12. Biodiversity

12.1 Terrestrial fauna habitat

There are four main habitat types identified at BS4. These habitats include hills and hilltops, plains and broad valleys, creek lines and flood plains, and gorges, gullies and free faces (Figure 19). Characteristics of these habitat types are provided in Table 12.

Hilltops, gullies and creek habitats are of high value due to the diversity of microhabitats and potential to support conservation significant fauna species, while plain and valley habitats have lower value. In contrast, cleared habitat, created through mine disturbance, provides little food, shelter, water or any other life essential and is considered to have little to no habitat value.

Table 12: Description of pre-mining habitats identified at BS4

Landform	Basic description
Hills and hilltops	Hills, ridges, plateaux remnants, gorges and breakaways of varied geological origin. Soil is generally skeletal sandy clay loams with greater than 80% stony detrital material. Under natural conditions, this habitat is characterised by Eucalyptus leucophloia subsp. Leucophloia low open woodland over various Triodia species. Rocky, sheltered ridges and breakaways provide a suite of specialist plants or species more typical of lowlands. This habitat creates a diverse array of microhabitats and refugia. The habitat often contains rock shelters in the form of overhangs, cracks, crevices, caves and areas for water to pool during the wet season. Vegetation provides microhabitats in the form of logs, debris and hollows. This habitat zone will be present in undisturbed areas of the lease and may evolve around the edge of the disturbed areas, especially where the pit shell intersects local hills after erosion processes occur. However, the characteristics of this habitat are not compatible with the closure landform is unlikely to be restored or introduced as part of the rehabilitation activities.
Gorges, gullies and free faces	Deep, often rocky gorges, with rocky structures providing large opportunities of refuge and foraging for a wide suite of vertebrate fauna species; numerous rock ledges, crevices and caves. Very steep topography with an irregular surface with little exposed soil. The soil, when available, is sandy to sandy-clay or stony compact soils, low levels of leaf litter, sparse open vegetation; small caves and crevices, surface water present in some areas. The common dominant species mentioned in this habitat are Acacia aptaneura, A. citrinoviridis, A. pruinocarpa, Corymbia ferriticola, Dodonaea pachyneura, Eriachne mucronata (typical form), Eucalyptus leucophloia subsp. leucophloia, Grevillea berryana and Triodia epactia. This habitat zone will be present in undisturbed areas of the mine and may evolve around the edge of the disturbed mine area especially where the pit shell intersects local hills after erosion processes occur. However, this habitat type will not be restored or rehabilitated as part of the closure plan. This habitat creates a diverse array of microhabitats and refugia. The habitat often contains rock shelters in the form of overhangs, cracks, crevices, caves and areas for water to pool during the wet season. This habitat zone will be present in undisturbed areas of the lease. The characteristics of this habitat are not compatible with the closure landform is unlikely to be restored or rehabilitated as part of the rehabilitation activities.

Landform	Basic description
Plains and broad valleys	Low and occasionally slightly undulating alluvial plains including outwash areas and broad drainage basins. Under natural conditions, soils often consisting of sandy-clay soils covered by rocky lag gravel. The habitat is characterised by Eucalyptus leucophloia, E. gamophylla, Corymbia hamersleyana, A. pruinocarpa, A. inaequilatera and species in the A. aneura complex open woodland to sparse trees over Acacia spp., Eremophila spp., Ptilotus spp., Senna spp. and Solanum lasiophyllum open shrub land over Triodia spp. open hummock grassland. The habitat includes minor drainage lines, where T. longifolia, Gossypium robinsonii and A. ancistrocarpa are characteristic. This habitat type contains limited microhabitats with the dominant Acacia species providing no tree hollows, few logs, limited leaf litter and sparse vegetation. SRE invertebrate species usually comprise mygalomorph (trapdoor) spiders, scorpions, pseudoscorpions and isopods. Most SRE invertebrates prefer the southern foot slopes where sun exposure is reduced and the level of moisture under shrubs and trees is increased. This habitat zone will be present in undisturbed areas of the lease. Characteristics of this habitat may be suitable for rehabilitation planning and could be considered where there is the opportunity for deep soils to develop, i.e. on waste dumps.
Creek line and flood plains	A habitat that begins at the top of hills and runs to the surrounding plains, or encompasses small tributaries that eventually flow into larger river and major drainage habitat types. Surface water is more likely to persist in this habitat after it has evaporated elsewhere, providing a refuge for fauna. The creek habitat includes areas that are periodically flooded due to large surface water volumes (floodplains). The habitat is characterised by Eucalyptus leucophloia subsp. Leucophloia and Acacia shrub land over Triodia sp open hummock grassland, including the presence of weed species such as *Cenchrus ciliaris. Creek habitats act as wildlife corridors that help flora and fauna disperse across the landscape. There is a high diversity of microhabitats including logs, debris, tree hollows and soft soils, as well as temporary and permanent pools. This habitat zone will be present in undisturbed areas outside of the lease. It is likely that rehabilitation of some disturbed drainage line habitat will be required coincident with, or as part of, local drainage controls. It is possible that drainage line habitat could be introduced coincident to surface water runoff controls in the closure landform.

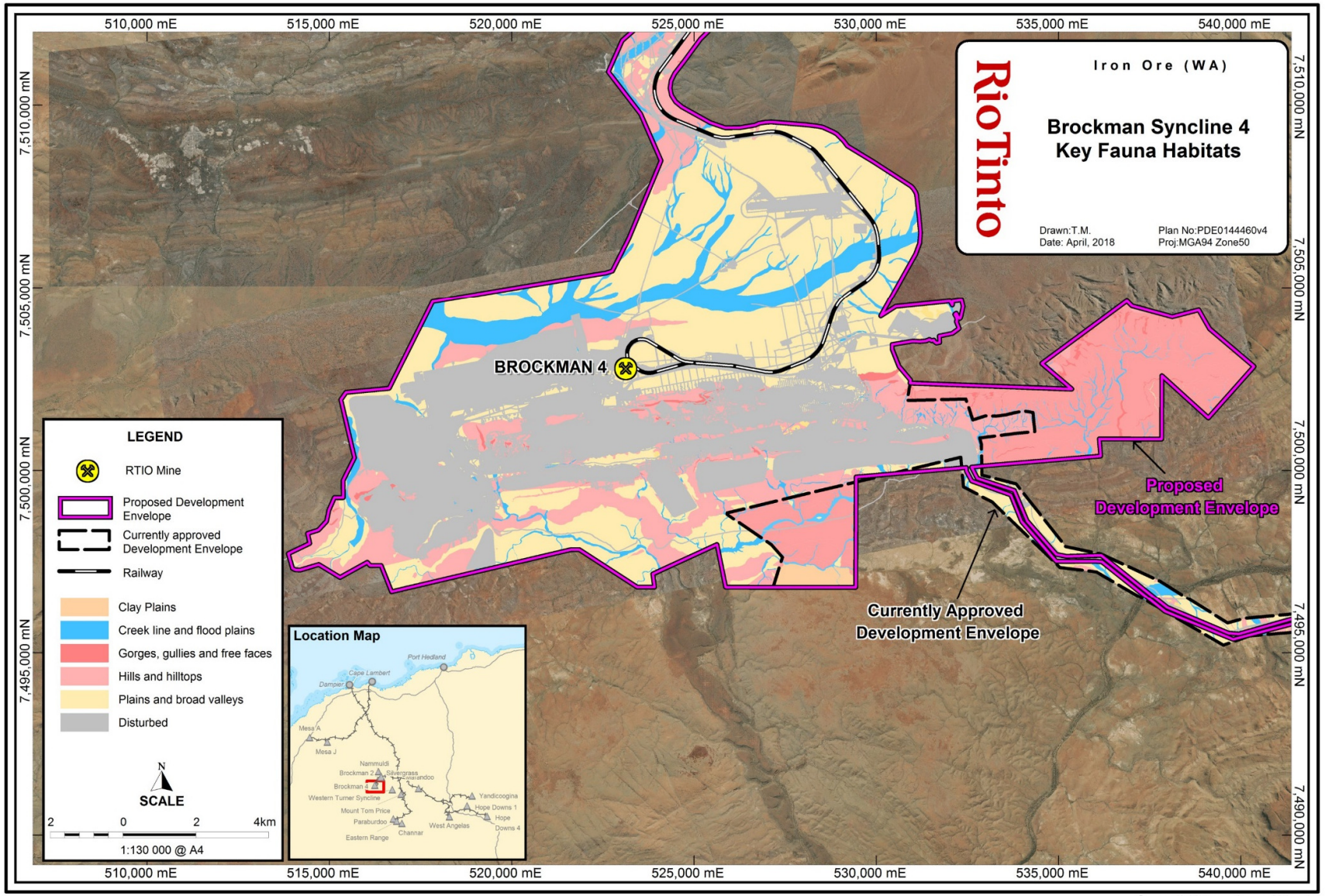

Figure 19: Terrestrial fauna habitats of Brockman Syncline 4

12.2 Fauna reintroduction

Re-introduction of fauna is not considered as part of this closure plan. Instead, natural migration of fauna species into rehabilitated land is encouraged by creating habitats with similar composition to pre-mining communities in appropriate locations and with consideration of the post-closure soil and landforms design. Habitat elements that are considered as part of the closure landform design include:

- vegetation known to provide preferred food or shelter preference;
- retaining and replacing woody debris;
- rapid generation and retention of leaf litter using small-scale topography (e.g. furrows created from ripping);
- introducing or leaving rocky features such as oversized waste burden or scree slopes;
- creating greater depths of friable soil (or suitable mineral wastes) for burrowing fauna;
- preserving connectivity with unmined areas, and maintaining the quality of these habitats; and
- managing feral predators and herbivores across both reference and rehabilitated areas.

