

The Australian Government EPBC Act protects species listed under Schedule 1 of the Act. In 1974, Australia became a signatory to the CITES. As a result, an official list of endangered species was prepared and is regularly updated. This listing is administered through the EPBC Act. The current list differs from the various State lists; however, some species are common to both.

10.1.4 International agreements

Australia is party to the Japan-Australia (JAMBA), China-Australia (CAMBA) and Republic of Korea-Australia (ROKAMBA) Migratory Bird Agreements. Most of the birds listed in these agreements are associated with saline wetlands or coastal shorelines and have little relevance to the Greater Nammuldi Area but some migratory birds not associated with water are also listed on these international treaties.

10.2 Description of factor

The Greater Nammuldi Area was subject to extensive vertebrate fauna surveys between 1998 and 1999 (Hamersley Iron 1999) for the CER assessment of the Original Proposal. The Greater Nammuldi Area has since been surveyed for terrestrial vertebrate and SRE invertebrate fauna, as shown in Table 40. The methodology and full results of these surveys are included in Appendix 2.

Table 40 Fauna surveys conducted in the Greater Nammuldi Area

Survey	Reference
Homestead Exploration leases. Biological Survey Report	Hamersley Iron 1996
Nammuldi Silvergrass Exploration Project. Biological Survey Report	Hamersley Iron 1999
Level 1 Fauna Assessment of the Approved Powerline Corridor	Biota 2007c
A Targeted Terrestrial Fauna Survey of Expansion Areas at Nammuldi-Silvergrass	Biota 2009a
A Targeted Terrestrial Fauna Survey of Brockman Syncline 2 Pit 7 Extension Areas	Biota 2009b
Silvergrass West Vertebrate Fauna, SRE and Habitat Assessment	Biota 2009c
Nammuldi Infill Areas Fauna Survey Report	Biota 2010f
Brockman 2 Sustaining Tonnes Targeted Fauna Survey	Biota 2010g
Greater Nammuldi irrigated agriculture project level 2 terrestrial vertebrate fauna assessment	Ecologia 2011a
Greater Nammuldi irrigated agriculture project short range endemic invertebrate survey	Ecologia 2011b

The objective of these surveys was to identify the abundance and diversity of fauna likely to occur within the Greater Nammuldi Area and the significance of the potential impacts of the Expansion Proposal on those identified species, particularly species of conservation significance. The studies were completed in accordance with EPA Position Statement No. 20 (EPA 2009) and Guidance Statement No. 56 (EPA 2004d). As impacts on aquatic fauna are associated with surface water, details on aquatic fauna are presented in Section 8.2.3.

10.2.1 Terrestrial fauna habitats

Fauna habitats were determined on the basis of dominant landforms and vegetation communities (described in Biota 2007a, 2010a, 2010b, 2010c; Mattiske 2011) and are shown in Figure 54.

Habitat conservation significance rating (shown in Table 41) has been determined during fauna surveys on the basis of landform and vegetation community distribution and survey results (Biota 2009a, 2009c, 2010f; Hamersley Iron 1999; Ecologia 2011a).

Table 41 Fauna habitats significance rating and extent of disturbance

Habitats	Integrated Vegetation Landforms (Biota 2012)	Integrated vegetation code (Biota 2012)	Habitat Significance (Hamersley Iron 1999, Biota 2009a, Biota 2010f , Ecologia 2011a)	Extent (ha) in Greater Nammuldi Area		Extent disturbed by Expansion Proposal	
						(ha)	(%)
Hills and plains	Plains - Calcareous plains	PL1, PL2, PL3, PL4, PL5, PL6, PL7, PL8	**LOW conservation significance**. Well represented on a local and regional scale. The majority of the hills and plains vegetation communities are considered to be consistent with vegetation of the Hamersley Region and not considered to be of elevated conservation significance (Mattiske 2011).	4141	45,331	4980	11
	Plains - Stony Plains	PS1, PS2, PS3, PS4, PS5, PS6, PS7, PS8, PS9, PS10, PS11, PS12, PS13, PS14, PS15, PS16, PS1/PS6		25,196			
	Hills - Hill slopes and crests	H1, H2, H3, , H4, H5, H6, H7, H8, H9, H10, H11, H12, H13, H14, H15		15,987			
	Breakaways	HG4		7			
Drainage lines	Creeklines - Creeklines and Drainage	CD1, CD2, CD3, CD4, CD5, CD6, CD7, CD8, CD9, CD10, CD11, CD12, CD13, CD14, CD15, CD16, CD17, CD18, CD19, CD20, CD21, CD22, CD23, CD24, CD25, CD26, CD27, CD28, CD29, CD30, CD31, CD32, CD33, CD34, CD4/CD22	**MODERATE LOCAL conservation significance**. Restricted habitat in the Greater Nammuldi Area. Riparian habitats are considered to provide significant fauna habitats as they have mature vegetation (in particular *Eucalyptus camaldulensis/Eucalyptus victrix* woodland) and can act as fauna corridors. Drainage line habitat may provide potentially suitable habitat for several species of conservation significance, including *Dasyurus hallucatus* (northern quoll), *Neochmia ruficauda subclarescens* (star finch) and *Notoscincus butleri* (Biota 2010b). Vegetation types in these areas provide shelter and habitat for a large range of animals and act as wildlife corridors allowing movement of animals between habitats, which are of critical importance when fires occur. Large eucalypts near creeklines also provide important nesting, shelter habitats and flyways (Biota 2009a). Vegetation community AanSEd is recognised as an intact Mulga Woodland stand (Biota 2010b). Although this vegetation community does not provide a significant habitat to any conservation significant fauna species, it does contain higher number of avifaunal species (Biota 2010f).	6124		697	11

Habitats	Integrated Vegetation Landforms (Biota 2012)	Integrated vegetation code (Biota 2012)	Habitat Significance (Hamersley Iron 1999, Biota 2009a, Biota 2010f , Ecologia 2011a)	Extent (ha) in Greater Nammuldi Area	Extent disturbed by Expansion Proposal	
					(ha)	(%)
Clay soils	Plains - Clay Plains	PC1, PC2, PC3, PC4, PC5, PC6, PC7, PC8, PC9, PC10, PC11	**HIGH conservation significance**. Restricted habitat in the region. Vegetation associations on cracking clay soils at Silvergrass provide important fauna habitat and seasonal cover in the immediate area and are considered to be significant to local vertebrate fauna assemblages.	3835	723	19
Gorges	Gorges (not Breakaways)	HG1, HG2, HG3	**HIGH conservation significance**. Restricted habitat in the region. Species of conservation significance, including *Sminthopsis longicaudata* (long-tailed dunnart) and *Pseudomys chapmani* (western pebble-mound mouse), may potentially utilise the rocky gorge habitats, such the area occurring northwest of Nammuldi or the area occurring northwest of Silvergrass Gorges may provide important foraging habitat for a number of fauna species of conservation significance such as *Macroderma gigas* (Ghost Bat) and *Rhinonicteris aurantius* (Pilbara orange leaf-nosed bat) (Biota 2010f).	684	0	0

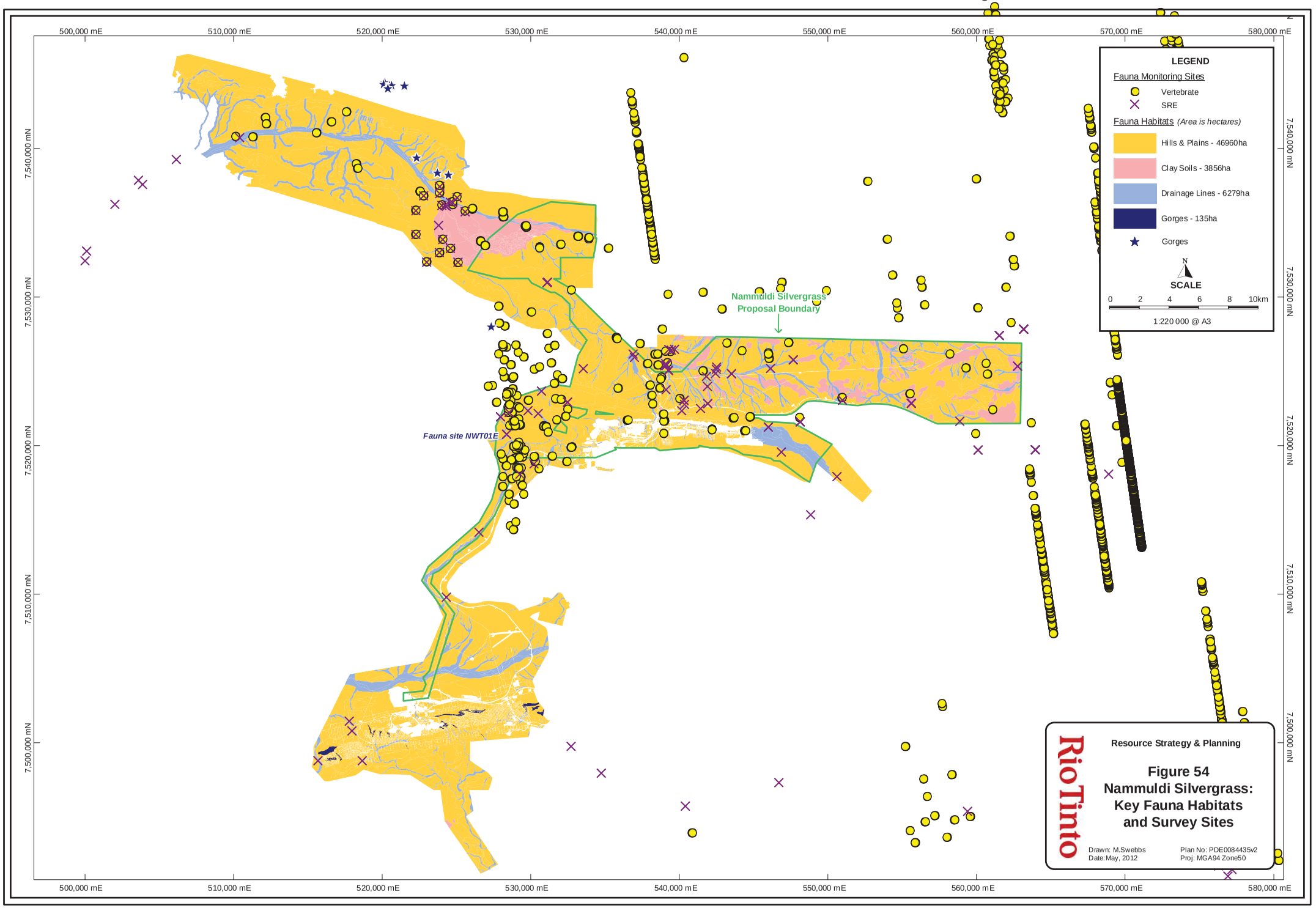

500,000 mE
510,000 mE
520,000 mE
530,000 mE
540,000 mE
550,000 mE
560,000 mE
570,000 mE
580,000 mE
7,540,000 mN
7,530,000 mN
7,520,000 mN
7,510,000 mN
7,500,000 mN
LEGEND
Fauna Monitoring Sites
Vertebrate
SRE
Fauna Habitats (Area is hectares)
Hills & Plains - 46960ha
Clay Soils - 3856ha
Drainage Lines - 6279ha
Gorges - 135ha
Gorges
N
SCALE
0 2 4 6 8 10km
1:220 000 @ A3
Nammuldi Silvergrass
Proposal Boundary
Fauna site NWT01E
Resource Strategy & Planning
Figure 54
Nammuldi Silvergrass:
Key Fauna Habitats
and Survey Sites
Drawn: M.Swebbs
Date:May, 2012
Plan No: PDE0084435v2
Proj: MGA94 Zone50

Figure 55 *Eucalyptus* sp. low woodland along a broad creekline north of Nammuldi

Figure 56 Rocky ridgeline with *Eucalyptus leucophloia* scattered low trees over *Acacia* sp. scattered shrubs over *Triodia* sp. hummock grassland north of Nammuldi

10.2.2 Terrestrial fauna recorded within the Greater Nammuldi Area

The fauna assemblage present in the Greater Nammuldi Area has been collated from field surveys conducted for the Original Proposal, recent surveys (Biota 2009a, 2009c, 2010f; Hamersley Iron 1999; Ecologia 2011a), and searches of the DEC NatureMap Database or the SEWPAC EPBC Act Protected Matters Database.

The terrestrial fauna surveys conducted to date in the Greater Nammuldi Area have recorded a number of species whose abundance and distribution is considered to be typical of the Pilbara region. The results of key surveys of the Greater Nammuldi Area are shown in Table 42 (Hamersley Iron 1999; Biota 2009a, 2009c, 2010f; Ecologia 2011a, 2011b).

Table 42 Number of native terrestrial vertebrate fauna recorded in the Greater Nammuldi Area

Report	Number of species recorded			
	Mammalian	Avian	Reptilian	Conservation Significance
Nammuldi/Silvergrass Exploration Project - Biological Survey Report (Hamersley Iron 1999)	21	76	66	6
A Targeted Terrestrial Fauna Survey of Expansion Areas at Nammuldi-Silvergrass (Biota 2009a)	7	16	9	1
Silvergrass West Vertebrate Fauna, SRE and Habitat Assessment (Biota 2009c)	17 (2 introduced species)	55	33	6
Nammuldi Infill Areas Fauna Survey Report (Biota 2010f)	12 (1 introduced species)]	37	26	2
Greater Nammuldi irrigated agriculture project short range endemic invertebrate survey (Ecologia 2011a)	15 (3 introduced species)	69	48	1

Mammals

A total of 29 species from 11 families have been recorded during surveys in the Greater Nammuldi Area (Biota 2009a, 2009c and 2010f, Hamersley Iron 1999). All species, excluding the donkey (*Equus asinus*), cat (*Felis catus*) and house mouse (*Mus musculus*), are endemic to the Pilbara and have been historically recorded in various surveys of the Pilbara (Hamersley Iron 1999).

The Dasyuridae were the most commonly recorded mammals with nine positively identified species, the most common marsupial being the *Ningaui timealeyi* (Pilbara ningaui). The Murides were the second most commonly encountered mammals with six identified species, the most common being the *Leggadina lakedownensis* (short-tailed mouse). Large kangaroos were very uncommon where *Macropus robustus* (euro) was the most common macropod encountered, while *Macropus rufus* was encountered infrequently in the Greater Nammuldi Area, with only 1 or 2 individuals observed (Hamersley Iron 1999). A few dingoes were recorded in addition to a wild cat (*Felis catus*). Several donkeys were observed during surveys of areas surrounding the Nammuldi site (Biota 2010f).

Eight species of bats from five families were recorded from sites along ridges at Nammuldi and Silvergrass and also at selected sites along Caves Creek. The Marra Mamba ridge at Silvergrass contains a large number of very prominent caves, the deeper of which were being used as roost sites by both species of *Taphozous hilli* and *T. georgianus* (Hamersley Iron 1999). Of the observed bat species in the Greater Nammuldi Area, Vespertillionidae was the most common family with three species identified.

Birds

A total of 82 species from 37 families have been recorded during surveys of the Greater Nammuldi Area (Biota 2009a, 2009c, 2010f; Hamersley Iron 1999; Ecologia 2011a). The Accipitridae (kites, goshawks, harriers and eagles) and Meliphagidae (honeyeaters) were the most common families with six and seven species in each respectively, while 17 families were represented by a single species. Similar patterns of family species composition were recorded historically (Hamersley Iron 1999).

Several species were widely distributed across the Greater Nammuldi Area (crested pigeon, weebill, budgerigar, diamond dove, zebra finch and variegated fairy-wren) while others mistletoe bird, little wood swallow and Richard pipit were restricted (Biota 2009a, 2009c, 2010f; Hamersley Iron 1999). Creekline areas were found to have a substantially more species-rich bird life than other habitat types due to the density and width of riparian vegetation (Biota 2009c).

The lack of diversity of habitats appears to be a key factor in determining the number of bird species in the Greater Nammuldi Area. Species numbers were found to be considerably lower than the numbers of species recorded from Karijini National Park, located approximately 50 km to the east of Nammuldi (approximately 70 km from Silvergrass) (Hamersley Iron 1999). The primary cause of the lower numbers within the Proposal Boundary appears to be the lack of mulga woodland habitat. These woodlands generally have extensive bird assemblages and are recognised as important areas of bird species diversity within the Pilbara (How *et. al* 1991). Only one area of mulga woodland habitat has been recorded in the Greater Nammuldi Area (vegetation community AanSEd), which was recorded to the east of Nammuldi (Biota 2010b).

Reptiles

A total of 79 species from 10 families have been recorded during surveys of the Greater Nammuldi Area (Biota 2009a, 2009c, 2010f; Hamersley Iron 1999; Ecologia 2011a). The Scincidae were the most common encountered family with total of 25 species recorded. *Ctenotus saxatilis* was the most commonly recorded species with 79 individuals surveyed. Three amphibian species were recorded during the recent survey west of Silvergrass including *Cyclorana maini* (Main's frog) (Biota 2009c), while *Litoria rubella* (desert tree frog) and *Uperoleia russelli* (Russell's toadlet) were recorded during the surveys undertaken for the CER (Hamersley Iron 1999).

The total number of species is considered low when compared to previous surveys in the Pilbara region even though the surveys recorded an extensive species richness of 79 species in the area (Hamersley Iron 1999). Locally, there was a large variation in species composition and richness observed between survey areas, where a much greater diversity and abundance was observed in areas associated with creeklines such as those to the west of Silvergrass (Biota 2009c) compared to those sites observed during the survey of areas adjacent to the existing Nammuldi operation (Biota 2009a). The Hamersley Iron (1999) survey also illustrated the natural variability between sampling periods and seasons, with temperatures, humidity, availability of food resources and breeding success (survival of young) all influencing the capture rate of reptiles.

Introduced species

Three mammalian species that have been introduced to the Pilbara since European settlement were observed in the Greater Nammuldi Area during surveys including the donkey (*Equus asinus*), cat (*Felis catus*) and house mouse (*Mus musculus*). The house mouse is well established in the region (Hamersley Iron 1999) and it appears that the donkey is also prominent in the area (Biota 2010f). Only one cat was observed during site surveys.

10.2.3 Species of conservation significance

Conservation significant vertebrate fauna species indicated in searches of DEC NatureMap Database or the SEWPAC EPBC Act Protected Matters Database as potentially occurring in the Greater Nammuldi Area are summarised in Table 43. An assessment was conducted of the likely impact to Matters of National Environmental Significance as listed under the EPBC Act that concluded the Expansion Proposal did not require referral under this act.

Table 43 Potentially occurring conservation-significant vertebrate fauna species

Species	Conservation status WA	EPBC Act status (Australian Government)	Likelihood of occurrence within the Proposal Boundary
Dasyurus hallucatus (northern quoll)	Schedule 1	Endangered	Potentially suitable habitat within the Proposal Boundary is limited to the rocky ridgelines to the west of Nammuldi (Biota 2009a) and the rocky gorge habitat northwest of the Nammuldi mining area (Biota 2010f). The northern quoll has been recorded in the Greater Nammuldi Area (Hamersley Iron 1999) (one record from 10 785 trap nights in the surrounding area) but has not been recorded in later surveys. It is unlikely to occur within the Proposal Boundary.
Rhinonicteris aurantia (Pilbara orange leaf-nosed bat)	Schedule 1	Vulnerable	The Pilbara leaf-nosed bat was detected west of the *Themeda* Grassland TEC near Silvergrass through recording and identification of its echolocation calls (Biota 2009c), but was not recorded during the targeted (Biota 2009a) or other surveys (Hamersley 1999, Biota 2010f) of the Greater Nammuldi Area. No other individuals have been recorded but several caves along Marra Mamba ridges north of Nammuldi, south of Silvergrass and in one area west of the Nammuldi may provide suitable roosts for this species (Biota 2009a, 2010f). These potential habitat caves are all outside the Proposal Boundary. The Pilbara leaf-nosed bat may fly within the Proposal Boundary but it is unlikely to be reliant on the site for habitat.
Liasis olivaceus barroni (olive python)	Schedule 1	Vulnerable	The Pilbara olive python is widespread in rocky areas within the Pilbara, showing a preference for rocky habitats near water, particularly rock pools. The species has not been recorded in any of the surveys of the Greater Nammuldi Area. However there is a small area of rocky hills, ridges and small breakaways to the northwest of the *Themeda* grassland TEC near Silvergrass (Biota 2009c) and Caves Creek that provides intermittent water to the area. Suitable habitat also occurs to the west of Nammuldi (Biota 2010f). The Pilbara Olive Python may possibly occur within the Proposal Boundary.
Falco peregrinus (peregrine falcon)	Schedule 4	-	The Peregrine Falcon has been recorded in the Greater Nammuldi Area (Hamersley Iron 1999) but has not been recorded in recent surveys. Considered to potentially occur within the Proposal Boundary.
Lagorchestes conspicillatus leichardti (spectacled hare-wallaby)	Priority 3	-	Not recorded within the Proposal Boundary to date. This species inhabits open forests, woodlands, shrublands and hummock grasslands (Ingleby 1991). Unlikely to occur within the Proposal Boundary due to a lack of suitable habitat (Biota 2009c, 2010f).
Leggadina lakedownensis (short-tailed mouse)	Priority 4	-	This species is known to occur on sandy soils and cracking clays and has been recorded in the cracking clay soil habitat of the *Themeda* grassland TEC around Silvergrass (Biota 2009c; Hamersley Iron 1999; Ecologia 2011a). Species is not considered to be restricted in habitat.
Pseudomys chapmani (western pebble-mound mouse)	Priority 4	-	Habitat for this species is rocky, hummock grasslands, with little or no soil. The western pebble-mound mouse occupies burrows beneath mounds of pebbles. Mounds are most common on the spurs and lower slopes of ridges. Recorded in the Greater Nammuldi Area (Biota 2009a, 2009c, 2010f; Hamersley Iron 1999; Ecologia 2011a), this species is considered to be common to very common in suitable habitat within the Hamersley and Chichester sub-regions of the Pilbara bioregion.
Sminthopsis longicaudata (long-tailed dunnart)	Priority 4	-	Recorded in the Greater Nammuldi Area (Hamersley Iron 1999) but has not been recorded in recent surveys. Likely to occur within the Proposal Boundary, with suitable habitat being rugged, rocky areas.

Species	Conservation status WA	EPBC Act status (Australian Government)	Likelihood of occurrence within the Proposal Boundary
Macroderma gigas (ghost bat)	Priority 4	-	A known ghost bat maternity roost has been recorded to the east of Silvergrass (outside Proposal Boundary) near Caves Creek (Hamersley Iron 1999) and it was recently recorded opportunistically to the west of the Silvergrass area (Biota 2009c). It is likely to fly within the Proposal Boundary.
Ardeotis australis (Australian bustard)	Priority 4	-	Habitat preferred by this species is tussock grassland, *Triodia* hummock grassland, grassy woodland and low shrublands. Recorded in the Greater Nammuldi Area (Ecologia 2011a; Biota 2009c; Hamersley Iron 1999), this species is likely to occur within Proposal Boundary.
Burhinus grallarius (bush stone-curlew)	Priority 4	-	This species inhabits open forests and woodlands, with sparse grassy understory. Recorded only once in the Silvergrass West area, outside the Proposal Boundary (Biota 2009c). This limited collection indicates it is unlikely to rely on areas within the Proposal Boundary for habitat.
Neochmia ruficauda subclarescens (star finch [western])	Priority 4	-	Not recorded to date within the Proposal Boundary. Preferred habitat is grasslands and eucalypt woodland and potentially occurs within the Proposal Boundary.
Notoscincus butleri	Priority 4	-	Habitat in which this species has been associated with includes spinifex-dominated areas near creek and river margins. Recorded west of the *Themeda* Grassland TEC near Silvergrass (Biota 2009c) and within the Original Proposal Boundary (Hamersley Iron 1999), this species may potentially occur within the Proposal Boundary.
Merops ornatus (rainbow bee-eater)	-	Migratory	This species has been found within open forests, woodlands and shrublands, and cleared areas. Open pit walls may be utilised to build nesting tunnels. The species has been recorded in the Greater Nammuldi Area (Biota 2009c, 2010f: Hamersley Iron 1999; Ecologia 2011a) and potentially occurs within the Proposal Boundary.
Haliaeetus leucogaster (white-bellied sea-eagle)	-	Migratory	Not recorded. Species or species habitat may occur within Greater Nammuldi Area, most likely associated with drainage line habitat.
Ardea alba (great egret, white egret)	-	Migratory	Not recorded. Species or species habitat may occur within Greater Nammuldi Area, most likely associated with drainage line habitat.
Ardea ibis (cattle egret)	-	Migratory	Not recorded. Species or species habitat may occur within Greater Nammuldi Area, most likely associated with drainage line habitat.
Charadrius veredus (oriental plover, oriental dotterel)	-	Migratory	Not recorded. Species or species habitat may occur within Greater Nammuldi Area, most likely associated with drainage line habitat.
Apus pacificus (fork-tailed swift)	-	Migratory	Not recorded. Species or species habitat may occur within Greater Nammuldi Area, most likely associated with drainage line habitat.

Source: Biota 2009a, 2009c, 2010f; Hamersley Iron 1999; Ecologia 2011a

Mammals of conservation significance

Northern quoll

The northern quoll is listed on Schedule 1 under the WC Act and as Endangered under the EPBC Act. This species was recorded in a previous study undertaken in the Greater Nammuldi Area in 1999 (Hamersley Iron 1999) but has not been recorded in any other surveys, including recent targeted surveys for northern quoll (Biota 2009a, 2009b). The total survey effort for northern quoll in the vicinity of the Greater Nammuldi Area was 10 785 nights of trapping and targeted non-systematic searching (for scats etc.) (Table 44). There was only one single record of northern quoll 11 years ago, but none has been captured since.

Habitat considered potentially suitable for the northern quoll occurs within the Greater Nammuldi Area along rocky ridgelines to the north of Nammuldi (Biota 2009a) and the rocky gorge habitat northwest of the Nammuldi mining area (Biota 2010f).

Sampling results indicate that the northern quoll are unlikely to use the area. If the species does utilise the area it has a very low population density.

Table 44 Survey effort for northern quoll in the vicinity of the Greater Nammuldi Area

Report Title / Reference	Survey Timing	Location	No. and type traps set or trap nights	Max. trap nights	Trap effort	Northern quoll captured
Flora and Fauna Studies: Brockman 2 Detritals Survey Area and Proposed Transport Corridor (Mattiske & Ninox 1990)	May 1990	B2 detrital ore mine and transport corridor	No traps. Foot and vehicle transects, hand foraging, recorded sightings and signs including scats, diggings, nests and habitat availability assessment. Survey over 4 days.	0	0	0
Homestead Exploration Leases. Biological Survey Report 1995 (Hamersley Iron1996)	Nov 1995	Homestead Exploration Lease 101 km^2	9 sites, 2 grids per site, 5 pit and 10 Elliot per grid. Pit effort: 450, Elliot effort: 900.	5	1350	0
Nammuldi Silvergrass Exploration Project. Biological Survey Report November 1998-May 1999 (Hamersley Iron1999)	Nov 1998 and May 1999	Nammuldi, Silvergrass & transport corridor (7 nights only)	21 x 10 lines of traps, 7 - 14 nights, Elliott and pitfall traps.	14	5460	1
Fauna Habitats and Fauna Assemblage of the Brockman No. 4 Project Area (Biota 2005a)	Oct 2004	BS4 Project Area	14 grids for 6 nights, 1 grid for 7 nights. 12 x 10 pit traps, 2 x 25 Elliot traps, 1 x 25 funnel traps Pit effort: 730, Elliot effort: 300, Funnel effort: 150.	7	1180	0
A Targeted Terrestrial Fauna Survey of Expansion Areas at Nammuldi-Silvergrass (Biota 2009a)	Oct 2008	Nammuldi Expansion Western area: 88.9 ha Eastern area: 1553.5 ha	122 Elliot traps, 5 nights.	5	510	0

Report Title / Reference	Survey Timing	Location	No. and type traps set or trap nights	Max. trap nights	Trap effort	Northern quoll captured
Silvergrass West Vertebrate Fauna, SRE and Habitat Assessment (Biota 2009c)	May 2009	Silvergrass West	5 - 7 nights. 130 pit (one with 2 funnel pairs), 50 Elliot, 10 funnel. Pit effort: 800, Elliot effort: 275, Funnel effort: 130.	7	1205	0
A Targeted Terrestrial Fauna Survey of the Brockman Syncline 2 Pit 7 Extension Area (Biota 2009d)	Sep 2009	B2 Pit 7 Extension area	40 Elliot traps over 4 nights.	4	160	0
Nammuldi Infill Areas Fauna Survey Report (Biota 2010f)	Nov 2009	Two areas immediately to the SE and NW of the Nammuldi site	Two nights sampling, 40 pit traps (10 only 1 night), 75 Elliot traps. Pit effort: 70, Elliot effort: 150.	2	220	0
Brockman 2 Sustaining Tonnes Targeted Fauna Survey (Biota 2010h)	Apr/May 2010	Pit 6/7 Extension, Pit 5, Maybelline and SW Deposit at B2	100 Elliot traps over 7 nights.	7	700	0
Total				**51**	**10 785**	**1**

Pilbara orange leaf-nosed bat

The Pilbara orange leaf-nosed bat is listed as Schedule 1 and Vulnerable conservation status under the WC Act and EPBC Act respectively. This species was detected west of the *Themeda* Grassland TEC at Silvergrass through recording and identification of its echolocation calls (Biota 2009c), but was not recorded during the targeted survey (Biota 2009a) or other surveys of the Greater Nammuldi Area (Hamersley Iron 1999, Biota 2010f).

Several caves along Marra Mamba ridges north of Nammuldi, south of Silvergrass and in one area to the west of the existing Nammuldi mining operation may provide suitable roosts for this species (Biota 2009a and 2010f). The Pilbara orange leaf-nosed bat is likely to occur in the above habitat within the Greater Nammuldi Area.

Other mammals

Four other mammalian species of conservation significance are likely to potentially occur in the Greater Nammuldi Area. The Priority 4 listed species were recorded during site surveys including: *Leggadina lakedownensis* (short-tailed mouse), *Pseudomys chapmani* (western pebble-mound mouse), *Macroderma gigas* (ghost bat) and *Sminthopsis longicaudata* (long-tailed dunnart).

Long-tailed dunnart and ghost bat may potentially utilise the gorge habitats and rocky ridgelines that occur at both Nammuldi and Silvergrass (Hamersley Iron 1999). Short-tailed mouse and western pebble-mound mouse are likely to occur in the hills and plains habitat, which is not restricted in the local area.

Birds of conservation significance

Of the bird species of conservation significance known to occur in the Pilbara, four were recorded during site surveys across the Greater Nammuldi Area (Biota 2009a, 2009c, 2010f, Hamersley Iron 1999). These species were *Merops ornatus* (rainbow bee-eater) (Migratory – JAMBA under the EPBC Act), *Falco peregrinus* (peregrine falcon) (Schedule 4), *Burhinus grallarius* (bush stone-curlew) (Priority 4) and *Ardeotis australis* (Australian bustard) (Priority 4). The peregrine falcon was only recorded during the

1998/99 surveys and although this species has not been recorded in recent surveys, it may potentially occur in the Greater Nammuldi Area.

An additional six bird species of conservation significance (Migratory under the EPBC Act) are considered to have a moderate to high likelihood to occur within the Proposal Boundary based on known distribution of the species in the region and the presence of suitable habitat within the Proposal Boundary, as detailed in Table 43. These are:

- *Neochmia ruficauda subclarescens* (star finch [western]) (Priority 4)
- *Haliaeetus leucogaster* (white-bellied sea-eagle) (CAMBA)
- *Ardea alba* (great egret, white egret) (JAMBA, CAMBA)
- *Ardea ibis* (cattle egret) (JAMBA, CAMBA)
- *Charadrius veredus* (oriental plover, oriental dotterel) (JAMBA, ROKAMBA)
- *Apus pacificus* (fork-tailed swift) (JAMBA, CAMBA, ROKAMBA).

These species are considered to have a large range, with a preference for riparian habitats, if they occur in the area.

Reptiles of conservation significance

Pilbara olive python

The Pilbara olive python is widespread in rocky areas within the Pilbara, showing a preference for rocky habitats near water, particularly rock pools (Biota 2010f). Although the species has not been recorded in any of the surveys of the Greater Nammuldi Area, there is a small area of suitable habitat comprising rocky hills, ridges and small breakaways to the northwest of the *Themeda* Grassland TEC near Silvergrass (Biota 2009c) and Caves Creek. Given this area may provide intermittent water, it could provide potential habitat. Suitable habitat for the Pilbara Olive Python also occurs to the west of the existing Nammuldi mining operation (Biota 2010f). The Pilbara olive python is likely to forage within the Proposal Boundary.

Short-range endemic (SRE) species

The original environmental assessment of the Nammuldi-Silvergrass project in 2000, and the subsequent conditions did not address short-range endemic (SRE) species. As short-range endemism is now considered to be an element in the conservation of biodiversity, surveys for SRE invertebrates in the Greater Nammuldi Area were conducted during vertebrate surveys in 2004 and 2009 (Biota 2005a, Biota 2009c, 2010f). This survey work focused on areas where the Expansion Proposal would require additional clearing to that specified in the Original Proposal. As no terrestrial fauna surveys had previously been conducted in the IAA, a specific SRE survey (Ecologia 2011b) was conducted that included 20 wet-pitfall and foraging sites.

Taxonomic groups of invertebrates with naturally small distributions are described as SREs and are characterised by poor dispersal capabilities, confinement to disjunct habitats and low fecundity (Harvey 2002; Ponder and Colgan 2002). Examples of taxonomic groups that show high levels of short-range endemism in this respect include mygalomorph spiders, millipedes, pseudoscorpions and freshwater and terrestrial molluscs.

The above recent surveys of the Greater Nammuldi Area found the following:

- terrestrial mollusc: approximately 900 specimens from the camaenid genus *Rhagada* sp. 'Brockman', specimens of *Rhagada* sp. nov. 'small banded' and *Succinea* sp.)
- land snail: three additional species at BS4: *Quistrachia* sp?, ?*Eremopeas s*p. and *Pupoides s*p. (Biota 2005a)
- mygalomorph spider: a specimen of *Missulena* was recorded from a pit-trap to the west of Silvergrass (Biota 2009c), one juvenile recorded at BS4 was unable to be further identified (Biota 2005a) and 29 mygalomorphs of the genera *Aname* were recorded (Biota 2009a, 2010f)
- araneomorph spiders: specimens from 15 families were recorded from BS4 (Biota 2005a)

- pseudoscorpions: specimens from the genus *Synsphyronus* (Garypidae) (>60 individuals), Chernetidae family (17 individuals), two specimens from the genus *Afrosternophorus* (Sternophoridae) (Biota 2009a, 2009c, 2010f), five morphospecies of *Beierolpium*, one specimen of *Austrohorus* sp. and one *Olpiidae* indet. sp. nov (Ecologia 2011b)
- scorpionida of the taxa *Lychas* sp. and *Urodacus* sp. (Ecologia 2011b) were recorded
- spirobolid millipede: specimens of *Austrostrophus stictopygus* (family Pachybolidae) were recorded from areas west and east of the existing Nammuldi mining operation (Biota 2010f)
- isopods: specimens of *Buddenlundia* sp.30, Nov. sp.2 and Nov. sp.3 sp. juv were recorded in the IAA (Ecologia 2011b)
- a selenopid spider and one silverfish were collected from locations west of the existing Nammuldi mining operation (Biota 2010f).

Of the invertebrate species recorded, 11 species represent potential SREs and five species have an unknown SRE status (Table 45). For poorly known species such as the majority of SREs, it can be difficult to demonstrate compliance with EPA objectives due primarily to the absence of contextual information on broader distributions (Biota 2009c; Ecologia 2011b). In recognition of this key limitation, an assessment of whether the species recorded represent SRE taxa was undertaken by Biota using the following criteria:

- the relationship between habitat and taxon distribution
- local distribution of that habitat based on available thematic layers; for example. geology, soils, vegetation, drainage (vegetation units may be preferable, as these are often mapped at the finest scale)
- proportion of suitable habitat that may be disturbed by project proposal.

The assessment in Table 45 indicates that all of the recorded terrestrial invertebrate fauna are unlikely to represent SRE species based on vegetation and landform mapping (Biota 2009a, 2009c, 2010f; Ecologia 2011b).

Table 45 Likelihood of SRE

Species	SRE status	Likelihood of being SREs
Buddelundia sp. 30	Potential	Unlikely. Not restricted to particular habitat or vegetation types likely to be affected by the Expansion Proposal.
Armadillidae nov. sp. 2	Potential	Unlikely. Not restricted to particular habitat or vegetation types likely to be affected by the Expansion Proposal.
Armadillidae nov. sp. 3	Potential	Unlikely. Not restricted to particular habitat or vegetation types likely to be affected by the Expansion Proposal.
Olpiidae genus indet.	Potential	Unlikely. Not restricted to particular habitat or vegetation types likely to be affected by the Expansion Proposal.
Rhagada sp.nov. 'small banded'	Potential	Unlikely. Not restricted to particular habitat or vegetation types likely to be affected by the Expansion Proposal.
Succinea sp.	Potential	Unlikely. Not restricted to particular habitat or vegetation types likely to be affected by the Expansion Proposal.
Beierolpium 'sp. (all five morphospecies)	Potential	Unlikely. Not restricted to particular habitat or vegetation types likely to be affected by the Expansion Proposal.
Austrohorus sp.	Unknown	Unlikely. Not restricted to particular habitat or vegetation types likely to be affected by the Expansion Proposal.
Urodacus sp.	Unknown	Unlikely. Not restricted to particular habitat or vegetation types likely to be affected by the Expansion Proposal.
Lychas sp.	Unknown	Unlikely. Not restricted to particular habitat or vegetation types likely to be affected by the Expansion Proposal.
Buddelundia sp. juv	Unknown	Unlikely. Not restricted to particular habitat or vegetation types likely to be affected by the Expansion Proposal.

10.3 Potential sources of impact

The following aspects of the Expansion Proposal may affect terrestrial fauna values:

- **clearing of vegetation** will directly disturb fauna habitat and may result in the loss of individual terrestrial fauna
- **changes to sheet flow** through extension of mine pits, and construction of additional waste dumps, infrastructure and diversion structures has the potential to have an impact on vegetation communities that are sustained by sheet flow and may subsequently affect fauna that may use this habitat
- **vehicle movements** within the Proposal Boundary may result in the loss of individual terrestrial fauna
- **dewatering** for BWT mining at Nammuldi and Silvergrass pits will lower ground water levels in proximity to the pits and may therefore affect local riparian vegetation and subsequently affect fauna utilising this habitat
- **discharge of surplus water** may alter the composition of local riparian vegetation communities downstream of the discharge and subsequently affect fauna that may use this habitat.

The proposed re-alignment to Caves Creek is considered unlikely to alter the long-term flow regime of this creek and thus will not have an impact on downstream riparian habitat (Section 8.4.3).

Other minor sources of potential impact include dust and noise emissions, particularly from mining activities, which may deter species from foraging and general habitation close to those sources. Noise and dust generated by the Expansion Proposal is addressed in Sections 15.1 and 15.2 respectively and is not likely to be substantially different to that which may occur by the implementation of the Original Proposal.