Species associated with plains, drainage line or disturbed habitats have the potential to benefit from the rehabilitation of mine, due to returned or expanded habitat post-closure.

12.3 Conservation significant fauna

Fauna survey coverage is shown in Figure 20 and Table 13 lists the significant fauna that were found within the BS4 area prior to disturbance activities. Seven species of conservation significance have been recorded to date in the study area, with evidence of the Northern Quoll (*Dasyurus hallucatus*) found adjacent to the study area.

The Pilbara leaf-nosed bat (*Rhinonicteris aurantia*) is present in the BS4 area. Audio calls of PLNB indicated the presence of a roost in the Brockman area, prompting further targeted surveys throughout 2015, 2016 and early 2017. A PLNb roost (the Upper Beasley River Roost (UBRR)) was confirmed in the Brockman ridge to the north of deposits M and N. A nearby pool (Ridge Pool) was identified as being important to the bats using the roost. An additional pool (Plunge Pool), also considered important to the bats using the roost, was identified to the east of BS4 MM Deposit M. Currently both Deposits M and N are proposed as AWT only, with investigations ongoing into the potential impact of dewatering these deposits on the pools.

Early work identified the *Rhagada sp Mt Brockman* land snail which was thought to be unique. This triggered an approval condition for the site (Condition 8 of MS 717) to implement a Snail Management Plan during operations to protect the species and further develop knowledge on it. Further testing and sampling determined that the snail was not endemic to the area, resulting in the plan becoming redundant. MS717 was superseded by MS1000, with no further requirements to manage *Rhagada sp Mt Brockman*.

A total of 19 sites have been sampled for stygofauna, despite this sampling effort, no stygofauna have been recorded from the study area to date and there is no evidence of a diverse or sizable stygofauna population at BS4. This finding is consistent with previous studies in the locality and if taken together with site related factors such as a relatively deep-water table, this suggests that it is unlikely that an abundant or diverse stygal community occurs in the study area. Some short range endemic troglofauna have been found in the study area.

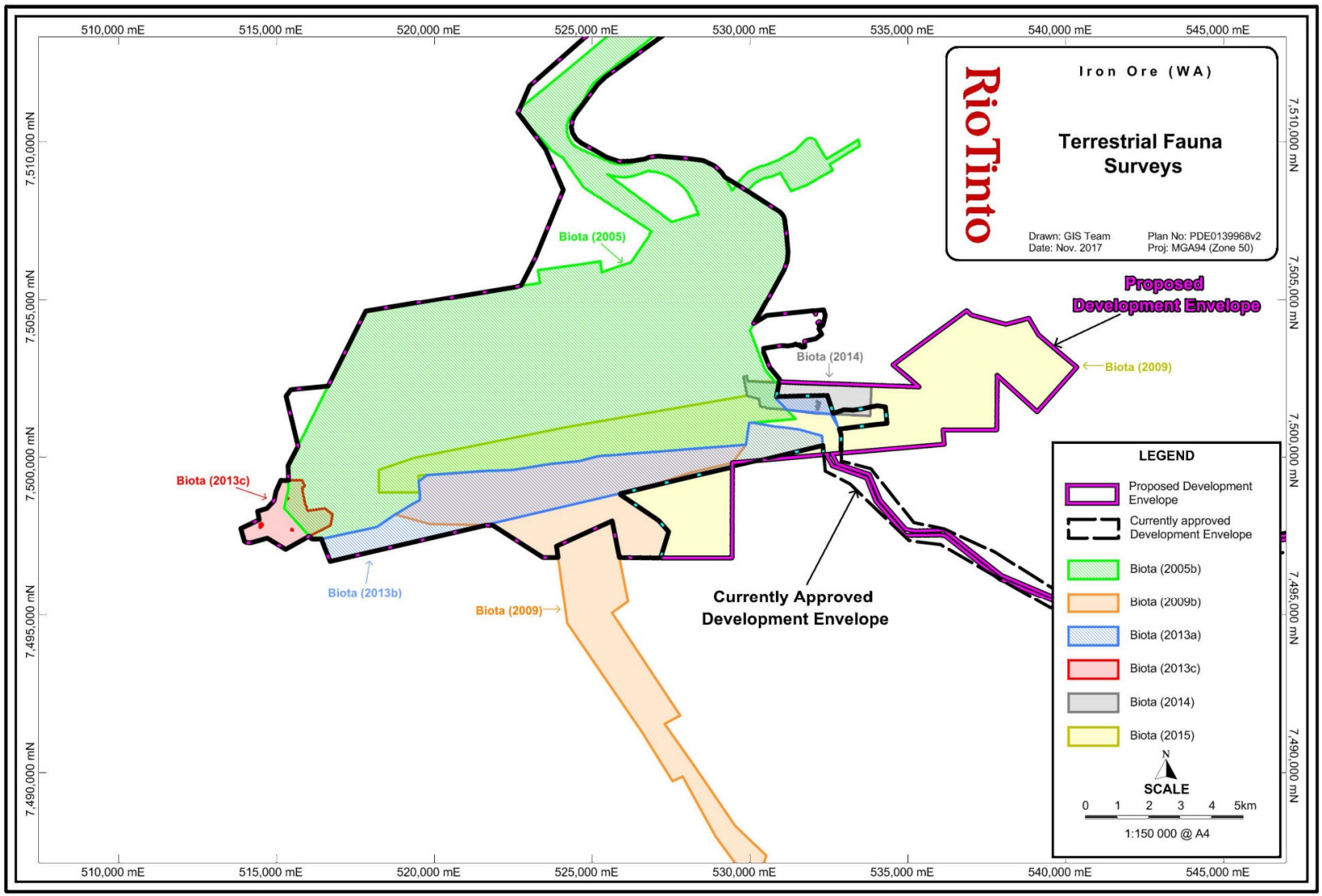

Figure 20: Fauna survey coverage at BS4

Table 13: Significant fauna and its relationship to habitat across the BS4 area

Fauna species	Conservation status WA	EPBC Act status	Habitat occurrence
Dasyurus hallucatus (Northern Quoll)	Schedule 2 (EN)	Endangered	Spinifex dominated areas near riparian habitats. Whilst not found within the proposed development envelope, evidence was found adjacent to the proposed development envelope.
Liasis olivaceus barroni (Pilbara Olive Python)	Schedule 3 (VU)	Vulnerable	All hill habitats.
Macroderma gigas (Ghost bat)	Schedule 3 (VU)	Vulnerable	Gullies & hilltops.
Rhinonicteris aurantia (Pilbara leaf-nosed bat)	Schedule 3 (VU)	Vulnerable	Gullies & hilltops. Forage along free faces, major creeklines, gorges, low hills & plains
Apus pacificus (Fork-tailed Swift)	Schedule 5 (IA)	Migratory	Creek line and drainage.
Merops ornatus (Rainbow bee-eater)	Schedule 5 (IA)	Migratory	Flats and colluvial plain.
Notoscincus butleri (Lined soil-crevice skink)	Priority 4	-	
Pseudomys chapmani (Western pebble-mound mouse)	Priority 4	-	All hill habitats

12.4 Feral animals

Feral carnivores (e.g. cats, dogs, foxes) can create locally increased predation pressure on native fauna as well as increase competition with native species for resources such as space (territory), water and food. Feral herbivores (e.g. cattle, camels, donkeys) can also have a significant impact in Rangeland areas, such as the Pilbara. In dry times, grazing pressure reduces the abundance of palatable native species, impacting biodiversity and can create conditions that encourage weeds to grow. Foot traffic impacts the soil conditions, and in combination with over grazing, can encourage erosion. Foot traffic has also been the cause of damage to cultural landmarks and Aboriginal sites. Overgrazing and damaged soils has a flow-on effect to native fauna species that rely on this vegetation for food and shelter.

12.5 Conservation significant flora

Flora survey coverage is shown in Figure 21. A total of 536 taxa of native flora from 200 genera, belonging to 62 families have been recorded from the BS4, with Acacia and Triodia being key genuses.

Table 14 describes the Threatened and Priority flora that have been identified at or near BS4 operations and have biodiversity value because of their rare and/or threatened status. To date, 18 priority flora species have been recorded within the study area boundary.

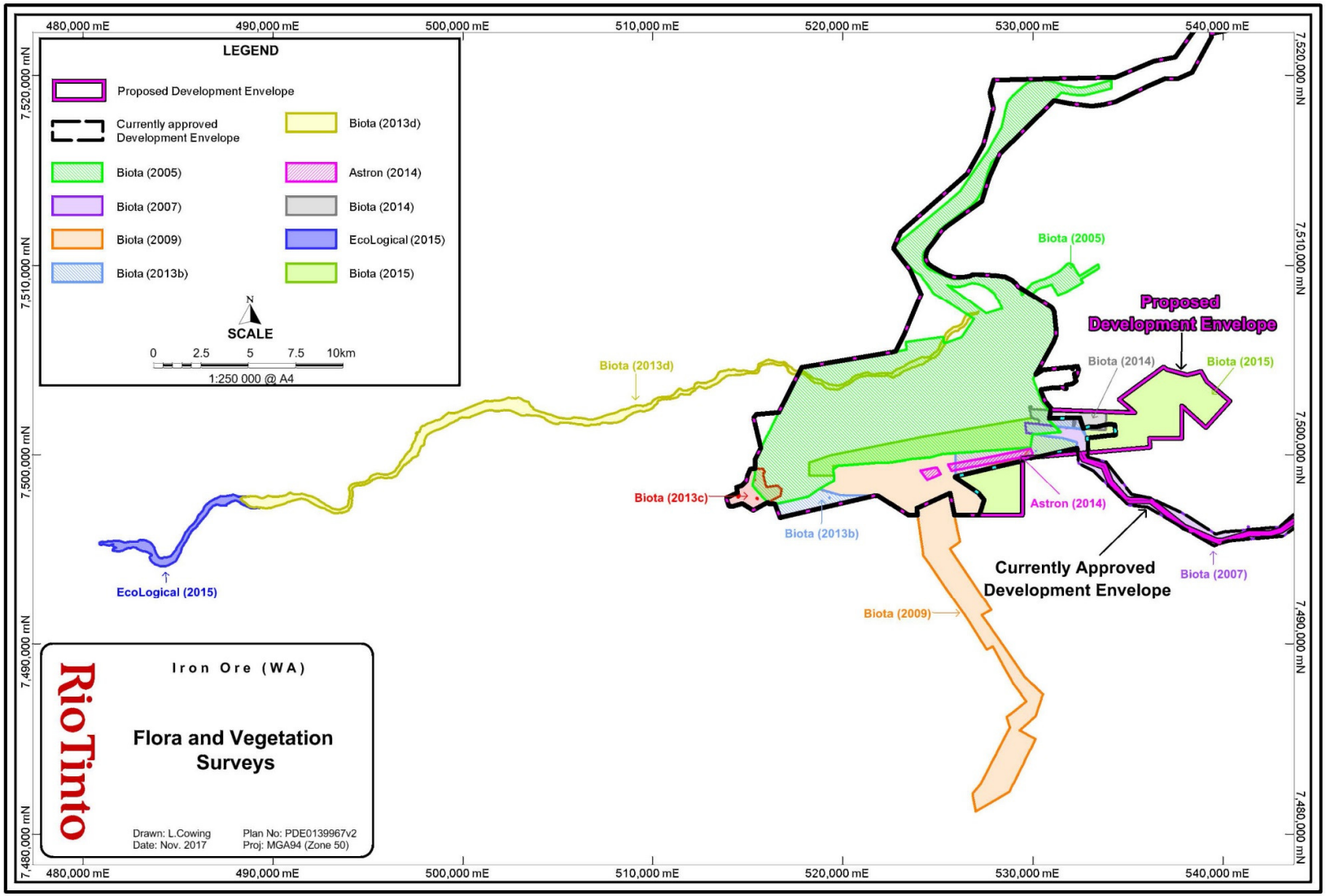

Figure 21: Flora and vegetation surveys over BS4

Table 14: Conservation significant flora identified near or at BS4

Flora taxon	Conservation status WA	Habitat comments
Goodenia pedicellata	Priority 1	Rocky clayey soils, slopes, crests, hills.
Hibiscus sp. Mt Brockman (E. Thoma ET 1354)	Priority 1	
Sida sp. Hamersley Range (K. Newbey 10692)	Priority 1	
Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708)	Priority 2	
Ipomoea racemigera	Priority 2	
Oxalis sp. Pilbara (M.E. Trudgen 12725)	Priority 2	
Pentalepis trichodesmoides subsp. hispida	Priority 2	
Eremophila magnifica subsp. velutina	Priority 3	
Grevillea saxicola	Priority 3	
Indigofera sp Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	
Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479)	Priority 3	
Ptilotus subspinescens	Priority 3	2016 targeted searches located additional records outside of the mine footprint
Themeda sp. Hamersley Station (M.E. Trudgen 11431)	Priority 3	
Triodia basitricha	Priority 3	
Acacia bromilowiana	Priority 4	Rocky hills, scree slopes, gorges, creeks
Eremophila magnifica subsp. magnifica	Priority 4	
Goodenia nuda	Priority 4	
Eulalia sp. (Three Rivers Station, B.Forsyth AQ6789133)	Pending	

12.6 Invasive flora

Flora and vegetation surveys have recorded a total of 23 introduced flora species (weeds) in the BS4 area. These species are listed in Table 15 and are largely found in low lying areas and along creek lines. None of these species are listed as Weeds of National Significance or declared plants for the Pilbara region under the Biosecurity and Agriculture Management Act 2007 (WA).

The Department Biodiversity, Conservation and Attractions Weed Species Ranking takes into account the potential distribution, current distribution, ecological impact, invasiveness and feasibility of control to derive a final broad qualitative weed species ranking corresponding to specific management actions.

Table 15: Weed species recorded at BS4

Scientific Name	Common Name	Ecological Impact	Invasiveness
**Aerva javanica*	Kapok	High	Rapid
**Argemone ochroleuca*	Mexican Poppy	Unknown	Rapid
**Bidens bipinnata*	Bipinnate Beggartick	Unknown	Rapid
**Cenchrus ciliaris*	Buffel grass	High	Rapid
**Cenchrus setiger*	Birdwood Grass	High	Rapid
**Chloris barbata*	Purpletop Chloris	High	Rapid
**Chloris gayana*	Rhodes Grass	-	-
**Citrullus lanatus*	Pie Melon	Unknown	Moderate
**Conyza bonariensis*	Flaxleaf Fleabane	-	-
**Echinochloa colona*	Awnless Barnyard Grass	High	Rapid
**Euphorbia hirta*	Asthma Plant	Low	Slow
**Flaveria trinervia*	Speedy Weed	-	-
**Lactuca serriola*	Prickly Lettuce	-	-
**Malvastrum americanum*	Spiked Malvastrum	High	Rapid
**Melochia pyramidata*	Pyramid Flower	-	-
**Portulaca pilosa*	Djanggara	-	-
**Rumex vesicarius*	Ruby Dock	High	Rapid
**Setaria verticillata*	Whorled Pigeon Grass	High	Rapid
**Sigesbeckia orientalis*	Indian Weed	Unknown	Rapid
**Solanum nigrum*	Blackberry Nightshade	Low	Rapid
**Sonchus oleraceus*	Common Sowthistle	Low	Rapid
**Tribulus terrestris*	Caltrop	Unknown	Moderate
**Vachellia farnesiana*	Mimosa Bush	High	Rapid

12.7 Priority and/or Threatened Ecological Communities

The current BS4 footprint is not expected to impact the conservation status of any flora or fauna species, populations or fauna habitat. This includes changes to abundance, species diversity, geographic distribution and / or productivity of flora at species or ecosystem levels. Similarly no conservation significant habitats were identified that are analogous to any known Threatened Ecological Community (TEC) or Priority Ecological Community (PEC). The nearest mapped TEC, the “Themeda grasslands on cracking clays (Hamersley Station)”, is located approximately 31 km north of the study area. There is no suitable habitat for this TEC in the study area. The only PEC in the locality is the “Brockman Iron cracking clay communities of the Hamersley Range”, which is also approximately 30 km north of the study area.

13. Progressive rehabilitation

Regular reviews of the mine plan are used to identify disturbed areas of the site where mining activity has been completed. These areas are then reviewed for potential to undertake progressive rehabilitation works. Lessons learnt during these activities and from subsequent monitoring campaigns are used to inform and update our standard management practices and provide input into suitability of final closure criteria for the site.

To date, 531.23 hectares of land has been progressively rehabilitated at BS4 since construction commenced in 2008. Table 16 and Figure 22 provide an overview of the main areas of progressive rehabilitation undertaken. The majority of rehabilitation at Brockman 4 has been flat areas used for construction or borrow. Rehabilitation areas from other local sites (Brockman 2/Nammuldi) are used as examples of current scenarios and likely outcomes for other landform types.