The potential introduction and/or spread of feral animals as a result of the Expansion Proposal are also not anticipated to significantly affect terrestrial fauna. A number of management measures will be implemented to manage feral animals in accordance with the Fauna Management Plan as part of the EMP (Appendix 3). These measures are also summarised in Section 10.5.

10.4 Assessment of likely direct and indirect impacts

The main potential sources of impacts on terrestrial fauna from the Expansion Proposal were outlined in Section 10.3 and the likely impacts are discussed in more detail below.

10.4.1 Vegetation clearing

Clearing of vegetation for the Expansion Proposal is considered in this section in terms of the effect on fauna habitat and fauna species of conservation significance.

Impact of clearing on fauna habitat

The majority of the disturbance included in the CER for the Original Proposal was in fauna habitats of low conservation significance, with limited disturbance to habitats of high conservation significance. Clearing for the Expansion Proposal will progressively remove vegetation from within the Proposal Boundary and will result in the removal of up to 3900 ha of habitat for the expansion of mining activities and an additional 2500 ha for the IAA (Figure 57).

The majority of the proposed clearing will be undertaken in the hills and plains fauna habitat, which is of low conservation significance, widely distributed and relatively well-represented in the locality (Table 41). The hills and plains fauna habitat will not be significantly affected with approximately 11% of the occurrence of this habitat being cleared.

The drainage line fauna habitat, which is of local significance, will be avoided where possible; however, only 11% of the mapped distribution in the local area will be cleared (Table 41). This is primarily in minor drainage lines, with the impact on major drainage lines being restricted to the 2.5 km section of Caves Creek that will be re-aligned. However, the loss of this vegetation is not considered to be significant considering that this vegetation community is well represented in the Greater Nammuldi Area. Further, the rehabilitation measures prescribed in the Surface Water Management Plan (included in the EMP Appendix 3) for the creek re-alignment will reinstate the ecological linkages along this potential fauna corridor.

Of the total 3835 ha of clay soil habitat mapped, approximately 19%, will be disturbed by the Expansion Proposal, however, this will not involve the clearing of the *Themeda* grassland TEC or areas of *Astrebla* tussock PEC mapped as a Good representation.

The mapped gorge fauna habitat, such the area occurring northwest of Nammuldi or the area occurring northwest of Silvergrass, will not be disturbed for the Expansion Proposal. The ecological linkages between these habitats and surrounding drainage line habitat will also be maintained.

As a result of planning to avoid fauna habitat of high conservation significance and limiting the clearing of locally significant drainage line habitat, the Expansion Proposal is not expected to have a significant effect on the distribution of fauna habitats in the Greater Nammuldi Area.

The removal of habitat due to clearing is likely to result in localised reductions in fauna populations immediately in, and around the footprint; however, given the representation of the fauna habitats in the Greater Nammuldi Area the regional diversity of habitats is unlikely to be affected.

In addition, the potential impacts on fauna as a result of vegetation clearing will be mitigated through implementation of management measures described in the Vegetation and Flora Management Plan and the Fauna Management Plan contained in the EMP (Appendix 3). Further details on the management of clearing are provided in Section 10.5.

Impact of clearing on fauna species of conservation significance

Table 46 outlines the predicted impacts of vegetation clearing and associated habitat removal on species of conservation significance, which have been identified as occurring or potentially occurring at the Greater Nammuldi Area.

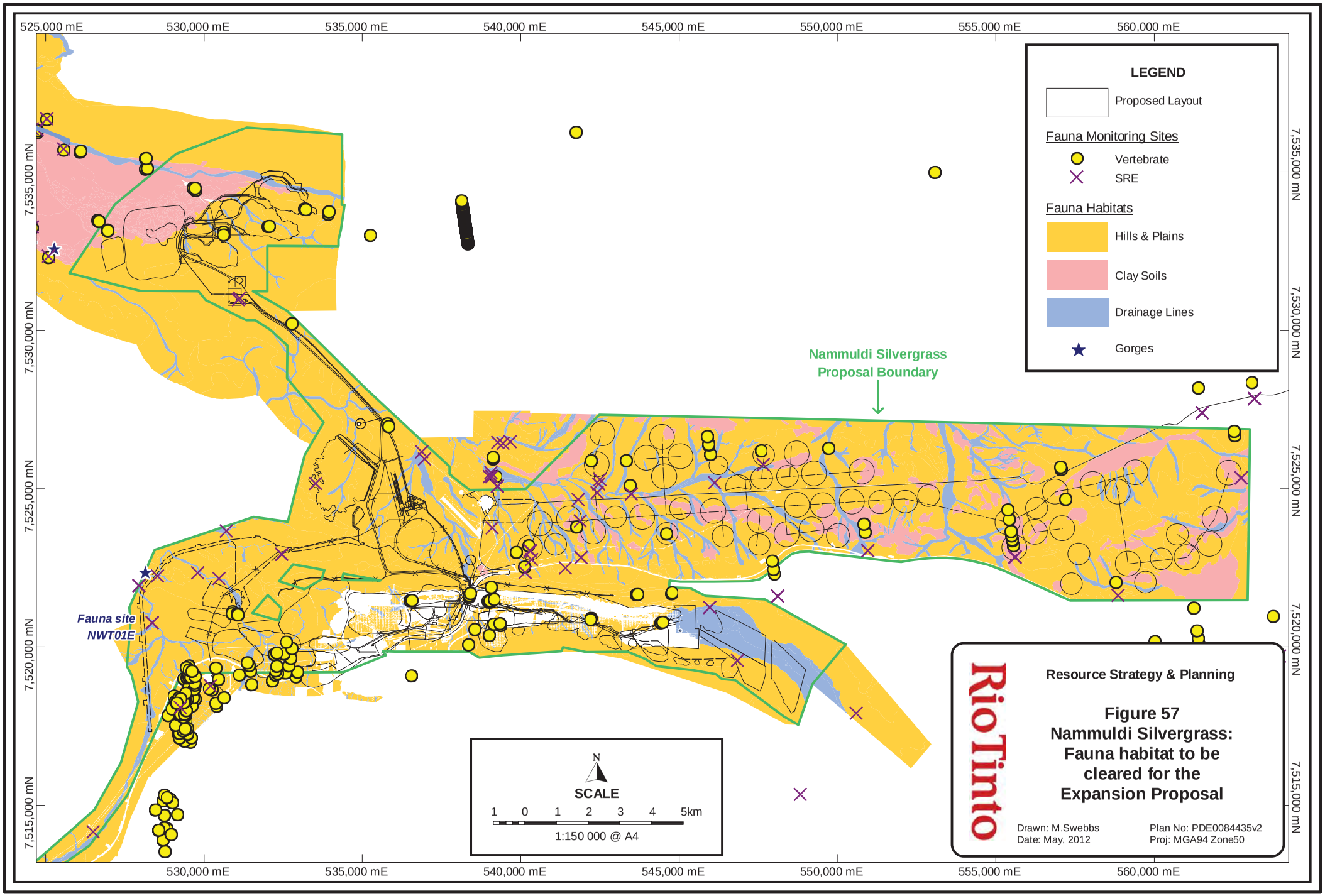

525,000 mE
530,000 mE
535,000 mE
540,000 mE
545,000 mE
550,000 mE
555,000 mE
560,000 mE
7,535,000 mN
7,530,000 mN
7,525,000 mN
7,520,000 mN
7,515,000 mN
LEGEND
Proposed Layout
Fauna Monitoring Sites
Vertebrate
SRE
Fauna Habitats
Hills & Plains
Clay Soils
Drainage Lines
Gorges
Nammuldi Silvergrass
Proposal Boundary
Fauna site
NWT01E
N
SCALE
1 0 1 2 3 4 5km
1:150 000 @ A4
Resource Strategy & Planning
Figure 57
Nammuldi Silvergrass:
Fauna habitat to be
cleared for the
Expansion Proposal
Drawn: M.Swebbs
Date: May, 2012
Plan No: PDE0084435v2
Proj: MGA94 Zone50

Table 46 Predicted impacts of clearing on conservation significant vertebrate fauna species

Species	Preferred habitat	Likelihood of occurrence	Predicted impact from clearing
Dasyurus hallucatus (northern quoll)	Potentially suitable habitat within the Proposal Boundary is limited to the rocky ridgelines to the west of Nammuldi (Biota 2009a) and the rocky gorge habitat northwest of the Nammuldi mining area (Biota 2010f).	Species unlikely to occur in the area. Based on survey effort any occurrence within the Proposal Boundary is likely to be infrequent.	**No impact expected.** As there will no clearing of rocky gorges, the Expansion Proposal will not result in the loss of any potential den areas and will only result in minor reduction in availability of suitable foraging habitat in proximity to the drainage line habitats. However this does not affect any denning habitat. The Expansion Proposal is highly unlikely to have a significant impact on this species given the broad distribution of the northern quoll habitat in the Pilbara bioregion and the relatively small scale of clearing of foraging habitat required for the proposal. The conservation status of this species will not be affected by the Expansion Proposal.
Rhinonicteris aurantia (Pilbara orange leaf-nosed bat)	Although not recorded during the targeted (Biota 2009a) or other surveys (Hamersley 1999, Biota 2010f) of the Greater Nammuldi Area, several caves along Marra Mamba ridges north of Nammuldi, south of Silvergrass and in one area west of the Nammuldi may provide suitable roosts for this species (Biota 2009a, 2010f).	Species may occur in the area. Species may fly over or forage within the Proposal Boundary. All potential roosting habitat that may be used by this species occurs outside the Proposal Boundary in caves west of Silvergrass, near Caves Creek.	**No impact expected.** The relatively small area of potential gorge and rocky habitat within the Proposal Boundary will be avoided. The Expansion Proposal is unlikely to have a significant effect on the local presence of this species. The conservation status of this species will not be affected by the Expansion Proposal.
Liasis olivaceus barroni (olive python)	A small area of suitable habitat comprising rocky hills, ridges and small breakaways to the northwest of the Themeda Grassland TEC near Silvergrass (Biota 2009c) and Caves Creek. Given this area may provide intermittent water, it could provide potential habitat. Suitable habitat for the Pilbara Olive Python also occurs to the west of the existing Nammuldi mining operation (Biota 2010f).	Species may occur in the area. Although not recorded, this species has a wide distribution throughout the Pilbara and is likely to forage within the Proposal Boundary.	**No impact expected.** As there will be no clearing of rocky gorges, the Expansion Proposal will not result in the loss of any potential high value habitat. As the species can travel long distances during the breeding season, there is some potential for minor interruptions to transit routes and there is potential for some direct mortality as a result of contact with vehicles and mobile machinery. The conservation status of this species will not be affected by the Expansion Proposal.
Falco peregrinus (peregrine falcon)	Species has a wide distribution throughout the Pilbara and	Species may occur in the area. The Proposal Boundary is likely to occur within the large ranges of individuals of this species.	**No impact expected.** With its cosmopolitan distribution and adaptability to varying habitats, the Expansion Proposal is not expected to affect the distribution of this species. The conservation status of this species will not be affected by the Expansion Proposal.
Lagorchestes conspicillatus leichardti (spectacled hare-wallaby)	This species inhabits open forests, woodlands, shrublands and hummock grasslands	Species unlikely to occur in the area. The Proposal Boundary does not contain suitable habitat and has not been recorded within the Proposal Boundary (Biota 2009c, 2010f).	**No impact expected.** Given that s habitat will remain largely undisturbed, the distribution of this species is not expected to be affected by the Expansion Proposal. The conservation status of this species will not be affected by the Expansion Proposal.
Leggadina lakedownensis (short-tailed mouse)	This species is known to occur on sandy soils and cracking clays but is not considered to be restricted in habitat.	Species likely to occur in the area. Species likely to use the of the *Themeda* grassland TEC.	**No impact expected.** As the *Themeda* grassland TEC habitat will not be affected by the Expansion Proposal the distribution of this species is not expected to be affected by the Expansion Proposal. The conservation status of this species will not be affected by the Expansion Proposal.

Species	Preferred habitat	Likelihood of occurrence	Predicted impact from clearing
Pseudomys chapmani (western pebble-mound mouse)	Habitat for this species is rocky, hummock grasslands, with little or no soil. The western pebble-mound mouse occupies burrows beneath mounds of pebbles. Mounds are most common on the spurs and lower slopes of ridges.	Species likely to occur in the area. This species is considered to be common to very common in suitable habitat within the Hamersley and Chichester sub-regions of the Pilbara bioregion.	**No impact expected.** Approximately 30% of the surveyed distribution of hills and plains habitat will be affected by the Expansion Proposal. Given the broad distribution and its habitat in the Pilbara of the this species, clearing of some potentially suitable habitat is not expected to affected the distribution of this species, either at the Pilbara bioregion or Hamersley sub-region level. The conservation status of this species will not be affected by the Expansion Proposal.
Sminthopsis longicaudata (long-tailed dunnart)	Suitable habitat consists of rugged, rocky areas associated with breakaways and scree slopes.	Species may occur in the area. Previously recorded in the Greater Nammuldi Area (Hamersley Iron 1999) but not recorded in recent surveys.	**No impact expected.** Suitable habitat within the Proposal Boundary is relatively small and unlikely to contain significant populations of the species. The distribution of this species will not be affected by the Expansion Proposal given the broader distribution of the hills and plains habitat and limited extent of disturbance of this habitat. The conservation status of this species will not be affected by the Expansion Proposal.
Macroderma gigas (ghost bat)	This species roosts in gorges.	Species likely to occur in the area. There is a known maternity roost to the east of Silvergrass (outside the Proposal Boundary) near Caves Creek (Hamersley Iron 1999). The species was recently recorded opportunistically in the Silvergrass West study area (Biota 2009c).	**No impact expected.** Vegetation clearing may result in the localised loss of foraging habitat, but this is not expected to affect the distribution of this species. No roosting habitat (gorge habitat) will be disturbed by the Expansion Proposal. The conservation status of this species will not be affected by the Expansion Proposal.
Ardeotis australis (Australian bustard)	Habitat preferred by this species is tussock grassland, *Triodia* hummock grassland, grassy woodland and low shrublands.	Species likely to occur in the area. Recorded in the Greater Nammuldi Area (Ecologia 2011a; Biota 2009c; Hamersley Iron 1999),	**No impact expected.** The main threat to this species is from individuals being killed or injured by vehicles along roads and tracks. Given the broad distribution and wide-ranging nature of this bird and the extent of potentially suitable hills and plains habitat, the distribution of this species is not expected to be affected by the Expansion Proposal. The conservation status of this species will not be affected by the Expansion Proposal.
Burhinus grallarius (bush stone-curlew)	This species inhabits open forests and woodlands, with sparse grassy understory.	Species unlikely to occur in the area. Recorded only once in the Silvergrass West area, outside the Proposal Boundary (Biota 2009c), which indicates it is unlikely to rely on areas within the Proposal Boundary for habitat.	**No impact expected.** Species occurs in a wide variety of woodland habitat that is not restricted to the Greater Nammuldi Area. The distribution of this species will not be affected by the Expansion Proposal given the broader distribution of habitat and limited extent of disturbance of habitat. The conservation status of this species will not be affected by the Expansion Proposal.
Neochmia ruficauda Subclarescens (star finch [Western])	Preferred habitat is grasslands and eucalypt woodland.	Species may occur in the area. Although not recorded to date within the Proposal Boundary and potentially occurs within the Proposal Boundary.	**No impact expected.** The main threat to the species is considered to be overgrazing by stock along waterways, which destroys the riparian vegetation on which they depend (Garnett and Crowley 2000). The star finch has not been recorded in the Greater Nammuldi Area but may occur in the *Eucalyptus camaldulensis*/*E. victrix* vegetation along Caves Creek. Excluding the localised re-alignment of Caves Creek, riparian vegetation will not be affected and given the local extent of riparian vegetation, the distribution of this species is not expected to be affected by the Expansion Proposal. The conservation status of this species will not be affected by the Expansion Proposal.

Species	Preferred habitat	Likelihood of occurrence	Predicted impact from clearing
Notoscincus butleri	This skink inhabits spinifex-dominated areas near creek and river margins	Species may occur in the area. This species has been rarely observed at Nammuldi/Silvergrass and may occur in the vicinity of creek vegetation within the Greater Nammuldi Area at Caves and Duck creeks	**No impact expected.** Given creekline habitats will remain largely undisturbed, the distribution of this species is not expected to be affected by the Expansion Proposal. The conservation status of this species will not be affected by the Expansion Proposal.
Merops ornatus (rainbow bee-eater)	The rainbow bee-eater is a regular breeding migrant to Western Australia. This species has been found within open forests, woodlands and shrublands, and cleared areas. The species nests in habitats that provide suitable sandy soil for nesting and a full stratum of vegetation for perching, particularly near water bodies (Higgins 1999).	Species may occur in the area. The species has been recorded in the Greater Nammuldi Area (Biota 2009c, 2010f: Hamersley Iron 1999; Ecologia 2011a).	**No impact expected.** Given the large range of this migratory bird and its use of disturbed areas for nesting, any impact is expected to be negligible, particularly given that there are no permanent water bodies within the Proposal Boundary. The conservation status of this species will not be affected by the Expansion Proposal.
Migratory wetland/ marine birds	The wetland species identified Table 43 as potentially occurring migratory species, which were predominately associated with watercourse or wetland habitats.	Species are unlikely to occur in the area. No permanent water bodies in the Proposal Boundary.	**No impact expected.** These species are not expected to be affected by this Proposal particularly given that there are no permanent water bodies within the Proposal Boundary,. The conservation status of any species will not be affected by the Expansion Proposal.

10.4.2 Sheet flow disruption

As described in Section 9.4.2, changes to surface water run-off patterns can affect downstream vegetation communities that are dependent on sheetflow, particularly mulga woodlands, which in turn, has the potential to affect fauna habitat.

The Expansion Proposal includes a heavy vehicle road between Nammuldi and BS4, and a network of roads between new mine pits and/or waste dumps. Approved and existing linear infrastructure between Nammuldi and BS4 include a powerline, rail-line access track, sealed road and water pipeline therefore the addition of the proposed haulroad for this project does not introduce linear infrastructure factor that is not already present.

The network of roads between new pits and / or waste dumps are not situated near any mulga woodlands or sheetflow-dependent communities, and previous studies suggest that there has been no appreciable negative effect of linear infrastructure on mulga woodlands ((Hick et. al. 1997, Muller 2005, Nickolls 2006 and Batini 2008).

10.4.3 Vehicle movements

Vehicle movement associated with construction and operation of the Expansion Proposal has the potential to cause the loss of some individuals of terrestrial fauna species. Less-mobile species, such as reptiles (including *Liasis olivaceus barroni* [olive python] if present) are most likely to be directly affected. In addition, as the more mobile species move away from areas cleared for mining, they inevitably cause disruption to adjacent populations and may become exposed to predators.

Potential impacts on fauna as a result of vehicle movement will be managed in accordance with the Fauna Management Plan in the EMP (Appendix 3). Speed limits will be enforced on all roads associated with the Proposal to reduce the risk of impact with fauna. The conservation status and distribution of any fauna species will not be affected by the small number of individuals that may be lost associated with vehicle movement.

10.4.4 Dewatering

As described in Section 7.4.1, dewatering has the potential to affect groundwater-dependent ecosystems (GDEs), which can affect fauna habitats. No GDEs occur within the extent of groundwater drawdown, thus the effect on the availability of fauna habitat from groundwater drawdown will be negligible.

Further details on the impact of groundwater drawdown on vegetation are outlined in Section 7.4.1.

10.4.5 Discharge of surplus water

The discharge of surplus water into Duck Creek will saturate the alluvium and modify the hydrological regime for a distance downstream of the discharge. The riparian ecosystems may experience increased water availability and ponding/inundation during the period of discharge (Section 9.4.4), resulting in altered composition and a potential loss of fauna habitat.

As described in Section 9.4.4, ongoing studies on riparian trees within the Pilbara (Biota 2011b) suggest that discharge of surplus water into creeks has not had any significant impact on riparian trees. As the distribution of riparian habitat is defined by the presence of riparian vegetation, the Expansion Proposal is, therefore, not expected to result in any changes in the distribution of riparian habitat. In addition, as the flow will only occur periodically it is considered unlikely that any terrestrial fauna species will become reliant on these flows. It is therefore considered unlikely that fauna will be appreciably impacted by the discharge of surplus water into Duck Creek.

Periodic releases of surplus water into Duck Creek also have the potential to adversely affect aquatic fauna and subterranean fauna. The impact of surplus water discharge on aquatic fauna is discussed in Section 8.4.2.

10.5 Management measures and performance standards

Potential impacts on terrestrial fauna within, and adjacent to the Proposal Boundary will be managed and mitigated through the implementation of measures described in the Fauna Management Plan contained in the EMP (Appendix 3). This plan is integrated with other management plans under the EMP and key aspects relating to fauna including habitat removal (minimising clearing of vegetation) and impact on Caves Creek are managed in accordance with the Vegetation and Flora Management Plan and the Adaptive Surface Water Management Plan respectively.

Key measures in the Fauna Management Plan include:

- as far as practicable, preferentially locating infrastructure in previously disturbed areas to minimise clearing of undisturbed native vegetation so as to prevent potential loss of fauna habitat
- avoiding fauna habitats of high conservation significance, wherever practicable
- clearing vegetation in a deliberately outward manner that allows for the progressive movement of fauna into areas beyond the disturbance footprint
- native animals encountered on-site (including during clearing) will be given the opportunity to move on if there is no threat to personnel safety in doing so
- maintaining low speed limits for mining equipment and light vehicles by ensuring all roads are sign-posted, vehicle speeds are monitored and all personnel and contractors are inducted on speed limit requirements
- providing workforce environmental education programs and training on the importance of protecting native vegetation, conservation-significant fauna and habitat and discouraging personnel from entering areas of high conservation significance
- progressively rehabilitating disturbed areas as soon as practicable following use, and in accordance with the EMP and site rehabilitation plan
- utilising cleared windrows of topsoil, log debris and leaf litter in rehabilitation, as they create microhabitat for a large range of fauna, particularly reptiles
- prohibiting the feeding of feral animals
- implementing a trapping and eradication program
- effectively managing rubbish as per the EMP (Appendix 3).

10.6 Predicted environmental outcomes against environmental objectives, policies, guidelines, standards and procedures

After application of mitigation measures, the Expansion Proposal is expected to result in the following outcomes in relation to terrestrial fauna:

- additional clearing and direct disturbance of up to 3900 ha of terrestrial fauna habitat of predominantly low conservation significance for the expansion of mining activities and an additional 2500 ha for the IAA
- no significant impact to habitats of high conservation significance with disturbance to clay soil habitat affecting only 19% of local distribution and no affect on mapped gorge habitat
- no significant impact to any fauna species of conservation significance
- no change to the conservation status of any terrestrial fauna species
- unavoidable loss of some individual fauna specimens through collisions with machinery and vehicles
- no significant impact to any SREs given the broad distribution in the region of the species located within the Proposal Boundary.

11. Assessment of impact on subterranean fauna

11.1 Relevant environmental objectives, policies, guidelines, standards and procedures

11.1.1 EPA objective

The EPA applies the following objective in its assessment of proposals that may affect subterranean fauna:

To maintain the abundance, diversity, geographic distribution and productivity of fauna species and ecosystems levels through the avoidance or management of adverse impacts and improvements in knowledge.

11.1.2 EPA statements and guidelines

EPA Guidance Statement No. 54 and Draft Guidance Statement No. 54a

EPA Guidance Statement No. 54 (EPA 2003) provides guidance on information the EPA will consider when assessing proposals where subterranean fauna is a relevant factor.

The draft EPA Guidance Statement No. 54a (EPA 2007b) has been developed as a technical appendix to EPA Guidance Statement No. 54 and provides guidance on sampling for subterranean fauna, including sampling effort, sampling design and ongoing monitoring.

11.1.3 Regulatory framework

State protection

In a legislative context, the conservation of fauna is covered primarily by the following Western Australian legislation:

- *Wildlife Conservation Act 1950* (WA) (WC Act)
- *Conservation and Land Management Act 1984* (WA).

In Western Australia, rare or endangered species are protected by the Wildlife Conservation (Specially Protected Fauna) Notice 2008, under the WC Act. Schedules 1 and 4 in this Notice are relevant to this assessment, providing a listing of those species protected by the Notice.

The DEC (Nature Conservation Division) Priority Fauna List also nominates conservation species from Priority 1 to 5. It is expected that the potential impacts of a proposal to these Priority listed species should be managed such that the species do not meet the IUCN criteria for threatened species.

11.2 Description of factor

Subterranean fauna are divided into two broad categories; stygofauna and troglofauna. Stygofauna are obligate groundwater-dwelling aquatic fauna that inhabit a range of groundwater systems, spending their entire life cycle below ground. Typical groundwater habitats of stygofauna include large caves, mesocaverns in karst and basalts and the interstitial spaces of alluvial aquifers. The most common stygofauna in Western Australia are crustaceans. Some species of stygofauna have extremely localised patterns of distribution, linked to a lack of connectivity between aquifers.

Troglofauna are obligate terrestrial fauna that inhabit air chambers in underground caves or small humid air-filled spaces above the watertable. While troglofauna have commonly been found in karstic limestone systems, they may occur in other fractured and cavernous geology types. Examples of troglofauna

invertebrates include spiders, scorpions, centipedes, millipedes, insects and crustaceans. Due to long periods of isolation and a lack of connectivity between populations, some troglofauna species have a restricted distribution.

There has been an increase in subterranean fauna surveys in WA over the past decade, revealing an exceptionally high diversity, particularly in the Pilbara region (Humphreys 2006; Humphreys et al. 2004). Research by the WA Museum has shown that calcrete and alluvial aquifers in the Pilbara and Yilgarn regions of Western Australia contain diverse stygofaunal communities (Humphreys 1999). In the arid zone, troglofauna are generally considered to be relictual rainforest litter fauna, having arisen from tropical fauna lineages that descended into subterranean environments during the aridification of Australia (Humphreys 1993).

Many Western Australian subterranean fauna species are of conservation significance as they appear to represent links to the time when Australia was part of Gondwanaland, bordered by the Tethys Sea (Humphreys 1999). In addition to this, troglofauna and stygofauna in Western Australia exhibit high levels of endemism, with many of the species having restricted ranges characteristic of subterranean fauna worldwide (EPA 2003).

11.2.1 Stygofauna sampling

Several surveys have been conducted in the Greater Nammuldi Area to identify and record the presence of subterranean fauna. At the time of release of the CER document for the Original Proposal at Nammuldi, Rio Tinto committed to undertaking further subterranean fauna surveys as the previous investigations were incomplete. Five phases of stygofauna sampling were conducted at Nammuldi and Silvergrass to satisfy Condition 6 of Statement 558; May 1999, October 1999, November 2000, May 2001 and July 2002 (Biota 2003). The survey results were submitted to the Department of Environmental Protection (now DEC) and Condition 6 of Statement 558 was signed off in March 2003.

All phases of stygofauna sampling at Nammuldi and Silvergrass followed a similar methodology to other stygofauna sampling projects previously undertaken in the Pilbara bioregion. Methodology and approach were consistent with those outlined in EPA Guidance Statement 54 (EPA 2003) and Draft Guidance Statement 54a (EPA 2007b). Groundwater sampling was undertaken by use of modified plankton haul nets, constructed from 70 µm plankton mesh, with 50 mm and 100 mm apertures attached to a weighted catch jar. Each bore was dragged a minimum of three times unless fauna were detected, in which case six hauls were completed (Biota 2010h).

The sampling effort at the Nammuldi site is substantial, with over 110 bore-sampling events taking place over four years (Figure 58). Three specimens of stygofauna were collected from Nammuldi, two of which have a wide occurrence in the Pilbara region (Table 47). Despite the extensive sampling, there is little evidence to suggest a significant stygal community exists at Nammuldi (Biota 2010h).

Table 47 Stygofauna collected from Nammuldi

Class	Order	Family	Taxon	No. collected
Copepoda	Cyclopoida	Cyclopidae	*Mesocyclops brooksi*	1
Malacostraca	Amphipoda	Paramelitidae	*Pilbarus millsi*	1
Malacostraca	Amphipoda	Melitidae	*Nedsia* sp.	1

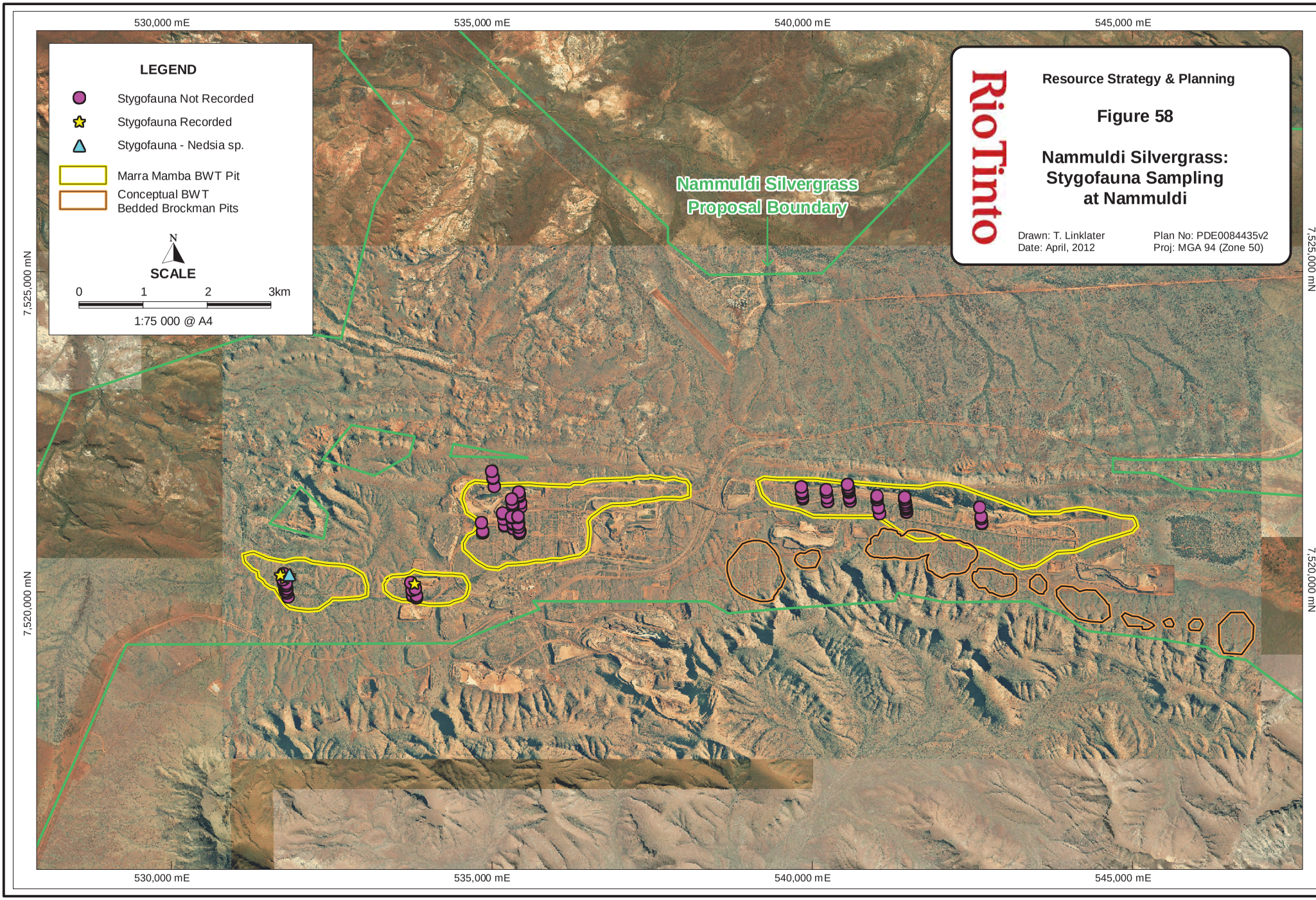
The original sampling at Silvergrass included nine bores within the Proposal Boundary, as well as 36 bores at Homestead, approximately 20 km west of Silvergrass. An additional subterranean fauna survey (including both stygofauna and troglofauna) was conducted at Silvergrass in May 2009, with sampling occurring within the Proposal Boundary and to the west of the Silvergrass TEC (referred to as Silvergrass West) (Biota 2010h, included in Appendix 2).

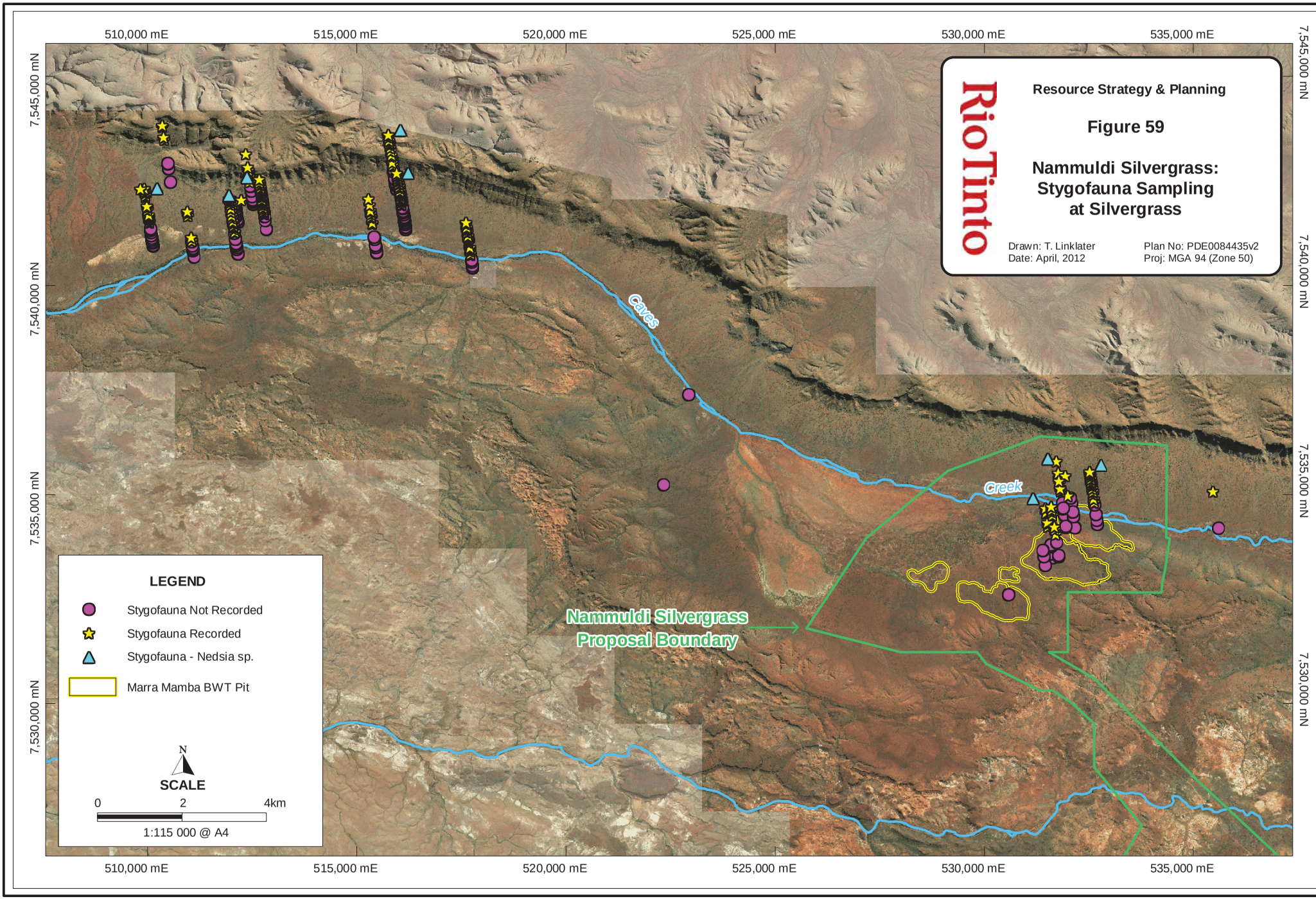
The sampling effort at Silvergrass to date has collected a total of 98 stygofauna specimens from within the Proposal Boundary, representing seven orders and 12 taxon. Several of the stygofauna species collected from Silvergrass were also found in bores at Homestead and Silvergrass West (Table 48). Crustacean orders dominated the collected fauna, with the most abundant representation being the Copepoda and Amphipoda orders (Biota 2010h). The majority of stygofauna species recorded at Silvergrass are known to be widely distributed in the Pilbara bioregion (Biota 2010h). Stygal taxa *Nedsia* sp. A may be restricted to the Caves Creek alluvial aquifer. A total of 35 specimens of this taxa were found within the Proposal Boundary, with a further 58 specimens recorded from bores at Homestead and along Caves Creek outside the Proposal Boundary.

Table 48 Summary of stygofauna collected from Silvergrass

Phylum/ Sub phylum	Class/ Sub Class	Order	Taxon	No. of individuals recorded		
				Within Proposal Boundary	Outside Proposal Boundary	Total
Platyhelminthes	Turbellaria	Indet.	*Turbellaria* sp.	1	4	5
Annelida	Oligochaeta	Haplotaxida	*Enchytraeidae* sp.	4	0	4
Crustacea	Malacostraca	Amphipoda	*Nedsia hurlberti*	7	11	18
			Nedsia sp.	14	18	32
			Nedsia sp. A	35	58	93
			Paramelitidae sp.	7	5	12
			Paramelitidae sp. 2 (DEC)	2	1	3
		Isopoda	*Pygolabis* sp. 'paraburdoo'	1	1	2
	Copepoda	Cyclopoida	*Diacyclops humphreysii humphreysi*	18	203	221
			Diacyclops sobreprolatus	5	0	5
		Harpacticoida	*Schizopera roberiverensis*	3	8	11
	Ostracoda	Podocopa	*Areacandona novitas*	1	1	2

In addition to stygofauna sampled during the targeted surveys, a number of stygobitic species were collected by WRM during the four phases of aquatic fauna sampling (WRM 2011a, 2011b). These were considered to be hyporheic species and have been discussed in Section 8.2.3.


530,000 mE
535,000 mE
540,000 mE
545,000 mE
7,525,000 mN
7,520,000 mN
LEGEND
Stygofauna Not Recorded
Stygofauna Recorded
Stygofauna - Nedsia sp.
Marra Mamba BWT Pit
Conceptual BWT
Bedded Brockman Pits
N
SCALE
0
1
2
3km
1:75 000 @ A4
Nammuldi Silvergrass
Proposal Boundary
RioTinto
Resource Strategy & Planning
Figure 58
Nammuldi Silvergrass:
Stygofauna Sampling
at Nammuldi
Drawn: T. Linklater
Date: April, 2012
Plan No: PDE0084435v2
Proj: MGA 94 (Zone 50)


Resource Strategy & Planning
Figure 59
Nammuldi Silvergrass: Stygofauna Sampling at Silvergrass
Drawn: T. Linklater
Date: April, 2012
Plan No: PDE0084435v2
Proj: MGA 94 (Zone 50)
510,000 mE
515,000 mE
520,000 mE
525,000 mE
530,000 mE
535,000 mE
7,545,000 mN
7,540,000 mN
7,535,000 mN
7,530,000 mN
Caves
Creek
Nammuldi Silvergrass Proposal Boundary
LEGEND
Stygofauna Not Recorded
Stygofauna Recorded
Stygofauna - Nedsia sp.
Marra Mamba BWT Pit
N
SCALE
0
2
4km
1:115 000 @ A4

11.2.2 Troglofauna

Three phases of troglofauna sampling have been conducted in the Greater Nammuldi Area. Phase 1 trapping occurred as part of the May 2009 Silvergrass subterranean fauna survey. The Phase 2 trapping occurred in April 2010 and Phase 3 trapping in July 2010, with troglofauna sampled for both at Nammuldi and Silvergrass.