Table 16: Progressive rehabilitation details

Location	Category	Area rehabilitated (ha, approximate)	Year of Rehabilitation (estimated)
B4 Rail Spur	Rail (Construction)	41.35	2009-2010
General	Infrastructure (Construction)	87.66	2009-2012
Brockman 4 Camp	Infrastructure (Construction)	15.24	2010-2011
White Quartz Road	Borrow Pits	137.46	2009-2011
Boolgeeda Airport	Infrastructure (Construction)	30.25	2012
Brockman Fuel Hub	Infrastructure (Construction)	13.93	2013
B2-B4 Road	Road (Construction)	205.35	2014-2016
Boolgeeda Camp	Camp	16.19	2018
Camp Borrow Pit	Borrow Pits	9.00	2018
White Quartz Road	Roads and Tracks	17.03	2018

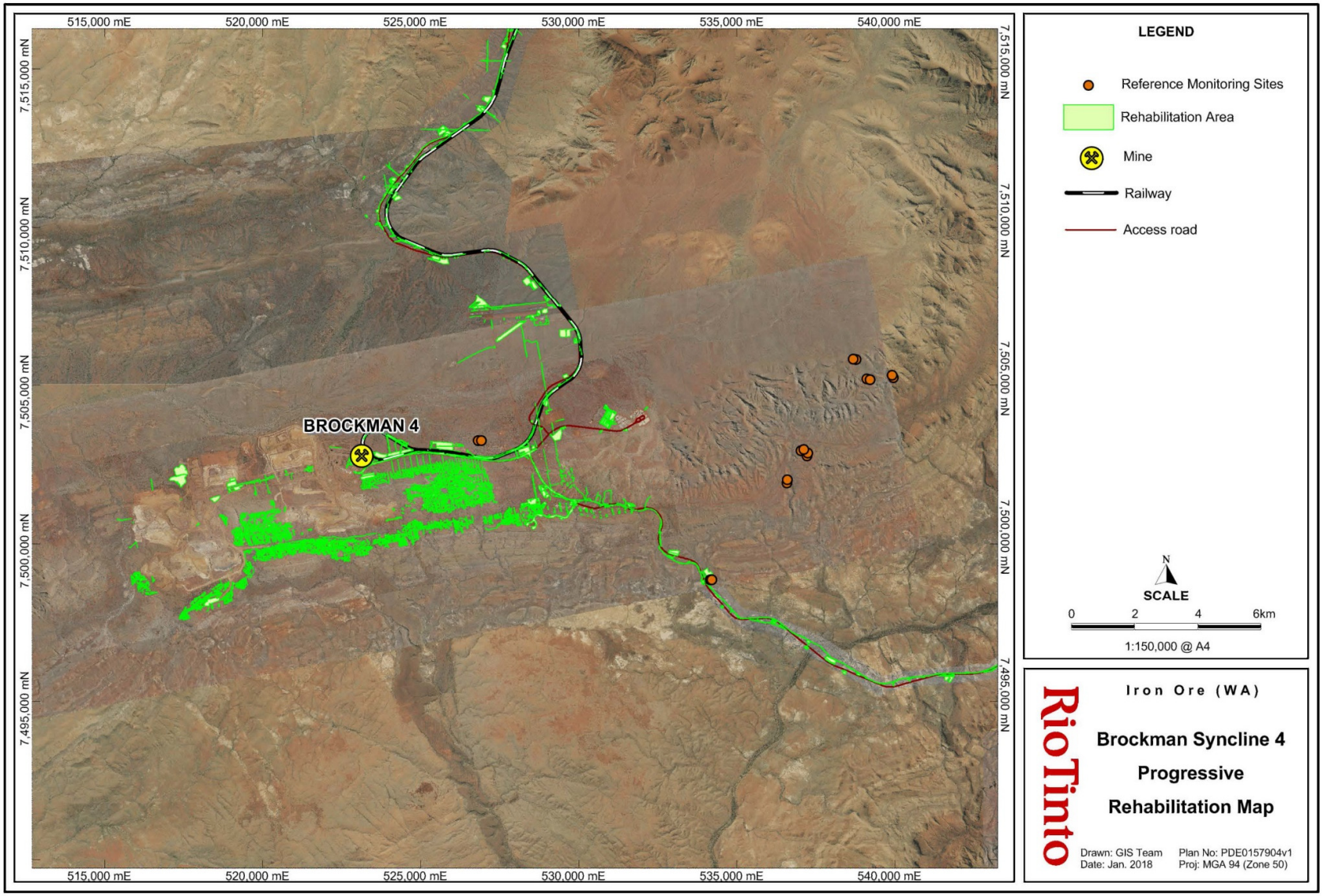

Figure 22: Progressive rehabilitation areas and reference sites at Brockman 4

13.1 Borrow pits

Borrow pits along WQR were rehabilitated in 2009. Rehabilitation details are largely unknown; however they generally appear ripped without seeding, with topsoil returned directly. Monitoring locations were installed in 2010 at 31 different borrow pits. These sites were monitored in 2010, 2011, 2012, 2014 and 2017 (Figure 23). The rehabilitation is compared to local undisturbed reference sites. The rehabilitation has generally established well, with a range of native perennial species present. Vegetation parameters are approaching the corresponding reference sites. Buffel Grass is present at some of the borrow pits in low to moderate densities. Weeds in rehabilitation are managed under the company's *Weed Management Strategy* which has control measures such as periodic spraying and equipment hygiene procedures.

WQR borrow pits (2010 – <1 year)

WQR borrow pits (2014 – 5 years)

WQR borrow pits (2017 – 8 years)

Figure 23: Borrow Pit rehabilitation over time at Brockman 4

Rehabilitation at the Camp Borrow Pit was completed in 2018. The area had topsoil installed and was ripped, however no seed was used. No monitoring has yet occurred on this area, but will be scheduled as per the internal monitoring procedure.

13.2 Waste dump rehabilitation

No waste dump rehabilitation has been completed at Brockman 4 as all dumps are currently still active. However, waste dumps have been rehabilitated at various Rio Tinto Pilbara sites, and can be used as examples of possible outcomes.

The Lens C Waste Dump at nearby Brockman 2 was completed in 2007. The single lift dump was reshaped into a concave slope, and received both topsoil and seed. Concave slopes are unusual in Rio Tinto Pilbara operations, which normally favour the batter/berm configuration. One monitoring location was installed in 2008, and subsequently monitored in 2009, 2010, 2012, 2013, 2014 and 2016 (Figure 24). The rehabilitation is compared to local undisturbed reference sites. The rehabilitation has established well, with parameters comparable to corresponding reference sites. Spinifex is starting to develop to supplement the other various native perennial species present. No weeds were present at last assessment. Some minor gullying had occurred, however all showed evidence of being stable or stabilising since last monitored.

Pit 6 Waste Dump, also at Brockman 2, was completed in 2017. This four lift dump was reshaped into the standard batter berm configuration, and received both topsoil and seed. Monitoring is likely to commence in 2018 or 2019.

Lens C Dump (2007 – <1 year)

Lens C Dump (2014 – 7 year)

Figure 24: Waste dump rehabilitation over time at nearby Brockman 2

13.3 Infrastructure areas

Rehabilitation at Boolgeeda Camp was completed in 2018. Buildings, footings and buried services were removed. The area had topsoil installed and was ripped and seeded with local provenance seed. No monitoring has yet occurred on this area, but will be scheduled as per the internal monitoring procedure.

13.4 Low impact disturbance areas, construction areas, roads

Rehabilitation at Boolgeeda Airport was completed in 2012, and at the Brockman Fuel Hub in 2013. Rehabilitation details are largely unknown; however they generally appear ripped without seeding, with topsoil returned directly. Monitoring locations were installed in 2014, two at each area. These sites were monitored in 2014 and 2016. The rehabilitation is compared to local undisturbed reference sites. The rehabilitation has established well, with vegetation parameters similar the corresponding reference sites. Weeds, particularly from the *Cenchrus* family were present at one location at the Airport in low densities. Weeds in rehabilitation are managed under the company's *Weed Management Strategy* which has control measures such as periodic spraying and equipment hygiene procedures.

Rehabilitation along White Quartz Road (WQR) was completed in 2018. Fence posts were removed and the area ripped. No topsoil or seed was used. No monitoring has yet occurred on these areas, but will be scheduled as per the internal monitoring procedure.

13.5 Seed provenance and selection

Locally collected seed is needed to assist in revegetation and the creation of a self-sustaining ecosystem. Over time the viability of seeds in stockpiled topsoil decreases, and thus the quality of the topsoil deteriorates. In addition the topsoil that was salvaged prior to disturbance may not contain seeds of all the target species of its new location / habitat.

Seed mixes for rehabilitation are of local provenance. Specific seed mixes are selected to provide a range of species appropriate to the desired habitat, taking into consideration landscape position and slope. In areas where erosion risks are identified, seed mixes may be modified to include or increase the portion of species that provide rapid cover.

Rio Tinto purchases seeds from commercial seed suppliers, with emphasis on ensuring that there are appropriate local provenance seeds available for rehabilitation of each of its sites. Seeds are stored in purpose-built, climate controlled storage facilities to maximise long term viability.