Troglofauna were sampled in accordance with EPA Guidance Statement 54 (EPA 2003) and Draft Guidance Statement 54a (EPA 2007b), by means of custom-built litter traps suspended within drill holes (Biota 2010h).

The sampling effort at Nammuldi covered a total of 116 traps set at 30 sampling sites (Table 49). Along Caves Creek (i.e. within the Proposal Boundary at Silvergrass and outside the Proposal Boundary at Silvergrass West), the sampling effort covered a total of 74 sites, with sampling from 185 traps (Table 49).

Table 49 Troglofauna sampling effort for Nammuldi and Silvergrass (including Silvergrass West)

Phase/Trapping date/Site	Bore holes sampled	Traps set
Phase 1 – May 2009		
Silvergrass	56	90
Phase 2 – April 2010		
Nammuldi	10	29
Silvergrass	18	32
Phase 3 – July 2010		
Nammuldi	30	87
Silvergrass	29	63

Source: Biota 2011c

The sampling effort within both the Greater Nammuldi Area recorded a total of 9688 specimens from 19 orders. Of these, five orders were considered to display troglomorphic characteristics: Blattodea (cockroaches), Diplura (diplurans, earwigs), Polyxenida (pincushion millipedes), Schizomida (Schizomids) and Geophilida (earth centipedes) (Biota 2011c).

A total of 140 potentially troglobitic specimens were collected by the three phases of sampling within the Silvergrass study area, including Silvergrass West (Figure 61). The Phase 2 and Phase 3 sampling at Nammuldi collected a total of 14 specimens of troglofauna from the taxa Polyxenida and Blattodea, both of which have also been collected from a number of locations near Silvergrass (Table 51). The specimens recorded at Nammuldi were found within three of the 30 sampling sites (Figure 60).

DNA sequencing was conducted on Polyxenida, Blattodea and Schizomida samples collected in Phase 1 and Phase 2 to facilitate identification at the species level (Biota 2011c). The results of the DNA analysis was compared to other specimens collected in the Pilbara and the specimens classified into specific lineages to allow for regional genetic comparison (Table 50).

Table 50 DNA results for select specimens collected from Nammuldi and Silvergrass

Order	Lineage	Regional distribution	Local distribution
Polyxenida	A	This taxon has been located only from the Silvergrass East study area.	A single specimen collected from Silvergrass.
	C	Widespread – represented by specimens from both the East and West Pilbara.	Nammuldi, Silvergrass and Silvergrass West.
	D	Widespread and has been collected from Western Ranges, Turee Syncline and Mesa G.	Silvergrass West.
Blattodea	A	Widespread throughout the Pilbara region.	Silvergrass and Nammuldi.
Schizomida	D	Lineage D is an undescribed taxon collected only from the Silvergrass West area.	Silvergrass West.

Source: Biota 2011c

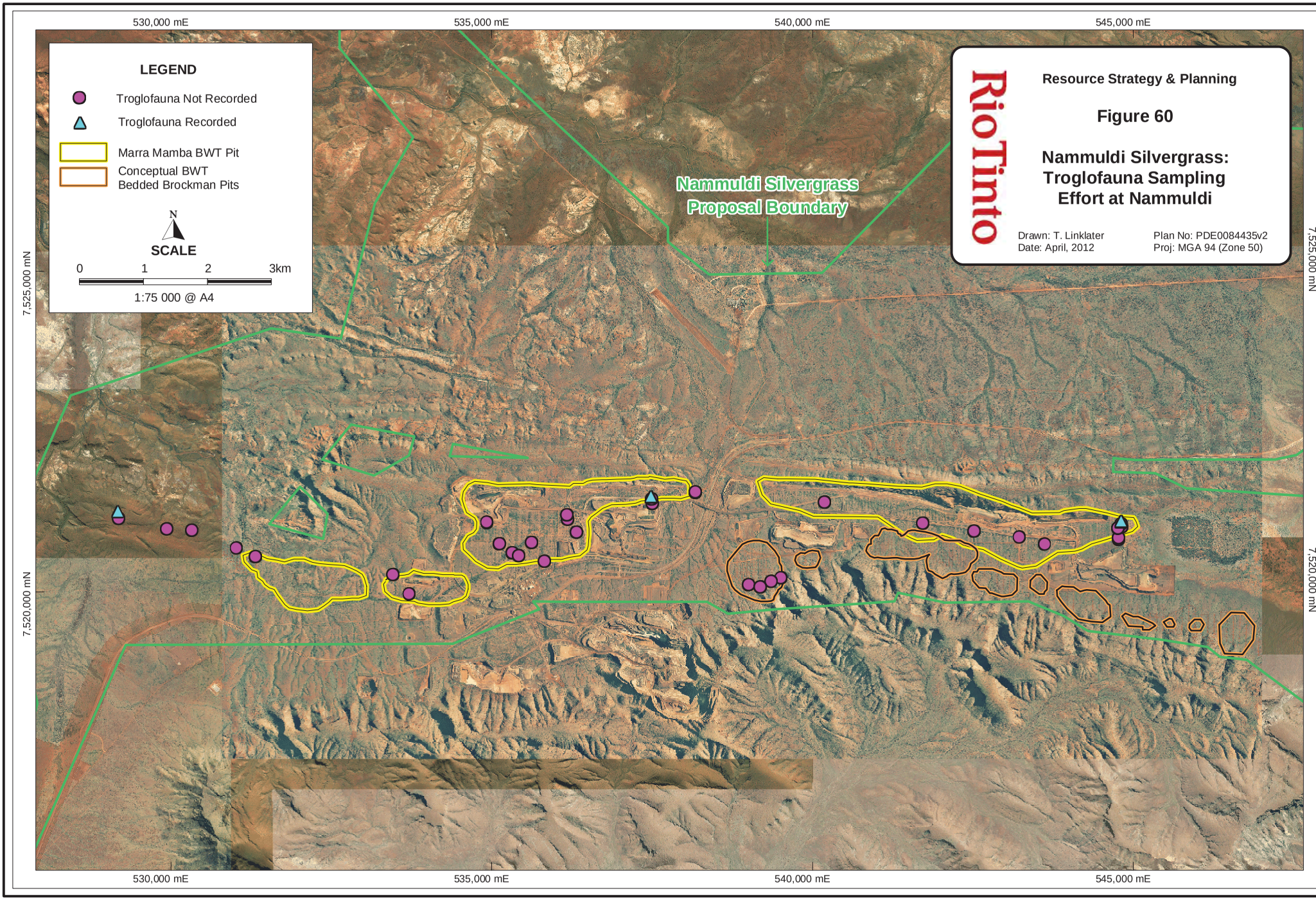
DNA analysis of potentially trogolobitic taxa within the Proposal Boundary identified at two Nammuldi and five at Silvergrass (Table 51).

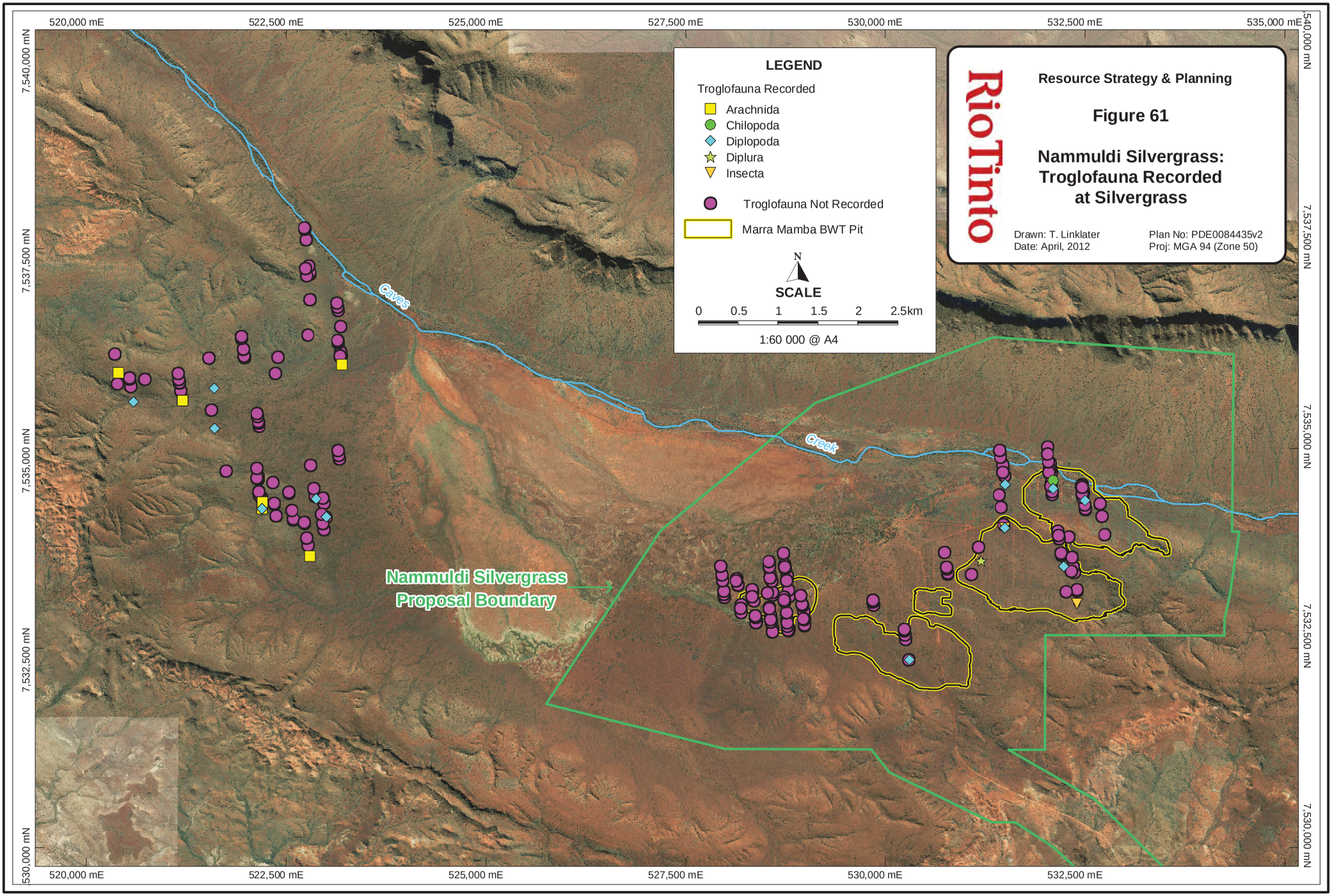
Table 51 Summary of troglofauna recorded at Nammuldi and Silvergrass (including Silvergrass West)

Order	Family	Lineage	No. collected
Nammuldi			
Polyxenida	Polyxenidae	C	10
Blattodea	Nocticolidae	-	4
Silvergrass (including Silvergrass West)			
Polyxenida	Polyxenidae	A	107
		D	
		C	1
Blattodea	Nocticolidae	C	17
Diplura	-	-	2
Geophilida	-	-	1
Schizomida	Hubbardiidae	D	12

Source: Biota 2011c

As the Schizomida specimens and Polyxenida lineage D were only collected from Silvergrass West sampling sites (remote from the potential area of impact of the Expansion Proposal), these species are not considered further in this impact assessment.


530,000 mE
535,000 mE
540,000 mE
545,000 mE
7,525,000 mN
7,520,000 mN
LEGEND
Troglofauna Not Recorded
Troglofauna Recorded
Marra Mamba BWT Pit
Conceptual BWT
Bedded Brockman Pits
N
SCALE
0
1
2
3km
1:75 000 @ A4
Nammuldi Silvergrass
Proposal Boundary
RioTinto
Resource Strategy & Planning
Figure 60
Nammuldi Silvergrass:
Troglofauna Sampling
Effort at Nammuldi
Drawn: T. Linklater
Date: April, 2012
Plan No: PDE0084435v2
Proj: MGA 94 (Zone 50)


520,000 mE
522,500 mE
525,000 mE
527,500 mE
530,000 mE
532,500 mE
535,000 mE
7,540,000 mN
7,537,500 mN
7,535,000 mN
7,532,500 mN
7,530,000 mN
LEGEND
Troglofauna Recorded
Arachnida
Chilopoda
Diplopoda
Diplura
Insecta
Troglofauna Not Recorded
Marra Mamba BWT Pit
N
SCALE
0 0.5 1 1.5 2 2.5km
1:60 000 @ A4
Caves
Creek
Nammuldi Silvergrass
Proposal Boundary
RioTinto
Resource Strategy & Planning
Figure 61
Nammuldi Silvergrass:
Troglofauna Recorded
at Silvergrass
Drawn: T. Linklater
Date: April, 2012
Plan No: PDE0084435v2
Proj: MGA 94 (Zone 50)

11.3 Potential sources of impact

The aspects and activities of the Expansion Proposal that have potential to affect subterranean fauna values include:

- **increased mining of overburden and ore** will remove potential subterranean fauna habitat or may affect the quality of habitat as a result of increased vibration
- **additional dewatering** will result in drawdown of the watertable, potentially reducing the extent of subterranean fauna habitat
- **surface and groundwater contamination**, through spills of hydrocarbon or waste water, exposure of potentially acid forming material and/or the transportation of sediment, may degrade the subterranean environment
- **increased clearing of vegetation** can potentially lead to a reduction of organic inputs to the subterranean environment.

As discussed in Section 8.4.3, the proposed realignment of Caves Creek is considered unlikely to alter flows and will not have an impact on downstream subterranean fauna habitat.

11.4 Assessment of likely direct and indirect impacts

11.4.1 Mining of overburden and ore

The Expansion Proposal involves expansion of approved pits at Silvergrass and Nammuldi, including removal of overburden and extraction of ore. Mining will result in removal of potentially suitable subterranean habitat. In addition to direct habitat removal, excavation activities and use of blasting methods in mining can generate vibration, potentially altering the surrounding geology. This may reduce availability of troglofauna habitat through compacting and collapsing of cavities.

Stygofauna

There is no evidence of a significant stygal community at the Nammuldi site, and stygofauna recorded at Silvergrass generally have a wider regional distribution. One species, *Nedsia* sp. A, identified as potentially being restricted to the Caves Creek catchment, has been recorded both upstream and downstream of the Proposal Boundary and the predicted extent of dewatering. The habitat loss resulting from excavation activities is not likely to present a high risk for regional stygofauna diversity.

The proposed expansion of Pit 1 (Range Pit) at Silvergrass requires realignment of Caves Creek as outlined in Section 8.4.3. The stygal community recorded in Caves Creek is considered to be at minimum, restricted to the alluvial aquifer underlying the creek. As samples were recorded along 30 km of the creek and approximately 2.5 km of the extent of the Caves Creek alluvial aquifer will be affected by the creek realignment, the Expansion Proposal will result in a loss of about 10% of this habitat. Given that there may be further occurrence of the community outside the 30 km surveyed reach, the pit expansions are not expected to have a significant impact on this community.

Troglofauna

The impacts of the Expansion Proposal on recorded troglofauna taxa at Nammuldi and Silvergrass are presented in Table 52. The impact assessment considers regional and local distribution, their troglobitic characteristics and DNA analysis. The DNA analysis of samples collected from the Greater Nammuldi Area and surrounding region has indicated that a majority of the species recorded within the Proposal Boundary are not locally restricted (Biota 2011c).

Table 52 Summary of the impact on troglofauna at Nammuldi and Silvergrass

Order	Lineage	Regional distribution	Local distribution	Summary of Impact
Polyxenida	A	Known only from Silvergrass; however, this may potentially be a result of limited regional sampling.	Recorded at Silvergrass. Found within calcrete geological horizon. The calcrete horizon has a limited occurrence in the Pilbara region; however, it does extend throughout the area and beyond the mining footprint.	The single specimen recorded from one bore at Silvergrass to date is likely to be a result of limited regional sampling. The calcrete geological horizon in which the specimen was recorded extends throughout the local area, well beyond the proposed mine pits. The proposed mining activities are unlikely to present a significant threat to the distribution or conservation status of this lineage of this Order.
	C	Widespread through the Pilbara. Recorded at Robe Valley (approximately 120 km west of Silvergrass). Pilbara polyxenid millipedes are not considered troglobitic or SREs.	Found in bores at Nammuldi, and Silvergrass as well as Silvergrass West.	This species is widespread and non-troglobitic, which is supported by the variety of habitats in which the Nammuldi-Silvergrass specimens were recorded.
Diplura	-	Diplurans have been collected in various different regions of the Pilbara. Typically soil dwellers and not likely to be restricted to specific geology.	Recorded at Silvergrass and Silvergrass West.	This Order is unlikely to be of conservation significance due to the members being soil dwellers. As this Order is not likely to be a SRE, the proposed mining activities are unlikely to present a significant impact on this species at a local or regional level.
Geophilida	-	Generally considered to be soil dwelling and non-troglobitic.	A single specimen recorded at Silvergrass.	This species is not troglobitic.
Blattodea	C	Widely distributed in the Pilbara region. Records at Robe Valley (120 km west of Silvergrass) and Ophthalmia Range (approximately 250 km southeast of Silvergrass).	Recorded at Silvergrass in small numbers.	The lineage of this Order is widespread throughout the Pilbara. The proposed mining is unlikely to impact on the local or regional distribution of this species.
	-	This species has been shown to have wider distributions and is unlikely to be an SRE.	Collected from Nammuldi in small numbers.	This species is not considered to be an SRE species.

Source: Biota 2011c

DNA work on Polyxenida specimens sampled within the Pilbara region has indicated that the Pilbara polyxenid millipede species are not troglobitic or SRE taxa. There have been widespread recordings of Polyxenida lineage C throughout the Pilbara, with a number of recordings at Robe Valley (approximately 120 km west of Silvergrass) (Biota 2011c). The widespread nature and characteristics that are not limited to troglobitic taxa of this lineage indicate that the proposed activities will not affect it. Polyxenida lineage A has only been recorded at Silvergrass; however, this is a potential indicator of limited regional sampling rather than restricted distribution (Biota 2011c).

The noctolid cockroach Blattodea is also widely recorded in the Pilbara, with records at Robe Valley and Ophthalmia Range (approximately 250 km southeast of Silvergrass). DNA analysis conducted for this

species has indicated that a majority of Blattodea lineages are widespread with little evidence of short-range endemism (Biota 2011c).

The Diplura Order recorded from Silvergrass has not been widely recorded throughout the region; however, species from this Order are not generally restricted to individual geological formations (Biota 2011c). The taxa was recorded at both Silvergrass and Silvergrass West and is unlikely to be restricted in the Proposal Boundary. The taxa is considered unlikely to affected by the Proposal Boundary as the representation of habitat for this taxa will not be significantly affected.

A single specimen of Geophilida was collected from Silvergrass in Phase 2 of sampling. This species is considered to be a deep soil dweller rather than being troglobitic, and is consequently not expected to be restricted to the area of proposed activity (Biota 2011c).

The troglofauna species recorded at Nammuldi and Silvergrass are either well distributed beyond the Proposal Boundary, or located within habitat that extends locally outside the mining footprint. The proposed removal of a relatively small portion of the available habitat will not significantly reduce the status of these species in the Pilbara and local vicinity.

11.4.2 Dewatering

Groundwater drawdown will reduce the extent of potential stygofauna habitat and may alter the humidity of the subterranean environment, reducing the suitability of adjoining troglofauna habitat. The proposed increase in dewatering at Silvergrass will increase the extent of drawdown of approximately 15 km along Caves Creek.

For further details of the extent of drawdown, refer to Section 7.

Stygofauna

Dewatering activities will result in a reduction of potential habitat. The Stygofauna assemblage at Silvergrass is well represented throughout the region, with the distribution of species extending at least 30 km along the Caves Creek catchment. The extent of the 2 m drawdown at Silvergrass will extend approximately 15 km along Caves Creek (Figure 34). The extent of dewatering will not reach the Silvergrass West or Homestead sampling area. The reduction in the extent of available stygofauna habitat from dewatering is not expected to significantly affect the distribution of habitat along Caves Creek.

It is considered unlikely that there will be a significant effect on any stygofauna as there was no significant stygofauna population detected at Nammuldi.

Troglofauna

Reduction in humidity levels can potentially lead to changes in use by troglofauna of retained habitat (Biota 2005b). Physiological and ecological responses identified by Hadley et al. (1981) and Humphreys (1991) have demonstrated that troglobitic fauna are sensitive to the drying of strata and reductions in subterranean relative humidity levels.

The large rainfall events in the Pilbara drive the recharge of aquifers through infiltration and humidity levels in strata. The humidity of the subterranean environment is governed by these large rainfall events and distance from the ground surface, rather than the distance to the watertable. Therefore, groundwater drawdown caused by the Expansion Proposal is not expected to alter the relative humidity in the soil matrix above the watertable and consequently is not likely to affect troglofauna in the remaining habitat by reducing the relative humidity of the subterranean habitat.

11.4.3 Surface and groundwater contamination

Contamination of surface water, groundwater and soil has potential to result in degradation of the subterranean environment. Contamination can result from hydrocarbon or waste water spills, exposure of potentially acid forming material or through the transportation of sediment.

Hydrocarbon storage and handling will be undertaken in accordance with the EMP (Appendix 3). Refer to Section 12 for further details of mineral waste issues and their management, including management of AMD.

Management measures proposed for prevention and control of hydrocarbons spills and PAF waste material will ensure that the potential impact of contamination on the subterranean fauna at Nammuldi-Silvergrass is negligible. Hydrocarbon and AMD contamination is not expected to affect subterranean fauna values.

11.4.4 Clearing of vegetation

The clearing of vegetation can potentially lead to a reduction in the availability of organic inputs to the foundation trophic levels. This may result in a reduction in the suitability of subterranean fauna habitat.

Clearing of vegetation will be managed according to the EMP (Appendix 3), and the clearing beyond the mine boundaries will not significantly reduce the extent of vegetation in the Proposal Boundary. In addition the subterranean fauna are not expected to be restricted to the Proposal Boundary. Therefore, the clearing of vegetation outside mine pit is not expected to have a significant effect on the subterranean fauna. The management of vegetation clearing is discussed further in Section 9.4.1.

11.5 Management measures and performance standards

Potential impacts on subterranean fauna within, and adjacent to the Proposal Boundary will be mitigated through management measures implemented under various management plans, including the Subterranean Fauna Management Plan, Hydrocarbon Management Plan, Groundwater Management Plan and Vegetation and Flora Management Plan as part of the EMP (Appendix 3). The key management measures relevant to subterranean fauna are:

- restricting mine pit disturbance to approved areas, in compliance with legislative requirements including Schedule 1 of any Statement issued by the Minister for the Environment
- monitoring the extent of groundwater drawdown
- containing and bunding hydrocarbon storage facilities, re-fuelling locations and areas of stationary hydrocarbon usage in compliance with corporate policy, relevant standards and legal requirements
- identifying opportunities to further reduce the clearing of previously undisturbed and rehabilitated vegetation within approved boundaries as described in the Flora and Vegetation Management Plan in the EMP.

11.6 Predicted environmental outcomes against environmental objectives, policies, guidelines, standards and procedures

After application of mitigation measures described in Section 11.5, the Expansion Proposal is expected to result in no significant impact to any troglofauna or stygofauna species on the basis of:

- no presence of a stygofaunal community within the Proposal Boundary at Nammuldi
- broad distribution of stygofauna species outside the Proposal Boundary at Silvergrass
- broad distribution of troglofauna species outside the Proposal Boundary at Nammuldi and Silvergrass
- a number of the invertebrates collected during sampling being non-troglobitic.

12. Assessment of impact from acid and metalliferous drainage and fibrous materials

12.1 Relevant environmental objectives, policies, guidelines, standards and procedures

12.1.1 EPA objective

In most circumstances, including this assessment, the EPA applies the following objective in its assessment of proposals that may affect surface water or groundwater, water quality and the ecology that surface water or groundwater supports:

To maintain the quantity and quality of water so that existing and potential environmental values, including ecosystem maintenance, are protected.

12.1.2 EPA statements and guidelines

Water Quality Protection Guidelines

In 2000, the Water and Rivers Commission (now DoW) and Department of Minerals and Energy (now DMP) developed *Water Quality Protection Guidelines No. 9 for Mining and Mineral Processing – Acid mine drainage* (WRC 2000a). This guideline applies to mining and mineral processing operations that have the potential to generate acidic mine water, or where acid mine water already exists.

Government and industry guidelines

Department of Industry, Tourism and Resources (now Department of Resources, Energy and Tourism) established a working group of experts, industry, and government and non-government representatives that produced *Managing acid and metalliferous drainage* (DITR 2007a) and *Tailings management* (DITR 2007b) as part of the Leading Practice Sustainable Development Program. These handbooks provide leading practice decision making, assessment, mitigation and management strategies for AMD and processing mineral waste.

Rio Tinto Iron Ore Standards

Rio Tinto has established policies and standards, some which may go beyond legislative and statutory requirements, and to which all operations must adhere. These policies and standards have been developed by Rio Tinto through the substantial experience and expertise Rio Tinto has in successfully managing for AMD across its operation in the Pilbara.

12.1.3 Regulatory framework

There are provisions under the EP Act and the *Mining Act 1978* (WA) to control discharge of AMD from mine sites.

The RIWI Act makes provision for the regulation, management, use and protection of water resources. Works approvals and licences to permit discharges to the environment are also required under Part V of the EP Act.

12.2 Description of factor

Acidic drainage is associated with sulfide containing minerals, in particular pyrite (FeS_2), which can occur within waste material in the pit zones. Pyrite is generally associated with below watertable lithologies. On exposure to oxygen caused by the mining process, pyrite can oxidise causing the release of sulphuric acid. Acid generation is accentuated by further reactions between pyrite and the ferric ion. Low pH conditions ensuing from this process can result in the mineral dissolution of a variety of metals (such as aluminium, manganese, zinc and/or copper) from exposed rocks. Combined with the action of water, these substances can be transported in surface run-off, or percolate into underlying substrates and groundwater systems; potentially creating a contamination issue.

Other sulfur-containing minerals, such as alunite and jarosite, also have the potential to generate acid. However in comparison with pyrite these minerals generally pose a lower geochemical risk due to self-limiting chemical processes (*i.e.* low solubility and reaction kinetics).

Under certain conditions pyrite oxidation can lead to neutral (i.e. non-acidic) metalliferous drainage. This is caused by the presence of neutralising materials (such as calcite, dolomite, ankerite and magnesite) which react with the acid component to restore near-neutral pH conditions. Following pyrite oxidation, but prior to acid neutralisation, some metals (e.g. zinc, arsenic, nickel, and cadmium) can be released by the aforementioned processes and remain in solution at near-neutral pH (DITR 2007a; Green and Borden 2011). These metals are then able to be transported in water.

Other types of neutral or alkaline metalliferous drainage can occur from rock types with elevated concentrations of metal and metalloid species, under particular reaction conditions. This includes species which form oxyanion complexes such as arsenic, selenium and molybdenum. Significant neutral and alkaline mine drainage issues associated with arsenic and selenium in particular are known from global experience. The mobility and toxicity of these elements is affected by a complex array of site-specific geochemical and biological factors; however, in many instances they are rapidly immobolised in groundwater systems (Plant *et al.* 2003; Kuisi & Abdel-Fattah 2010; Williams 2001). In iron-rich environments such as the Pilbara, the high sorption capacity iron oxy-hydroxides is likely to be an important constraint for arsenic and selenium mobility.

In addition to the environmental risks and management requirements associated with AMD, this section also considers the risks from fibrous (or asbestiform) material (Section 12.2.3). The potential for AMD and asbestiform material to contaminate waste fines is also addressed (Section 12.2.4).

12.2.1 Potential for AMD

Hamersley lithologies are generally highly weathered (oxidised) in situ and as such the potential for further oxidation on exposure is intrinsically low overall.

The potential for waste rock or ore to produce AMD was considered negligible in the previous environmental impact assessment for the Nammuldi-Silvergrass Iron Ore Project. Greater testing of the deposit for the Expansion Proposal has determined the presence of PAF material, specifically within lithologies containing lignite and siderite. The testing has identified that PAF material would be encountered in the pit alignment of the Original Proposal. The AWT mining undertaken to date at Nammuldi has not exposed any PAF material.

To quantify the potential for the generation of AMD this section has been structured to first consider the potential production of acidic drainage. The likelihood of the production of acidic drainage is assessed based on the presence of PAF material, which is determined by analysing sulfur distribution in drillhole samples and using this data to undertake static acid base accounting (ABA) test work. The test work is then supplemented with kinetic testwork. Note that metalliferous drainage associated with the generation and subsequent neutralisation of acidic water is implicitly addressed in the consideration of PAF materials.

The potential for other forms of metalliferous (i.e. non-acidic) drainage is assessed based on elemental enrichments of metals and metalloids in ore and waste materials and liquid extract tests. This work is then supplemented with kinetic test work.

Acid base accounting

Geochemical static tests using ABA are commonly used to evaluate the balance between acid generation processes (oxidation of sulfide minerals) and acid neutralising processes. The purpose of test work is to identify the distribution and variability of sulfur content, acid neutralising capacity, and elemental composition, and the acid-generating and element leaching characteristics (DITR 2007a). Across the central Pilbara region, Rio Tinto has undertaken extensive ABA test work on a number of different rock types in the Hamersley Group to identify the potential for different rock types to generate acidity. The results of the extensive ABA test identified the following cut off total sulfur values for PAF material:

- >0.1% total sulfur for black pyritic shales
- >0.3% total sulfur is suitable for non-shale lithologies (lignite and siderite).

The distribution of samples exceeding these cut off values have been used to identify the distribution of PAF material as it relates to the quantities of PAF waste materials and incidence of pit shell exposures (Table 53). In addition to posing an AMD risk, an elevated sulfide content combined with organic carbon can also pose a self-heating risk potentially resulting in spontaneous combustion. This is most likely to occur within lignite material from the BWT portion of Nammuldi Pit C.

For management purposes all lignite is considered to possess a spontaneous combustion risk (classified as Category SR) and therefore requires selective management. No other types of PAF material identified at Nammuldi are expected to pose a spontaneous combustion risk or react to ANFO, therefore all siderite and all other identified PAF waste material is not considered to possess a spontaneous combustion risk (classified as Category S material).

As described in Table 53, PAF material has only a limited occurrence with only 677 of nearly 160 000 samples tested (less than 0.5% of samples) containing sulfur above the 0.3% cutoff. Therefore mining at Nammuldi and Silvergrass is unlikely to encounter significant volumes of material that has the potential to generate acid.

Table 53 Summary of total sulfur analysis

Proposed mining area	Within pit shell		Waste	Pit shell exposures
	Number of samples assayed	Number of samples with S>0.3%		
Nammuldi Pits A and B	4003	6	The six samples that exceeded the %S cut off were recorded from above the water table (at a depth of 8 m below the surface) and are likely to represent sulfate and not pyritic S. Based on block modelling, up to approximately 25 kt of PAF waste material will be mined.	Sulfidic lignite and siderite are not expected to be exposed
Nammuldi Pits C and D	36 891	501	The majority of samples that exceeded the %S cut off were recorded in lignite and siderite lithologies. Based on block modelling, up to 4.4 Mt of lignite and 1.8 Mt of siderite may be mined (worst case scenario), which constitute up to approximately 3% of mine wastes from Pit C. In addition approximately up to approximately 15 kt of PAF material from other lithologies (MacLeod Member and Wittenoom dolomite) will be mined.	In total exposures of PAF material are expected to contribute approximately 1% of the total pit shell.

Proposed mining area	Within pit shell		Waste	Pit shell exposures
	Number of samples assayed	Number of samples with S>0.3%		
Nammuldi Pit EF	45 720	52	The majority (51) of the samples that exceeded the %S cut off were from AWT detritals and Mount Newman (ore) lithologies, and are likely to represent sulfate and not pyritic S. Based on block modelling, up to approximately 110 kt of PAF waste material will be mined.	Siderite occur adjacent to the proposed pit shell which could be exposed during mining
Bedded Brockman material	38 000	78	The majority (57) of the samples that exceeded the %S cut off were from black Mount McRae Shale lithologies, which were located in the footwall below Pit 8. As a result, less than 10 kt of PAF waste will be mined.	Significant pit shell exposures of PAF material are not expected as less than 1% of the samples from the pit wall contained s>0.1% and the majority of these were above the watertable and considered likely to be from sulfate minerals (such as alunite or gypsum).
Silvergrass all pits	34 980	40	The majority of samples that exceeded the %S cut off were recorded from above the water table (at a depth of 4 m from the surface). Mineralogical (XRF) analysis on 15 samples confirmed that sulfate S is the dominant form of sulfur in this material. Some samples from the hydrated West Angela Member exceeded the %S cut off. However, these comprised only about 0.4% of samples from this lithologies. An estimated 400 kt of PAF material is expected to be mined from the Silvergrass area. This constitutes approximately 0.15% of the total waste expected to be mined.	Sulfidic lignite and siderite are not expected to be exposed

Kinetic column leach test work

Kinetic tests measure sulfide reactivity, oxidation kinetics and metal solubility over time. Kinetic testwork is scheduled for all rock types in 2012-13 that are expected to be produced. This test work provides a closer representation of field leachate water quality that static testwork but can require months to complete. This work is generally used to confirm the results of the inherently conservative static test work and is considered to supplement the previous work.

Results from the kinetic testwork will be applied, on an ongoing basis, to contribute to the extensive knowledge base that Rio Tinto has developed in the prediction and management of AMD. It is not anticipated that any management practices will need to be changed from the outcomes of this test work.

Presence of potentially neutralising minerals

Risks associated with metalliferous drainage derived from acidic metalliferous drainage that has been neutralised are related to the abundances of PAF and neutralising materials respectively.

Based on block modelling, the distribution of both PAF material and neutralising material is generally restricted to Pit C at Nammuldi. In total, the volume of neutralising material will be limited to approximately 65 Mt of calcrete (CAL) and 13 Mt of Wittenoom Formation dolomite (DOM) from Pit C. The mining of this material is not expected to come in contact with acidic material. Where this material is used in waste dumps that contain PAF material, the PAF material will be completely encapsulated to mitigate the AMD

risk in accordance with Rio Tinto standards. Use of neutralising material in waste dumps is not expected to produce metalliferous drainage.

Both CAL and DOM are expected to be exposed on the final Lens C pit shell. This is not expected to come in contact with any acidic material.

Elemental enrichments and liquid extract tests

The geochemistry of waste materials has been analysed from drill-hole samples from the initial element suite of Al, Ca, Fe, Mg, Mn, P, S, Si, and Ti. Further detailed testing using XRF (X-ray Fluorescence) was then conducted for the following additional analytes: As, Ba, Cl, Co, Cr, Cu, Pb, Ni, K, Na, Sr, Sn, V, Zn and Zr. In addition elemental abundances in solids were determined for Ag, B, Be, Cd, F, Hg, Mo, N, Sb, Se, Th, and U by either inductively coupled plasma mass spectrometry/atomic emission spectroscopy (ICP-MS/ICP-AES), trace XRF, or by specific ion electrode methods.

Liquid extract testing was performed on a subset of samples. Solid and liquid water extracts (1:2 ratio respectively) were thoroughly mixed and left overnight before the liquor was siphoned off and used in a multi-element analysis. Analysis was conducted for the following additional analytes: pH, EC, SO4, Al, As, Fe, Mn, Cu, Zn, Ca, K, Mg, Cl, Na, HCO3-, Co, Cr, Pb, Ni , F, Hg, Ba, B, Sb, Se, U, Mo, Cd, Ag.

The results of the geochemical testwork are generally typical of iron ore deposits and are shown in Table 54. Whilst enrichments were detected for some elements of interest (such as arsenic and selenium), liquid extract tests suggested their solubility was low.

Table 54 Element enrichment

Elements	Comments
Fe, As and Sn	Generally enriched in the majority of Pilbara lithologies. Elevated or enriched in Nammuldi and Silvergrass lithologies.
Cr, Co, Cu, Pb and Zn	Can be elevated in dolomite lithologies.
Se and Sb	Can be elevated in some non-sulfidic rock types, however, solubility is low based on liquid extract tests.
S and Mn	Elevated in some ore and waste rock types in Nammuldi pits D and EF.
As, Cd, Mg, S, Sb and Se	Can be enriched in lignite and siderite, however, solubility is low based on liquid extract tests.
Mn	Enriched in the West Angela Member waste; and elevated in the West Angela Member ore, Mount Newman Member ore and some detritals.
B	Enriched in alluvial lithologies, however its solubility is low based on liquid extract tests.

12.2.2 Ecological risk assessment

To support the assessment of AMD an Ecological Risk Assessment (ERA) was prepared by Equinox Environmental (2012). The ERA assesses the ecological risk of the Expansion Project by identifying potential contaminant sources, transport pathways and environmental receptors. The assessment of each of the potential impacts in Section 12.4 includes a summarised ecological risk assessment.

12.2.3 Presence of fibrous minerals

Fibrous minerals have been intersected during exploration and resource drilling throughout the proposed mine layout areas at Nammuldi/Silvergrass. Fibrous minerals are likely to be exposed during the mining operations. Rio Tinto has extensive experience in managing fibrous minerals in the Pilbara. Occurrences in the Pilbara of fibrous minerals are generally restricted to limited fibrous mineral intersections.

12.2.4 Waste Fines Storage Facility

Wet processing of ore will produce a benign residue that will be stored safely at the site in the proposed waste fines storage facility (WFSF). Investigations at Nammuldi have revealed that Fe, Cu and Zn have the potential to leach from tailings under acidic leaching conditions and migrate to groundwater (Green 2010a). The pH of the leachate in the fines, however, is slightly alkaline so leaching of chemicals from landforms after closure is considered unlikely.

Liquid extract testing of the waste fines material has been analysed using multi-element analysis. The testing included for EC, pH, SO_4, Al, As, Fe, Mn, Cu, Zn, Ca, K, Mg, Cl, Na, HCO_3, Co, Cr, Pb, Ni, F, Hg, Ba, B, Sb, Se, U, Mo, Cd and Ag. Kinetic testwork scheduled for 2012-13 will include waste fines.

The WFSF will be designed in accordance with the 'Tailings management' guidelines (DITR 2007b) with a 100 year ARI rainfall event capacity with the aim to minimise seepage into groundwater. The WFSF will require approval from the DMP. A Mining Proposal will be prepared that includes further details on the design of the WFSF.

The banks of the WFSF will constructed from asbestiform free waste material.