The inclusion of rare and threatened species in rehabilitation programmes is limited by:

- habitat preference (preference for drainage lines, gullies, calcretes or other habitat not suitable or similar to those likely to be present in the rehabilitation landscapes);
- abundance – very few populations or small populations from which to source seed;
- difficult taxonomy / unresolved taxonomy issues and thus status of species highly uncertain;
- growth form – e.g. short lived annual species with preference for growth under woodland canopies;
- seed production – some species do not regularly produce seed;
- propagation methods – some species are not able to germinate from seed and cuttings are required which is not a suitable method for broad scale application in an arid environment;
- availability of seed at the time when rehabilitation occurs; and/or
- seed dormancy.

Given these issues, the main focus of rehabilitation programs is to restore vegetation complexes that include the more common species present in the particular habitat type, and to achieve a diverse range of strata. Seed mixes may include species of conservation significance if they are available, but presence of these species in rehabilitation areas is more likely to result from natural recruitment from surrounding areas.

14. Contaminated sites

Rio Tinto Iron Ore maintains registers for potentially contaminating activities and known or suspected contaminated sites which have been formally reported under s11 of the *Contaminated Sites Act 2003* (WA). The registers are informed by regular review of operations and where required preliminary or detailed site investigations to assess contaminants associated with such activities and assess their risk of harm to human health, the environment and environmental values. Potentially contaminating activities and land uses as described in the 2014 Department of Environmental Regulation guideline '*Assessment and management of contaminated sites'*, that may be associated with mining activities onsite include, but not limited to:

- Airport facilities;
- Automotive repair workshops (light and heavy machinery);
- Substations and transformers;
- Fertiliser and explosives storage;
- Landfill sites;
- Mineral processing, mining, screening and crushing facilities;
- Rail transport corridors;
- Hydrocarbon storage, handling and dispensing facilities;
- Sewage waste water treatment plants and irrigation areas; and
- Disturbance of potentially acid forming materials during the course of mining.

All potentially contaminating activities and land uses identified on the site register are managed as part of the ongoing mining operation. Prior to closure as part of the decommissioning process, a contaminated site assessment will be undertaken. Based on this assessment, specific plans will be developed to remediate or manage contaminants, where required, to support the final land use.

Currently no locations at BS4 have been reported under the *Contaminated Sites Act* 2003 (WA).

15. Cultural heritage

Rio Tinto Iron Ore recognises and respects the significance of Australia's cultural heritage, and in particular the cultural heritage of Aboriginal people who have traditional ownership of, and/or cultural connections to, the land on which we operate. Extensive archaeological and ethnographic surveys have been undertaken in the BS4 area, and these surveys help to inform the heritage values of the area. We take all reasonable and practicable measures to prevent harm to cultural heritage sites, this includes during works associated with rehabilitation and closure. Where this is not possible, steps are taken to minimise or mitigate impacts and ensure required statutory approvals are obtained. Closure works consider issues such as post closure access requirements to culturally significant sites and appropriate return of any materials salvaged during mining operations.

15.1 Relevant Aboriginal groups

The Puutu Kunti Kurrama and Pinikura (PKKP) People and the Eastern Guruma People are the traditional custodians of the land identified in this closure plan (Figure 4).

The PKKP People hold Native Title rights over a determined claim area which includes a portion of the BS4 area. The Eastern Guruma People have Native Title rights determined over the remaining portion of the land identified in this closure plan footprint, to the east of the current mining area.

Rio Tinto has entered into Native Title Agreements with both the Eastern Guruma and PKKP People covering the claim wide areas (Figure 4). Pursuant to these Agreements, forums have been established for consultation and ongoing engagement with the native title holders on processes such as: land access; tenure acquisition; heritage surveys and environmental management relating to the Rio Tinto's operations.

The Agreements include the Rio Tinto and PKKP Indigenous Land Use Agreement (ILUA) (Area Agreement) registered with the National Native Title Tribunal on 24 April 2013 and the Pilbara Iron and Eastern Guruma Body Corporate ILUA registered on 23 June 2008.

15.2 Ethnographic and archaeological values

Archaeological and ethnographic surveys have been conducted with nominated Eastern Guruma and PKKP representatives, who have identified sites and made recommendations on the significance and management of each site.

Purlykuti Creek, a minor creek to the west of the mining area, has been identified during ethnographic surveys as being of high significance to the PKKP Traditional Owners. The area is a corridor that has been used by Traditional Owners for generations to reach their significant art and archaeology places to the north and south of Boolgeeda River. It is from this area that the PKKP group took their name.

A 40,000 year old rock shelter, named Juukan 2, was discovered in 2003 during survey work of the area, which was located adjacent to an important ancient travel route for PKKP ancestors (Purlykuti Creek). Brockman 4 mining operations were unable to avoid impacting this site, therefore full salvage excavation of the site was undertaken in 2014, in accordance with Western Australian law. Thousands of stone artefacts and animal bones were discovered up to 170 cm below the surface. Creative methods were explored to preserve aspects of the site for future generations, including a visual display of the site using a latex peel of one of the excavation trench walls. This involved liquid latex being sprayed on the trench wall, to enable a piece of the wall to be removed for preservation in a custom built cabinet, which is stored at BS4 mine administration building. Accompanying the peel is a selection of the discovered artefacts and information on the archaeological and ethnographic stories of the BS4 landscape.

Further heritage investigation of the three pools identified in proximity to the development envelope of the BS4 MM project, Ephemeral Pool, Ridge Pool and Plunge Pool (Section 11.1), by the Eastern Guruma People will determine their significance and management requirements for closure.

Numerous other archaeological sites have been found in the Brockman area across both PKKP and Eastern Guruma determination areas. In some cases where disturbance has been unavoidable, artefacts from these sites have been removed and placed into storage to facilitate mining activity, and consideration of post-closure management will be required. Artefacts that have been salvaged for the PKKP group prior to mine disturbances in accordance with Section 18 of the Aboriginal Heritage Act 1972 are currently stored in a shipping container at a Brockman 4 laydown area, and in the BS4 administration building. Such materials recovered within Eastern Guruma country have been relocated to a shipping container located at Brockman 2 Camp.

Consultation with PKKP and Eastern Guruma traditional owners will be maintained in established forums throughout the life of the operation to ensure that proposed closure strategies address cultural requirements, and to ensure closure objectives for the site remain appropriate.

Closure works consider issues such as post closure access requirements to culturally significant sites and appropriate return of any materials salvaged during mining operations. The plan for these artefacts post closure has not been discussed with PKKP or Eastern Guruma group members to date. Whilst this closure plan does not include strategies for maintaining or restoring cultural values, it does recognise that post-closure access to some of these sites may be required and that the area will need to be made safe for this purpose (Section 19.4).

16. Regional Community

BS4 does not have a local community directly associated with it. The closest town is Tom Price 60 km away, which was established in 1966 specifically to support the adjacent Tom Price mine - it has since grown to become a significant regional centre with a resident population of over 3,000 people. Road access to Tom Price is via White Quartz Road and Nameless Valley Road. The closure of BS4 will have minimal impact on Tom Price; however this may change in future if the nature of this interaction changes. Tom Price town is subject to a separate closure plan and is not considered in this plan.

BS4 closure may have a minor effect on the regional communities from which the workforce is sourced, namely Geraldton, Albany and Busselton. Although it is anticipated that many positions would be transferable to other Rio Tinto mining operations in the vicinity, there may be some contraction in workforce at closure. This will need to be managed as the site approaches closure and is expected to be addressed through the Workforce Management Plan.

The area is overlain by Rocklea Station pastoral lease; however, the closest residential property is Hamersley Station Homestead which is approximately 55 kilometres to the north. The Cheela Plains Homestead is located near the Nanutarra-Munjina Road close to Paraburdoo.

There are no permanent Aboriginal communities in close proximity to BS4. The closest Aboriginal community is Wakathuni, located 20 kilometres south of Tom Price. There is a private camp located along White Quartz Road (referred to as the White Quartz Culture Camp) which has one Eastern Guruma resident and is used intermittently by the Eastern Guruma people during lore time and for educational activities.

17. Workforce

The majority of staff is flown directly from Perth to the BS4 operated Boolgeeda airport, with small numbers also flying directly from Geraldton, Albany and Busselton. Personnel are housed on BS4, in a fully serviced accommodation facility that will be decommissioned as part of this closure plan. A small number of employees commute by road from Tom Price.

Mining activities are anticipated to continue at a similar rate within the wider Pilbara region after the BS4 mine ceases to operate. Thus regional employment opportunities and mine related services are not anticipated to be significantly impacted by closure of the mine, however there may be some contraction in the workforce in Greater Brockman area.

IDENTIFICATION AND MANAGEMENT OF CLOSURE ISSUES

18. Risk evaluation process

A closure risk assessment was completed to identify and assess closure issues for BS4. The risk assessment is included in Appendix D. The assessment was completed by an internal panel of multi-disciplinary subject matter experts with the aim of:

- identifying hazards, aspects and opportunities that could influence the successful closure of the site;
- evaluating the resulting risks to people, property and the environment; and
- defining the actions required to reduce the risk to below the risk acceptance threshold.