12.3 Potential sources of impact

Potential impacts associated with exposure, storage and handling of mineral waste material include:

- **exposure of PAF material to oxygen** has the potential to generate acid that could then be mobilised and release metals through mineral dissolution (if it comes in contact with rainwater/runoff), which in turn may result in groundwater or surface water contamination
- **storage of PAF mineral waste** has the potential to cause spontaneous combustion and could generate acidic water and/or metalliferous drainage if it comes in contact with infiltration or rainwater/runoff, which may result in groundwater or surface water contamination
- **disturbance of enriched in situ elements** has the potential to produce neutral metalliferous drainage, which may result in groundwater or surface water contamination
- **extracting and exposing fibrous minerals during mining operations** has the potential to present a health risk to mine workers and post-mining land users
- **dewatering** may expose PAF material to oxidising conditions as a result of the groundwater drawdown, which has the potential to contaminate groundwater.

The production of AMD can also adversely affect revegetation programs, as described in Section 13.

12.4 Assessment of likely direct and indirect impacts

The environmental aspects listed in Section 12.3 are addressed in sections 12.4.1 to12.4.6. Within each of these sections is an ecological risk assessment that assesses the potential for environmental receptors to be exposed to contaminants and the potential ecological effects of these contaminants. The ecological risk assessment is based on the Nammuldi-Silvergrass Ecological Risk Assessment (Equinox Environmental 2012, contained in Appendix 2).

The structure of the impact assessment within sections 12.4.1 to 12.4.6 is primarily based on the management measures approach identified in Equinox Environmental (2012) for mitigating the risks of AMD. The approach is based on the following:

1. Minimising contaminant sources (pollutant volumes and concentrations).
2. Obstructing physical, chemical and biological pathways connecting contaminant sources with environmental receptors.
3. Avoiding or otherwise minimising the exposure of sensitive environmental receptors to pollutants.

12.4.1 Management of exposed PAF material in the pit wall

Exposure of PAF material on the pit wall has the potential to generate acid when it comes in contact with incident rainfall either on the surface or from runoff channelled onto the surface. Acid that is produced from water that contacts exposed PAF material may potentially collect in the base of the pit or infiltrate to the orebody aquifer. This acidic water has the potential to induce weathering of minerals and mobilise metals (such as aluminium, manganese, zinc and/or copper).

The prevention of AMD during and after the completion of mining is reliant on appropriate management of pit wall exposures to minimise source of contaminants. Sulfidic rock types, including lignite and siderite, are expected to be exposed on the surface of the pit shell during the mining of the Nammuldi BWT Pit C. No PAF material is expected to be exposed on the pit shell surface for Nammuldi Lens A/B, D, E/F or bedded pits or at any of the Silvergrass pits.

The primary management measure to reduce the generation of acid is to provide bunding to divert runoff away from the pit exposures (as shown on Figure 62). By limiting the volume of water flowing onto the exposed surface the potential source of contamination will be limited to the volume of rain water that direct falls on the exposed surface.

The other significant management measure to minimise the production of AMD is to minimise the formation of talus (rock debris that forms at the base of a slope) from the pit exposures. The formation of talus from the pit exposures has the potential to generate acid from incident rainfall. The strategies under consideration for preventing the build up of talus include encapsulating PAF material wall exposures using low erodibilty materials such as polymers, shotcrete or mined DOM. This strategy would most likely require that cover material be re-applied annually to account for sulfidic talus build up on the berms over the year. Another option under investigation is to design pit berms below the PAF exposures that are wide enough to allow appropriate access to remove sulfidic talus for storage in the appropriate waste dump, and to allow access to cover exposed PAF material pit walls.

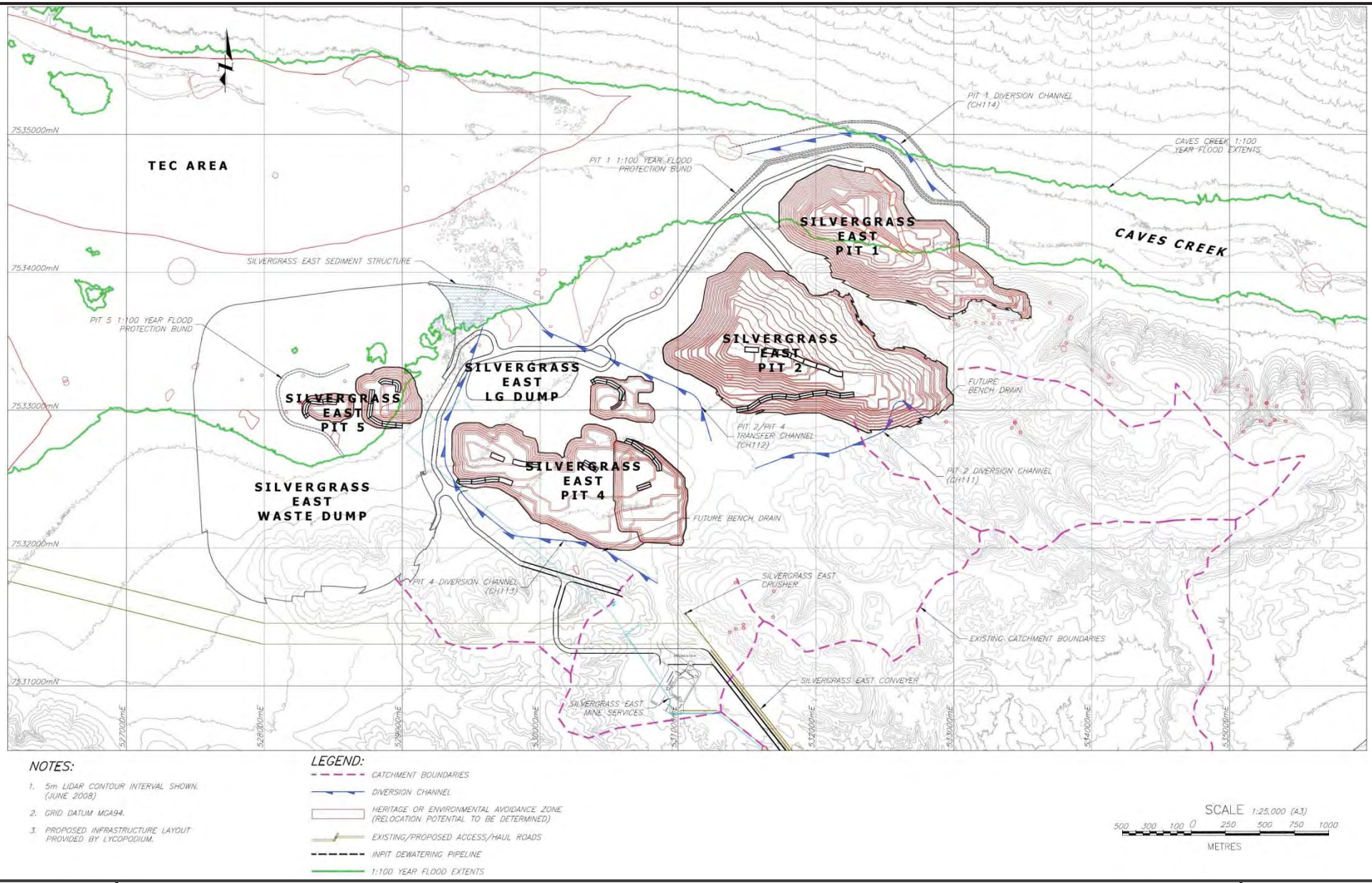
The next stage of the approach for minimising the risk from AMD is obstructing the pathway of the contaminant from reaching sensitive environmental receptors. Where acidic water is generated from incident rainfall it will be contained entirely within the pit. After period of heavy rainfall if there is acidic water generated it will be treated. The water will be monitored in accordance with appropriate trigger levels established under ANZECC & ARMCANZ (2000) guidelines or WA Interagency Guidelines (WRC 2000b) for water quality, considering baseline water quality. Therefore acidic or metalliferous drainage will not be in contact with any ecological receptor.

Exposure of PAF material is not expected to cause a detrimental effect on surface water outside of the pit shell as the only water that will contact the exposed PAF material on the pit walls will be from incident rainfall, which will be treated as required prior to discharge. Strategies to manage PAF material will minimise significant environmental impacts. In addition, there are no vulnerable groundwater-dependent ecosystems inside or in the vicinity of the Proposal Boundary that have the potential to be affected by any acid water seepage (if this was to occur) into the orebody aquifer.

Given that the PAF material is unlikely to produce significant volumes of acidic water, it is therefore considered unlikely that the acidic water will produce significant volumes of neutralised acidic metalliferous drainage.

Summarised ecological risk assessment

Generation of acidic water from incident rainfall on pit exposures of PAF material within pit voids is unlikely to produce significant volume of AMD. Any AMD that is generated will be entirely contained within the pit, where it will be treated. The discharge of water from the pit will only be undertaken if water meets appropriate water quality standards. Therefore, the generation of AMD from pit exposures is considered to be readily manageable and to not pose a significant ecological risk.



STRATEGEN

Nammuldi-Silvergrass Expansion Proposal

Surface water drainage design

Figure 62

12.4.2 PAF mineral waste storage and management

The design and construction of mineral waste dumps will be optimised so as to minimise the project footprint and the location of each proposed waste dump is shown in Figure 18. Stable waste dumps will be constructed in such a way that rainfall events cause minimal erosion and disruption to progressive and rehabilitation works during closure. The designed height of each waste dump is dependent on the erodibility of material and the design will keep within the landform character of the area.

The SCARD Management Plan will be implemented to manage all waste that poses an AMD risk including selective dumping and encapsulation of moderate and high risk material in the base of Pit D. Regular groundwater monitoring up-gradient and down-gradient of the PAF material disposal area will be undertaken in accordance with the SCARD Management Plan. For further detail about the final landforms at Nammuldi/Silvergrass, refer to Section 14.

All Rio Tinto operations manage PAF waste in accordance with two management plans:

1. The Rio Tinto (WA) Operations Mineral Waste Management Plan (MWMP), which is used to identify geochemical risks.
2. The Rio Tinto (WA) Operations Spontaneous Combustion and Acid Rock Drainage (SCARD) Management Plan for Operations, which is used to manage the AMD risks identified in the MWMP.

Both management plans outline the actions that need to be completed to manage or identify geochemical risks and assign these actions to the appropriate superintendant or manager. The MWMP is relevant to every Rio Tinto operation in the Pilbara and the SCARD Management Plan is relevant for every operation that needs to manage material with an AMD or spontaneous combustion risk.

These management plans are detailed documents that are regularly updated and improved. Improvements are made based on discussions with relevant groups at the sites, current best management practices, auditing of the plans (every 2 years) or any new material characterisation information.

The SCARD Management Plan has been implemented at other iron ore mine sites under the control of Rio Tinto in the Pilbara and has proven to be effective in controlling and mitigating potential AMD (Green 2009 and 2010b). Rio Tinto's storage and handling management of PAF material is broadly based upon the following principles:

- identification of PAF material distribution and character
- minimising the exposure and mining of PAF material to the extent possible
- identification and special handling of PAF material that must be mined
- encapsulation of PAF material inside inert waste rock dumps to limit water contact and allow the dumps to be revegetated.

During operations, PAF material waste will be placed in designated PAF material waste dumps located outside the pit above ground. Where necessary, PAF material that also has spontaneous combustion risk (i.e. lignite) will be placed in a specifically designated Category SR waste dump.

The PAF material waste dumps will be designed and constructed as in accordance with the Rio Tinto SCARD Management Plan. Category S waste dumps (Figure 63) will generally have the following features:

- the base of the dump will have at least 5 m of inert or net-neutralising waste rock to minimise surface water through flow risks
- enough inert waste rock will be placed against hillsides so that Category S material is not located within 5 m of the hillside as measured both vertically or horizontally
- the thickness of each lift of Category S PAF material will not exceed 10 m
- enough inert or net neutralising waste rock will be placed on the outer skin of the Category S waste rock dump so that no sulfidic material is located within 5 m of the dump surface

- the uppermost lift will be covered with a minimum 2 m layer of inert or net-neutralising waste rock to prevent runoff water from contacting the underlying material until the minimum 4 m thick temporary store and release cover can be constructed (Figure 65)
- during construction, the Category S upper dump surface will be designed so that it only receives incident rainfall with no run-on from adjacent areas.

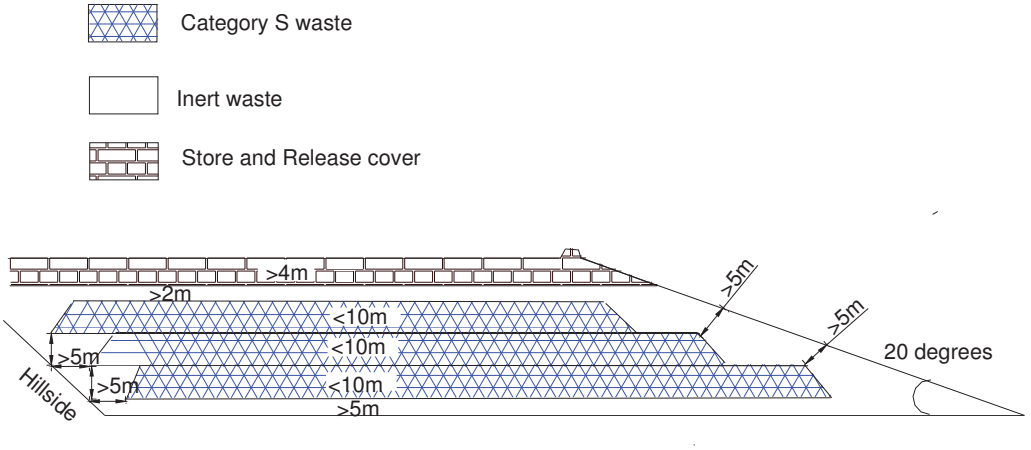


Figure 63 Example of the minimum design criteria for Category S dumps

Category SR temporary waste dumps (Figure 64) will generally have the same features as Category S dumps with a few significant changes to reduce the risk of spontaneous combustion:

- each sulfide material lift will not exceed 2.5 m and followed by a minimum 2 m lifts of preferably neutralising material (e.g. calcrete) surrounded by at least 5 m of inert and or neutralising material
- Category SR sulfide material should be excluded from beneath waste rock dump slopes.

Rio Tinto has conducted substantial test work at the Tom Price mine site (on two dumps using oxygen and temperature measurements) to validate this design.

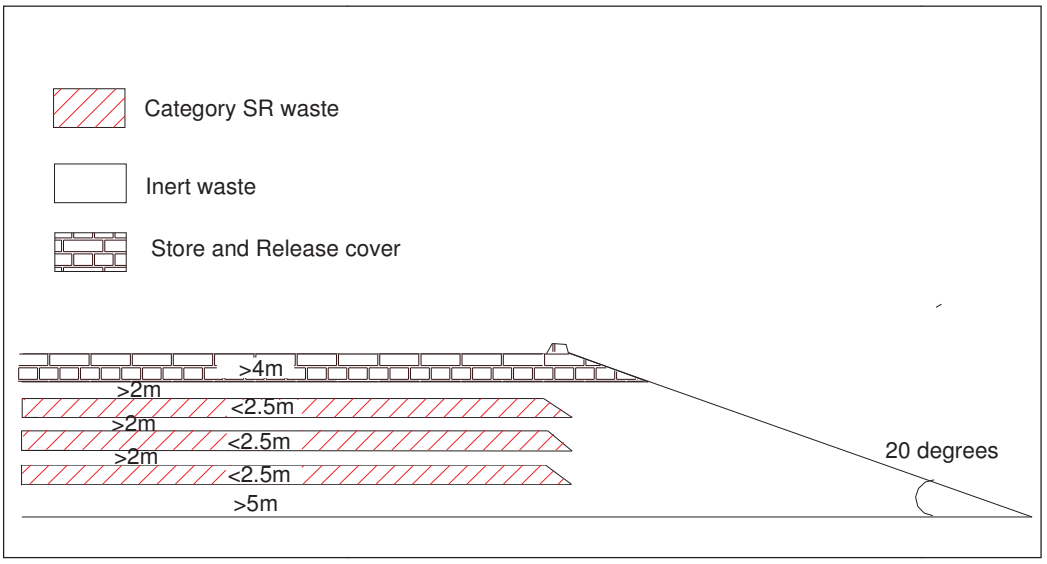


Figure 64 Example of optimum design for Category SR dumps

A store and release cover will be constructed over the PAF material waste dump(s) to ensure that a stable landform is produced and reduces the possibility for contamination to surface water or groundwater in the long-term. The store and release cover is designed to limit infiltration into the underlying waste rock by maximising water storage near the surface during the wet season so that during the dry season, it can be removed from the cover material and returned to the atmosphere via evaporation and plant transpiration. The final landform (Figure 65) will include:

- a heavy vehicle compacted store and release cover layer with an average depth of at least 2 m will be established on top of the 2 m layer of inert material specified for the cover of the waste dump
- a second heavy vehicle compacted store and release cover on top of the first layer with an average depth of at least 2 m will then be established
- topsoil spread on top of the second store and release cover layer ripped and seeded deep enough (> 0.3 m) to mix in the topsoil and to ensure that there are not compacted zones that could inhibit plant growth and rooting on top of the upper layer.

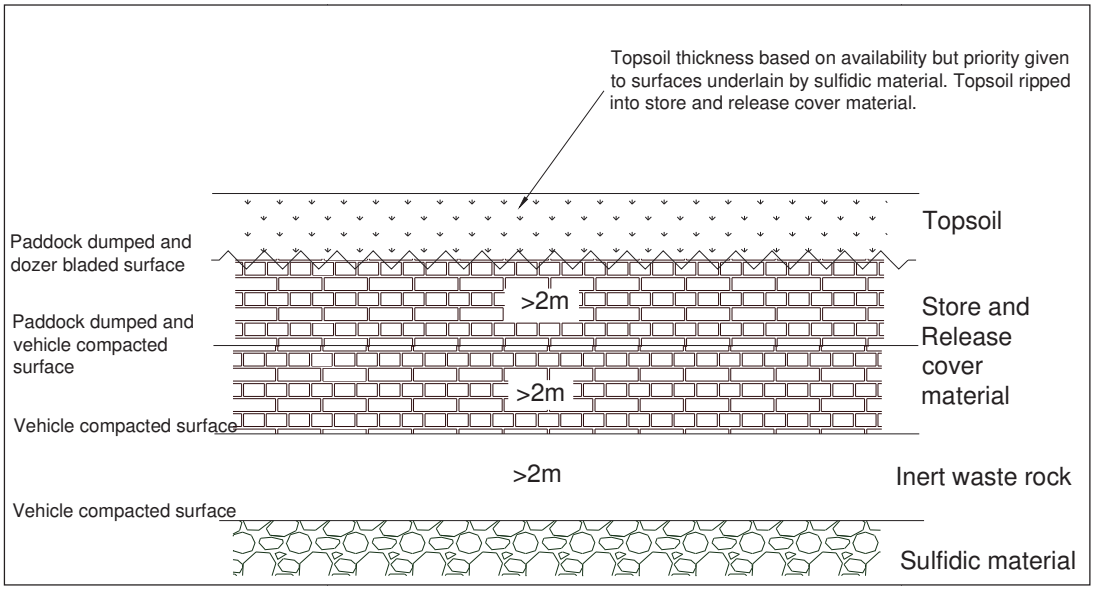


Figure 65 Final landform design for PAF material waste dump showing the store and release cover

Investigations are underway to develop strategies for the effective use of neutralising waste material (CAL and DOM) during the construction of PAF material waste dumps to mitigate potential AMD.

Investigations will be undertaken to determine if PAF material, primarily Category SR material, can be placed in waste dumps within the pit voids. PAF material will not be placed directly within at least 5 m of the modelled mean post-mining watertable level in the pit voids following the cessation of mining. In-pit disposal of PAF material is generally more secure than disposal in above ground waste rock dumps and therefore, where practicable, in-pit disposal will be considered the preferred disposal alternative because it:

- reduces the long-term risk of erosion exposing sulfides
- inhibits convective oxygen transport because the waste is surrounded by relatively impermeable rock walls
- reduces the footprint of the waste disposal facilities.

This will ensure that the seasonal watertable fluctuate does not expose the PAF material to oxidising conditions reducing the risk of AMD. Investigations are also underway to determine whether timing of mining will allow a portion of the B2 pit voids to be used to backfill PAF material during operations as an alternative management strategy. If dumping PAF material directly into one of the pit voids at B2 is possible it would reduce the need to move the material twice reducing the degree of oxidation in these rock types reducing the risk of AMD.

Current mine planning estimates indicate that approximately 0.65% of the waste material (approximately 6.2 Mt) mined at Nammuldi pits will need to be stored in a PAF material waste dump. Approximately 4.4 Mt (0.46%) of the total waste is predicted to be lignite, which presents a spontaneous combustion risk and will be stored in a Category SR waste dump. During mining, field inspections will be conducted to ensure lignite is transported to the correct dump. The time between blasting and hauling is reduced during the summer months to limit the amount of time that the material will be exposed to incident rainfall

The application of these management practices will minimise the acidity generated from the PAF waste dumps and control any acid that may be generated. Runoff from the waste dump will be monitored in accordance with the Rio Tinto standards, which include:

- regular groundwater monitoring up-gradient and down-gradient of the areas proposed for PAF material waste dump(s)
- monitoring of runoff from the waste dumps and pit surface exposures containing PAF material following rainfall events.

Summarised ecological risk assessment

Generation of acidic water from PAF waste dumps is unlikely to produce significant volume of AMD. Any AMD that is generated will be entirely contained within the waste dump. Therefore, the generation of AMD from PAF waste dumps is considered to be readily manageable and to not pose a significant ecological risk.

12.4.3 Disturbance of enriched elements

Disturbance of material with enriched elements that are soluble at neutral or alkaline condition has the potential to generate non-acidic metalliferous drainage. Metalliferous drainage produced by the contact of water with the disturbed material may potentially collect in the base of the pit or infiltrate to the orebody aquifer.

The principal elements with the potential to be soluble under non-acidic conditions are selenium and arsenic. These two elements can exist in a range of oxidation states (i.e. arsenic can exist in +5, +3, 0 and -3 states) which affects their solubility, as mediated by environmental conditions.

The potential mobility of selenium and arsenic in disturbed lithologies is expected to be limited by their low solubilities and high sorptive affinity for iron oxy-hydroxides , clays, and organic materials (Equinox Environmental 2012). Furthermore, some of the key materials containing enrichments of these elements (i.e. lignite and siderite) will be handled as PAF. Therefore risks associated with arsenic and selenium mobilising are considered to be low.

To further minimise metalliferous drainage risks the management approach will focus on obstructing pathways by which potential contaminants could reach sensitive environmental receptors. If any metalliferous drainage is generated from incident rainfall it will be contained entirely within the pit. The water will be monitored and only discharged if it meets relevant ANZECC & ARMCANZ (2000) guidelines or WA Interagency Guidelines (WRC 2000b) for water quality, considering baseline water quality. Therefore metalliferous drainage will be isolated from any ecological receptor.

Exposure of material with enriched arsenic and selenium is not expected to cause a detrimental effect on surface water outside the pit shell as the only water that will contact the exposed material on the pit walls will be from incident rainfall, which will be treated, as required,

prior to discharge. Strategies to manage material with enriched elements will minimise significant environmental impacts. In addition, there are no vulnerable groundwater-dependent ecosystems inside or in the vicinity of the Proposal Boundary that have the potential to be affected by any metalliferous drainage (if this was to occur) into the orebody aquifer.

Summarised ecological risk assessment

Generation of metalliferous drainage from material with enriched elements is unlikely to produce significant volume of AMD. Any AMD that is generated will be entirely contained within the pit or waste. Therefore, the generation of AMD from the pits or waste dumps is considered to be readily manageable and to not pose a significant ecological risk.

12.4.4 Management of fibrous minerals

Rio Tinto has existing management plans and procedures in place for encountering and managing fibrous minerals. Fibrous minerals will be stored and managed according to the Rio Tinto Fibrous Mineral Management Plan and a decontamination facility will be present on site. In current Rio Tinto operations, there is a high awareness of and extensive experience in managing this potential hazard. To ensure safety of staff, all contaminated areas will be decontaminated and rehabilitated so there is no potential for future unsuspected exposure to this hazard.

The Fibrous Mineral Management Plan included in Appendix 2) provides procedures for the management of fibrous material. The post closure management of fibrous mineral dumps is described in Section 14.3.6.

Summarised ecological risk assessment

The management measures that will be employed to protect personnel from the risks associated with fibrous material will ensure that the fibrous material does not come in contact with any sensitive environmental receptors. Therefore, fibrous material is considered to be readily manageable and to not pose a significant ecological risk.

12.4.5 Dewatering

Dewatering will lower the watertable, which will potentially increase the supply of oxygen to potentially sulfidic material previously within the saturated zone. Depending on the rate of oxygen supply to the dewatered zone containing sulfidic material there is risk of oxidation and mobilisation of acidic water following infiltration from recharge events. This process could also potentially generate acidic water following the dewatering process.

Acid generation under saturated conditions is not anticipated as the reaction between oxygen in groundwater and PAF material in the bedrock is very slow and the concentration of oxygen in groundwater at depth is very low.

Unsaturated PAF material (due to dewatering) may be rewetted by infiltrated rainwater. Rio Tinto will ensure the dewatering is monitored and meets either the relevant ANZECC & ARMCANZ (2000) guidelines or WA Interagency Guidelines (WRC 2000b) for water quality, considering baseline water quality. If groundwater becomes acidic then the water management plan for the site will be updated, the water will be discharged to a temporary basin for neutralisation treatment using similar techniques for event based surface water acidity.

Summarised ecological risk assessment

Dewatering is unlikely to produce significant volume of AMD. Any AMD that is generated will be drain into the pit. Therefore, the generation of AMD is considered to be readily manageable and to not pose a significant ecological risk.

12.4.6 Waste fines

Based on experience at other Rio Tinto mine sites, background water chemistry and basic geochemistry it is expected that there will be limited remobilisation of metals into the underlying groundwater.

Summarised ecological risk assessment

Waste fines are unlikely to come in contact with any receiving environment and are therefore considered unlikely to not pose a significant ecological risk.

12.5 Management measures and performance standards

Management and mitigation measures for AMD and fibrous materials include the following:

- constructing bunding in accordance with the surface water management design to reduce surface runoff flowing over exposed PAF material in the pit face
- constructing PAF material waste dumps in accordance with Rio Tinto SCARD management plan in areas that are not likely receive runoff from surrounding areas
- constructing fibrous material waste dumps in accordance with the Rio Tinto Fibrous Minerals standards
- using calcrete (and any other net neutralising material) in specific waste dumps to use in permanent PAF material waste dumps
- conducting field inspections during mining to ensure all PAF material is transported to the appropriate dumps
- monitoring dewatering effluent for quality and diverting it for treatment if it does not meet appropriate trigger values for the area as defined by ANZECC & ARMCANZ (2000) guidelines or WA Interagency Guidelines (WRC 2000b) for water quality, taking into consideration baseline water quality
- reducing the time between blasting and hauling during the summer months to limit the amount of time that the material can oxidise or possibly generate AMD in case there is rainfall.
- mineral waste at Nammuldi/Silvergrass will be managed using current industry recognised best practice. This includes regular monitoring of performance through rock sample collection, water quality testing and external auditing against the Rio Tinto SCARD management plan for compliance. Rio Tinto is committed to research and development in regard to AMD and will continue to invest in improving industry best practice and ensure this is implemented at Nammuldi/Silvergrass. During the 2009 financial year Rio Tinto invested AU$1.2 million into mineral waste research in the Pilbara and included research into modelling of final pit void water quality, bioremediation, cover designs (i.e. store and release cover), waste dump designs and geochemical characterisation (Green 2009).

12.6 Predicted environmental outcomes against environmental objectives, policies, guidelines, standards and procedures

After mitigation measures have been applied, the Expansion Proposal cumulatively with the Original Proposal is expected to result in the following outcomes in relation to AMD and fibrous materials:

- PAF material will be stored and retained in specifically designed waste dumps during the operation of the mine to minimise the exposure of PAF material to water and the generation of AMD and to prevent discharge of AMD to the environment
- fibrous material will be stored in specifically designed waste dumps during the operation of the mine to prevent emissions of fibrous materials
- any excess groundwater discharged will not cause the receiving environment to exceed site specific water quality requirements (based on the application of ANZECC & ARMCANZ (2000) guidelines or WA Interagency Guidelines (WRC 2000b)
- surface water runoff from exposed PAF material in the pit wall or waste dump will be collected and prior to discharge will be tested and treated as required to meet site specific water quality requirements (based on application of the ANZECC/ARMCANZ (2000) guidelines)
- options for reducing contact with incident rainfall will be investigated to address AMD risks from exposure of PAF in pit walls.

13. Assessment of impact on Aboriginal heritage

13.1 Relevant environmental objectives, policies, guidelines, standards and procedures

13.1.1 EPA objective

The EPA applies the following objective in its assessment of proposals that may affect aboriginal heritage sites:

To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.

13.1.2 EPA statements and guidelines

EPA Guidance Statement No. 41

EPA Guidance Statement No. 41, "*Assessment of Aboriginal Heritage*" (EPA 2004b), provides guidance on the process for the assessment of Aboriginal heritage as an environmental factor. In its assessment of proposals, the EPA will expect proponents to:

- report on the likelihood of the presence of matters of heritage significance to Aboriginal people
- analyse if the proposed biophysical changes will result in an impact on matters of heritage significance to Aboriginal people.

Based on this information, the EPA will make a determination on whether Aboriginal heritage is a relevant environmental factor. Where it is determined to be a relevant environmental factor, the EPA will expect the proponent to properly consider how to minimise any adverse impact that the proposal may have on heritage values.

This guidance statement also details those actions that may be pertinent to the factor of Aboriginal heritage, including:

- consultation with DIA staff and desktop review of sites
- undertaking an Aboriginal heritage and/or archaeological survey in consultation with relevant Aboriginal representatives
- inform relevant Aboriginal people of the proposal and conduct appropriate consultation
- demonstrate that any concerns raised by the Aboriginal people have been considered in the environmental management of the factor and that this is made known to the relevant Aboriginal people.

13.1.3 Regulatory framework

State legislation

The Minister for Indigenous Affairs is responsible for the administration of the *Aboriginal Heritage Act 1972* (Aboriginal Heritage Act). Under section 17 of the Aboriginal Heritage Act, it is an offence to disturb any Aboriginal site without consent under section 18 of that Act. The Minister considers recommendations from the Aboriginal Cultural Material Committee and the general interests of the community when making a decision on disturbance to a site and may also impose conditions on the approval.

The Registrar of Aboriginal Sites is responsible for maintaining the Register of Places and Objects. The Department of Indigenous Affairs (DIA) has a database of all recorded sites.

Native title

Native title, or indigenous land rights, is a concept in the law of Australia that recognises the continued ownership of land by local Australian Aborigines or Torres Strait Islanders. The legal concept of Native Title as it applies in Australia was recognised by the judicial system in 1992, and the *Native Title Act 1993* (Commonwealth) was enacted to clarify the legal position of landholders and the processes that must be followed for Native Title to be claimed, protected and recognised through the courts.

13.2 Description of factor

The Greater Nammuldi Area is predominantly within the Eastern Guruma Native Title Determination Area and the Eastern Guruma Native Title Holder is recognised as the group that can speak for the area (Figure 17). Rio Tinto has an established ILUA with Eastern Guruma and takes direction from this group and other groups who may have an interest in the area. The Kuruma Marthudunera, and Puutu Kunti Kurrama and Pinikura (PKKP) groups are adjacent Native Title claimants, who also have an interest in this area, in particular Palm Springs (Figure 17).

Numerous Aboriginal heritage surveys have previously been conducted in the Greater Nammuldi Area since 1979 (Figure 66). The most recent ethnographic survey encompassing the Expansion Proposal was conducted in 2009 to assess the area surrounding B2, Nammuldi and Silvergrass (Ethnosciences 2009). This survey was conducted with six Eastern Guruma representatives and outlined the following sites with ethnographic significance within the Greater Nammuldi Area:

- Silvergrass
  - *Mallumallu* (Palm Springs) on Caves Creek downstream of Silvergrass (cultural significance)
  - three semi-permanent waterholes, *Karingkulanha* (Pancake Spring), *Jerithikuna* (Cockle Spring) and *Yantinha* (rockhole and camp) downstream of Silvergrass (cultural significance)
  - *Marramampa* – Aboriginal place name west of Silvergrass
  - *Marmparrnha* – waterhole north of Silvergrass and outside of the Proposal Boundary
  - *Thangkulu* – section of the ridge to the west of Silvergrass and outside of the Proposal Boundary
  - Brockman (Old Brockman Homestead)
  - HSA12 (burial site)
  - HSA13 (burial site)
  - P07064 (burial site).
- Nammuldi
  - areas of the western foothills of the Brockman range (*Minnha, Jawunmullungkanha, Pirtungarranmunha, Jawunpa*) (cultural significance).

All of these sites will be avoided and surrounded by a ‘no-go’ buffer of sufficient size (at least 50 m) to protect the values of the sites, as determined by consultation with Eastern Guruma.

To date, archaeological surveys have recorded 66 sites in the Greater Nammuldi Area including the area around the nearby B2 and BS4 operations. The most recent archaeological survey was conducted within the Greater Nammuldi Area in three stages – Stage 1 in March 2010, Stage 2 in April 2010 and Stage 3 in November 2010 (Wood & Westell 2010). There are currently ongoing surveys in the IAA and the Western Ridge accommodation camp (Option c).

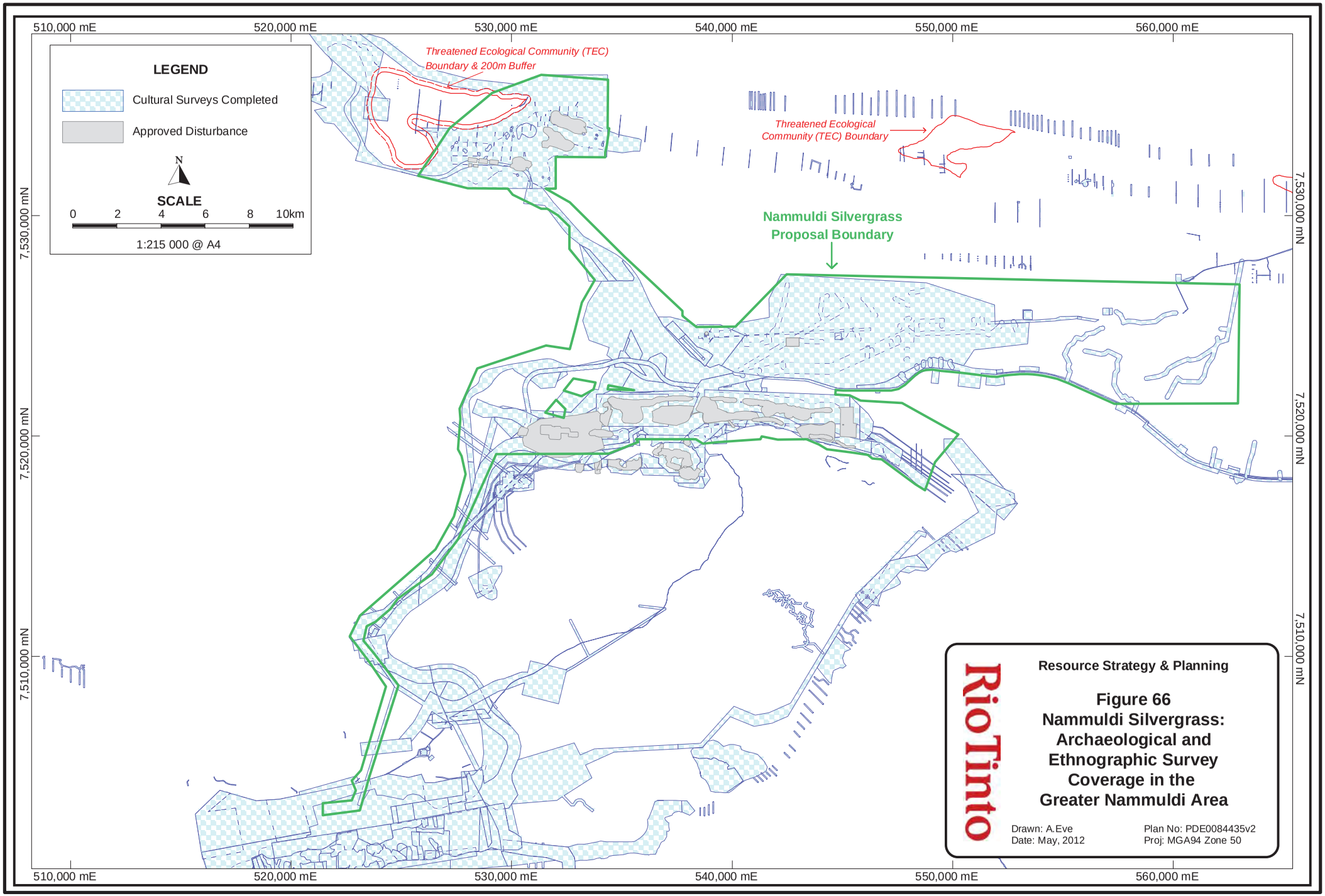
Of the 66 sites previously recorded, six were identified as occurring partially or wholly within the Proposal Boundary and were further investigated during the 2010 field surveys. The 2010 surveys also identified 49 previously unrecorded sites. The ethnographic values were assessed for the 49 sites identified in 2010 and six sites from previous surveys that are within the Proposal Boundary. Out of the 55 sites assessed, 12 sites were considered to have greater ethnographic significance values (Wood & Westell 2010):

- one art work (engravings) of extreme significance
- two quarries of high and moderate significance
- two quarries and artefact scatter combinations of low-moderate and moderate significance
- one rock shelter of low-moderate significance
- six stone artefact scatters, five of low-moderate and one of moderate significance.

The Eastern Guruma Representatives requested that avoidance in the first instance should be the primary goal for all sites. The consultants recommended that members of the group be involved with this process, and that any unverified sites be avoided until the group was able to make an assessment of the cultural significance of the site. The Eastern Guruma recommended that the locations of the other sites be verified prior to the preparation of a section 18 application, to allow for an informed assessment of the cultural significance of these sites.

The Rio Tinto heritage process stipulates that, upon receipt of final reports from the heritage consultants commissioned to conduct heritage surveys, the identified sites are registered with the WA Department of Indigenous Affairs.

Under agreement with the Eastern Guruma, reports containing cultural information will not be released publicly.


510,000 mE
520,000 mE
530,000 mE
540,000 mE
550,000 mE
560,000 mE
7,530,000 mN
7,520,000 mN
7,510,000 mN
LEGEND
Cultural Surveys Completed
Approved Disturbance
N
SCALE
0 2 4 6 8 10km
1:215 000 @ A4
Threatened Ecological Community (TEC) Boundary & 200m Buffer
Threatened Ecological Community (TEC) Boundary
Nammuldi Silvergrass Proposal Boundary
Resource Strategy & Planning
Figure 66
Nammuldi Silvergrass: Archaeological and Ethnographic Survey Coverage in the Greater Nammuldi Area
Drawn: A.Eve
Date: May, 2012
Plan No: PDE0084435v2
Proj: MGA94 Zone 50

13.3 Potential sources of impact

The primary aspects of the Expansion Proposal that may potentially affect Aboriginal heritage values are:

- **physical disturbance to land** during construction, mining and associated activities
- **dewatering** of the mining area to allow access to the below watertable ore has the potential to affect watercourses within and adjacent to the Proposal Boundary, which have heritage significance
- **discharge of surplus water** from dewatering has the potential to affect watercourses, which have ethnographic significance
- **alteration of surface drainage** will alter flow paths due to construction of diversion channels, mine pit, waste dumps and infrastructure and re-alignment of Caves Creek which may affect heritage values.