Risk was evaluated on the basis of the maximum reasonable outcome consequence and the likelihood of that consequence occurring. Risks were evaluated inclusive of current management and commitments, and represent current residual risk.

Issues are assessed against the following consequence criteria:

- **Costs:** economic impacts if the risk were to eventuate ranging from low to very high, determined as a percentage of the projected closure cost for the operation;
- **Health:** reversible health effects of little concern (very low) to multiple fatalities (very high);
- **Personal safety:** inconvenient first aid treatments (very low) to multiple fatalities (very high);
- **Environment:** reversible impact (very low) to widespread, long-term impacts (very high). These risks are separated into two categories – during decommissioning/active closure implementation or post closure.
- **Community trust:** mistrust amongst a small section of the wider community (very low) to widespread mistrust with key stakeholders (very high). Also includes potential heritage impacts ranging from reparable damage to a site of low cultural significance (very low) through to irreparable damage to a site of international cultural significance (very high); and
- **Compliance:** non-conformance to internal requirements (very low) to prosecution for breach of regulatory licence(s) (very high).

Risks are classified as follows:

- **Low** (Class I): Risks that are below the risk acceptance threshold and do not require further management.
- **Moderate** (Class II): Risks that lie on the risk acceptance threshold and require regular review to ensure management remains adequate and fit-for-purpose.
- **High** (Class III): Risks that, based on the current level of knowledge, could exceed the risk acceptance threshold and require proactive management and / or resolution of knowledge gaps.
- **Critical** (Class IV): Risks that, based on the current level of knowledge, will exceed the risk acceptance threshold and need urgent and immediate attention to develop an alternative approach.

Actions are assigned to risks that exceeded the risk acceptance threshold and therefore require additional control measures to reduce the risk to an acceptable level. Actions are also assigned to address knowledge gaps where it is assessed that further information is required to better understand and/or adequately assess the risk presented by an issue. This would typically be the case in the early stages of closure where the detailed knowledge of the issues may be low. These actions are captured in Appendix E.

19. Management of key issues

The DMP/EPA *Guidelines for Preparing Mine Closure Plans* lists a number of rehabilitation and closure issues that may be relevant for mine sites, including seven that are identified as key issues. An evaluation of the relevance of each of these issues to BS4 and the proposed BS4 MM expansion is presented in Table 17. The information in this table is intended to compliment that contained in the risk assessment presented as Appendix D.

Table 17: Relevance of potential closure and rehabilitation issues to BS4 and BS4 MM

Issue	Evaluation of relevance to BS4	Further discussion
Acid and metalliferous drainage	Geochemical studies have identified an AMD risk for BS4.	Section 19.1
Challenges associated with rehabilitation and revegetation	Rehabilitation conducted to date is progressing towards suitable outcomes.	Not addressed further in this chapter.
Dispersive, sodic and erosive materials	BS4 mineral waste contains a fraction of material that is classified as highly erodible.	Section 19.2.
Radioactivity	Not a significant issue for BS4.	Not addressed further in this chapter.
Mine pit lakes	The current closure strategy involves backfill to a level that prevents the formation of pit lakes.	Not addressed further in this chapter.
Geotechnical instability	Some waste dumps intersect zones of instability around pit walls.	Section 19.3.
Inadvertent public access	Abandonment bunds will be required to restrict inadvertent public access.	Section 19.4.
Hazardous materials	Hazardous materials (e.g. hydrocarbons, ammonium nitrate) will be removed prior to, or during, decommissioning.	Not addressed further in this chapter.
Hazardous and unsafe facilities	All infrastructure will either be demolished during decommissioning, or handed to the State in accordance with State Agreement requirements.	Not addressed further in this chapter.
Contaminated sites	There are no reportable contaminated sites.	Not addressed further in this chapter.
Fibrous materials	Fibrous mineral wastes are present.	Section 19.5.
Non-target metals and target metal residues in mine wastes	No chemical processing occurs at the site.	Not addressed further in this chapter.
Adverse impacts on surface and groundwater quality	There is not predicted to be any significant surface or groundwater impacts.	Not addressed further in this chapter.
Design and management of surface water structures	A surface water diversion is proposed.	Section 19.6.
Dust emissions	This is not considered to be a significant closure issue for the site due to its remote location.	Not addressed further in this chapter.
Flora and fauna diversity/threatened species	The PLNb UBRR is located in proximity to the project area. Nearby deposits are AWT only, with investigations underway to determine the impacts of potential dewatering.	Not addressed further in this chapter.
Visual amenity	This is not considered to be a significant closure issue for the site due to its remote location.	Not addressed further in this chapter.
Heritage issues	Management of cultural heritage values is conducted through processes established under the Indigenous Land Use Agreement, and strategies incorporated into Cultural Heritage Management Plans.	Not addressed further in this chapter.

Issue	Evaluation of relevance to BS4	Further discussion
Alteration of the direction of groundwater flow	Alteration of groundwater flows is not expected.	Not addressed further in this chapter.
Alteration of the depth to water table of the local aquifer	Groundwater recovery is not anticipated to be significantly impacted.	Section 19.7.
Alteration of the hydrology and flow of surface waters	Alterations to the hydrology and flow of surface waters are expected to be localised and not significant. Discharge to creek expected to cease well in advance of mine closure.	Not addressed further in this chapter.

19.1 Acid and / or metalliferous mine drainage

Acid and/or metalliferous mine drainage is an issue that is common across Rio Tinto iron ore operations in the Pilbara and processes have been developed and implemented to appropriately manage the PAF materials to reduce the risk of AMD generation. This includes the *Iron Ore (WA) Mineral Waste Management Work Practice* and the *Spontaneous Combustion and Acid Rock Drainage (SCARD) Management Plan*. As AMD has been identified as an issue for the site, the SCARD management plan is required.

19.1.1 Geochemical assessment and management

The management strategy for PAF material is based upon the following principles:

- identification of black shale distribution and character;
- minimising the exposure and mining of black shale to the extent possible;
- identification and special handling of black shale that must be mined;
- encapsulation of black shale inside inert waste rock dumps to limit water contact and allow the dumps to be revegetated; and
- placement of black shale below the water table in backfilled open pits to limit oxygen contact.

In pit disposal of PAF material is generally more secure than disposal in above ground waste rock dumps. Where practicable, in pit disposal is the preferred disposal alternative because it:

- reduces the risk of erosion exposing PAF material in the long term;
- inhibits convective oxygen transport because the waste is surrounded by relatively impermeable walls;
- reduces the footprint of the waste disposal facilities;
- reduces the volume of inert or net neutralising waste needed to encapsulate the PAF material; and
- may help to prevent the formation of acidic or hyper-saline pit lakes if the pit can be filled to above the post-mining water table.

Where backfill of PAF material into pits is not possible, waste rock dumps will be required to be constructed on top of the original ground surface. More stringent design criteria are required than for in-pit disposal because of the risk of erosion exposing encapsulated sulfidic material and because of the likelihood of the convective transport of oxygen through the side slopes of the dump.

When designing new PAF dumps, the dump location and footprint are selected to minimise potential long term environmental impacts and financial liabilities. Selection and design criteria that must be considered include:

- The PAF dump location should not receive runoff from surrounding areas. In particular waste dumps must not be sited in established drainages with significant upstream catchments.
- In pit disposal should be considered a priority instead of the construction of above ground waste dumps.
- Placement of PAF material in pits that already contain PAF exposures is preferable to placement in pits that do not have these exposed on the pit walls.
- PAF dumps should not be placed over or adjacent to significant regional aquifers such as saturated valley fill alluvial deposits or fractured bedrock aquifers such as the Wittenoom Formation.
- PAF dumps should not be placed over or adjacent to significant seeps or springs.
- The number of sites containing PAF material and the footprint of these dumps should be kept to a minimum.
- PAF dumps should be located near sources of clean waste rock for encapsulation.

19.1.2 BS4 acid and / or metalliferous mine drainage management

PAF materials have been identified in the mineral waste at BS4. There is a high AMD risk for Pits 3, 5 and 18, a moderate risk for Pit 7 and a low AMD risk for all other pits including most proposed BS4 MM pits. BS4 MM Deposit S and BS4 EN areas are due for assessment before the next closure plan. Backfilling pits above wall exposures ensures that no additional black shale is exposed due to wall failures in addition to reducing the amount of oxygen able to access the exposure thus preventing further oxidation. Pit backfill levels will be reviewed to ensure that a groundwater flow through system is not established; however, groundwater modelling shows the water recovery level is lower than pre-mining levels and that the pits will become sinks.

Where in situ geochemical materials are present in the pit, e.g. exposed on the pit walls, the exposures will be covered with mineral waste as soon as practicable, to reduce oxidation of in-situ sulfides. This will reduce the volume of acid drainage produced. All exposures of PAF on the final pit walls will be covered with backfill material, thereby reducing the risk of acid or metalliferous drainage at closure. The mapped location of McRae shale exposures in Pit 1, Pit 3, Pit 5, Pit 6, Pit 7 and Pit 18 at closure are shown in Figure 25 to Figure 30. Further modelling work is required for Pit 2, Pit 4, Pit O5, Pit Q2 and Pit R, and will be completed progressively as the mine plan approaches the bench where PAF is expected. Current designs indicate exposures in Pit 1, Pit 3 and Pit 6 after backfill. The requirement to backfill above these zones has been included as a task in Appendix E and will be address in a future iteration of the mine planning cycle. Current proposed backfill levels are shown in Table 18.

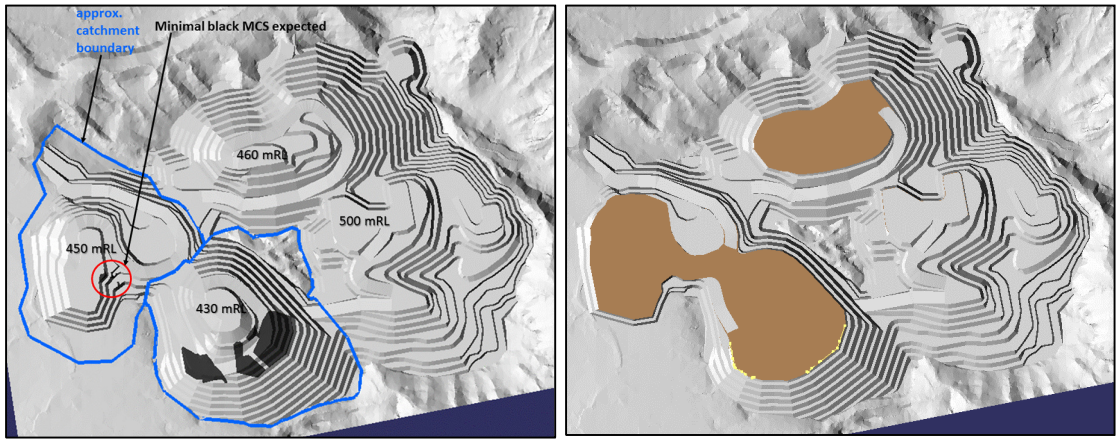

Figure 25: Pit 1 McRae shale exposures at closure (prior to backfill and post-backfill)

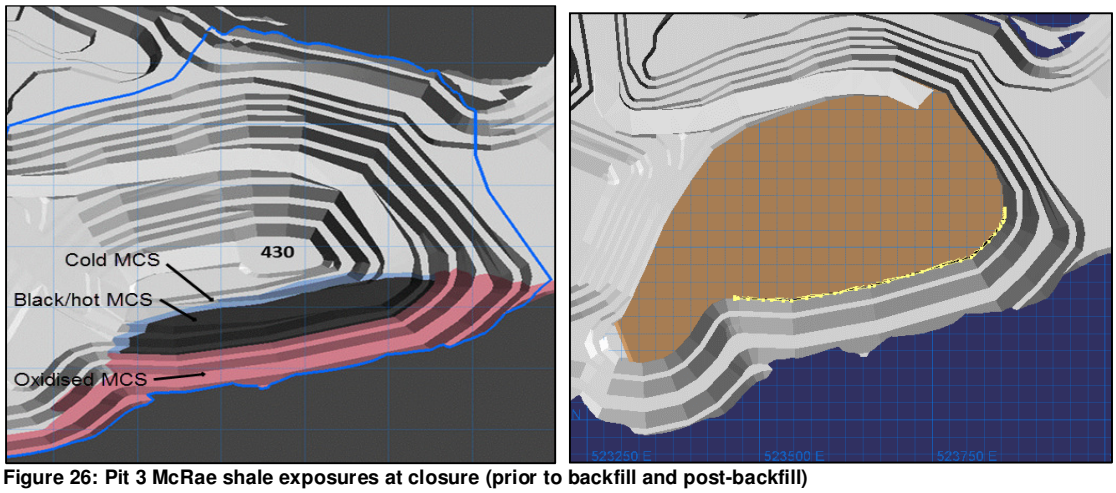

Figure 26: Pit 3 McRae shale exposures at closure (prior to backfill and post-backfill)

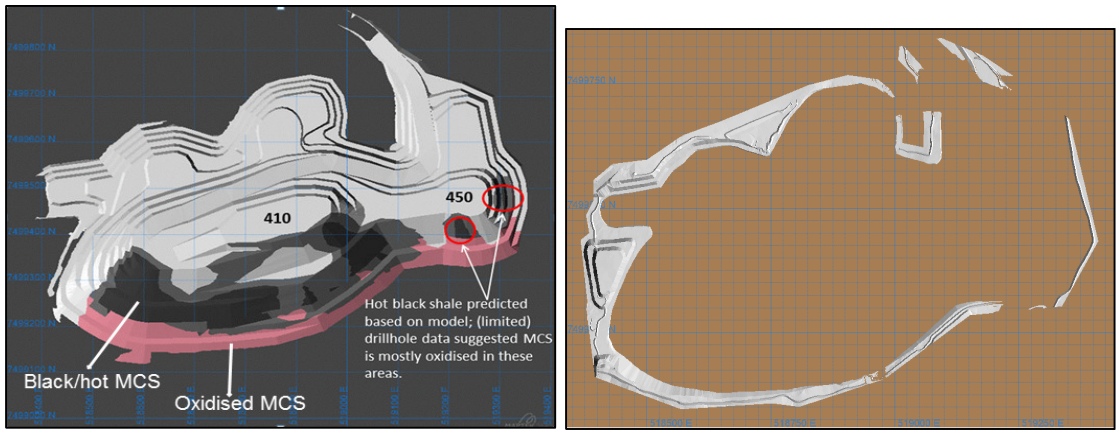

Figure 27: Pit 5 McRae Shale exposures at closure (prior to backfill and post-backfill)

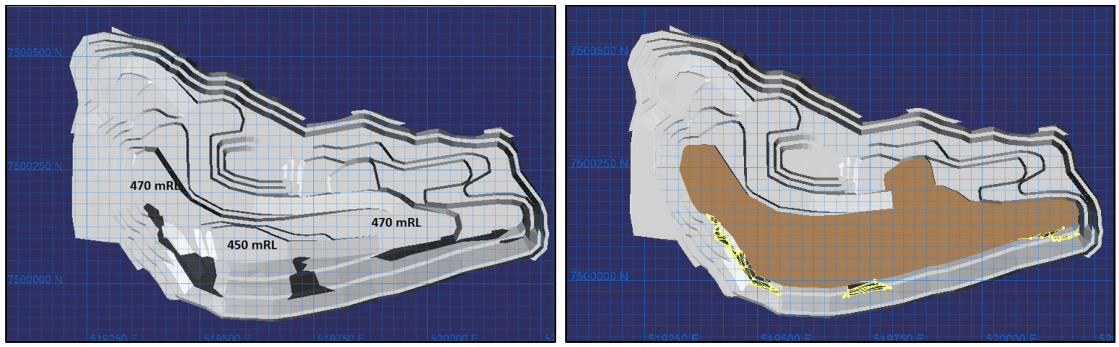

Figure 28: Pit 6 McRae Shale exposures at closure (prior to backfill and post-backfill)

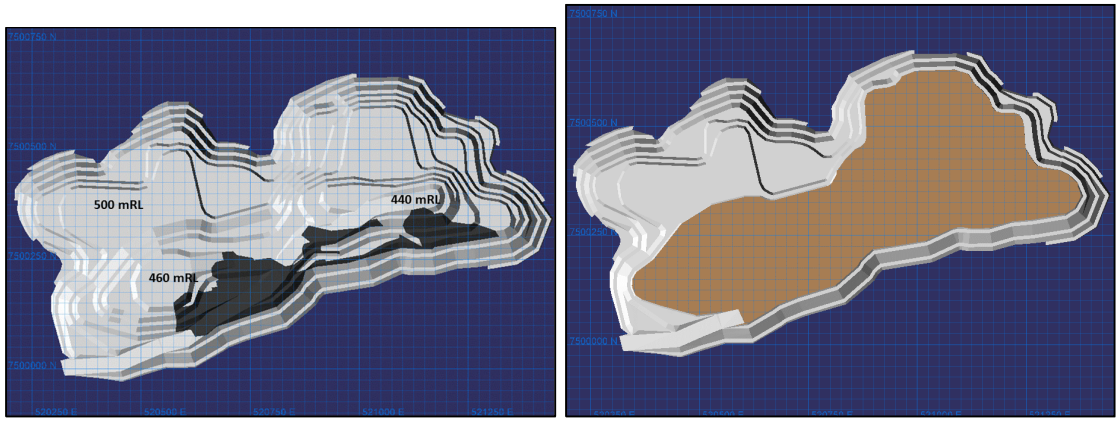

Figure 29: Pit 7 McRae Shale and other rock types exposures upon closure (prior to backfill and post-backfill)