13.4 Assessment of likely direct and indirect impacts

13.4.1 Physical disturbance to land

The Expansion Proposal will not disturb any ethnographic sites of High or Extreme value. The Expansion Proposal will affect some sites considered to be of Low-Moderate value. The sites that will be disturbed will be subject to section 18 applications, and those not to be disturbed by the mine development will remain protected and will be barricaded and signposted for the life of mine. They will also be managed through the Cultural Heritage Management Plan in the EMP (Appendix 3).

13.4.2 Dewatering

The Eastern Guruma representatives present during the 2009 survey have indicated concern regarding the effects of groundwater drawdown on springs and the environment. Rio Tinto is conducting ongoing consultation with this group with regards to the effects of the Expansion Proposal on groundwater.

Three semi-permanent waterholes of ethnographic significance have been identified on Caves Creek, downstream of the proposed Silvergrass activities (Ethnosciences 2009). One of these water sources, *Yantinha*, is located within the extent of the 2 m drawdown contour after 6 years of dewatering (Section 7.4.1). A field visit with Eastern Guruma representatives in May 2011 to find Yantinha showed no surface pools in that section of the creek despite heavy rain in summer 2011. Given there was no evidence of these pools during the field trip, it is likely that these pools are very short-lived immediately after rainfall and therefore are not expected to be affected by the Expansion Proposal. The locations of the other two waterholes on Caves Creek were unable to be verified during the 2009 survey. It is likely that these pools are only very short-lived and unlikely to be affected by the Expansion Proposal. Eastern Guruma representatives indicated that any sources of fresh water in the area, particularly springs, should be avoided.

As identified in Section 7.2.2, Caves Creek is underlain by a consistent and extensive 15 – 20 m stiff clay unit. Above the clay layer is an alluvium/colluvium layer comprising clay and silt and a calcrete layer. Flows within Caves Creek are rainfall-fed and therefore have the potential to form transient pools that are unlikely to be affected by changes to groundwater conditions. Given the presence of the clay unit beneath Caves Creek, dewatering to support the Expansion Proposal is considered unlikely to affect the transient pools.

13.4.3 Discharge of surplus water

Rio Tinto has adjusted the surplus water management strategy to avoid discharge into Caves Creek to avoid disturbance to heritage sites and protect ethnographic values. The primary method of surplus water management is to supply an irrigated agriculture scheme on Hamersley Pastoral Station as outlined in Section 7.4.2; however, discharge to Duck Creek will be required during some winter months.

No waterholes of ethnographic or archaeological significance have been recorded along these stretches of the creeks and consultation is being undertaken by Rio Tinto within the Eastern Guruma Native Title determination area (Wood & Westell 2010). Some sites that are culturally significant to PKKP have been recorded downstream of the confluence of Boolgeeda Creek and Duck Creek, which is approximately 80 km downstream from the discharge. As the surplus water is of good quality and will have a minimal affect on the depth below the confluence, the periodic discharge of water is not expected to affect any heritage sites.

13.4.4 Alteration of surface drainage

Designs for pits and infrastructure that have the potential to affect surface flows will be developed to avoid heritage sites wherever possible.

The Caves Creek realignment will necessitate a realignment of approximately 2.5 km of the main channel of the creek (Figure 26 and Figure 27). The design of the realignment will ensure that a 100 year ARI flood event is safely conveyed through the realigned section without risk to infrastructure but without significantly increasing the velocity of the flow and will withstand possible maximum flood.

The realignment is unlikely to affect any heritage values associated with the creek. Rio Tinto is undertaking ongoing consultation with the Native Title holders with regard to impacts on heritage to ensure that heritage values associated with the creek are managed.

13.5 Management measures and performance standards

Rio Tinto will manage and protect Aboriginal heritage values within the Proposal Boundary according to the guidelines and conditions outlined in the ILUA and *Iron Ore (Hamersley Range) Agreement Act 1963*. Aboriginal heritage values within and around the Proposal Boundary will be addressed and controlled through the implementation of the Aboriginal Heritage Management Plan. The plan includes specific management measures during construction as well as operations. The following key management measures will be implemented:

- prior to any ground disturbance, undertake an Aboriginal heritage survey (i.e. archaeological and ethnographic survey) on the area proposed to be disturbed and report any suspected sites under Section 15 of the Aboriginal Heritage Act
- conduct all Aboriginal heritage surveys in consultation with the DIA and the Eastern Guruma People
- liaise with Eastern Guruma and PKKP Traditional Owners and keep them informed of the progress of the development and implementation of the Expansion Proposal
- prepare a community and social benefits plan in consultation with local government(s) and submit completed plan to the Minister for approval
- avoid disturbance as far as practicable
- obtain approvals for any disturbance required to identified sites in accordance with section 18 of the AH Act
- implement contingency actions described in the Cultural Heritage Management Plan in the case of identification of a potential Aboriginal heritage site and/or skeletal remains during construction (i.e. immediately stop work at the discovery site)
- arrange for the local Aboriginal groups to receive training and monitor ground disturbing activities
- prepare and implement an Aboriginal cultural awareness programme for all site personnel (e.g. discuss gender-restricted locations)
- undertake mitigative salvage at sites with the co-operation and involvement of the local Aboriginal groups, including the Eastern Guruma People
- protect all identified sites located near construction or operational areas that are not approved to be disturbed under section 18 of the AH Act through the implementation of measures determined in consultation with the Eastern Guruma People. A minimum 50 m buffer zone is preferred
- prepare reports on all archaeological findings and monitoring
- document the location of all protected sites in a Geographic Information System and on-site plan.

13.6 Predicted environmental outcomes against environmental objectives, policies, guidelines, standards and procedures

The Expansion Proposal will be implemented in accordance with EPA Guidance Statement No. 41 (EPA 2004b) through the implementation of the Cultural Heritage Management Plan, ILUA and the Aboriginal Heritage Act which specifies avoidance of sites of significance, wherever practicable. The Expansion Proposal will not disturb any ethnographic sites of High or Extreme value. The Expansion Proposal will affect some sites considered to be of Low-Moderate value.

The Eastern Guruma representatives have indicated that they would have no objection (subject to appropriate salvage) to applications under section 18 of the Aboriginal Heritage Act for disturbance of verified sites where avoidance was not possible.

Ongoing consultation with Native Title Holders will continue throughout the implementation stages which will allow for appropriate levels of management and understanding of the Aboriginal heritage values of the Greater Nammuldi Area.

14. Closure

14.1 Relevant environmental objectives, policies, guidelines, standards and procedures

14.1.1 EPA objective

In most circumstances, including this assessment, the EPA applies the following objective in its assessment of proposals that have a closure component:

To ensure, as far as practicable, that rehabilitation achieves a stable and functioning landform that is consistent with the surrounding landscape and other environmental values.

14.1.2 EPA statements and guidelines

EPA Guidance Statement No. 6

EPA Guidance Statement No. 6 (EPA 2006b) provides guidance on the rehabilitation of terrestrial ecosystems following disturbance. The Guidance Statement states that the key aims of rehabilitation are to:

- ensure the long-term stability of soils, landforms and hydrology required for the sustainability of sites
- partially or fully repair the capacity of ecosystems to provide habitats for biota and services for people.

Actions relevant to rehabilitation planning and design include the identification of relevant rehabilitation objectives (in consultation with key stakeholders), as well as the development of clear targets for rehabilitation that can be effectively monitored and audited to confirm objectives are achieved. Rehabilitated sites should (EPA 2006b):

- include safe, stable and resilient landforms and soils
- include appropriate hydrology
- provide visual amenity
- retain heritage values
- be suitable for agreed land uses
- include resilient and self-sustaining vegetation comprised of local provenance species
- reach agreed numeric targets for vegetation recovery
- comprise habitats capable of supporting all types of biodiversity.

14.1.3 Government and industry guidelines

Regulatory agencies and industry bodies have established guidelines (industry best-practice) to assist mining companies achieve acceptable standards of mine closure and rehabilitation. While there are no legislative requirements to adhere to these guidelines, Rio Tinto subscribes to the intent and advice of such guidelines.

The DMP is the regulatory agency for mining operations (subject to provisions of *Iron Ore (Hamersley Range) Agreement Act 1963*) in Western Australia. The DMP has developed a number of guidelines and environmental notes in relation to mining and rehabilitation, which include:

- Guidelines for Preparing Mine Closure Plans (DMP and EPA 2011)
- Environmental Notes on Mining – Waste Rock Dumps (DMP 2009 – produced by the former Department of Industry and Resources)
- Mine Void Water Resource Issues in Western Australia (Johnson and Wright 2003 – produced by the [former] Water and Rivers Commission)
- Mining Environmental Management Guidelines, Safe Design and Operating Standards for Tailings Storage (DMP 1999).

Other key government and industry guidelines relevant to mine closure and rehabilitation include:

- Strategic Framework for Mine Closure (ANZMEC/MCA 2000)
- Enduring Value – The Australian Minerals Industry Framework for Sustainable Development (Minerals Council of Australia 2004)
- Mine Closure and Completion (Department of Industry, Tourism and Resources [DITR] 2006a)
- Mine Rehabilitation (DITR 2006b)
- Best Practice Environmental Management in Mining Series (EPA 1995, Environment Australia 1998, 2002).

14.1.4 Corporate requirements

Rio Tinto has the following established policies and standards, some which may go beyond statutory requirements, and to which all operations must adhere.

Rio Tinto Closure Standard

The Rio Tinto Closure Standard directs the development and implementation of closure activities at Rio Tinto operations. The implementation of this standard, by Rio influences the design, development, operation and closure of all its operations to ensure optimisation of post-closure outcomes in terms of social, environmental and economic development needs and expectations.

In addition to the Closure Standard, there are a number of environmental standards that have direct or indirect implications for closure. These standards outline the minimum level of compliance for all operations and are regularly audited.

Rio Tinto Closure Vision

The Rio Tinto Closure Vision, applicable to all sites, includes:

- working with Indigenous communities and other stakeholders to preserve, protect and manage the cultural heritage values of the area
- considering the implications of closure on local communities when developing and implementing closure strategies
- negotiating completion criteria with Government stakeholders, and working towards achieving those goals
- returning the area to landforms that are safe, stable and compatible with the surrounding environment
- working towards achieving environmental outcomes that are compatible with the surrounding environment
- working with employees and stakeholders to identify and manage ongoing employment and other opportunities
- achieve closure objectives in a cost effective manner.

14.2 Closure planning

14.2.1 Closure Study

Closure planning is a dynamic process that requires regular review and development throughout the life of the operation, to take into account changes in legal obligations, corporate requirements, community expectation and changes in technical knowledge.

The Rio Tinto Closure Standard requires a new closure study to be conducted for each site every five years, with the level of detail and accuracy increasing as the site approaches closure as information becomes available on final mine landforms and from closure studies. This information is then used in the development of the Final Decommissioning Plan, which is required by Rio Tinto five years before closure.

A conceptual closure plan was developed before the implementation of the Original Proposal to satisfy internal closure planning standards. The conceptual closure plan for the Original Proposal identified a number of specific objectives and targets, the outcomes of stakeholder consultation, and was consistent with the closure criteria defined by the Strategic Framework for Closure (ANZMEC/MCA 2000).

Rio Tinto has prepared closure studies for both Nammuldi and Silvergrass to ensure the closure management requirements as a result of the changes to the operations from the Expansion Proposal are addressed. This process will continue for the life of mines. A major closure study will then be conducted in the final years of operation in order to develop a robust Closure Strategy and schedule, which will ensure that both the State and Rio Tinto objectives and requirements for mine closure are met.

The closure studies for the Nammuldi and Silvergrass mines have been prepared in accordance with the *Guidelines for Preparing Mine Closure Plans* (DMP & EPA 2011). However, as these guidelines were released 12 months after the Expansion Proposal was referred there may be gaps in the initial plans provided with this PER. The closure studies identify the timing of investigations that are still required to be completed as a result of the release of these new guidelines. This is consistent with discussions regarding application of the guidelines that have been held between Rio Tinto and the EPA.

The key aims of the closure studies for Nammuldi and Silvergrass are to identify closure objectives and closure planning requirements for the sites. The closure planning requirements are documented for each of the identified domains (i.e. aspect of the Expansion Proposal, such as mine pits). The closure planning requirements include the following components:

- establishment of post-mining land use
- identification of risks associated with closure
- indicative completion criteria
- ongoing monitoring requirements
- financial requirements
- implementation strategies, including decommissioning and decontamination measures.

This document summarises the closure objectives and the above closure planning components of the closure plans in Section 14.2.2 to 14.2.7. The document then provides an overview of the closure implementation strategy for each of the following domains in Section 14.3:

- surface waste dumps
- PAF/ metalliferous material waste dumps
- mine pit voids
- waste fine storage facility
- Irrigated Agriculture Area
- other minor elements.

14.2.2 Closure objectives

Closure objectives provide the basis for achieving desired closure outcomes. The preliminary closure objectives for the Expansion Proposal developed to achieve the desired closure vision are:

1. Preserve, protect and manage the cultural heritage values of the area, in cooperation with the Traditional Owners and other stakeholders.
2. Develop and implement strategies for closure which consider the implications on local communities.
3. Achieve completion criteria which have been developed with stakeholders and agreed with Government.
4. Develop landforms that are safe and stable and compatible with the surrounding environment and post-mining land use.
5. Achieve environmental outcomes that are compatible with the surrounding environment.
6. Implement a workforce strategy which addresses the impacts of closure on employees and contractors
7. Achieve successful closure in a cost effective manner.
8. Post-closure pit voids are safe, stable and non-polluting.
9. Minimise the potential for AMD generation and minimise long term exposure to fibrous materials.
10. Post-closure use of the Irrigated Agriculture Area meets social, environmental and economic aspirations of key stakeholders.
11. Post-closure landforms are compatible with maintaining the ecological values of Duck Creek.
12. Caves Creek hydrological functionality is maintained, including the avoidance if impeding surface water flows within the 1 in 100 year flood extent.
13. Maintenance of cultural heritage values of Palm Springs and significant cultural sites.
14. Environmental values of cracking clay Threatened Ecological Communities (west of Silvergrass) should not be compromised.

These provisional objectives will be subject to ongoing review in consultation with key closure stakeholders.

14.2.3 End land use

The intended post-closure land use will take into consideration the specific values and constraints of the surrounding physical and biological environment, heritage requirements and Agreements with Native Title Claimants, as well as other socio-economic aspects of the Expansion Proposal. Rio Tinto's preliminary determination is, where possible, to reinstate a 'natural' ecosystem with similar elements and functional characteristics to the pre-mining ecosystem, which does not significantly impact and where possible complements adjacent pastoral land uses.

The anticipated end land use will be reviewed regularly throughout the life of the project in consultation with key stakeholders. The anticipated final land use will be similarly determined as part of the final mine design plan. This will ensure that the value from progressive rehabilitation is maximised. Ongoing post-mining land use planning will take into consideration:

- opportunities exist to reinstate biodiversity components of the pre-disturbance landscape
- preventing livestock access into rehabilitated mining areas is likely to improve landscape rehabilitation outcomes
- agricultural production may continue in the IAA post closure
- alternative beneficial land use (*e.g.* recreation or aquaculture) is unlikely to be viable in rehabilitated mining areas.

14.2.4 Identification of risks

Detailed risk assessments associated with closure at both Nammuldi and Silvergrass are being undertaken and will be included in the closure studies for each mine. The risk assessment process is being undertaken by a multidisciplinary team including (but not limited to) personnel with experience in geology, mine engineering, hydrogeology, hydrology, metallurgy, engineering, health and safety, environment and regulatory approvals. The risk assessment will be made available in accordance with the *Guidelines for Preparing Mine Closure Plans* (DMP & EPA 2011).

To address ongoing project risk associated with unplanned or temporary closure the following plans have been identified. In the event of sudden or unplanned closure, an accelerated closure process will be implemented. This involves the immediate preparation and implementation of a Decommissioning and Closure Plan (based on the most current closure plan), taking into account the early cessation of activities at the site.

Operation may possibly be temporarily suspended due to adverse economic or operational circumstances (for example an extreme downturn in commodity prices). A temporary shutdown of this nature is normally supported by pre-existing plans and assumes that the operation will recommence. This would involve preparation and implementation of a Care and Maintenance Plan that takes the likelihood of future commencement of operations into account.

14.2.5 Indicative completion criteria

Indicative completion criteria have been developed as a basis for determining whether the desired closure outcomes have been achieved (Table 55). These will provide the basis for developing more detailed completion criteria as the site approaches closure.

Table 55 Indicative completion criteria

Objective	Indicative Completion Criteria
Preserve, protect and manage the cultural heritage values of the area, in cooperation with the Traditional Owners and other stakeholders	Consultation activities ensure that: • internal and external stakeholders are receiving information in a transparent and timely manner • internal and external stakeholders have an opportunity to put forward their concerns and ideas on closure issues • the input provided by stakeholders is considered and, where possible, incorporated into the planning and implementation of closure. A consultation register is maintained, which documents stakeholder input on closure objectives and proposed methodologies, and is used to inform closure planning. Any significant landscape and cultural heritage values are identified and protected.
Develop and implement strategies for closure which consider the implications on local communities	Consultation activities ensure that: • internal and external stakeholders are receiving information in a transparent and timely manner • internal and external stakeholders have an opportunity to put forward their concerns and ideas on closure issues • the input provided by stakeholders is considered and, where possible, incorporated into the planning and implementation of closure. A consultation register is maintained, which documents stakeholder input on closure objectives and proposed methodologies, and is used to inform closure planning. Aesthetic values and public experience of the landscape are identified, and measures are adopted to reduce the visual impacts on the landscape.

Objective	Indicative Completion Criteria
Achieve completion criteria which have been developed with stakeholders and agreed with Government	Consultation activities ensure that: • internal and external stakeholders are receiving information in a transparent and timely manner • internal and external stakeholders have an opportunity to put forward their concerns and ideas on closure issues • the input provided by stakeholders is considered and, where possible, incorporated into the planning and implementation of closure. A consultation register is maintained, which documents stakeholder input on closure objectives and proposed methodologies, and is used to inform closure planning. The removal of the agreed infrastructure is achieved.
Develop landforms that are safe and stable and compatible with the surrounding environment and post-mining land use	Known contaminated sites have been remediated to agreed levels as soon as possible and prior to site handover. The pollution potential of the site is reduced to a practicable minimum. All identified AMD materials are adequately contained or covered to prevent contamination of surface and ground water. There is no contamination of ground or surface water from inappropriate storage or handling of chemicals including hydrocarbons. Pollutant levels at potential contaminated sites are within agreed levels. Erosion of reconstructed surfaces is equivalent to surrounding natural ecosystems.
Achieve environmental outcomes that are compatible with the surrounding environment	The post-closure landform designs are informed by studies conducted. The agreed post-closure land use is enabled. The quality and quantity of ground and surface water is maintained such that existing and potential environmental values are maintained. No deterioration in the conservation status of threatened and endemic species, and high priority conservation areas, occurs as a result of the mine operation. Impacted areas are returned to self-sustaining vegetation and fauna communities that have similar ecosystem function to analogue sites. Opportunities for positive biodiversity impacts are sought and implemented where possible.
Implement a workforce strategy which addresses the impacts of closure on employees and contractors	A workforce management strategy has been developed and implemented. In terms of employees, this strategy details how reemployment, retraining and/or retrenchment is addressed.
Post-closure pit voids are safe, stable and non-polluting.	Pit voids enable fauna assemblages in the surrounding environment to co-exist. Pit voids/lakes do not release pollutants into the surrounding ecosystem. Appropriate ecological measurement parameters and methods for this objective are selected/developed.
Minimise the potential for AMD generation and minimise long term exposure to fibrous materials	Final landform designs minimise the potential for AMD generation, based on specifications developed for this purpose. Appropriate ecological measurement parameters and methods for this objective are selected/developed.
Post-closure use of the Irrigated Agriculture Area meets social, environmental and economic aspirations of key stakeholders.	Stakeholder consultation regarding post-closure use of Irrigated Agriculture Area is undertaken and documented. An Irrigated Agriculture Area Management Plan is developed prior to closure, which addresses the social, environmental and economic aspirations of key stakeholders
Post-closure landforms are compatible with maintaining the ecological values of Duck Creek.	The ecological values of Duck Creek are characterised prior to closure, and documented in a Duck Creek Baseline Report. The Baseline Report is used to inform post-closure landform designs.
Achieve successful closure in a cost effective manner	Closure cost estimates have been developed, and have been reviewed on a regular basis in accordance with Rio Tinto corporate requirements. The final land use option implemented is selected using a suitable sustainable development assessment methodology.

Objective	Indicative Completion Criteria
Caves Creek hydrological functionality is maintained, including the avoidance if impeding surface water flows within the 1 in 100 year flood extent.	The final landform does not significantly impede surface water flows within the 1 in 100 year flood extent. Erosion control measures are built into the final landform to limit sedimentation in runoff into local waterways. Monitoring demonstrates that hydrological functionality has been maintained.
Maintenance of cultural heritage values of Palm Springs and significant cultural sites.	The landscape and cultural heritage values associated with Palm Springs are identified and protected. Consultation activities ensure that: • internal and external stakeholders are receiving information in a transparent and timely manner; • internal and external stakeholders have an opportunity to put forward their concerns and ideas on closure issues; and • the input provided by stakeholders is considered and, where possible, incorporated into the planning and implementation of closure. Access to country around Palm Springs is maintained.
Environmental values of cracking clay Threatened Ecological Communities (west of Silvergrass) should not be compromised.	The Environmental values of cracking clay Threatened Ecological Communities is maintained at closure and is considered self-sustaining. Any species loss within the cracking clay Threatened Ecological Communities is considered to be within natural parameters.

14.2.6 Ongoing monitoring requirements

The monitoring program will be finalised during development of the Final Decommissioning Plan. The monitoring program will focus on measuring performance against closure completion criteria developed and include the elements identified in Table 56. Ongoing monitoring of water quality changes in mine void lakes will be addressed as part of closure planning.

Table 56 Indicative closure monitoring program

Element	Phase		
	Pre-closure	Active closure	Post-closure
Baseline fauna surveys (terrestrial and subterranean fauna)	✓		
Baseline vegetation and flora surveys	✓		
Duck Creek baseline ecological surveys	✓		
Hydrology/hydrogeology baseline study	✓		
Landform and soils baseline study	✓		
Heritage baseline survey	✓		
Erosion monitoring (analogue natural landforms)	✓	✓	✓
Vegetation monitoring (analogue vegetation communities)	✓	✓	✓
Surface water and ground water quality monitoring	✓	✓	✓
Contaminated sites assessment		✓	
Erosion monitoring (rehabilitated landforms)		✓	✓
Vegetation monitoring (i.e. revegetation success on rehabilitated landforms)		✓	✓

14.2.7 Financial requirements

Rio Tinto considers specifics of the closure cost estimate to be commercially sensitive information, as such specific closure cost assumptions and calculations have not been included and this document presents the principles of closure cost estimation. The development of closure cost estimates includes consideration of:

- decommissioning (i.e. removal of infrastructure)
- final landform construction
- rehabilitation activities (e.g. revegetation)
- heritage management
- remediation of contamination
- workforce management (i.e. training costs and redundancy payments)
- research and trials
- monitoring costs
- costs associated with the development of a Final Decommissioning Plan
- costs associated with undertaking a final shutdown of operations
- allowance for failed rehabilitation or pollution that may necessitate rework of rehabilitation areas
- assignment of indirect costs in accordance with Rio Tinto Accounting Policy.

The cost estimation methods will be determined by using the best and most recent estimate of the expected cost at that time. The closure cost estimation methodology takes into account factors such as:

- closure strategy assumptions and inputs
- closure scope changes
- tax rates/deductions, inflation and exchange rate differentials
- evolving regulatory requirements
- stakeholder consultation processes
- closure project management costs
- provision for unexpected closure
- provision for potential delays, extreme events or other relevant external factors
- contingency factors.

14.3 Specific closure management and decommissioning strategies for each identified domain

14.3.1 Surface waste dumps

Existing and proposed mine landforms for the Expansion Proposal consist of permanent and temporary landforms. Temporary landforms may consist of mine overburden, low grade stockpiles or rehabilitation material stockpiles, including topsoil. These temporary landforms will be progressively decommissioned and rehabilitated as part of the closure process for the Proposal.

Permanent waste landforms will remain as raised landforms and will be designed in accordance with the Pilbara Iron Landform Design Guidelines so they are stable in the long term and will facilitate successful rehabilitation. The indicative location of the permanent landforms is shown on Figure 19 and Figure 20; with preliminary designs also presented in Figure 67 and Figure 68. However, the final design of these landforms will be determined by the results of waste material characterisation.

In total it is estimated that the Expansion Proposal will produce approximately 955 Mt of waste, include approximately 725 Mt from Nammuldi and 230 Mt from Silvergrass.

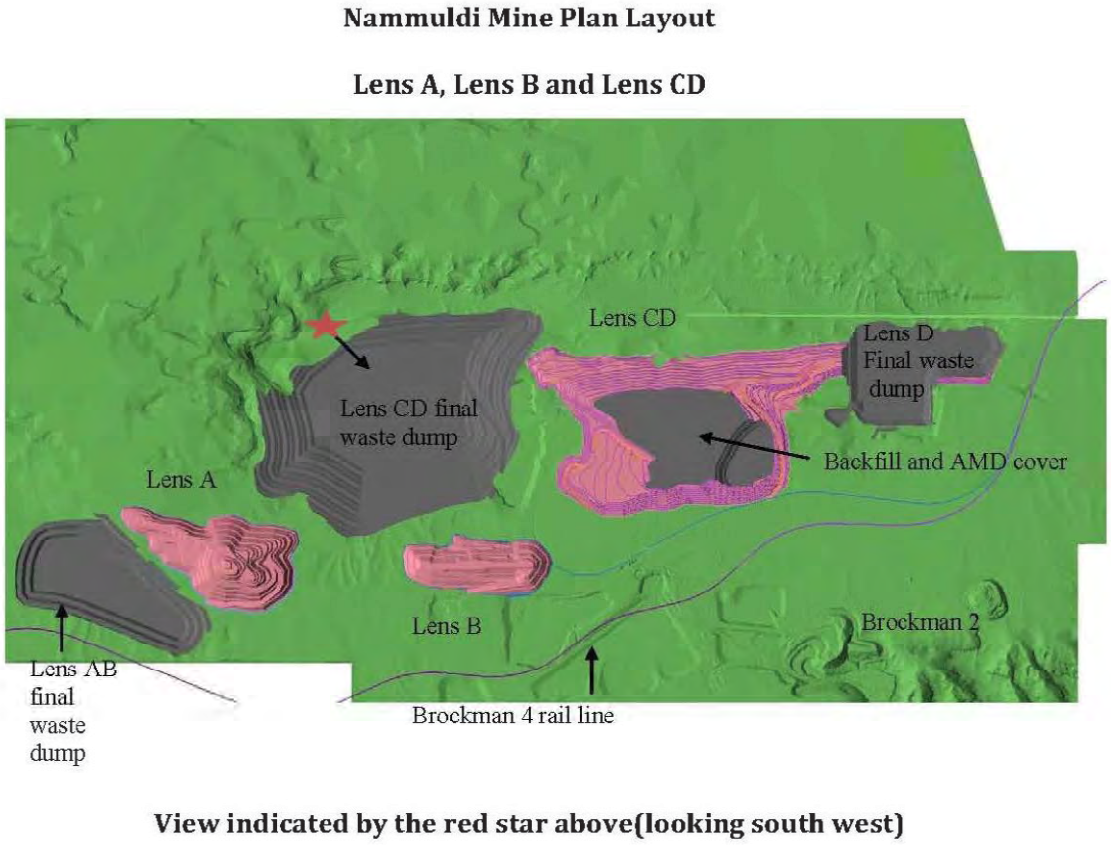


Figure 67 Preliminary landform design at Nammuldi

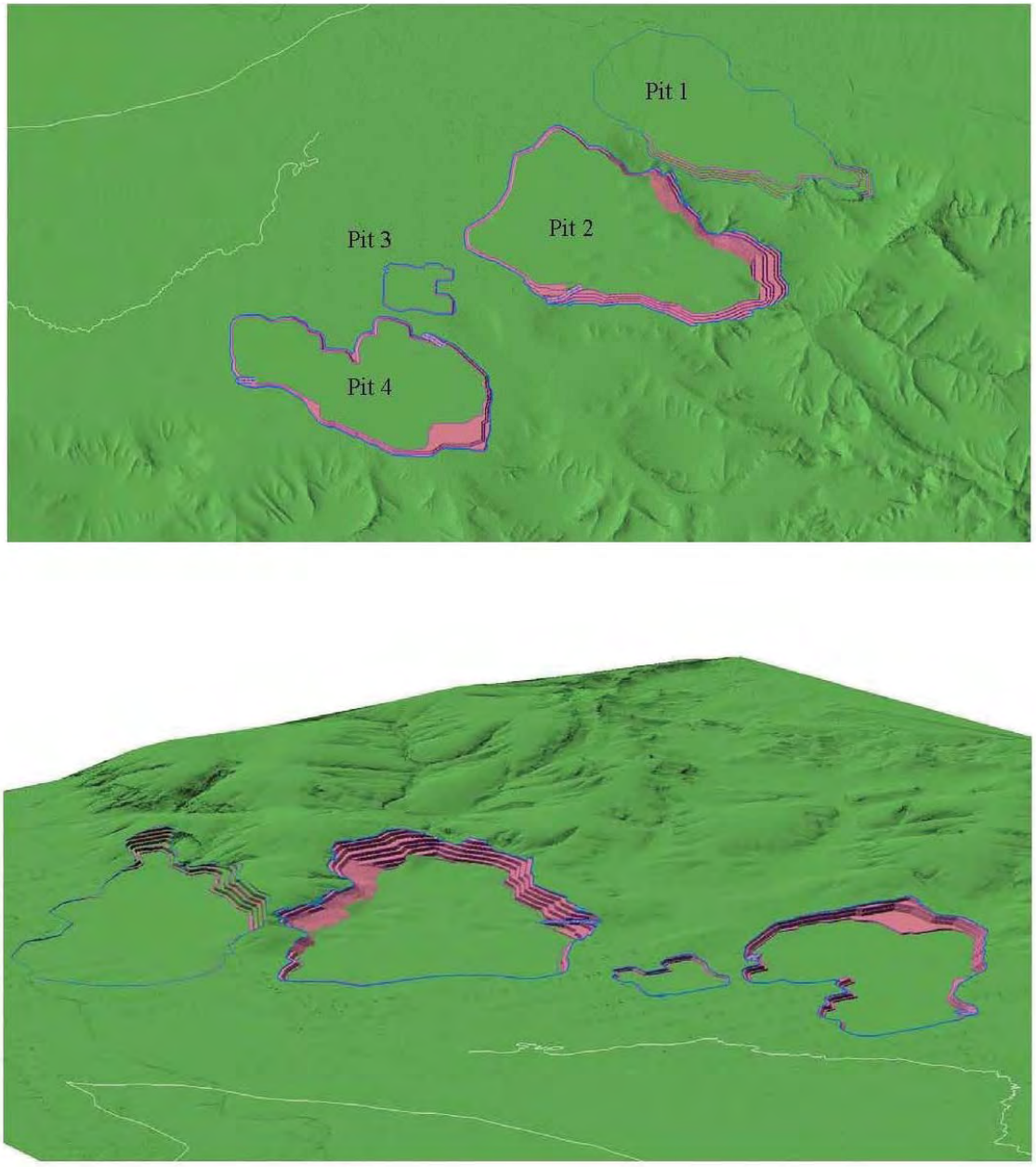


Figure 68 Preliminary landform design at Silvergrass

Surface water runoff from adjoining landforms will be directed away from waste dumps, such that the top surface of waste dumps will receive only incident rainfall. The top surface may be sloped towards the centre and may have surface treatments applied and windrows constructed to minimise water travelling over the slope to allow the formation of one or more pools and minimise erosion along the waste dump slopes. Surface water drainage from the constructed landform areas will be directed to downstream creekline(s) via a sediment capture area to ensure the quality of surface water flow into the creekline(s) remains acceptable meeting ANZECC guideline criteria.

Final waste dumps may consist of variable waste rock types with varying susceptibility to erosion. The maximum slope and length of each waste dump will be dependent on the erodibility of the waste material. Topsoil and mulch (where available) will be spread over the waste dump surface. Conceptual designs have been prepared for the Lens C/D dump (shown in Figure 69), based on the conservative assumption

that all material will be highly erodible, and similar designs will be produced for other Nammuldi waste dumps. Conceptual designs include the following design constraints:

- maximum slope gradient: 20 Degrees
- maximum slope length: 50 m
- maximum lift height: 20 m.

However, these designs may be overly conservative as they do not consider the potential to use capping material to reduce erosion risks. Final designs are yet to be developed and integrated into the mine plan. Dump slopes will then be ripped and seeded.

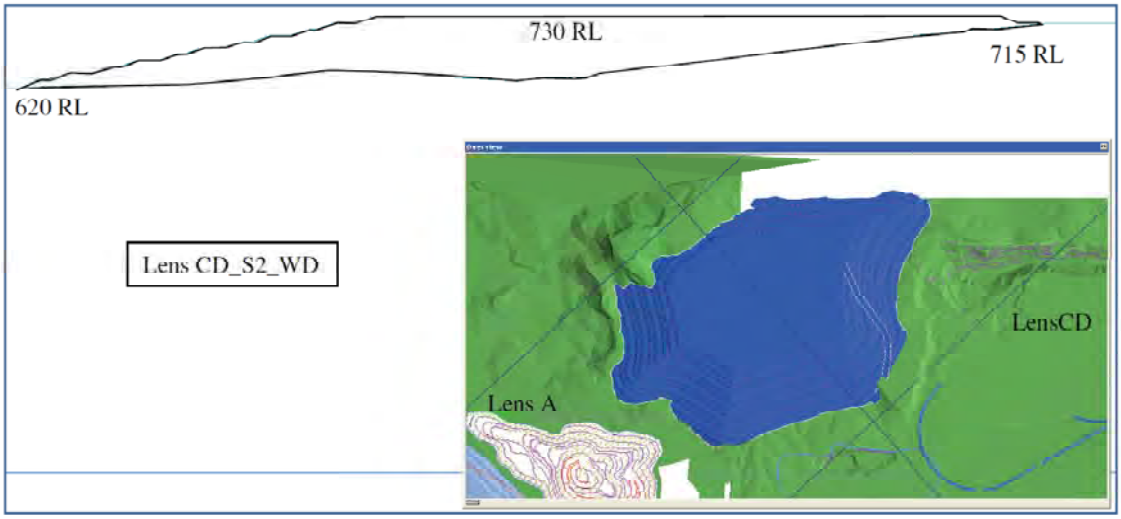


Figure 69 Schematic of Lens CD waste dump with elevation

14.3.2 PAF/ metalliferous material waste dumps

Geochemical characterisation of mine waste samples determined the presence of PAF material within the mine waste at Nammuldi/Silvergrass. The AMD risks associated with BWT mining at the Nammuldi and Silvergrass mines were considered in Section 12 to be low at all pits during mining, with the exception of Lens C/D pit which poses a moderate AMD risk. The major AMD risk for the Expansion Proposal is from lignite (4.4 Mt) and siderite (1.8 Mt) that is mostly found below the watertable from Lens C.

Investigations relevant to the post-closure management of PAF material are ongoing to quantify the risks and associated PAF material exposed in the final pit shells and identify management strategies. As lignite and siderite will be exposed in the pit wall of Pit C/D low erodibility dolomite will be used to encapsulate wall exposures to limit oxygen from reaching the PAF material.

The management of all PAF waste material will be managed in accordance with the Rio Tinto SCARD Management Plan. PAF material encountered during mining it will be separately encapsulated in waste facilities by low permeability inert material. Calcrete will be used strategically as a neutralising material to ensure that PAF waste dumps are safe and non-polluting.

14.3.3 Mine pit voids

Nammuldi

Greater than 90% of the known high grade ore resource occurs below the current watertable and dewatering will drawdown the watertable during operations (Section 3.3.10). As several pits will be mined concurrently, there will be minimal opportunities for progressive disposal of waste to pit voids during mine life. In addition, there will likely be insufficient material to backfill the Nammuldi pits to above the pre-mining watertable since greater than 90% of the ore to be mined occurs below the watertable.

As described in Section 4.5, there are a number of alternatives being considered for the pit void after closure. Due to the difficulties associated with modelling partially back-filled pits, modelling of post closure conditions has only been undertaken assuming no back filling.

Modelling of groundwater recovery (assuming no backfilling) indicates it will take between 50 and 70 years before groundwater levels across Nammuldi reach a quasi-steady state after dewatering of the Nammuldi pits ceases (Rio Tinto 2010g). On average, these post mining groundwater levels will be approximately 65 – 75 m lower than pre mining groundwater levels (Figure 70). Pit lakes are expected to form in all Nammuldi pit voids except for Lens B. Mine void lakes will be in the order of 90m (Lens A and Lens E/F) to 160m (Lens C/D) deep.

Evaporation from the pit lakes is expected to exceed local rainfall runoff and groundwater inputs into the voids, which will cause the pit lakes to become local groundwater sinks. Although the pit lakes are expected to increase in salinity as a result of evaporation over time, modelling of the mine pit water quality indicates that after 150 years the water quality is still likely to be within the freshwater range (Table 57) (Rio Tinto 2010g).

Table 57 Modelling results of chloride concentration (mg/L) pit lake water in each Nammuldi pit 150 years after closure

Pit	2030	2180
Lens A	140	430
Lens C/D	130	340
Lens E/F	100	250

Modelling has indicated that the outflow component of the water balance from the mine pits will be predominately from evaporation with flow of water from the pit voids to groundwater likely to be limited to approximately 2% of the outflow from Lens C/D pit void, approximately 11% from Lens A and approximately 21% from Lens E/F. This flow of water from pit lakes to the underlying groundwater is not expected to significantly affect the water quality of the groundwater. In addition, there are no nearby groundwater-dependent vegetation, water holes or restricted subterranean fauna communities within the Nammuldi valley that are likely to be affected by the minor change to groundwater quality.

It is therefore considered that whichever option is chosen the outcomes are unlike to have significant environmental effects.

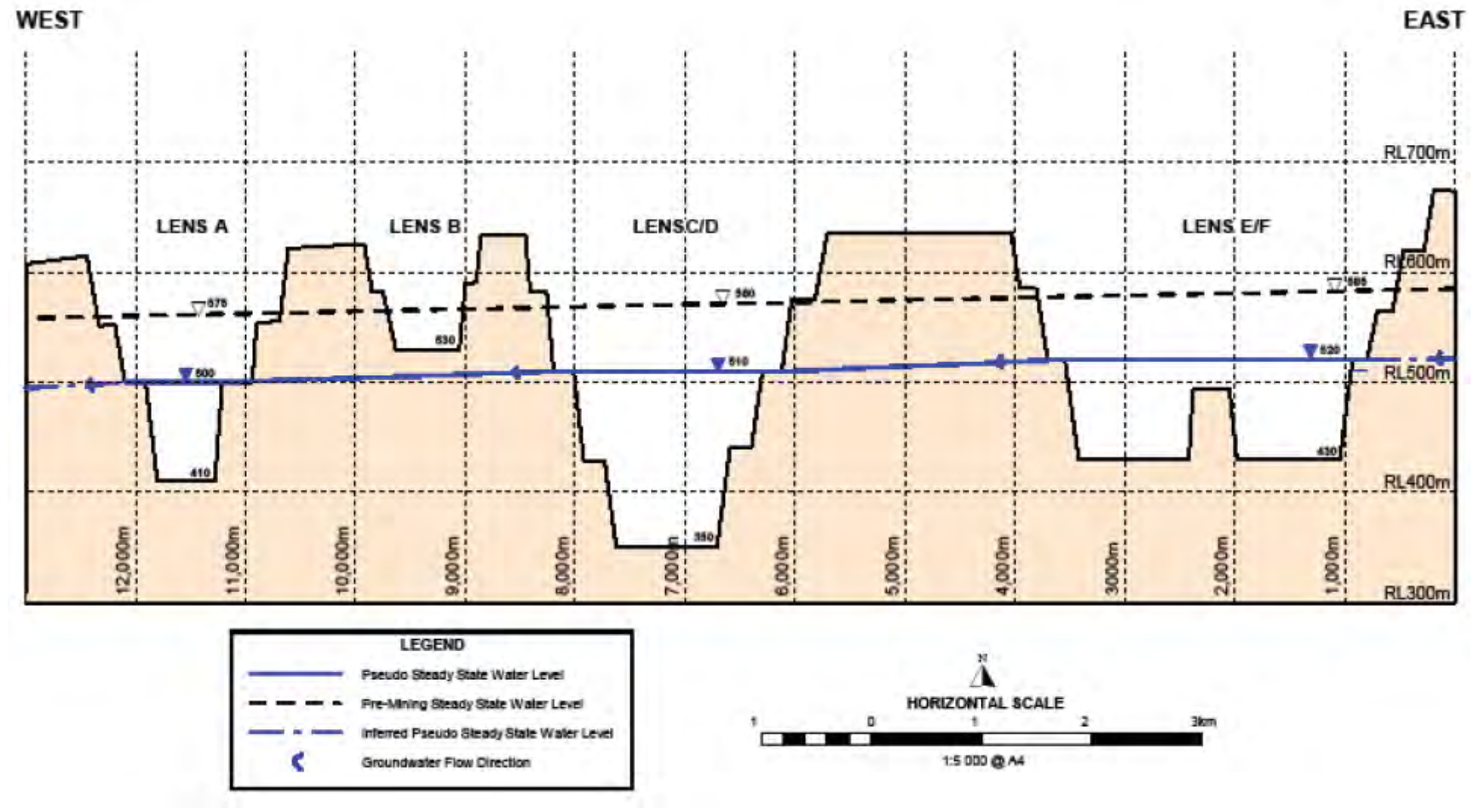


Figure 70 East-west pseudo steady-state conceptual closure cross section at Nammuldi

Silvergrass

All Silvergrass pits will be backfilled to above the predicted stable post mining watertable level as a minimum to ensure no permanent pit lakes form. The extent of the 2 m drawdown contour will initially continue to expand after dewatering has ceased as water flows from the surrounding aquifer to the deepest part of the previous dewatering cone.

Modelling of groundwater recovery at Silvergrass indicates that it will take approximately 125 years after mine closure and the cessation of dewatering before recovering close to pre-mining levels (Rio Tinto 2010f). The backfilled pits will enable groundwater throughflow and prevent permanent groundwater sinks forming. These rates of recovery are approximate and sensitive to specific yield of the backfill material.

14.3.4 Waste fines storage facility

Planning for the closure of the WFSF is being undertaken as part of the design of the WFSF with the results to be included in the Mining Proposal. The closure strategy for the WFSF will include battering the walls of the WFSF to an angle to be determined by the results of waste material characterisation and then rehabilitating the outer walls of the WFSF.

Samples of the tailings material have been subject to liquid extract tests to determine the potential for metallic elements such as arsenic, selenium, cadmium and tin to become mobile in the groundwater (Green 2010a). The liquid extracts indicated the presence of copper, zinc, and iron. Copper and zinc mobilisation in the WFSF, which increases at acidic pH levels, is unlikely as the pH of water extractions/ tailings samples were slightly alkaline (average 8.2 pH units) and is not believed to pose a significant environmental issue. Furthermore, the concentrations of Fe in the leachate are likely to represent colloidal matter which has passed through the filter used during the leach tests. Rio Tinto expects that there will be limited remobilisation of metals into the groundwater and the geochemical risk from waste fines is deemed low based on experience at other Rio Tinto mine sites background water chemistry and basic geochemistry.

The WFSF will be revegetated with native species to ensure self-sustaining ecosystems can be established.

14.3.5 Irrigated Agricultural Area

The IAA is located with the Hamersley Pastoral station and is currently used for pastoral activities. It is considered likely that once the IAA is no longer required, infrastructure will be removed and native vegetation established on pivots to enable pastoral activities to re-commence.

14.3.6 Minor elements

Subject to negotiations prescribed under section 11(e) of the *Iron Ore (Hamersley Range) Agreement Act 1963,* decommissioning of all minor elements (such as infrastructure) will be conducted in accordance with the following principles:

- demolition/removal of all above ground structures (structures more than 1 m below final ground level may be left in situ if they pose no long-term threat to the environment)
- removal/burial of all concrete slabs, footings and retaining walls
- removal of services (including water lines, power lines and communications) unless approved for further use (services more than 1 m below final ground level may be left in situ if they pose no long-term threat to the environment)
- removal of all culverts (including those along rail corridor) to reinstate natural drainage contours
- permanently capping bores no longer required and removal of all associated infrastructure (piping greater than 1 m deep to remain in situ)
- draining of ponds and removal and disposal of any liners

- removal of all services and infrastructure associated with the waste water treatment plants, rail line and rail loop (including rails, sleepers, ballast and signalling equipment)
- removal of decking and piers of the bridges (should the bridges require removal); steelwork and other re-usable items will be salvaged
- removal of all bitumen surfaces within the site
- removal and dismantling of decontaminated storage tanks
- on-site landfill will be capped with a minimum of 2 m of inert material and the topsoil and stockpiled vegetation (if available) will be spread over the area before being deep-ripped and seeded
- initial mine planning to ensure location and design of infrastructure (including camps, dewatering infrastructure and processing facilities) minimises potential post-closure impacts.

Decommissioning requirements for infrastructure within the Proposal Boundary (including the infrastructure corridor) will be dependent on the final end land use. Some components (e.g. sealed roads and rail) may be retained to assist future developments in the vicinity of the Expansion Proposal in agreement with relevant stakeholders.

The extent of rehabilitation required in disturbed areas will be determined according to the level of disturbance, primarily the degree of modification from the original relief. Areas of low disturbance (including unsealed roads and laydown areas) are likely to require deep ripping and revegetation only. Areas of moderate disturbance (including rail formations, if required to be removed post-closure) may require minor earthworks to either return the area to natural relief or to create a landform compatible with the surrounding natural relief and landforms. The rail formation (other than culvert areas) will be re-profiled to a stable slope within the existing disturbance. Areas of high disturbance (including plant site areas) are likely to require extensive earthworks to either return the area to natural relief or to create a landform compatible with the surrounding natural relief and landforms. These areas typically contain concrete footings that require cracking and covering with fill, capping or filling with waste rock, and significant reshaping and contouring creating the required relief.

Following re-contouring, disturbed areas will be deep ripped (if required), spread with topsoil and seeded (if required) as per waste rock dumps. Tracks may be lightly scarified and left to rehabilitate naturally where topsoil has not been removed and compaction is limited to two wheel tracks.

Natural drainage lines will be re-established similar to that following removal of sealed roads.

Contaminated sites

A detailed contaminated site investigation has not yet been conducted. Nammuldi/Silvergrass has not been reported as a known or suspected contaminated site and there are currently no obligations under the *Contaminated Sites Act 2003* with respect to closure of the mines. However, this may change if planned future contaminated site investigations identify contaminants on-site. Should this eventuate the area will be deemed a contaminated site and be managed in accordance with appropriate Rio Tinto standards and guidelines, which includes reporting the site to the Department of Environment and Conservation and remediated if obligations are imposed.

Rio Tinto will maintain a register of known or suspected contaminated sites within the Proposal Boundary throughout the operational phase of the Expansion Proposal as required by the *Contaminated Sites Act 2003* (WA) and the corporate Environmental Management System. The remediation of contaminated areas will typically occur during operations; however, depending on the nature and location of the contamination, this may not be possible in all cases. The register will be used during the development of the final decommissioning plan to determine any contaminated sites remaining at the site and remediation requirements.

14.4 Potential sources of impact

The potential sources of impact at closure (including progressive closure) are:

- **insufficient allocation of funds/resources** for closure, particularly in the event of unforseen closure, due to poor closure planning
- **progressive and final rehabilitation** not conducted in a timely manner
- rehabilitation does not promote the establishment of the agreed **post mining land use**
- **final landforms not stable** leading to erosion issues and contaminating ground and surface water systems.

14.5 Assessment of likely direct and indirect impacts

14.5.1 Insufficient allocation of resources

Estimates of costs and resource requirements are already being established to ensure closure planning can be achieved. The planning process will be ongoing throughout the life of the mine to ensure that where there are changes to closure planning as a result of new technology or regulations that the cost and resource requirements are fully taken into account.

The closure plan will also establish robust strategies that can be implemented in the case of unforeseen or unplanned closure.

With the application of the management measures identified in the EMP and monitoring methods established in the closure studies Rio Tinto have a high level of confidence that sufficient funds/resources will be available to achieve the closure objectives.

14.5.2 Rehabilitation

Rehabilitation planning is already in progress to enable, where possible, progressive rehabilitation to be undertaken prior to closure. Rehabilitation planning involves planning to collect native seed, stockpile topsoil (and manage it appropriately), weed management as well as ripping and seeding surfaces. These measures are specified in the EMP (Appendix 3). Rehabilitation planning takes into account end land use and completion criteria (specified in Sections 14.2.3 and 14.2.5).

With the application of the management measures identified in the EMP and monitoring methods established in the closure studies Rio Tinto have a high level of confidence that appropriate rehabilitation outcomes will be achieved.

14.5.3 Post mining land use

As identified in Section 14.2.3, post mining land use planning is underway; however, the anticipated end land use will be reviewed regularly throughout the life of the project in consultation with key stakeholders. To ensure that post mining land uses are achievable where possible 'natural' ecosystems with similar elements and functional characteristics to the pre-mining ecosystem will be reinstated, which does not significantly impact and where possible complements adjacent pastoral land uses.

With the application of the management measures identified in the EMP and monitoring methods established in the closure studies Rio Tinto have a high level of confidence that end land use outcomes will be achieved.

14.5.4 Stability of final landforms

The stability of final landforms is dependent on establishing final landforms that are non-polluting and that do not erode at a rate greater that their surroundings.

There is the risk of landform erosion (constructed or altered) occurring due to the removal or lack of established vegetation complexes. Erosion (wind or water) can further heighten landform instability, causing down gradient surface water quality impacts and localised aesthetic impacts in the long term. Management measures to mitigate these risks will be executed during the closure period.

Acid and Metalliferous Drainage

As discussed in Section 12, mining of Nammuldi Lens A, B, D and E/F and all Silvergrass pits poses a low AMD risk as PAF waste material is stored within specifically designed facilities upon closure. The management of all PAF waste material will be managed in accordance with the SCARD Management Plan. PAF material encountered during mining it will be separately encapsulated in the waste facility by low permeability inert material. These dumps will be stable, safe and non-polluting and will be subject to ongoing monitoring. It is unlikely that the generation of AMD will produce ongoing pollution.

Leachates from WFSF

The pH of the leachate from tailings storage is slightly alkaline so leaching of Fe, Cu and Zn from landforms after closure is considered unlikely. The remobilisation of metals into the groundwater and the geochemical risk from tailings based is deemed low based on experience at other Rio Tinto mine sites, background water chemistry and basic geochemistry it is expected that there will be limited. At closure the WFSF will be encased in inert material as specified in the Closure Plan.

Pit lake quality

Pit lakes will form in Nammuldi Lens A, C/D and E/F pit voids following cessation of dewatering as discussed in Section 14.3.3 which will act as local groundwater sinks. After closure of each pit it will take at least 50 years before the water levels in the mine voids reach a quasi-steady state and the groundwater level across the entire Nammuldi site stabilises. The water salinity in these voids will slowly change from fresh to brackish over the next 1000 years and the salinity will increase indefinitely. This increase will not significantly affect water quality of the surrounding groundwater as outflow from the pit voids is predicted to be minimal in comparison to the throughflow of groundwater and the affected aquifer is contained within the Nammuldi valley which does not have a strong hydraulic connection to adjacent aquifers. There is also no groundwater-dependent vegetation at Nammuldi so formation of the pit lakes will not affect local flora. In terms of salinity, the water from these pit lakes may not be suitable for consumption after thousands of years after closure.

With the application of the management measures identified in the EMP and monitoring methods established in the closure studies Rio Tinto have a high level of confidence that stable, non-polluting landforms will be achieved.

14.5.5 Ceasing the intermittent discharge of surplus groundwater

Upon cessation of the intermittent discharge of surplus water to creekline(s), the creekline(s) will return to being drier ephemeral system, with surface flows occurring predominantly in summer months in response to local rainfall. Biota that have been advantaged by the intermittent discharge will most likely have adapted to this regime by extending their extent and abundance together with an increased biodiversity in response to the increased security in water availability. The return to pre-mine conditions may result in the decreased abundance over time of vegetation and fauna advantaged by the intermittent discharge conditions, while also potentially resulting in the stranding of fish and other fauna in pools as they dry. The gradual cessation of surplus water to creekline(s) will have implications for terrestrial fauna that have adapted and become dependent on the extra availability of surface water during the operation of the mine.

Documenting the pre-mining condition of the creekline system(s), including the biota that utilise the system, is will be undertaken to counter future perceived losses evident upon closure.

14.6 Predicted environmental outcomes against environmental objectives, policies, guidelines, standards and procedures

The early consideration of closure in the development of the Expansion Proposal is expected to ensure closure concepts are fully integrated into short- and long-term mine planning activities and that acceptable and cost-effective closure outcomes are achieved. The Expansion Proposal is not likely to result in significant environmental impact following closure due to the application of closure planning and management measures. Ongoing investigations and monitoring undertaken during the life of mine will refine closure planning and management measures required to achieve the long term objectives of mine closure and in accordance with EPA's closure objective. This will include implementation of the Closure Plan to achieve documented objectives and monitoring to check implementation and measure outcomes.

The key likely long-term outcomes for closure are:

- final pit walls will be stabilised in accordance with regulatory requirements
- at Nammuldi the watertable within mine voids will have recovered to a level approximately 65 – 75 m lower than pre-mining levels (subject to year to year fluctuation), potentially resulting in the creation of pit lakes depending on back filling alternatives selected
- Nammuldi pits are expected to become slowly saline over the next thousand years, but are not expected to significantly affect on the quality of groundwater throughflow
- waste dumps will have been rehabilitated to form stable final landforms
- WFSF will be encapsulated with inert material and revegetated
- at Silvergrass all pits will have been backfilled to above the predicted stable post mining watertable level as a minimum to ensure no permanent pit lakes form and groundwater through flow occurs
- the new section of channel for the Caves Creek re-alignment will be stable and revegetated, and riparian and ecological habitat re-establishes similar to that in the original disturbed section of creek
- altered surface water regimes will be stable and re-vegetated with stable self-sustaining ecosystems
- all areas disturbed will be rehabilitated following decommissioning and meet specified final land use criteria specified in the Closure Plan.

15. Other environmental impacts

15.1 Noise and vibration

The EPA environmental objective (EPA 2010b) for noise is:

> *To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards* (EPA 2010b).

The Expansion Proposal is situated in a remote location, with the nearest noise-sensitive premises being the Hamersley Station Homestead, approximately 40 km northwest from the Nammuldi site. The existing B2 accommodation village is located approximately 2.5 km north of Pit E at Nammuldi. As discussed in Section 3.3.7, additional workforce for Nammuldi will be housed at the BS4 Mine camp. The Silvergrass workforce will be housed at either a new camp at Western Ridge or a new camp next to the existing B2 camp. The design of a new camp at B2 would require noise attenuation measure (such as an embankment) and will be completed during the design phase.

The relevant legislation and standards for noise level that apply to the mine site, are:

- Mine operations – *Environmental Protection (Noise) Regulation 1997*
- Rail operations – State Planning Policy 5.4 'Road and Rail Transport Noise and Freight Considerations in Land Use Planning' (SPP 5.4 gazetted September 2009)
- Dongas – AS2107 'Acoustic-Recommended design sound levels and reverberation times for building interior'.

The assigned noise level for the mine site, given that no noise-sensitive premises are located in proximity are 60 dBA (LA 10), 80 dBA (LA 1) and 90 dBA (LA max). Noise targets applicable are identified in Table 58.

Table 58 Noise targets applicable to the Greater Nammuldi Project in dB(A)

Phase	Mine operations	Rail operations	Dongas
Noise target	35.0	50.0	25.0

Potential sensitive receptors include the proposed West Village, proposed operations village at Western Ridge (PES), the existing B2 camp, the second preferred operations village (SGE) next to the existing B2 camp and proposed East Villages 1 and 2.

15.1.1 Potential sources of impact

Noise and vibration will be generated during construction and operational phases of the Expansion Proposal resulting in an increase in vibration and ambient noise levels in the vicinity of the Expansion Proposal. Sources of noise and vibration from the Expansion Proposal include:

- blasting activities
- operation of machinery and equipment (including crushing/screening plant)
- vehicle traffic
- on-site train movements.

Noise and vibration may affect fauna behaviour or surrounding residents/camps/mine sites, however, the effect is dependent on the distance from the source of noise/vibration and the location of sensitive receptor or the sensitivity of fauna.

15.1.2 Impact of noise and vibration

Due to the remoteness of the Expansion Proposal, impacts will primarily be restricted to the health and safety of the workforce and, to a lesser extent, fauna disturbance in the immediate vicinity. Noise modelling predicted received noise levels for the years 2014, 2018 and 2027 using worst case meteorological conditions, worst case operational conditions using standard equipment with no noise control. The received noise levels are below the assigned levels for the West Village, the Proposed Operations Village PES and inside the dongas at Proposed East Villages 1 and 2.

Received noise levels exceed the assigned levels for the Proposed East Villages 1 and 2, B2 operations camp and SGE operations village. Full details of noise modelling outcomes are outlined in the SVT report (2011), provided in Appendix 2.

Accommodation facilities will be located at sufficient distance to achieve appropriate noise control and / or may require the inclusion of noise attenuation within the design to ensure that noise levels comply with the assigned levels.

15.1.3 Key management measures

Management measures that may need to be considered, excluding those specific to health and safety, include:

- accommodation camps and other sensitive receptors will, where possible, be designed and constructed at locations modelled to be compliant with the noise levels assigned under the Environmental Protection (Noise) Regulations 1997, SPP 5.4 and AS2107. Noise levels will also comply with assigned noise levels for noise-sensitive premises as recommended by EPA Guidance Statement No.8
- where accommodation camps are within areas modelled as non-compliant (i.e. Location Option B: new B2 Accommodation), noise attenuation will be incorporated into the design. This will ensure noise levels at the camp are below the assigned levels.
- use of low-noise equipment or other mitigation measures as far as practicable
- monitoring blast noise (if undertaken) near sensitive receptors (if present) to determine allowable blasting mass.

15.1.4 Outcome

After the application of management measures it is unlikely that noise and vibration will have a significant impact on sensitive receptors.

15.2 Dust

The EPA environmental objective (EPA 2010b) for air quality is:

> *To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.*

Rio Tinto has developed a number of Health, Safety and Environment Standards including *Standard E2 - Air Quality Control*. The overall intent of the Air Quality Control Standard is:

> *… to ensure that Rio Tinto operations have identified and minimised air pollutant emissions and their potential impacts from their activities. This is to be accomplished by evaluating and prioritising them according to the significance of their impact, and taking effective measures to design and implement appropriate controls of emissions to ensure protection of ambient air quality.*

A desktop study was conducted in 2010 to assess the extent to which air quality may be affected by the Expansion Proposal against the Rio Tinto Standard (Environmental Alliances 2010). This assessment was confined to investigating dust-related impacts as these are considered to be the most likely air quality issue.

Dust in the atmosphere is generally characterised by three size ranges: less than 50 µm, less than 10 µm and less than 2.5 µm, abbreviated as PM_{50}, PM_{10} and $PM_{2.5}$ respectively (Environmental Alliances 2010). The PM_{10} and $PM_{2.5}$ are considered to be significant from public health point of view. Background dust levels surrounding the Greater Nammuldi Area are expected to be naturally high as it is located in an arid zone where dust lift-off occurs from the sparsely vegetated landscape. The existing mine operations at Nammuldi may also contribute locally to background levels.

Airborne dust in the Pilbara can be a problem as background levels can be close to, or higher than, the trigger levels under the *National Environmental Protection Measures Act 1998*. Environmental Alliances 2007 estimated background dust levels based on ambient monitoring conducted at Dampier and on measurements made at Dampier for the purpose of assessing the impacts of dust of the Expansion Proposal. Based on these studies, the background concentrations of PM_{10} and PM_{50} were estimated to be 10 µg/m^3 and 20 µg/m^3 respectively.

The location of the Expansion Proposal is remote from developed areas with no other major industries within15 km of the operation (Environmental Alliances 2007).

15.2.1 Potential sources of impact

The generation of dust can be triggered by a number of sources, including on-site and background sources. Potential on-site sources of dust include:

- **mining activity:** blasting, loading, hauling, crushing, conveying, screening and stockpiling material
- **exposed surfaces:** wind movement over pits, waste dumps and additional disturbed ground
- **vehicle activity:** heavy mining equipment, light vehicles and rail locomotives on dry, unsealed surfaces
- **agricultural activity:** harvesting of crops at the irrigated agriculture area may generate dust.

15.2.2 Impact of dust

The deposition of dust can potentially have a physical effect on native vegetation; however the effects of dust emissions from the Expansion Proposal are likely to be restricted to vegetation in the immediate area. Studies and modelling with Pilbara vegetation species have not indicated any significant loss of plant function as a result of dust exposure (Butler 2009). Periodic rainfall events will naturally mitigate the build-up of dust on vegetation.

Environmental Alliances (2010) identified that the maximum predicted dust deposition at the most affected (nearest) point of the *Themeda* grasslands TEC, located to the west of Silvergrass (refer to Section 9.2) will be 0.2 g/m^2 month. This deposition on the *Themeda* grasslands TEC is minor compared with the anticipated background deposition and is not anticipated to cause any adverse affects on the condition of the vegetation.

The dust generated by harvesting activities within the IAA is not likely to add significantly to background dust fallout levels in areas outside the IAA.

Dust has the potential to adversely affect human health in the case of nearby residences; however, due to the remoteness of the Expansion Proposal there are no nearby residential areas that could potentially be affected. As detailed in Section 3.3.7, the current accommodation option for the Nammuldi workforce is a centralised camp located at BS4, to be developed separate to the Expansion Proposal. Options for the Silvergrass workforce accommodation are still being investigated, with potential locations considering the impacts of dust emissions.

A subsequent survey was conducted in 2011 (Environmental Alliances 2011) where a preliminary modelling assessment of the impact of dust emissions was undertaken for 2015, 2019 and 2026. This was based on the locations of the surrounding sensitive receptors which comprised the existing B2 camp, four potential village sites and the *Themeda* grasslands TEC to the west of Silvergrass. The study predicted that all dust concentration and deposition guidelines will be met at all of the sensitive receptor locations considered.

15.2.3 Key mitigation and management measures

The generation of dust within the Proposal Boundary will be controlled through the implementation of the following management measures;

- using equipment enclosures, water sprays and dust extraction at the crushing, stockyard and rail load-out facilities as appropriate
- application of water sprays to reduce dust and maintain ore moisture content when mining ore above watertable to haul roads, working surfaces and stockpiles as required
- operation of scrapers to remove excess material from plant conveyor belts
- sealing roads wherever practicable
- application of water (including recycled water where appropriate) or appropriate suppressants to unsealed roads
- installing signage and enforcing speed limits to reduce dust generation from unsealed roads
- reducing the clearing of vegetation as far as practicable to reduce the area of exposed surfaces
- staging clearing and undertaking progressive rehabilitation to minimise total exposed area
- implementing procedures to ensure no accumulation of waste materials around conveyor, transfer points and hardstand areas under crushers and associated plant
- undertaking regular inspections to visually assess dust generation and to ensure the correct functioning of dust suppression equipment.

Detailed management of dust issues is covered in the EMP (Appendix 3).

15.2.4 Outcome

After the application of management measures it is unlikely that dust will have a significant impact.

15.3 Waste

Wastes generated by the Expansion Proposal will include:

- domestic solid and liquid wastes (e.g. food scraps and ablution effluent)
- washdown water
- general mine site waste (including scrap metal, drums, tyres and batteries)
- general office waste
- waste oils and lubricants.

15.3.1 Impact of waste

Waste from the Expansion Proposal has the potential to cause contamination if not appropriately managed. In addition, food scraps have the potential to attract feral animal in appropriate managed.

15.3.2 Key mitigation and management measures

Rio Tinto will obtain environmental licences under Part V of the EP Act for the disposal of, and handling and treatment of sewage and waste within the Proposal Boundary, where appropriate. Approval for the installation of sewerage will be obtained under the Health (Treatment of Sewerage and Disposal of Effluent and Liquid Waste) Regulations 1974. The storage and disposal of wastes generated by the Expansion Proposal will be controlled in accordance with conditions set out in the environmental licence, and also through implementation of the following management measures:

- maintaining and servicing equipment regularly
- disposing of putrescible and inert waste to appropriately licensed facilities (either on- or off-site)
- segregate wastes to facilitate recycling and appropriate disposal
- collecting and treating ablution effluent in an appropriately licensed sewage treatment facility by a licensed contractor
- maintaining sediment control structures at washdown facilities
- maintaining hydrocarbon treatment facilities at the workshop and washdown facilities
- re-using treated water from the workshop and washdown facilities for dust suppression, where possible
- disposal of liquid hydrocarbon waste through a licensed contractor.

Further details of waste management are discussed in the EMP (Appendix 3). Management of mineral waste is discussed in Section 12.

15.3.3 Outcome

After the application of management measures it is unlikely that waste will have a significant impact.

15.4 Greenhouse gases

The EPA environmental objective (EPA 2010b) for greenhouse gases is:

> *To minimise emissions to levels as low as practicable on an on-going basis and consider offsets to further reduce cumulative emissions.*

The greenhouse effect is a natural phenomenon caused by atmospheric (primarily carbon-based) gases, where heat radiating off the Earth's surface is trapped within the atmosphere. Greenhouse gases (GHG) in the atmosphere include carbon dioxide, water vapour, methane, nitrous oxide, non-methane volatile organic compounds, halocarbons, carbon monoxide and sulfur hexafluoride. The main anthropogenic greenhouse gas emission is carbon dioxide (CO_2), which has increased in concentration in the atmosphere by about 31% over the last 200 years (EPA 2002b).

The EPA Guidance Statement No. 12, '*Guidance Statement for Reducing Greenhouse Gas Emissions*' (EPA 2002b) sets out objectives regarding the minimisation of greenhouse gas emissions from new or expanding operations.

The Kyoto Protocol is an international agreement created under the United Nations Framework Convention on Climate Change (UNFCCC) in Kyoto, Japan in 1997. In December 2007, the Australian Government ratified the Kyoto Protocol, which came into effect on the 11th of March 2008.

The *National Greenhouse and Energy Reporting Act 2007* (Commonwealth) (NGER Act) establishes the National Greenhouse Gas Emissions Reporting Scheme (NGERS) as a national framework for Australian corporations to report GHG emissions, reductions, removals and offsets, and energy consumption and production. The NGER Act requires controlling corporations to register and report to the Greenhouse and Energy Data Officer if they emit greenhouse gases, produce energy, or consume energy at or above specified quantities per financial year (DoCC 2008). The minimum values (thresholds) which trigger the requirement to register and report are:

- greenhouse gas emissions of 25 kt of CO_2-e
- energy production of 100 terajoules
- energy consumption of 100 terajoules.

Increasing global greenhouse gas (GHG) emissions and the implications for climate change is a significant issue at the national and international level. The current Climate Change Plan (Commonwealth of Australia 2011) incorporates a range of mechanisms and initiatives:

- a Carbon Pricing Mechanism (CPM)
- substantial funding for renewable and clean energy development
- energy efficiency initiatives
- assistance packages for certain entities that will be affected by the CPM.

The Australian Government has announced that the CPM will commence on 1 July 2012, using the broad framework of the previously proposed Carbon Pollution Reduction Scheme (CPRS) and the existing *National Greenhouse Gas Emissions Reporting Act 2007* (NGER Act) as a base.

The CPM will be structured with two phases: During the first phase (referred to as the Fixed Price Period), businesses covered by the CPM (including mining, electricity generation, stationary energy, non-legacy waste and industrial processes) will be required to purchase a permit. Purchase will be at a fixed price of A$23 and permits can be surrendered for each tonne of CO_2-e directly emitted through their operations.

There will be an unlimited number of permits available at the fixed price. The price of permits will increase over the following three years at a rate of 2.5% per year, up to commencement of the Flexible Price Period on 1 July 2015. This carbon price is intended to force 500 of Australia's highest GHG emissions producers to pay for their GHG emissions.

Once the CPM transitions to the Flexible Price Period, it will operate as an emissions trading scheme. The number of permits issued will be restricted over time, and the price of the permits will float, initially between a floor and cap price. If the market price for the permits reaches the cap, the restriction on the issue of permits may be eased.

The Australian Government (Commonwealth of Australia 2011a) has set the target ranges to be achieved by 2020 as being 5% unconditional, with up to 15% and 25% both conditional on the extent of action by other countries.

15.4.1 Potential sources of impacts

The main potential sources of greenhouses gases associated with the Expansion Proposal include:

- combustion of fuels by mobile plant, equipment and on-site vehicles
- use of explosives for blasting
- clearing of vegetation
- decomposition of waste (landfill)
- indirectly from electrical power usage by dewatering infrastructure, processing plants and conveyors.

Greenhouse gas emissions of up to 200 ktCO_2-e/annum (150 ktCO_2-e/annum from mining), with a greenhouse gas intensity of 10 t CO_2-e/kt of product (based on 20 Mtpa of extraction) were estimated for the Original Proposal. The Expansion Proposal will increase the mining rate from 20 Mtpa to 45 Mtpa and the greenhouse gas intensity for the Expansion Proposal will be 38 CO_2-e/kt of product. The additional annual greenhouse gas emissions from the Expansion Proposal will be up to 450 ktCO_2-e/annum from mining, resulting in a total of approximately 600 ktCO_2-e/annum from the mine.

Sequestration of CO_2-e by rehabilitation or the production of hay from the IAA is not included in the peak emission calculation. Emissions during construction as a result of vegetation clearing are 'once off', occurring in effect at the time of clearing, and will add to operational annual emissions in some years. Based on the estimated clearing footprint required for the operation (up to approximately 3900 ha), vegetation clearing will result in an emission of up to 7.2 ktCO_2-e/annum, thus a total of 122 ktCO_2-e is expected over the life of the mine.

15.4.2 Key mitigation and management measures

Rio Tinto is committed to minimising emissions to levels as low as reasonably practicable on an on-going basis through the implementation of the following management actions:

- identifying energy efficiency opportunities during project design
- conducting regular energy efficiency audits
- preventing unnecessary clearing of vegetation through clearing procedures (refer to Section 9.5)
- connecting to existing power generation and rail infrastructure that currently service the Original Proposal and B2 operation where possible, thereby reducing the need for additional infrastructure
- increasing the efficiency of the operation through scheduling, pit optimisation and minimisation of rehandling
- increasing the efficiency of waste and ore haulage
- regularly maintaining and servicing equipment
- maintaining the rate of dewatering to the minimum required for safe mining
- implementing energy saving measures into accommodation camp design including thermal insulation, heat pumps and energy efficient appliances
- evaluating and adopting appropriate technology during the detailed design phase to improve greenhouse efficiency.

An energy efficiency audit of the Expansion Proposal was conducted during prefeasibility studies and will be repeated as sufficient additional information becomes available.

In accordance with the requirements under the NGER Act, Rio Tinto will report annually on:

- production of energy
- consumption of energy
- Scope 1 (direct) emissions
- Scope 2 (indirect) emissions.

The implementation of greenhouse gas and energy conservation measures will enable the company to minimise emissions and provide a mechanism for continuous improvement in GHG resulting from the Expansion Proposal. In addition to these measures, Rio Tinto will comply with all relevant statutory requirements and legislation relating to GHG. The management of greenhouse gases is discussed in the EMP (Appendix 3).

16. Potential for and nature of any cumulative impacts

Potential cumulative effects of the Expansion Proposal (including that of the Original Proposal) have been considered in Table 59.

Table 59 Potential cumulative impacts

Potential cumulative impact	Assessment
Drawdown from dewatering overlapping the drawdown cone from other projects	No details of any proposed developments in the area are available to Rio Tinto. Any potential for cumulative impacts associated with dewatering from other projects (excluding the Original Proposal) is considered unlikely due to the relatively confined nature of the drawdown. In addition, licences issued by the DoW under the RIWI Act are required to abstract groundwater (including for mine dewatering purposes). In assessing these licence applications, the DoW considers potential impacts on groundwater resources and determines acceptable maximum abstraction rates based on Rio Tinto's requirements and likely impacts to regional aquifers.
Extent of surplus water discharge into Duck Creek	No details of any proposed developments in the area are available to Rio Tinto. Any potential for cumulative impacts associated with discharge of surplus water from other projects (excluding the Original Proposal) is considered unlikely due to the relatively isolated nature of Duck Creek.
The full extent of clearing relative to clearing for other projects	No details of any proposed clearing in the area are available to Rio Tinto. Any potential for cumulative impacts from clearing associated with other projects (excluding the Original Proposal) is considered unlikely due to the relatively isolated location of the project.
Reduction to potential terrestrial and subterranean fauna habitats, which have also been impacted by other projects	No details of any proposed clearing in the area are available to Rio Tinto. Any potential for cumulative impacts from reduction of faunal habitats associated with other projects (excluding the Original Proposal) is considered unlikely due to the relatively isolated location of the project.

17. Requirements for offsets

17.1 Determination of Critical and High Value Assets

EPA Position Statement No. 9: Environmental Offsets (EPA 2006a) and EPA Guidance Statement No. 19: Environmental Offsets (EPA 2008a) provide guidance to proponents on the approach needed to determine offset requirements for proposals. The environmental aspects of the Greater Nammuldi Area were assessed for their potential value as critical or high value assets as per the definitions and additional criteria presented in these policy documents. Environmental aspects meeting the requirements for either category have been included in the determination of appropriate offsets Table 60.

The definitions of critical and high value assets in EPA Position Statement No. 9: Environmental Offsets are as follows:

> *Critical Assets: represent the State's most important environmental assets that must be fully protected and conserved (as defined in Section 4). Significant adverse impacts to these assets should be avoided at all costs. Therefore, the EPA in providing its advice will adopt a presumption against approval of project proposals where significant adverse impacts affect 'critical assets'. However, where projects have been approved by the State Government (see Section 4) approval should be conditional on the:*
>
> - *consideration or demonstration (to the maximum extent possible) of onsite impact mitigation; and*
> - *development and implementation of an acceptable offsets package for significant, residual adverse impacts.*
>
> *High Value Assets: represents those environmental assets that are in good to excellent condition, are considered valuable by the community and / or government, but are not identified as 'critical assets'. Project proposals and offset activities for these assets may be referred to and assessed by the EPA on a case-by-case basis, but are otherwise considered by relevant environmental government agencies.*

In order to determine which vegetation communities or fauna habitats within in the Proposal Boundary are 'high value' assets, their condition and value to community and / or government was considered.

The Proposal Boundary is not considered to contain any assets considered of value to the government as it does not lie within a State or Commonwealth Government reserve or protected area. Community value was assigned to those assets which are:

- locally or regionally restricted in their distribution
- considered to be important habitat for Priority Flora and Priority Fauna, or
- have identified cultural heritage values.

Vegetation communities mapped within the Greater Nammuldi Area were generally found to be in Very Good to Excellent condition as per the Keighery Condition Scale. Evidence of grazing was apparent in the lower foothills and slopes near Silvergrass and dense grazing has occurred on the flats and clay plains (including the *Themeda* grasslands TEC) resulting in vegetation of Poor condition (Biota 2010c). Vegetation within the IAA was found to range in condition from Very Good to Pristine (Mattiske 2011).

As described in Section 9, the majority of vegetation communities recorded in the Greater Nammuldi Area are well represented across the Pilbara region, with the exception of the *Themeda* grassland TEC (a critical asset) and *Astrebla* tussock grassland PEC units (a high value asset). In line with the EPA assessment of the Original Proposal (Bulletin 997) the riparian vegetation in the Greater Nammuldi Area (vegetation unit CD1) is also considered to be a high value asset, primarily due to its value to fauna habitat. The clay soil fauna habitat, as represented by the *Themeda* grassland TEC and *Astrebla* tussock grassland PEC, is also considered to be of high value asset. In addition, gorges are considered to represent fauna habitat elevated conservation significance and as such also a high value asset. The remainder of the mapped vegetation and fauna habitats are not considered to be especially valuable to the community in terms of environmental significance.

Whilst some occurrences of Priority Listed Species (flora and fauna) have been recorded within the Greater Nammuldi Area, none of these were found to be restricted to the Proposal Boundary, and therefore have not been individually classified as 'high value assets'.

17.2 Offset requirements for the Expansion Proposal

The EPA's objective for environmental offsets is to ensure that significant and unavoidable adverse environmental impacts are counterbalanced by a positive environmental gain, with an aspirational goal of achieving a 'net environmental benefit'. The requirement for offsets is considered in Table 60.

Statement 558 for the implementation of the Original Proposal did not specify the need for offsets at the time.

Table 60 Environmental offsets reporting form

Section A: Administrative information
1. Proposal or scheme name: Nammuldi-Silvergrass Expansion Proposal
2. Summary of proposal or scheme: The Proponent, Hamersley Iron Pty Limited (a wholly owned subsidiary of Rio Tinto Iron Ore [Rio Tinto]), proposes to expand the existing Nammuldi-Silvergrass Iron Ore Project (the Original Proposal) located in the Pilbara region of Western Australia (WA). The Original Proposal as implemented consists of above watertable (AWT) and below watertable (BWT) mining of two mines; Nammuldi and Silvergrass. Only the AWT phase of mining at Nammuldi has commenced to date. The Nammuldi-Silvergrass Expansion Proposal (the Expansion Proposal) is the planned expansion of both the Nammuldi and Silvergrass mines.
Section B: Type of environmental asset (s) – State whether Critical or High Value, describe the environmental values and attributes
No Critical environmental assets are located within the Proposal Boundary. Environmental assets that are present in the Greater Nammuldi Area, and could be considered 'Critical' assets as defined in EPA Position Statement No. 9: Environmental Offsets (EPA 2006a) include: *Critical asset category (iii) Biodiversity – Threatened Ecological Community* • *Themeda* grassland TEC – occurs outside the Proposal Boundary. *Critical asset category (viii) Ecosystems vulnerable to threats and category (ix) Heritage- Place of Indigenous Heritage of high importance* • Palm Springs – located outside the Proposal Boundary. Environmental assets that are present within the Greater Nammuldi Area, and could be considered 'High Value' environmental assets defined in EPA Position Statement No. 9: Environmental Offsets (EPA 2006a) include: • *Astrebla* tussock grassland PEC of "broad / continuous good representation" (Figure 15) – occurs outside the Proposal Boundary • riparian vegetation (mapped as vegetation unit CD1 *Eucalyptus camaldulensis, E. victrix* open woodland over *Acacia citrinoviridis* tall shrubland over mixed open tussock grassland) – none of which is restricted to the Proposal Boundary • fauna habitat associated with gorges.

Section C: Significant impacts (describe the significant adverse environmental impacts related to the proposal or scheme before mitigation measures are applied)

Potential significant impacts on critical or high assets from the Expansion Proposal are:

- discharging surplus water to Duck Creek may elevate the watertable locally and provide a more constant flow regime in the short term. This may in turn change the composition of creek vegetation communities
- clearing of vegetation will directly reduce the extent of vegetation communities, including vegetation communities of local conservation significance
- clearing of vegetation will reduce a small proportion of locally available habitat for Priority Flora species and potentially disturb individual occurrences of Priority Flora species
- clearing of vegetation will directly disturb fauna habitat and will result in the displacement of fauna and the loss of individuals of some terrestrial fauna species.

Section D: Mitigation measures (describe all measures to Avoid, Minimise, Rectify and Reduce)

Mitigation measures to avoid, minimise, rectify and reduce impacts of the Expansion Proposal on environmental assets include:

Avoid:

- no clearing of *Themeda* grassland TEC
- no clearing of areas mapped as "broad / continuous good representation *Astrebla* tussock grassland"
- avoidance of high value fauna habitat (e.g. gorges).

Minimise:

- minimise clearing of areas mapped as 'mosaic to relatively good representation of *Astrebla* tussock grassland' (approximately 1% of mapped extent)
- as far as practicable, infrastructure preferentially located in previously disturbed areas to minimise clearing of undisturbed native vegetation and to prevent loss of potential fauna and Priority Flora habitat
- design of creek realignment to protect upstream and downstream channel, TEC, water quality and Palm Springs
- establishment of IAA to provide secondary use of surplus water, allowing for only periodic discharge.

Rectify and Reduce:

- backfilling pits at Silvergrass to aid post mining recovery of groundwater to pre mining levels
- modification of final landform to maximise surface runoff to the TEC
- construction of final landform to ensure no impedance to flows in 1 in 100 year ARI flood events of Caves Creek
- monitor creek ecosystems during discharge and compare against baseline data
- undertake progressive rehabilitation of riparian vegetation where monitoring indicates significant changes in riparian vegetation condition during project operation
- if, at cessation of discharge, riparian vegetation differs significantly from baseline (pre-impact) riparian vegetation condition, rehabilitation actions will be undertaken to restore (as far as practicable) riparian vegetation to baseline (pre-impact) condition
- rehabilitate areas disturbed (excluding pit voids) following decommissioning, meeting final land use criteria specified in the Closure Plan
- clearing vegetation in a deliberately outward manner that allows for the progressive movement of fauna into areas beyond the disturbance footprint
- implement an Adaptive Surface Water Management Plan that includes monitoring and adaptive management measures as well as contingency measures to ensure that discharge does not have an adverse effect on the water quality of Duck Creek.

Section E: Significant residual impacts (describe all the significant adverse residual impacts that remain after all mitigation attempts have been exhausted)

The Expansion Proposal is not expected to have significant residual impacts to any Critical Assets within the Greater Nammuldi Area. Following the implementation of all mitigation measures the Expansion Proposal may have the following residual impacts on 'High Value' assets:

- clearing of approximately 45 ha of riparian vegetation (approximately 9% of mapped extent in the Greater Nammuldi Area) to enable realignment of approximately 2.5 km section of Caves Creek
- clearing and direct disturbance of approximately 91 ha of 'mosaic to relatively good representation of *Astrebla* tussock grassland' PEC vegetation (approximately 1% of the total mapped occurrence of the mosaic within the Silvergrass valley – refer to Figure 15). Of this proposed disturbance 47 ha comprises vegetation units PC6, PC9 and PC10, which are classed as "high conservation value" (Table 29and Figure 47).

Section F: Proposed offsets for each significant residual impact (identify direct and contributing offsets). Include a description of the land tenure and zoning / reservation status of the proposed offset site. Identify any encumbrances or other restrictions on the land that may impact the implementation of the proposed offset and provide evidence demonstrating how these issues have been resolved.

Rio Tinto proposes that offsets are required for the following significant residual impacts to the following high value assets:

- clearing of approximately 45 ha of riparian vegetation at Caves Creek
- clearing and direct disturbance of approximately 47 ha of vegetation of high conservation significance within the mosaic of *Astrebla* tussock grassland PEC at Silvergrass.

Palm Springs is a Critical Environmental Asset outside of the Proposal Boundary but within the Greater Nammuldi Area. Palm Springs comprises high riparian vegetation habitat values and Indigenous Heritage values, making it an appropriate focus for provision of an offset for the likely residual impacts of the Expansion Proposal described above.

Rio Tinto proposes to provide funds to support the development and implementation of a Palm Springs Management Plan. The Palm Springs Management Plan would deliver a framework for increasing scientific knowledge and effective management of threatening processes at Palm Springs. The Plan would be developed in consultation with Traditional Owners, relevant government agencies (i.e. DoW / DEC / EPA) and other key stakeholders. Specific details concerning monetary and in-kind support for the development and implementation of the Palm Springs Management Plan will be decided in negotiation with OEPA and presented in a detailed Offsets Package.

Section G: Spatial data relating to offset site/s (see *EPA Guidance Statement No. 19: environmental offsets-biodiversity*, Appendix 4)

Not Applicable

Section H: Relevant data sources and evidence of consultation (consultation with agencies, relevant stakeholders, community and references to sources of data / information). Include details of specific environmental, technical or other relevant advice and information obtained to assist in the formulation of the offset.

Additional technical detail has been provided in Appendix 2.

18. Summary of environmental measures and controls

18.1 Environmental management framework

Rio Tinto will minimise environmental impacts through the implementation of ongoing management measures, which include:

- maintaining an Environmental Management System (EMS) and business systems
- implementing an Environmental Management Plan (EMP) and Agriculture Environmental Management Plan (AEMP) for the Expansion Proposal (Appendix 3)
- developing environmental improvement plans each year for priorities identified in reviews of systems and performance
- improving mechanisms to measure water and energy use, and greenhouse gas emissions
- improving the efficiency of natural resource use
- updating plans for disturbance and closure, progressively rehabilitating and measuring success
- training staff and contractors in environmental requirements of their work
- ensuring that community views are sought, respected and considered
- reporting regularly to stakeholders on performance
- aligning with the Rio Tinto (WA) Health Safety Environment and Quality Policy (HSEQ).

Rio Tinto acknowledges the environmental protection principles listed in section 4a of the EP Act through its strong commitment to sustainable development and environmental management at its operations (Section 6.3). These principles are clearly reflected in the Rio Tinto (WA) HSEQ Policy (Section 18.1.1) and the Rio Tinto corporate environmental standards that are implemented across the Rio Tinto Group.

Rio Tinto maintains membership of the Australian Greenhouse Challenge Plus program and continues to evaluate and adopt appropriate technology to improve greenhouse efficiency wherever possible (Section 15.4).

18.1.1 Rio Tinto (WA) HSEQ Policy

Rio Tinto aims to conduct business in an efficient and environmentally responsible manner that is compatible with the expectations of shareholders, the government and the community. Rio Tinto also recognises that environmental responsibilities go beyond those required under statutory regulations to encompass social obligations, leadership in sustainable development and minimising environmental impacts.

The existing operation at Nammuldi operates under the Rio Tinto (WA) HSEQ Policy. The Policy is the guiding document for environmental management and provides context and specific direction for continuous improvement.

Rio Tinto also operates under an ISO14001 framework through implementation the Rio Tinto (WA) Environmental Management System. ISO14001 is an internationally recognised continuous improvement model, the key elements of which include assessing environmental risk and legal requirements, developing objectives and targets for improvement, training, operational control, communication, emergency response, corrective actions, audits and review.

Rio Tinto's sites were certified to ISO14001 in 2003. To maintain ISO14001 certification, these sites are required to successfully complete regular external independent surveillance audits. Successful demonstration of commitment to continual improvement resulted in re-certification of Rio Tinto's sites to ISO14001 in 2006.

18.1.2 Environmental Management Plan (EMP) and Agriculture Environmental Management Plan (AEMP)

The environmental aspects of the Expansion Proposal will be primarily managed through the EMP for the Expansion Proposal. This has been prepared and will be implemented to manage specific environmental issues arising from the Expansion Proposal (Appendix 3). The purpose of the EMP is to document environmental management objectives and strategies in relation to the Expansion Proposal, including:

- environmental factors potentially affected by the construction and operational phases of the Expansion Proposal
- measures to prevent, minimise, mitigate and manage any potential environmental impacts of the Expansion Proposal
- monitoring and reporting procedures.

Rio Tinto has comprehensive standard corporate practices in place to manage potential environmental impacts at all operations, including the existing Nammuldi AWT operation. These standard procedures address in detail all management measures required to mitigate potential risks resulting from the implementation of the Expansion Proposal.

The following management plans have been developed as part of the EMP:

- Groundwater Management Plan
- Adaptive Surface Water Management Plan
- Vegetation and Flora Management Plan
- Terrestrial Fauna Management Plan
- Subterranean Fauna Management Plan
- Cultural Heritage Management Plan
- Mineral Waste Management Plan
- Hydrocarbon Management Plan
- Emissions Management Plan
- Waste Management Plan
- Fire Management Plan.

Closure Plans for both Nammuldi and Silvergrass have been prepared separately.

The majority of the management plans represent a summary of the relevant existing corporate procedures; however, the Surface Water Management Plan has been developed to a higher detailed standard than other management plans, to address uncertainties in predicted impacts and provide additional protection to areas of high conservation significance. This has been achieved through the incorporation of an adaptive management plan.

The Cultural Heritage Management Plan represents a summary of the site-specific Cultural Heritage Management Plan that has already been developed for the existing Nammuldi operation. This Cultural Heritage Management Plan will be further refined as results of ongoing surveys become available.

The Proponent has prepared an AEMP to address potential impacts of the establishment and operation of the IAA. The purpose of the AEMP is to document environmental management objectives and strategies in relation to the IAA, including:

- environmental factors potentially affected by the implementation and operation stages of the IAA
- measures to prevent, minimise, mitigate and manage any potential environmental impacts of the IAA
- monitoring and reporting procedures.

This AEMP will form the basis of the minimum standards that will be carried forward by the Proponent during the implementation, operation, closure and rehabilitation of the Agriculture Area. The AEMP

defines the overarching environmental management procedures, processes and systems in place to ensure all management measures are adequately implemented. This includes details on statutory obligations, responsibilities, environmental awareness and inductions, document and incident management and the AEMP review procedure.

The following management plans have been developed as part of the AEMP:

- Nutrients, Chemicals and Irrigation Management Plan
- Terrestrial Fauna Management Plan
- Flora and Vegetation Management Plan
- Fire Management Plan
- Surface Water Management Plan
- Closure and Rehabilitation Management Plan.

18.2 Summary of likely environmental control instruments

Table 61 outlines the controls that either currently exist or will be put in place to ensure appropriate management of the Proposal for each key environmental factor. The controls include:

- implementation conditions as per any Statement issued by the Minister for the Environment
- conditions of the DEC (Environmental Management Division) Works Approval (under Part V of the EP Act) for construction of works on prescribed premises
- conditions of the DEC (Environmental Management Division) Licence (under Part V of the EP Act) for the operation of activities on prescribed premises (ore processing, landfill and sewage facility)
- conditions of the Licences to 'Take Water' and disturbance to bed and banks (under *Rights in Water and Irrigation Act 1914* (WA)).
- relevant Rio Tinto Environmental Standards and guidelines.

Proponent management controls that will be regularly reviewed and that will apply to the Proposal include measures and/or actions contained within the following documents:

- Operation Environmental Management Plan (EMP)
- Agriculture Environmental Management Plan (AEMP)
- Annual Environmental Report
- Annual Aquifer Review
- Closure Plans.

Table 61 Statutory and environmental management controls for the Proposal

Factor	Topic	Potential Statement Conditions (Part IV)	EMP/ Closure Management Plan	Works Approval/ Licence (Part V)/ regulation	Other relevant legislation and regulations***
Key environmental factors					
Groundwater	Extent of groundwater drawdown		✓		✓ Licence under RIWI Act
	Groundwater quality and quantity monitoring	✓	✓	✓	
	Waste fines disposal		✓	✓	
Surface water	Discharge of surplus water		✓	✓	
	Diversion of Caves Creek	✓	✓	✓	✓ Bed and Bank licence under RIWI Act

Factor	Topic	Potential Statement Conditions (Part IV)	EMP/ Closure Management Plan	Works Approval/ Licence (Part V)/ regulation	Other relevant legislation and regulations***
	Modified surface drainage	✓	✓	✓	
	Surface water quality and monitoring	✓	✓	✓	
Vegetation and flora	Extent of vegetation clearing	✓	✓		
	Weeds	✓	✓		
Terrestrial fauna	Extent of habitat removal		✓		
	Rare and endangered fauna		✓		✓ WC Act
	Feral fauna		✓		
Subterranean fauna	Extent of groundwater drawdown (removal of stygofauna habitat)		✓		
	Extent of mine pits (removal of troglofauna and stygofauna habitat)	✓	✓		
AMD and Fibrous materials	Exposure of PAF material		✓		
	Storage of PAF mineral waste		✓		
	Exposure and management of fibrous minerals		✓		
	Incidence of acid or metalliferous drainage		✓		
Aboriginal heritage	Disturbance to Aboriginal heritage sites		✓		✓ Aboriginal Heritage Act
Closure	Decommissioning, decontamination/remediation, and rehabilitation	✓	✓		✓ State Agreement Act ✓ Mining Act
	Monitoring groundwater properties post- closure	✓	✓		
Other management considerations					
Noise and vibration	Emissions of noise and vibration		✓	✓	
Dust	Dust generation		✓	✓	
Waste (other than PAF material)	Mineral waste dumps		✓		
	Liquid waste (including sewage)		✓	✓	✓ Health Act
	Solid waste disposal (landfill)		✓	✓	✓ Health Act
Greenhouse gases	Emissions reduction		✓		✓ Carbon Pollution Reduction Scheme (proposed)
	Reporting				✓ NGER Act

18.3 Summary of proposed environmental management measures and performance standards

18.3.1 Groundwater

The management measures to protect the groundwater values include:

- dewatering of mining areas will be kept to a minimum, whilst allowing safe mining of the orebodies
- groundwater abstraction and discharge will be undertaken in accordance with relevant licences
- groundwater levels in the vicinity of the dewatering area will be regularly monitored
- waste fines storage will be designed in order to mitigate the potential for the generation of AMD
- an adaptive management plan will be developed with monitoring and contingency actions for the discharge of surplus water to natural watercourses.

18.3.2 Surface water

The management measures to protect the surface water values include:

- adaptive surface water management plans will be developed that include ongoing monitoring and contingency actions to ensure to there is no adverse effect on the water quantity and quality, in particular to Palm Springs
- erosion protection will be installed at surplus discharge points.

18.3.3 Vegetation and flora

The management measures to protect the vegetation and flora values include:

- establishing and demarcating Environmental Exclusion Areas to prohibit disturbance covering significant areas such as the Themeda grasslands TEC around which a 200 m buffer zone will be established
- continuing internal approval system for ground disturbance
- modifying infrastructure layout and location wherever feasible to avoid significant species or vegetation
- conducting further flora and vegetation surveys as required within the Proposal Boundary
- maintain quality of surplus water discharge in accordance with trigger values developed under ANZECC/ARMCANZ guidelines
- minimising the clearing of riparian vegetation for the Caves Creek channel alignment at Silvergrass
- reducing the discharge of dewatering water through diversion to agricultural use
- implementing a surplus water management strategy that takes account of the relative values of downstream vegetation and flora for each of the discharge locations, where practicable.

18.3.4 Terrestrial fauna

The management measures to protect the terrestrial fauna values include:

- as far as practicable, locating infrastructure and transport routes preferentially in previously disturbed areas to minimise clearing of undisturbed native vegetation to prevent potential loss of fauna habitat
- avoiding fauna habits of high conservation significance wherever practicable
- clearing vegetation in a deliberately outward manner that allows for the progressive movement of fauna into areas beyond of the disturbance footprint

- native animals encountered on-site (including during clearing) will be given the opportunity to move on if there is no threat to personnel safety in doing so
- maintaining appropriate speed limits for mining equipment and light vehicles by ensuring all roads are sign-posted, vehicle speeds are monitored and all personnel and contractors are educated
- providing workforce environmental education programs and training on the importance of protecting conservation significant fauna and habitat and discouraging personnel from visiting areas of high conservation significance
- disturbed areas will be progressively rehabilitated as soon as possible following use and in accordance with the EMP and site rehabilitation plan
- rehabilitation will utilise topsoil, log debris and leaf litter formed and retained during clearing, as they create extremely good microhabitat for a large range of fauna, particularly reptiles
- development and implementation of fauna management plans for species of elevated conservation significance, as appropriate.

18.3.5 Subterranean fauna

The management measures to protect the subterranean fauna values of the Proposal Boundary include:

- restricting mine pit disturbance to areas indicated in Schedule 1 of Ministerial Statement 558
- monitoring the extent of groundwater drawdown within observation bores at Silvergrass
- containing and bunding hydrocarbon storage facilities, re-fuelling locations and areas of stationary hydrocarbon usage in compliance with corporate policy, relative standards and legal requirements.

18.3.6 AMD and Fibrous materials

Management and mitigation measures for geochemical risk identified include:

- constructing bunding in accordance with the surface water management design to reduce surface runoff flowing over exposed PAF material on the pit walls
- constructing PAF material waste dumps in accordance with Rio Tinto SCARD management plan in areas where runoff from surrounding areas is minimal
- conducting field inspections during mining to ensure all PAF material is transported to the appropriate dumps
- monitoring dewatering effluent for quality and diverting it for segregation and/or treatment if appropriate trigger values, established in accordance with ANZECC/ARMCANZ (2000) guidelines or WA Interagency Guidelines (WRC 2000b) for water quality, are exceeded
- reducing the time between blasting and hauling during the summer months to limit the amount of time that the material can oxidise or possibly generate AMD in case there is rainfall.

18.3.7 Aboriginal heritage

The management measures to protect the Aboriginal heritage values of the Proposal Boundary include:

- prior to any ground disturbance, undertake an Aboriginal heritage survey (i.e. archaeological and ethnographic survey) on the area proposed to be disturbed and report any suspected sites under Section 15 of the Aboriginal Heritage Act
- conduct all Aboriginal heritage surveys in consultation with the DIA and the Eastern Guruma People
- liaise with local Aboriginal community and keep them informed of the progress of the development and implementation of the Expansion Proposal
- prepare a community and social benefits plan in consultation with local government(s) and submit completed plan to the Minister for approval
- obtain approvals for any disturbance required to identified sites in accordance with section 18 of the AH Act

- implement contingency actions described in the Aboriginal Heritage Management Plan in the case of identification of potential Aboriginal heritage sites and/or skeletal remains during construction (i.e. immediately stop work at the discovery site)
- arrange for the local Aboriginal groups to receive training and monitor ground disturbing activities
- prepare and implement an Aboriginal cultural awareness programme for all site personnel (e.g. discuss gender-restricted locations)
- undertake mitigative salvage at sites with the co-operation and involvement of the local Aboriginal groups including the Eastern Guruma People
- protect all identified sites located near construction or operational areas that are not approved to be disturbed under section 18 of the AH Act through the implementation of measures determined in consultation with the Eastern Guruma People. A minimum 50m buffer zone is preferred, and the actual implemented buffer will be greater than this in most places, specifically at Silvergrass
- prepare reports on all archaeological findings and monitoring
- document the location of all protected sites in a Geographic Information System and on-site plan.

18.3.8 Closure

Rio Tinto will develop and implement a closure plan for each site in accordance with the *Guidelines for Preparing Mine Closure Plans* (DMP & EPA 2011) to manage and mitigate unavoidable and/or potential long-term impacts on the environment. Closure management will assist in ensuring that disturbed areas are safe and are suitably rehabilitated for the long-term end land use (pastoral activity and/or ecosystem re-establishment). The following closure objectives have been identified as part of the current closure vision for the Expansion Proposal:

- minimise the post-closure environmental impact by returning the land and water resources to a state compatible with regional ethnographic and ecological values, preserving local biodiversity and delivering a net positive result with respect to regional biodiversity
- remediate the area to end states that are safe and stable that are compatible with the surrounding environment and with the agreed end land use.
- work with employees and key stakeholders to identify and manage ongoing employment and other opportunities
- work with Indigenous communities and other stakeholders towards the preservation, protection and management of the region's cultural heritage.

Detailed management of closure is be covered in the Closure Plans.

18.4 Suggested environmental conditions

The proposed changes to the relevant key characteristics table (Table 1, Schedule 1 of Statement 558) Nammuldi-Silvergrass are identified in Table 5.

Rio Tinto has reviewed in Table 62 the existing Environmental Conditions in Statement 558 for the approved operations, where relevant, and proposed new Environmental Conditions for the Expansion Proposal, such that the Expansion Proposal and existing operations can be defined under a single statement. Rio Tinto Commitments listed in Schedule 2 of Statement 558 have been review in Table 63. Rio Tinto considers there are a number of conditions and Proponent commitments in the existing Statement that are either not auditable or no longer relevant (that is, they have been fulfilled).

New Environmental Conditions have been suggested in Table 64 to consolidate the existing Environmental Conditions and Proponent Commitments in Statement 558. The new Environmental Conditions do not to duplicate other regulatory controls that are capably and likely to be applied under other existing legislation. The proposed conditions replace the conditions and commitments in the existing Statement.

A condition has not been suggested if the environmental impact can, or is adequately addressed by other environmental control instruments (Section 18.3), the EMP and AEMP (Appendix 3) or the Closure Plans. The proposed conditions are outcome-based and are thus auditable. Any breach of these instruments will

require a response involving investigation of potential impacts and implementation of mitigation and management measures and stakeholder consultation, as required.

Table 62 Review of existing environmental Conditions

No.	Statement 558 Condition	Consideration
Implementation		
1-1	Subject to these conditions and procedures, the proponent shall implement the proposal as documented in schedule 1 of this statement.	Condition to be replaced with equivalent contemporary condition: The proponent shall implement the proposal subject to the conditions of this statement and within the footprint defined in Schedule 1 of this Statement.
1-2	Where the proponent seeks to change any aspect of the proposal as documented in schedule 1 of this statement in any way that the Minister for the Environment determines, on advice of the Environmental Protection Authority, is substantial, the proponent shall refer the matter to the Environmental Protection Authority	No change, retained.
1-3	Where the proponent seeks to change any aspect of the proposal as documented in Schedule 1 of this statement in any way that the Minister for the Environment determines, on advice of the Environmental Protection Authority, is not substantial, those changes may be effected.	No change, retained.
Proponent Commitments		
2-1	The proponent shall implement the consolidated environmental management commitments documented in Schedule 2 of this statement.	Condition no longer relevant, existing commitments can be incorporated into Schedule 1. May be deleted.
2-2	The proponent shall implement subsequent environmental management commitments which the proponent makes as part of the fulfilment of conditions and procedures in this statement.	
Proponent		
3-1	The proponent for the time being nominated by the Minister for the Environment under section 38(6) or (7) of the Environmental Protection Act 1986 is responsible for the implementation of the proposal until such time as the Minister for the Environment has exercised the Minister's power under section 38(7) of the Act to revoke the nomination of that proponent and nominate another person in respect of the proposal.	Condition to be replaced with equivalent contemporary condition: The proponent nominated by the Minister for the Environment under section 38(6) or 38(7) of the *Environmental Protection Act 1986* (WA) is responsible for the implementation of the Proposal.
3-2	Any request for the exercise of that power of the Minister referred to in condition 3-1 shall be accompanied by a copy of this statement endorsed with an undertaking by the proposed replacement proponent to carry out the proposal in accordance with the conditions and procedures set out in the statement.	No change, retained.
3-3	The proponent shall notify the Department of Environmental Protection of any change of proponent contact name and address within 30 days of such change.	Condition to be replaced with equivalent contemporary condition: The proponent shall notify the Chief Executive Officer (CEO) of the Office of the Environmental Protection Authority (OEPA) of any change of the name and address of the Proponent for the serving of notices or other correspondence within 30 days of such change.

No.	Statement 558 Condition	Consideration
Commencement		
4-1	The proponent shall provide evidence to the Minister for the Environment within five years of the date of this statement that the proposal has been substantially commenced.	Condition to be replaced with equivalent contemporary condition: The authorisation to implement the proposal provided for in this Statement shall lapse and be void within five years after the date of this Statement if the Proposal to which this Statement relates is not substantially commenced.
4-2	Where the proposal has not been substantially commenced within five years of the date of this statement, the approval to implement the proposal as granted in this statement shall lapse and be void. The Minister for the Environment will determine any question as to whether the proposal has been substantially commenced.	Condition to be replaced with equivalent contemporary condition: The proponent shall provide the CEO of the OEPA with written evidence which demonstrates that the Proposal has substantially commenced, on or before the expiration of five years from the date of this Statement.
4-3	The proponent shall make application to the Minister for the Environment for any extension of approval for the substantial commencement of the proposal beyond five years from the date of this statement at least six months prior to the expiration of the five year period referred to in conditions 4-1 and 4-2.	No change, retained.
4-4	Where the proponent demonstrates to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority that the environmental parameters of the proposal have not changed significantly, then the Minister may grant an extension not exceeding five years for the substantial commencement of the proposal.	No change, retained.
Compliance Auditing		
5-1	The proponent shall submit periodic Compliance Reports, in accordance with an audit program prepared in consultation between the proponent and the Department of Environmental Protection.	Condition to be replaced with equivalent contemporary condition: The proponent shall prepare and maintain a compliance assessment plan.
5-2	Unless otherwise specified, the Chief Executive Officer of the Department of Environmental Protection is responsible for assessing compliance with the conditions, procedures and commitments contained in this statement and for issuing formal, written advice that the requirements have been met.	Condition to be replaced with equivalent contemporary condition: The proponent shall submit to the CEO of the OEPA, the compliance assessment plan required by condition 5-1 at least six months prior to the first compliance report required by condition 5-6. The compliance assessment plan shall indicate: • frequency of compliance reporting • approach and timing of compliance assessments • retention of compliance assessments • methods for reporting of potential non-compliances and associated corrective actions • table of contents of compliance reports • public availability of compliance reports.
5-3	Where compliance with any condition, procedure or commitment is in dispute, the matter will be determined by the Minister for the Environment.	Condition to be replaced with equivalent contemporary condition: The proponent shall assess compliance with conditions in accordance with the compliance assessment plan required by condition 5-1.

No.	Statement 558 Condition	Consideration
5-4		New contemporary condition proposed: The proponent shall retain reports of all compliance assessments described in the compliance assessment plan required by condition 5-1 and shall make those reports available when requested by the CEO of the OEPA.
5-5		New contemporary condition proposed: The proponent shall advise the CEO of the OEPA of any potential non-compliance as soon as practicable.
5-6		New contemporary condition proposed: The proponent shall submit a compliance assessment report annually from the date of issue of this Statement addressing the previous 12 month period or as agreed by the CEO of the OEPA. The compliance assessment report shall: • be endorsed by the proponent's Managing Director or a person, approved in writing by the OEPA, delegated to sign on the Managing Director's behalf; • include a statement as to whether the proponent has complied with the conditions; • identify all potential non-compliances and describe corrective and preventative actions taken; • be prepared and made publicly available in accordance with the compliance assessment plan; • indicate any proposed changes to the compliance assessment plan required by condition 5-1.

No.	Statement 558 Condition	Consideration
Subterranean Fauna Sampling Plan		
6-1	Within twelve months following the issuing of the formal authority to decision-making authorities under section 45(7) of the Environmental Protection Act 1986, or at least three years prior to commencing dewatering operations at either the Nammuldi or Silvergrass area, the proponent shall develop a Subterranean Fauna Sampling Plan for the respective area, to the requirements of the Environmental Protection Authority on advice of the Department of Environmental Protection, the Western Australian Museum and the Department of Conservation and Land Management. The objective of this Plan is: • to increase scientific knowledge about subterranean fauna to assist in the conservation of subterranean fauna species. This Plan shall address: 1. subterranean fauna surveys of the areas to be affected by dewatering operations to establish the conservation significance of any species within the affected areas; 2. characterisation of subterranean fauna habitats to be affected by dewatering and identification of similar subterranean fauna habitats outside the affected areas; 3. subterranean fauna surveys of similar habitats outside the areas to be affected by dewatering operations to establish the uniqueness, or otherwise, of fauna within the areas to be affected; and 4. specific measures to record and preserve biological information on any species collected in the project area.	Condition no longer relevant, sampling and impact assessment has been conducted for subterranean fauna. May be deleted
6-2	The proponent shall implement the approved Subterranean Fauna Sampling Plan required by condition 6-1	
6-3	The proponent shall make the Subterranean Fauna Sampling Plan required by condition 6-1 publicly available, to the requirements of the Environmental Protection Authority.	
6-4	The results from the Subterranean Fauna Sampling Plan shall be submitted to the Environmental Protection Authority, the Western Australian Museum and the Department of Conservation and Land Management.	
6-5	Should the Environmental Protection Authority consider, based on the review of the results required by condition 6-4, that its objective to maintain the abundance, species diversity and geographical distribution of subterranean fauna would be compromised, then the proponent shall develop an action plan to the requirements and timing of the Environmental Protection Authority	
Decommissioning Plan		
7-1	At least six months prior to the anticipated date of decommissioning, or at a time agreed with the Department of Environmental Protection, the proponent shall prepare a Final Decommissioning Plan designed to ensure the site is left in a suitable condition, with no liability to the State, to the requirements of the Environmental Protection Authority on advice of the Department of Environmental Protection. The Final Decommissioning Plan shall address: 1. removal or, if appropriate, retention of plant and infrastructure; 2. rehabilitation of all disturbed areas to a standard suitable for the agreed new land use(s); and 3. identification of contaminated areas, including provision of evidence of notification to relevant statutory authorities.	Retained as Final Closure Plan.

No.	Statement 558 Condition	Consideration
7-2	The proponent shall implement the Final Decommissioning Plan required by condition 7-1until such time as the Minister for the Environment determines that decommissioning is complete.	
7-3	The proponent shall make the Final Decommissioning Plan required by condition 7-1 publicly available, to the requirements of the Environmental Protection Authority.	
Performance Review		
8-1	Each six years following the commencement of construction, the proponent shall submit a Performance Review to the Department of Environmental Protection: • to document the outcomes, beneficial or otherwise; • to review the success of goals, objectives and targets; and • to evaluate the environmental performance over the six years; relevant to the following: 1. environmental objectives reported on in Environmental Protection Authority Bulletin 997 or subsequent bulletin; 2. proponent's consolidated environmental management commitments documented in schedule 2 of this statement and those arising from the fulfilment of conditions and procedures in this statement; 3. environmental management system environmental performance targets; 4. environmental management programs and plans; and/or 5. environmental performance indicators; to the requirements of the Environmental Protection Authority on advice of the Department of Environmental Protection. Note: The Environmental Protection Authority may recommend changes and actions to the Minister for the Environment following consideration of the Performance Review.	No change, retained.

Table 63 Consideration of existing environmental Commitments (Schedule 2 of Statement 558)

	Commitments	Consideration
Environmental Management Plan		
1	The proponent will prepare and implement an EMP for the Project that will outline the: • environmental performance objectives for relevant environmental factors; • management of environmental impacts from construction and operation; • monitoring of key environmental aspects; • reporting and auditing procedures The EMP will be prepared in consultation with relevant Government agencies and will be subjected to a targeted public review.	Commitment to be incorporated into Schedule 1 and modified to state: The proponent will implement an EMP and AEMP for the Project that includes: • environmental performance objectives for relevant environmental factors; • management of environmental impacts from construction and operation; • monitoring of key environmental aspects; • reporting and auditing procedures.
Environmental Management System		
2	The proponent will develop and subsequently implement an Environmental Management System for the Project that incorporates the following elements: • environmental policy and associated corporate commitment • mechanisms and processes to ensure – planning to meet environmental requirements – implementation and operation of actions to meet environmental requirements – measurement and evaluation of environmental performance – review and improvement of environmental outcomes	Commitment to be incorporated into Schedule 1 and modified to state: The proponent will implement an Environmental Management System for the Project that includes: • environmental policy and associated corporate commitment • mechanisms and processes to ensure – planning to meet environmental requirements – implementation and operation of actions to meet environmental requirements – measurement and evaluation of environmental performance – review and improvement of environmental outcomes.
Annual Environmental Reporting		
3	The proponent will include the Project in its consolidated annual and triennial environmental reporting to Government once construction commences	Commitment to be incorporated into Schedule 1.
Closure Plan		
4	The proponent will prepare a detailed closure plan for the Project. The plan will address closure actions to be taken toward: • mine voids • waste dumps • tailings storage facilities • transport linkage between Silvergrass and Nammuldi • processing plants • associated infrastructure and will provide the basis for the development of an eventual 'walk-away' closure strategy for the Project. As part of this closure plan, final backfill levels in-pit voids will be assessed, taking account of mean water table levels and capillary rise relationships.	Commitment to be incorporated into Schedule 1 and modified to state: The Proponent will prepare Closure Plans over the life of the Project in accordance with the requirements of the EPA/DMP Guidelines for Closure Planning. Closure Plans will be updated with the results of closure planning and resubmitted to EPA every three years.

	Commitments	Consideration
Additional surveys - biological		
5	The proponent will undertake additional biological (flora, vegetation and fauna) surveys of those areas not already surveyed where Project infrastructure is planned, such as the tailings storage facility (central thickened discharge area), the Village and the power line from the Dampier - Tom Price line. If relevant, appropriate actions will be taken during design to avoid significant areas.	Biological survey requirements have been completed for most aspects. The biological work for the BS4 haul road has not been completed. Commitment to be incorporated into Schedule 1 and modified to state: The proponent will undertake additional biological (flora, vegetation and fauna) surveys of those areas not already surveyed where Project infrastructure is planned, such as the proposed heavy vehicle road between Nammuldi and BS4.
Riverine vegetation monitoring		
6	The proponent will develop and implement a riverine monitoring program to determine the extent of any impacts on vegetation that may occur as a result of dewatering the Silvergrass mine pits and from mine dewatering discharges into Caves Creek. It will also assess, and where appropriate implement, feasible options (such as periodic irrigation/flooding) to reduce significant impacts.	Riverine management actions, monitoring regime and contingency actions are specified in the Surface Water Management Plan, contained in the EMP. Delete commitment.
Rare Fauna		
7	The proponent will prepare and implement a management plan for the Ghost Bat *(Macrodermas gigas)* as part of the EMP, required by commitment *1,* plus any fauna species that are present in the Project area which may be listed in future revisions of the Western Australian Rare and Endangered List or the Commonwealth Critically Endangered List.	Terrestrial fauna management actions, monitoring regime and contingency actions are specified in the Terrestrial Fauna Management Plan, contained in the EMP. Delete commitment.
Caves Creek stream flow		
8	The proponent will monitor stream flows in Caves Creek and make the data available to the Water and Rivers Commission and utilise the data in project design	Riverine management actions, monitoring regime and contingency actions are specified in the Surface Water Management Plan, contained in the EMP. Delete commitment.
Groundwater monitoring and modelling		
9	The proponent will prepare and implement a groundwater monitoring plan (including monitoring water levels in Palm Springs) and incorporate the outcomes to improve the groundwater modelling predictions	Groundwater management actions, monitoring regime and contingency actions are specified in the Groundwater Management Plan, contained in the EMP. Delete commitment.
Recharge options		
10	The proponent will investigate the feasibility of groundwater recharge options at Nammuldi for handling water generated from mine dewatering that will otherwise be discharged via surface drainage	Groundwater management actions, monitoring regime and contingency actions are specified in the Groundwater Management Plan, contained in the EMP. Delete commitment.
Additional surveys – Aboriginal sites		
11	The proponent will involve the Maliwartu Aboriginal Corporation in additional archaeological and ethnographic surveys to identify sites, and their significance, within the Project area that are likely to be disturbed in accordance with a heritage survey protocol as agreed with the Maliwartu Aboriginal Corporation	Aboriginal heritage survey requirements have been described for the Survey Area, any additional surveys will conducted in accordance with the Aboriginal Heritage Plan, contained in the EMP. Delete commitment.
Mechanism for future Aboriginal site surveys		
12	Additional Aboriginal site surveys will be undertaken in accordance with a heritage survey protocol as agreed with the Maliwartu Aboriginal Corporation	Aboriginal heritage survey requirements have been described for the Survey Area, any additional surveys will conducted in accordance with the Aboriginal Heritage Plan, contained in the EMP. Delete commitment.

	Commitments	Consideration
Consultation on Section 18 application		
13	The proponent will consult with the Maliwartu Aboriginal Corporation and Eastern Guruma Elders on Aboriginal sites in the Project area before any Section 18 application is developed in keeping with an agreed protocol	As approval under Section 18 of the AH Act requires consultation with native title holders, this commitment is no longer considered necessary. Delete commitment.
Aboriginal social and cultural issues associated with the environment		
14	The proponent will consult with the Maliwartu Aboriginal Corporation (and the Native Title Claimants it represents) to identify and assess any social and cultural aspects of the physical and biological environment impacted. This will be addressed through the establishment of a Land Use Agreement.	An Indigenous Land Use Agreement (ILUA) has been established with the Eastern Guruma People, the recognised native title claimant group. Therefore this commitment is no longer considered necessary. Delete commitment.

Table 64 Suggested Conditions

No.	Condition for Expansion Proposal
Implementation	
1-1	The proponent shall implement the proposal subject to the conditions of this statement and within the footprint defined in Schedule 1 of this Statement.
1-2	Where the proponent seeks to change any aspect of the proposal as documented in schedule 1 of this statement in any way that the Minister for the Environment determines, on advice of the Environmental Protection Authority, is substantial, the proponent shall refer the matter to the Environmental Protection Authority
1-3	Where the proponent seeks to change any aspect of the proposal as documented in Schedule 1 of this statement in any way that the Minister for the Environment determines, on advice of the Environmental Protection Authority, is not substantial, those changes may be effected.
Proponent	
2-1	The proponent nominated by the Minister for the Environment under section 38(6) or 38(7) of the *Environmental Protection Act 1986* (WA) is responsible for the implementation of the Proposal.
2-2	Any request for the exercise of that power of the Minister referred to in condition 3-1 shall be accompanied by a copy of this statement endorsed with an undertaking by the proposed replacement proponent to carry out the proposal in accordance with the conditions and procedures set out in the statement.
2-3	The proponent shall notify the Chief Executive Officer (CEO) of the Office of the Environmental Protection Authority (OEPA) of any change of the name and address of the Proponent for the serving of notices or other correspondence within 30 days of such change.
Environmental management	
3-1	The proponent will implement an EMP for the Project that includes: • environmental performance objectives for relevant environmental factors; • management of environmental impacts from construction and operation; • monitoring of key environmental aspects; • reporting and auditing procedures
3-2	The proponent will implement an Agricultural EMP for the Project that includes: • environmental performance objectives for relevant environmental factors; • management of environmental impacts from construction and operation of the IAA; • monitoring of key environmental aspects; • reporting and auditing procedures
3-3	The proponent will implement an Environmental Management System for the Project that includes: • environmental policy and associated corporate commitment • mechanisms and processes to ensure – planning to meet environmental requirements – implementation and operation of actions to meet environmental requirements – measurement and evaluation of environmental performance – review and improvement of environmental outcomes

No.	Condition for Expansion Proposal
Groundwater and surface water	
4-1	The proponent will include detailed groundwater quality and quantity monitoring programs in the EMP and Agricultural EMP required under 3-1 and 3-2.
4-2	The proponent will include detailed surface water quality monitoring programs in the EMP and Agricultural EMP required under 3-1 and 3-2.
Vegetation and Flora	
5-1	The proponent will include controls to manage fire and weed introduction in the EMP and AEMP required under 3-1 and 3-2.
Commencement	
6-1	The authorisation to implement the proposal provided for in this Statement shall lapse and be void within five years after the date of this Statement if the Proposal to which this Statement relates is not substantially commenced.
6-2	The proponent shall provide the CEO of the OEPA with written evidence which demonstrates that the Proposal has substantially commenced, on or before the expiration of five years from the date of this Statement.
6-3	The proponent shall make application to the Minister for the Environment for any extension of approval for the substantial commencement of the proposal beyond five years from the date of this statement at least six months prior to the expiration of the five year period referred to in conditions 4-1 and 4-2.
6-4	Where the proponent demonstrates to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority that the environmental parameters of the proposal have not changed significantly, then the Minister may grant an extension not exceeding five years for the substantial commencement of the proposal.
Compliance Auditing	
7-1	The proponent shall prepare and maintain a compliance assessment plan.
7-2	The proponent shall submit to the CEO of the OEPA, the compliance assessment plan required by condition 5-1 at least six months prior to the first compliance report required by condition 5-6. The compliance assessment plan shall indicate: • frequency of compliance reporting • approach and timing of compliance assessments • retention of compliance assessments • methods for reporting of potential non-compliances and associated corrective actions • table of contents of compliance reports • public availability of compliance reports.
7-3	The proponent shall assess compliance with conditions in accordance with the compliance assessment plan required by condition 5-1.
7-4	The proponent shall retain reports of all compliance assessments described in the compliance assessment plan required by condition 5-1 and shall make those reports available when requested by the CEO of the OEPA.
7-5	The proponent shall advise the CEO of the OEPA of any potential non-compliance as soon as practicable.
7-6	The proponent shall submit a compliance assessment report annually from the date of issue of this Statement addressing the previous 12 month period or as agreed by the CEO of the OEPA. The compliance assessment report shall: • be endorsed by the proponent's Managing Director or a person, approved in writing by the OEPA, delegated to sign on the Managing Director's behalf; • include a statement as to whether the proponent has complied with the conditions; • identify all potential non-compliances and describe corrective and preventative actions taken; • be prepared and made publicly available in accordance with the compliance assessment plan; • indicate any proposed changes to the compliance assessment plan required by condition 5-1.
Annual Environmental Reporting	
8-1	The proponent will include the Project in its consolidated annual and triennial environmental reporting to Government once construction commences
Final Closure and Decommissioning	
9-1	The Proponent shall prepare Closure Plans over the life of the Project in accordance with the requirements of the EPA/DMP Guidelines for Closure Planning.
9-2	Closure Plans will be updated with the results of any closure planning and submitted to EPA every 5 years.

No.	Condition for Expansion Proposal
9-3	At least 3 years prior to Closure the Proponent shall submit Final Closure and Decommissioning Plans that demonstrate how the chosen strategy will achieve the following for all aspects of the Nammuldi-Silvergrass Project: • safe stable non-polluting self sustaining landforms • landform and vegetation consistent with surrounding natural landscape and agreed land use • meets objectives agreed with key stakeholders.
9-4	The Proponent shall implement the Closure Plans required by 9-3 and shall demonstrate through monitoring that the objectives have been met. The results shall be reported to the EPA every three years.
9-5	The proponent shall make the Final Decommissioning Plan required by condition 9-3 publicly available, to the requirements of the Environmental Protection Authority.
Performance Review	
10-1	Each six years following the commencement of construction, the proponent shall submit a Performance Review to the Department of Environmental Protection: • to document the outcomes, beneficial or otherwise; • to review the success of goals, objectives and targets; and • to evaluate the environmental performance over the six years; relevant to the following: 1. environmental objectives reported on; 2. proponent's consolidated environmental management commitments documented in schedule 2 of this statement and those arising from the fulfilment of conditions and procedures in this statement; 3. environmental management system environmental performance targets; 4. environmental management programs and plans; and/or 5. environmental performance indicators; to the requirements of the Environmental Protection Authority on advice of the Department of Environmental Protection. Note: The Environmental Protection Authority may recommend changes and actions to the Minister for the Environment following consideration of the Performance Review.

19. References

Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand (ANZECC & ARMCANZ) 1996, *National Principles for the Provision of Water for Ecosystems*, Sustainable Land and Water Resources Management Committee Subcommittee on Water Resources Occasional Paper SWR No. 3.

Australian and New Zealand Environment Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand (ANZECC & ARMCANZ) 2000, *National Water Quality Management Strategy: Paper No 4 - Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 1 - The Guidelines (Chapters 1-7)*, prepared by Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT, October 2000.

Australian and New Zealand Minerals and Energy Council (ANZMEC) & Minerals Council of Australia (MCA) 2000, *Strategic Framework for Mine Closure*, National Library of Australia Catalogue.

Batini, F 2008, *Marandoo Mulga Monitoring – Summary of 2005 Results*, unpublished report prepared for Rio Tinto Iron Ore, April 2008.

Batley GE, Humphrey CL, Apte SC, & Stauber JL, 2003, *A Guide to the Application of ANZECC/ARMCANZ Water Quality Guidelines in the Mineral Industry*, Australian Centre for Mining Environmental Research, September 2003.

Biota Environmental Sciences (Biota) 2003, *Nammuldi Stygofauna Assessment Programme*, unpublished report prepared for Hamersley Iron.

Biota Environmental Sciences (Biota) 2005a, *Fauna Habitats and Fauna Assemblage of the Brockman No. 4 Project Area*, unpublished report prepared for Hamersley Iron Pty Ltd, January 2005.

Biota Environmental Sciences (Biota) 2005b, *Mesa A and Robe Valley Mesas Troglobitic Fauna Survey – Draft Subterranean Fauna Assessment,* unpublished report prepared for Robe River Iron Associates, November 2005.

Biota Environmental Sciences (Biota) 2005c, A Vegetation and Flora Survey off the Brockman Syncline 4 Project Area near Tom Price, unpublished report prepared for Hamersley Iron Pty Ltd, July 2005.

Biota Environmental Sciences (Biota) 2007a, *A Vegetation and Flora Survey of the Approved Powerline Corridor (East of Brockman Operation) for the Brockman Syncline 4 Project*, unpublished report prepared for Pilbara Iron.

Biota Environmental Sciences (Biota) 2007b, Regional Survey for *Ptilotus* sp. Brockman, *Aluta quadrata* and *Geijera* aff. *salicifolia*, unpublished report prepared for Pilbara Iron.

Biota Environmental Sciences (Biota) 2007c, *Level 1 Fauna Assessment of the Approved Powerline Corridor*, prepared for Pilbara Iron, September 2007.

Biota Environmental Sciences (Biota) 2007d, A Flora Survey of the Brockman Syncline 4 Rail and Infrastructure Corridor, unpublished report prepared for Pilbara Iron, February 2007.

Biota Environmental Sciences (Biota) 2009a, *A Targeted Terrestrial Fauna Survey of Expansion Areas at Nammuldi-Silvergrass*, unpublished report prepared for Pilbara Iron, October 2009.

Biota Environmental Sciences (Biota) 2009b, *A Targeted Terrestrial Fauna Survey of Brockman Syncline 2 Pit 7 Extension Areas*, unpublished report prepared for Pilbara Iron Company.

Biota Environmental Sciences (Biota) 2009c, *Silvergrass West Vertebrate Fauna, SRE and Habitat Assessment*, unpublished report prepared for Rio Tinto Iron Ore.

Biota Environmental Sciences (Biota) 2009d, *A Targeted Terrestrial Fauna Survey of the Brockman Syncline 2 Pit 7 Extension Area,* unpublished report prepared for Rio Tinto Iron Ore, October 2009.

Biota Environmental Sciences (Biota) 2010a, *A Vegetation and Flora Survey of Expansion Areas at Nammuldi*, unpublished report prepared for Rio Tinto Iron Ore, June 2010.

Biota Environmental Sciences (Biota) 2010b, *Nammuldi Infill Areas Vegetation and Flora Survey*, unpublished report prepared for Rio Tinto Iron Ore, June 2010.

Biota Environmental Sciences (Biota) 2010c, *A Vegetation and Flora Survey of Silvergrass West,* unpublished report prepared for Rio Tinto Iron Ore.

Biota Environmental Sciences (Biota) 2010d*, Preliminary Ecological Assessment of Creek Systems Potentially Affected by Proposed Developments in the Greater Nammuldi Area August 2009*, unpublished report prepared for Rio Tinto Iron Ore.

Biota Environmental Sciences (Biota) 2010e, *Greater Nammuldi Creeks Monitoring: Report on Riparian Vegetation*, prepared for Rio Tinto Iron Ore, September 2010.

Biota Environmental Sciences (Biota) 2010f, *Nammuldi Infill Areas Fauna Survey Report*, unpublished report prepared for Rio Tinto Iron Ore.

Biota Environmental Sciences (Biota) 2010g, *Brockman 2 Sustaining Tonnes Targeted Fauna Survey*, unpublished report prepared for Rio Tinto Iron Ore, June 2010.

Biota Environmental Sciences (Biota) 2010h, *Nammuldi-Silvergrass Subterranean Fauna Assessment*, unpublished report prepared for Rio Tinto Iron Ore.

Biota Environmental Sciences (Biota) 2011a, *Themeda Grasslands Threatened Ecological Community – Phase 1 Botanical Survey,* unpublished report prepared for Rio Tinto Iron Ore.

Biota Environmental Sciences (Biota) 2011b, *Greater Nammuldi Creeks Monitoring: Report on Riparian Vegetation,* unpublished report prepared for Rio Tinto Iron Ore.

Biota Environmental Sciences (Biota) 2011c, *Nammuldi-Silvergrass Troglobitic Fauna Assessment,* unpublished report prepared for Rio Tinto Iron Ore, March 2011.

Biota Environmental Sciences (Biota) 2012, *Nammuldi-Silvergrass Vegetation Mapping Integration,* unpublished report prepared for Rio Tinto Iron Ore, May 2012.

Bureau of Meteorology (BOM), 2011, *Climate Data Online*, [Online], Australian Government Bureau of Meteorology, Available from: http://www.bom.gov.au/climate/data/index.shtml, [24 September 2011].

Butler, R 2009, *Vulnerability of Plant Functional Types to Dust Deposition in the Pilbara*, unpublished internal presentation to Rio Tinto Iron Ore, 7 October 2009.

Commonwealth of Australia 2011, *Securing a Clean Energy Future – the Australian Government's Climate Change Plan*, Australian Government, Canberra, Australian Capital Territory.

Department of Climate Change (DoCC) 2008, National Greenhouse and Energy Reporting Act 2009, Australian Government.

Department of Conservation and Land Management (CALM) 1999, *Environmental Weed Strategy for Western Australia*, WA Department of Conservation and Land Management.

Department of Environment and Conservation (DEC) 2010a, *Current List of Protected Fauna*, [Online], Department of Environment and Conservation, Government of Western Australia, Available from: http://www.dec.wa.gov.au/content/view/852/2010/, [September 2010].

Department of Environment and Conservation (DEC) 2010b, *List of Threatened Ecological Communities on the Department of Environment and Conservation's Threatened Ecological Community (TEC) Database endorsed by the Minister for the Environment*, August 2010.

Department of Industry, Tourism and Resources (DITR) 2006a, *Mine Closure and Completion Guidelines*, Australian Government, Canberra.

Department of Industry, Tourism and Resources (DITR) 2006b, *Mine Rehabilitation Guidelines,* Australian Government, Canberra.

Department of Industry, Tourism and Resources (DITR) 2007a, *Managing Acid and Metalliferous Drainage,* Leading Practice Sustainable Development Program for the Mining Industry, Commonwealth of Australia, Canberra.

Department of Industry, Tourism and Resources (DITR) 2007b, *Tailings Management*, Leading Practice Sustainable Development Program for the Mining Industry, Commonwealth of Australia, Canberra.

Department of Mines and Petroleum (DMP) 1999, *Guidelines on the Safe Design and Operating Standards for Tailings Storage*, Government of Western Australia, Perth.

Department of Mines and Petroleum (DMP) 2009, *Environmental Notes on Mining – Waste Rock Dumps*, Government of Western Australia, Perth.

Department of Mines and Petroleum (DMP) 2010, *Western Australian Resources Industry Shows Encouraging Signs in 2009 Despite Difficult Economic Climate*, [Online], Department of Mines and Petroleum, Available from: http://www.dmp.wa.gov.au/1525.aspx#1597, [10 September 2010].

Department of Mines and Petroleum (DMP) and Environmental Protection Authority (EPA) 2011, *Guidelines for Preparing Mine Closure Plans*, Government of Western Australia, Perth.

Department of Water (DoW) 2009, *Pilbara Water in Mining Guideline,* Department of Water, Perth, September 2009.

Ecologia Environment (Ecologia) 2011a, *Greater Nammuldi Irrigated Agriculture Project Level 2 Terrestrial Vertebrate Fauna Assessment*, prepared for Rio Tinto Iron Ore by Ecologia Environment, December 2011.

Ecologia Environment (Ecologia) 2011b, *Greater Nammuldi Irrigated Agriculture Project Short Range Endemic Invertebrate Survey*, prepared for Rio Tinto Iron Ore by Ecologia Environment, September 2011.

Environment Australia 1998, *Best Practice Environmental Management in Mining Series – Landform Design for Rehabilitation*, Commonwealth of Australia, Canberra.

Environment Australia 2000, *Revision of the Interim Biogeographic Regionalisation for Australia (IBRA) and Development of Version 5.1, Summary Report,* Environment Australia, November 2000.

Environment Australia 2002*, Best Practice Environmental Management in Mining Series – Mine Decommissioning*, Commonwealth of Australia, Canberra.

Environmental Alliances 2007, *Preliminary Air Quality Assessment Report – Brockman/Nammuldi Operations*, prepared for Pilbara Iron by Environmental Alliances Pty Ltd, February 2007.

Environmental Alliances 2010, *Preliminary Dust Assessment Report – Expansion of Greater Nammuldi (including Silvergrass) Operations*, prepared for Rio Tinto Iron Ore by Environmental Alliances Pty Ltd, September 2010.

Environmental Alliances 2011, *Dust Assessment Report – Expansion of Greater Nammuldi (including Silvergrass) Operations,* prepared for Rio Tinto Iron Ore by Environmental Alliances July 2011.

Environmental Protection Authority (EPA) 1993, *Red Book Status Report; on the implementation of Conservation Reserves for Western Australia, as recommended by the Environmental Protection Authority (1976-1984)*, Environmental Protection Authority, Perth, Western Australia.

Environmental Protection Authority (EPA) 1995, *Rehabilitation and Revegetation – One Module in a Series on Best Practice Environmental Management in Mining*, June 1995.

Environmental Protection Authority (EPA) 2000a, *Environmental Protection of Native Vegetation in Western Australia*, Position Statement No. 2, December 2000.

Environmental Protection Authority (EPA) 2000b, *Prevention of Air Quality Impacts from Land Development Sites*, Guidance Statement No. 18, March 2000.

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

Environmental Protection Authority (EPA) 2002b*, Guidance Statement for Minimising Greenhouse Gas Emissions*, Guidance Statement No. 12, October 2002.

Environmental Protection Authority (EPA) 2003, *Consideration of Subterranean Fauna in Groundwater and Caves during Environmental Impact Assessment in Western Australia*, Guidance Statement No. 54, December 2003.

Environmental Protection Authority (EPA) 2004a, *Principles of Environmental Protection*, Position Statement No. 7, August 2004.

Environmental Protection Authority (EPA) 2004b, *Assessment of Aboriginal Heritage,* Guidance Statement No. 41, April 2004.

Environmental Protection Authority (EPA) 2004c, *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*, Guidance Statement No. 51, June 2004.

Environmental Protection Authority (EPA) 2004d, *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia*, Guidance Statement No. 56, June 2004.

Environmental Protection Authority (EPA) 2006a, *Environmental Offsets*, Position Statement No. 9, January 2006.

Environmental Protection Authority (EPA) 2006b, *Rehabilitation of Terrestrial Ecosystems*, Guidance Statement No. 6, June 2006.

Environmental Protection Authority (EPA) 2007a, *Environmental Noise*, Draft Guidance Statement No. 8, May 2007.

Environmental Protection Authority (EPA) 2007b, *Sampling Methods and Survey Considerations for Subterranean Fauna in Western Australia*, Draft Guidance Statement No 54a, August 2007.

Environmental Protection Authority (EPA) 2008a, *Environmental Offsets*, Guidance Statement No. 19, September 2008.

Environmental Protection Authority (EPA) 2008b, *Environmental Guidance for Planning and Development,* Guidance Statement No. 33, May 2008.

Environmental Protection Authority (EPA) 2009, *Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia*, Guidance Statement No. 20, May 2009.

Environmental Protection Authority (EPA) 2010a, *Timelines for Environmental Impact Assessment of Proposals*, Environmental Assessment Guideline No. 6, November 2010.

Environmental Protection Authority (EPA) 2010b, *Guide to EIA Environmental Principles, Factors and Objectives*, November 2010.

Equinox Environmental Pty Ltd (Equinox Environmental) 2011, *Nammuldi-Silvergrass Expansion Project Ecological Risk Assessment*, prepared for Rio Tinto Iron Ore by Equinox Environmental Pty Ltd, January 2012.

Ethnosciences 2009, *Report of an Ethnographic Survey of Proposed Evaluation Drilling, Mine Extension and Infrastructure Projects at Homestead, Silvergrass, Brockman 2 and Nammuldi, Pilbara, Western Australia,* unpublished report prepared by Ethnosciences for Rio Tinto Iron Ore and the Windiwari Gurama Aboriginal Corporation.

Garnett ST and Crowley GM 2000, *The Action Plan for Australian Birds 2000*, Environment Australia, Canberra

Gentilli J 1972, *Australian Climate Patterns,* Nelson's Australasian paperbacks, Melbourne.

Global Groundwater 2010, *Proposed Irrigated Agriculture Project – Prefeasibility Study*, report prepared for Rio Tinto Iron Ore, December 2010.

Global Groundwater 2011, *Nammuldi Mining Operation Proposed Irrigated Agriculture -Weed Management Plan*, unpublished report prepared for Rio Tinto Iron Ore Pty Ltd, Perth, Western Australia.

Global Groundwater 2012, *Nammuldi Mining Operation Proposed Irrigated Agriculture Project - Nutrient and Irrigation Management Plan: Including Stand and Graze Management*, unpublished report prepared for Rio Tinto Iron Ore Pty Ltd, Perth, Western Australia.

Green R & Borden RK 2011, 'Geochemical Risk Assessment Process for Rio Tinto's Pilbara Iron Ore Mines', Chapter 19 in *Integrated Waste Management - Volume I*, Ed. S Kumar, InTech, available at: *http://www.intechopen.com/books/show/title/integratedwaste*-management-volume-i.

Green R 2009, *Holistic Management of Sulfides at Rio Tinto Iron Ore's Pilbara Mine Sites*, *Water in Mining Conference*, Perth, WA, 15–17 September 2009.

Green R 2010a, *ARD and Geochemical Risk from Nammuldi Tailings*, unpublished report for Rio Tinto Iron Ore.

Green R 2010b, 'Holistic Management of Sulfides at Rio Tinto Iron Ore's Pilbara Mine Sites', in *Mining Technology*, vol. 118, pp. 232 – 237.

Hadley NF, Ahearn GA & Howarth FG 1981, 'Water and metabolic relations of cave-adapted and epigean lycosid spiders in Hawaii', in *Journal of Arachnology*, vol. 9, pp. 215–222.

Halpern Glick Maunsell 1998, *Nammuldi Trial Operation Vegetation and Flora Survey*, unpublished report prepared for Hamersley Iron Pty Ltd.

Halpern Glick Maunsell 1999a, *Nammuldi/Silvergrass Soils, Vegetation and Flora Survey*, unpublished report prepared for Hamersley Iron Pty Ltd,. Report ES995117A.

Halpern Glick Maunsell 1999b, *Nammuldi/Silvergrass Transport Corridor Vegetation and Flora Survey*, unpublished report prepared for Hamersley Iron Pty Ltd.

Hamersley Iron Pty Ltd (Hamersley Iron) 1996, *Homestead Exploration Leases. Biological Survey Report 1995*, unpublished internal report.

Hamersley Iron Pty Ltd (Hamersley Iron) 1999, *Nammuldi Silvergrass Exploration Project. Biological Survey Report November 1998–May 1999*, unpublished internal report.

Hamersley Iron Pty Ltd (Hamersley Iron) 2000, *Nammuldi-Silvergrass Iron Ore Project*, Consultative Environmental Review prepared for the Environmental Protection Authority.

Harvey M 2002, 'Short-range endemism among the Australian fauna: some examples from non-marine environments', in *Invertebrate Systematics*, 16: 555-570.

Hick, Caccetta and Corner 1997, *An assessment of vegetation condition and monitoring strategy for Hamersley Iron's Central Pilbara Railway reserve (CPR) through Karijini National Park using remotely-sensed and ancillary data*, Unpublished report for Rio Tinto.

Higgins PJ. (ed.), 1999, *Handbook of Australian, New Zealand and Antarctic Birds, Volume Four – Parrots to Dollarbird*, Melbourne: Oxford University Press.

How R, Dell J & Cooper N 1991, 'Vertebrate Fauna', in *Ecological Survey of Abydos Woodstock Reserve, Western Australia*, Rec W. A. Mus. Supplement No. 37: 30-77.

Humphreys WF 1991, 'Experimental re-establishment of pulse-driven populations in a terrestrial troglobite community', in *Journal of Animal Ecology*, vol. 60, pp. 609-623.

Humphreys WF 1993, 'Cave Fauna in Semi-Arid Tropical Western Australia: A diverse relict wet-forest litter fauna', in *Memoires de Biospeologie*, Tome XX, pp. 105–110.

Humphreys WF 1999, 'Relict stygofaunas living in sea salt, karst and calcrete habitats in arid northwestern Australia contain many ancient lineages' in *The other 99%: The Conservation and Biodiversity of Invertebrates*, ed W. Ponder and D. Lunney, Transactions of the Royal Zoological Society of New South Wales, Mosman, pp. 219-227.

Humphreys WF 2006, 'Aquifers: the ultimate groundwater-dependent ecosystems', in *Australian Journal of Botany* 54: 115-132.

Humphreys WF, Watts CHS & Bradbury JH, 2004, 'Emerging knowledge of diversity, distribution, and origins of some Australian stygofauna' in *Symposium on World Subterranean Biodiversity*, Villeurbanne City.

Hurter, J. & Naaykens, J. 2010, Report on the suspected invasiveness of the grass Chloris gayana on Kilto & Wooramel Stations in WA, unpublished report prepared for Rio Tinto Iron Ore, December 2010.

Ingleby S 1991, *Distribution and Status of the Spectacled Hare-Wallaby, Lagorchestes conspicullatus*, Wildlife Research vol 18: 421-429

Ingram L 2011, *Water Use By Kangaroo Grass (*Themeda triandra*)*, unpublished report prepared for Rio Tinto Iron Ore, University of Sydney.

Johnson SL & Wright AH 2003, *Mine Void Water Resource Issues in Western Australia*: Western Australia, Water and Rivers Commission, Hydrogeological Record Series, Report HG 9, 93p.

Kendrick P 2001, 'Pilbara 3 (PIL3 – Hamersley subregion), In: May JE & NL McKenzie 2003, *A Biodiversity Audit of Western Australia's Biogeographical Subregions in 2002*, Department of Conservation and Land Management, Western Australia.

Kuisi MA & Abdel-Fattah A 2010, 'Groundwater vulnerability to selenium in semi-arid environments: Amman Zarqa Basin, Jordan', *Environ. Geochem. Health*, vol. 32, pp: 107- 128.

Mattiske Consulting Pty Ltd (Mattiske) 2011, *Flora and Vegetation Survey of the Greater Nammuldi Irrigated Agriculture Survey Area*, report prepared for Rio Tinto Iron Ore, May 2011.

Mattiske EM & Associates and Ninox Wildlife Consulting (Mattiske & Ninox) 1990, *Flora and Fauna Studies: Brockman 2 Detritals Survey Area and Proposed Transport Corridor,* report prepared for Hamersley Iron Pty Ltd, June 1990.

Minerals Council of Australia 2004, *Enduring Value: The Australian Minerals Industry Framework for Sustainable Development*, October 2004.

Muller C 2005, *Water flow in mulga areas adjoining Fortescue marsh*, unpublished report prepared for Fortescue Metals Group Ltd.

Nicholls O 2006, *Marandoo mulga monitoring– Summary of 2005 results,* unpublished report prepared for Rio Tinto Iron Ore

Pilbara Iron 2006, V*arious rare flora searches conducted by Pilbara Iron botanists*, unpublished internal report

Pilbara Iron 2007a, *Botanical Survey Work for Silvergrass West - Marra Mamba Evaluation Drilling Over ML 272SA AR_07_02345*, unpublished internal report.

Pilbara Iron 2007b, *Botanical Survey Work for Nammuldi - Lens A&B- AR_07_02357*, unpublished internal report.

Pilbara Iron 2007c, *Botanical Survey Work for the B4R Regrade GD_06_01762 & B4R Rail Construction Camp GD_06_01763*, unpublished internal report.

Plant JA, Kinniburgh DG, Smedley PL, Fordyce FM & Klinck BA 2003, 'Arsenic and Selenium', *Treatise on Geochemistry*, Elsevier, pp: 17–66.

Ponder W & Colgan D 2002, 'What makes a narrow-range taxon? Insights from Australian fresh-water snails', in *Invertebrate Systematics* 16: 571–582.

PPK Environment & Infrastructure (PPK) 1999, Nammuldi/Silvergrass *East Hydrogeological Investigations vol 1 & 2*, unpublished report prepared for Hamersley Iron Pty Ltd.

Rio Tinto Iron Ore (Rio Tinto) June 2007, *The Economic Impact of Mining in Tom Price and Paraburdoo*, [Online], Available from http://www.riotintoironore.com/documents/economic_impact_of_mining_on_towns_brochure_June_07.pdf, (14 September 2009).

Rio Tinto Iron Ore (Rio Tinto) 2010a, *Dewatering Requirements for Nammuldi*, July 2010.

Rio Tinto Iron Ore (Rio Tinto) 2010b, *Dewatering Requirements for Silvergrass East*, August 2010.

Rio Tinto Iron Ore (Rio Tinto) 2010c, *Baseline Groundwater Sampling Programme throughout the Caves Creek*, September 2010.

Rio Tinto Iron Ore (Rio Tinto) 2010d, Baseline Hydrology Assessment for Caves Creek Discharge

Rio Tinto Iron Ore (Rio Tinto) 2010e, Hydrology Drivers for the TEC at Silvergrass East

Rio Tinto Iron Ore (Rio Tinto) 2010f, *Closure Modelling for Silvergrass East based on Greater Nammuldi Conventional Schedule v5.1 Mine Plan*, August 2010.

Rio Tinto Iron Ore (Rio Tinto) 2010g, *Nammuldi BWT Void Model Post Closure Water and Chloride Balance Models for Lens A, B, CD and EF*.

Rio Tinto Iron Ore (Rio Tinto) 2011a, *Potential Impacts of Dewatering and Discharge to Duck Creek and Caves Creek, Greater Nammuldi*, internal memo prepared by Rio Tinto Iron Ore, July 2011.

Rio Tinto Iron Ore (Rio Tinto) 2011b, *Aquifer Re-injection at Nammuldi and Silvergrass East,* internal memo prepared by Rio Tinto Iron Ore, August 2011.

Rio Tinto Iron Ore (Rio Tinto) 2011c, *Nammuldi Dewatering Strategy – Groundwater Numerical Modelling,* internal memo prepared by Rio Tinto Iron Ore, June 2011.

Rio Tinto Iron Ore (Rio Tinto) 2011d, Baseline Hydrology Assessment for Duck Creek Discharge.

Rio Tinto Iron Ore (Rio Tinto) 2012, Caves Creek Floodplain Assessment for Silvergrass East Deposits.

Smith AJ & Turner JV 1999, *Artificial Storage and recovery in Pilbara Aquifers: Nammuldi Infiltration Trial*, Draft Report to Hamersley Iron, CSIRO Centre for Groundwater Studies, May 1999.

SVT Engineering Consultants (SVT) 2011, Environmental *Noise Assessment of the Greater Nammuldi Project,* unpublished report prepared for Rio Tinto Iron Ore, August 2011

URS 2010a, *Modelling Dewatering at Nammuldi*, unpublished report prepared for Rio Tinto Iron Ore Expansion Projects.

URS 2010b, *Preliminary Groundwater Modelling for Dewatering Design – Silvergrass Deposits*, unpublished report prepared for Rio Tinto Iron Ore Expansion Projects, April 2010

Wager R 1996, 'Leiopotherapon aheneus' In *IUCN 2010. IUCN Red List of Threatened Species. Version 2010.3,* www.iucnredlist.org,.[20 October 2010].

Water and Rivers Commission (WRC) 2000a, *Water Quality Protection Guidelines No. 9 Mining and Mineral Processing: Acid Mine Drainage*, Government of Western Australia, Perth.

Water and Rivers Commission (WRC) 2000b, *Water Quality Protection Guidelines No. 5 Mining and Mineral Processing: Minesite Water Quality Monitoring*, Government of Western Australia, Perth.

Wetland Research & Management 2011a, *Nammuldi-Silvergrass Project: November 2009 & April 2010 Sampling Report*, unpublished report prepared for Rio Tinto Iron Ore, June 2010.

Wetland Research & Management 2011b, *Nammuldi-Silvergrass Project: Dry 2010 & Wet 2011 Sampling Report*, unpublished report prepared for Rio Tinto Iron Ore, October 2011.

Williams M 2001, 'Arsenic in mine waters: an international study', *Environ. Geol.*, vol. 40, pp: 267–279.

Wood and Westell 2010, *Nammuldi Below Watertable (BWT) Project, Pilbara, Western Australia: Aboriginal Archaeological Assessment –Stage 3*, unpublished report prepared for Rio Tinto Iron Ore.

List of appendices

The following supporting documents are contained on CD-ROM inside the back cover of this report:

Appendix 1:
Statement 558

Appendix 2:
Groundwater

Rio Tinto Iron Ore (Rio Tinto) 2010a, *Dewatering Requirements for Nammuldi*, July 2010.
Rio Tinto Iron Ore (Rio Tinto) 2010b, *Dewatering Requirements for Silvergrass East*, August 2010.
Rio Tinto Iron Ore (Rio Tinto) 2010c, *Baseline Groundwater Sampling Programme throughout the Caves Creek*, September 2010.
Rio Tinto Iron Ore (Rio Tinto) 2011b, *Aquifer Re-injection at Nammuldi and Silvergrass East*, internal memo prepared by Rio Tinto Iron Ore, August 2011.
Rio Tinto Iron Ore (Rio Tinto) 2011c, *Nammuldi Dewatering Strategy – Groundwater Numerical Modelling*, internal memo prepared by Rio Tinto Iron Ore, June 2011.
URS 2010a, *Modelling Dewatering at Nammuldi*, unpublished report prepared for Rio Tinto Iron Ore Expansion Projects.
URS 2010b, *Preliminary Groundwater Modelling for Dewatering Design – Silvergrass Deposits*, unpublished report prepared for Rio Tinto Iron Ore Expansion Projects, April 2010

Surface Water

Rio Tinto Iron Ore (Rio Tinto) 2010d, *Baseline Hydrology Assessment for Caves Creek Discharge*
Rio Tinto Iron Ore (Rio Tinto) 2010e, *Hydrology Drivers for the TEC at Silvergrass East*
Rio Tinto Iron Ore (Rio Tinto) 2011a, *Potential Impacts of Dewatering and Discharge to Duck Creek and Caves Creek*, Greater Nammuldi, internal memo prepared by Rio Tinto Iron Ore, July 2011.
Rio Tinto Iron Ore (Rio Tinto) 2011d, *Baseline Hydrology Assessment for Duck Creek Discharge*, March 2011.
Rio Tinto Iron Ore (Rio Tinto) 2012, *Caves Creek Floodplain Assessment for Silvergrass East Deposits*, January 2012
Wetland Research & Management 2011a, *Nammuldi-Silvergrass Project: November 2009 & April 2010 Sampling Report*, unpublished report prepared for Rio Tinto Iron Ore, December 2011.
Wetland Research & Management 2011b, *Nammuldi-Silvergrass Project: Dry 2010 & Wet 2011 Sampling Report*, unpublished report prepared for Rio Tinto Iron Ore, October 2011.

Flora and Fauna

Biota Environmental Sciences (Biota) 2010a, *A Vegetation and Flora Survey of Expansion Areas at Nammuldi*, unpublished report prepared for Rio Tinto Iron Ore, June 2010.
Biota Environmental Sciences (Biota) 2011c, *Nammuldi-Silvergrass Troglobitic Fauna Assessment,* unpublished report prepared for Rio Tinto Iron Ore, March 2011.
Biota Environmental Sciences (Biota) 2009a, *A Targeted Terrestrial Fauna Survey of Expansion Areas at Nammuldi-Silvergrass*, unpublished report prepared for Pilbara Iron, October 2009.

Biota Environmental Sciences (Biota) 2009c, *Silvergrass West Vertebrate Fauna, SRE and Habitat Assessment*, unpublished report prepared for Rio Tinto Iron Ore.
Biota Environmental Sciences (Biota) 2010b, *Nammuldi Infill Areas Vegetation and Flora Survey*, unpublished report prepared for Rio Tinto Iron Ore, June 2010.
Biota Environmental Sciences (Biota) 2010c, *A Vegetation and Flora Survey of Silvergrass West,* unpublished report prepared for Rio Tinto Iron Ore.
Biota Environmental Sciences (Biota) 2010d*, Preliminary Ecological Assessment of Creek Systems Potentially Affected by Proposed Developments in the Greater Nammuldi Area August 2009*, unpublished report prepared for Rio Tinto Iron Ore.
Biota Environmental Sciences (Biota) 2010e, *Greater Nammuldi Creeks Monitoring: Report on Riparian Vegetation*, prepared for Rio Tinto Iron Ore, September 2010.
Biota Environmental Sciences (Biota) 2010f, *Nammuldi Infill Areas Fauna Survey Report*, unpublished report prepared for Rio Tinto Iron Ore.
Biota Environmental Sciences (Biota) 2010h, *Nammuldi-Silvergrass Subterranean Fauna Assessment*, unpublished report prepared for Rio Tinto Iron Ore.
Biota Environmental Sciences (Biota) 2011a, *Themeda Grasslands Threatened Ecological Community – Phase 1 Botanical Survey,* unpublished report prepared for Rio Tinto Iron Ore.
Biota Environmental Sciences (Biota) 2011b, *Greater Nammuldi Creeks Monitoring: Report on Riparian Vegetation,* unpublished report prepared for Rio Tinto Iron Ore.
Ecologia Environment (Ecologia) 2011a, *Greater Nammuldi Irrigated Agriculture Project Level 2 Terrestrial Vertebrate Fauna Assessment*, prepared for Rio Tinto Iron Ore by Ecologia Environment, December 2011.
Ecologia Environment (Ecologia) 2011b, *Greater Nammuldi Irrigated Agriculture Project Short Range Endemic Invertebrate Survey*, prepared for Rio Tinto Iron Ore by Ecologia Environment, September 2011.
Halpern Glick Maunsell 1998, *Nammuldi Trial Operation Vegetation and Flora Survey*, unpublished report prepared for Hamersley Iron Pty Ltd.
Halpern Glick Maunsell 1999a, *Nammuldi/Silvergrass Soils, Vegetation and Flora Survey*, unpublished report prepared for Hamersley Iron Pty Ltd,. Report ES995117A.
Hamersley Iron Pty Ltd (Hamersley Iron) 1996, *Homestead Exploration Leases. Biological Survey Report 1995*, unpublished internal report.
Hamersley Iron Pty Ltd (Hamersley Iron) 1999, *Nammuldi Silvergrass Exploration Project. Biological Survey Report November 1998–May 1999*, unpublished internal report.
Mattiske Consulting Pty Ltd 2011, *Flora and vegetation survey of the Greater Nammuldi Irrigated Agriculture Survey Area*, report prepared for Rio Tinto Iron Ore, May 2011.

AMD

Equinox Environmental Pty Ltd (Equinox Environmental) 2012, *Nammuldi-Silvergrass Expansion Project Ecological Risk Assessment*, prepared for Rio Tinto Iron Ore by Equinox Environmental Pty Ltd, March 2012.

Other Factors

Environmental Alliances 2011, *Dust Assessment Report – Expansion of Greater Nammuldi (including Silvergrass) Operations,* prepared for Rio Tinto Iron Ore by Environmental Alliances July 2011.

Rio Tinto Iron Ore (Rio Tinto) June 2007, *The Economic Impact of Mining in Tom Price and Paraburdoo*, [Online], Available from http://www.riotintoironore.com/documents/economic_impact_of_mining_on_towns_brochure_June_07.pdf, (14 September 2009).

SVT Engineering Consultants (SVT) 2011, *Environmental Noise Assessment of the Greater Nammuldi Project*, unpublished report prepared for Rio Tinto Iron Ore, August 2011

Closure

Rio Tinto Iron Ore (Rio Tinto) 2010f, Closure Modelling for Silvergrass East based on Greater Nammuldi Conventional Schedule v5.1 Mine Plan, August 2010.

Rio Tinto Iron Ore (Rio Tinto) 2010g, Nammuldi BWT Void Model Post Closure Water and Chloride Balance Models for Lens A, B, CD and EF.

Nammuldi Closure Plan, April 2012.

Silvergrass Closure Plan, May 2012.

Appendix 3:

Nammuldi-Silvergrass Expansion Proposal Environmental Management Plan.

Nammuldi-Silvergrass Expansion Proposal Agriculture Environmental Management Plan