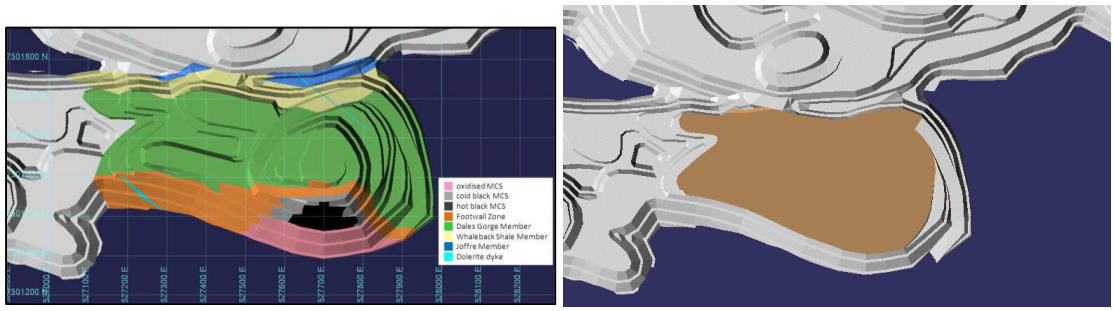

Figure 30: Pit 18 (south east section) McRae Shale exposures and other rock types upon closure (prior to backfilling)

Where the storage of PAF waste material in pits (backfill) is not possible, PAF material will be encapsulated in waste rock dumps on top of the original ground surface. More stringent design criteria are required for PAF waste dumps than for in-pit disposal because of the risk of erosion exposing encapsulated sulfidic material and the greater likelihood of convective transport of oxygen through the side slopes of the dump. As shown in Figure 31, PAF material will not be stored under waste dump slopes. Waste dumps DP2 is the designated PAF dump. DP2 extends into Cheela Plains; however a 50m standoff has been adopted in the design, as shown in Appendix F, to ensure PAF cells are not located on Cheela Plains.

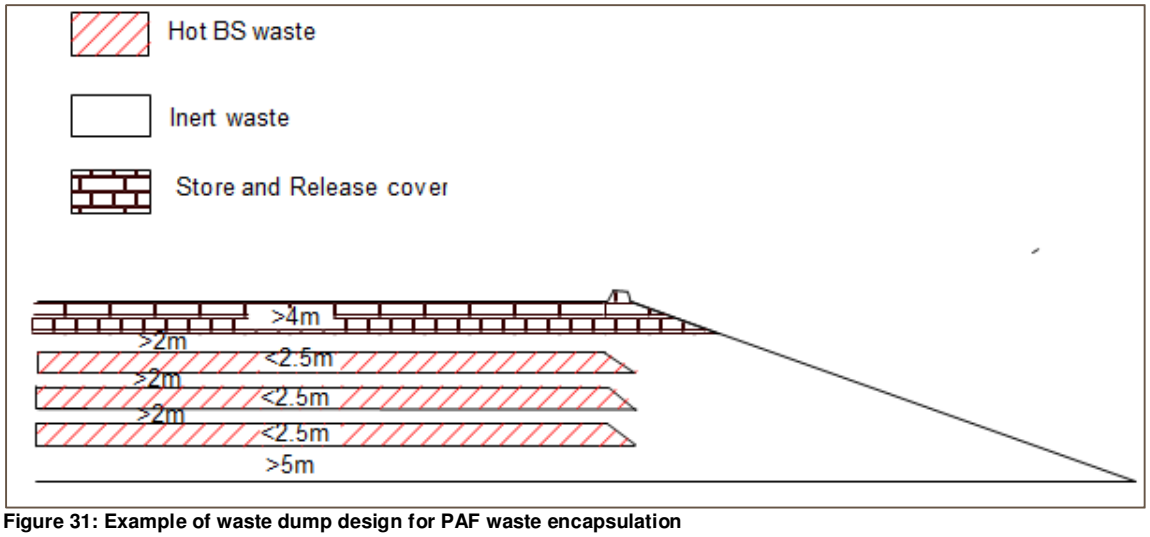

Figure 31: Example of waste dump design for PAF waste encapsulation

Geochemical characterisation of mineral waste and AMD risk reviews will continue throughout operations. With proactive management and planning in place, AMD is not expected to be an issue for the site as a result. However, given that the current geochemical assessment for BS4 identifies AMD as a medium risk, it is important that this issue continues to be actively managed in accordance with the *Iron Ore (WA) Mineral Waste Management Work Practice* and the SCARD Management Plan.

Ongoing geochemical assessment will occur throughout the life mine to ensure that any unexpected AMD risks are identified early and appropriately managed. During operations and post closure, monitoring will be undertaken to assess for any potential contamination of surface and groundwater by acid or metalliferous drainage. If such contamination occurs, appropriate strategies will be developed to monitor and where appropriate, remediate this contamination.

19.2 Erodible mineral waste

Achieving long term stability of waste landforms is considered fundamental to successful rehabilitation and closure of a site. Rio Tinto iron ore has performed, and continues to undertake, characterisation and landform evolution modelling of mineral waste types encountered at its Pilbara operations to determine erodibility characteristics. This modelling has been used to develop design guidelines and procedures for waste landforms which take into account the specific mineral wastes present, climatic conditions present, and the influence of the surrounding landscape.

19.2.1 Principles of waste dump design

Waste dumps located on mine sites that are operated by Rio Tinto are designed and rehabilitated in accordance with internal *Landform Design Guidelines*. This document provides guidance on:

- the objectives of waste dump design, which is to achieve dumps that are:
  - safe;
  - stable;
  - aesthetically compatible with the surrounding landscape;
  - vegetated;
  - non-polluting;
  - compatible with the agreed post-mining land use; and
  - progressively rehabilitated;
- selection of appropriate locations for the siting of waste dumps;
- appropriate shapes and designs of waste dumps;
- appropriate surface treatments; and
- links to other relevant internal and external guidance material.

A progressive rehabilitation field trial at West Angelas mine was conducted in 2006 to measure the erosion rates of erodible waste types. Rain simulations and overland flows were applied to experimental plots, and measurements made of runoff and sediment. This information was then used to provide input data for landform evolution modelling. The trial slopes are being tracked from an erosion perspective, with few gullies evident and are supporting good vegetation growth. These *Guidelines* were developed from characterisation, modelling and trial work such as this.

The *Guidelines* are updated on a regular basis to incorporate learnings from research, studies and rehabilitation implementation projects. The most significant recent update occurred in 2012 to provide designs for waste dumps based on the specific waste types present. This was the result of several years of materials testing and landform evolution modelling studies of wastes typically found in the Pilbara including those at BS4, with design recommendations based on the assumption that an average erosion rate of 5t/ha/year (with a maximum of 10t/ha/year) will be acceptable. Further studies have since been undertaken on additional waste types, and this resulted in another update in 2016.

It should be noted that erosion modelling is conducted on the conservative assumption that slopes are not vegetated. However, vegetation is expected to establish on all slopes, further reducing the erosion potential.

19.2.2 BS4 Erosion risk

The majority of the waste material at BS4 is classified as having low to moderate erodibility (75% of all waste). A portion of the BS4 mineral waste (e.g. detrital material and shales) is comprised of geological units that are generally classified as being of high erodibility (25% of all waste). Management options for highly erodible waste material at BS4 have been reviewed with respect to the mine sequence, considering frequency of occurrence for highly erodible waste material, availability of pits for in-pit backfill, availability of materials for capping and stockpile requirements for capping. BS4 waste dump rehabilitation designs are therefore conservative, adopting one or more of the following approaches:

- construction of ‘berm and batter’ slopes to prevent excessive surface water flows down the slope;
- reduction of slope angles from angle of repose (~37 degrees) to 14-20 degrees;
- restriction of individual lift heights (i.e. the vertical distance between berms) based on laboratory testing of the dominant material types at BS4 and subsequent landform evolution modelling;
- stockpiling of competent material to apply to the surface of waste dumps prior to rehabilitation, to enable a greater lift height of up to 20 m; and/or
- selective dumping of material during operations to ensure that more competent waste types are concentrated on the surface of the dump.

All dumps within the scope of this closure plan are expected to have sufficient volumes of low erodibility material to create stable final landforms. The rehabilitation design for DP5, DP6 and DP9 have been conservatively modelled to suit erodible material. The mining model has been amended to differentiate material characterisation as it is mined from the various pits scheduled to supply waste material to this dump. Waste dumps DP11 and DP12 are proposed to be completely reclaimed and all material will be returned in-pit.

19.3 Geotechnical instability

19.3.1 Geotechnical instability compromising closure outcomes

The rockmass units spanning all of Rio Tinto iron ore’s Pilbara operations are categorised in general, as ‘weathered’. Figure 32 illustrates the zone of instability methodology used for all pits. A 25° line from the pit toe or decoupling berm is projected to the surface topography. Where backfilling occurs, the pit toe may be considered from the surface of the backfilled area. In addition to this, a 10 m offset from the 25° projection line on the surface is included, plus a 5 m abandonment bund base width. The point at which this projection line intersects the topography back to the pit crest, is termed the Zone of Instability (ZOI).

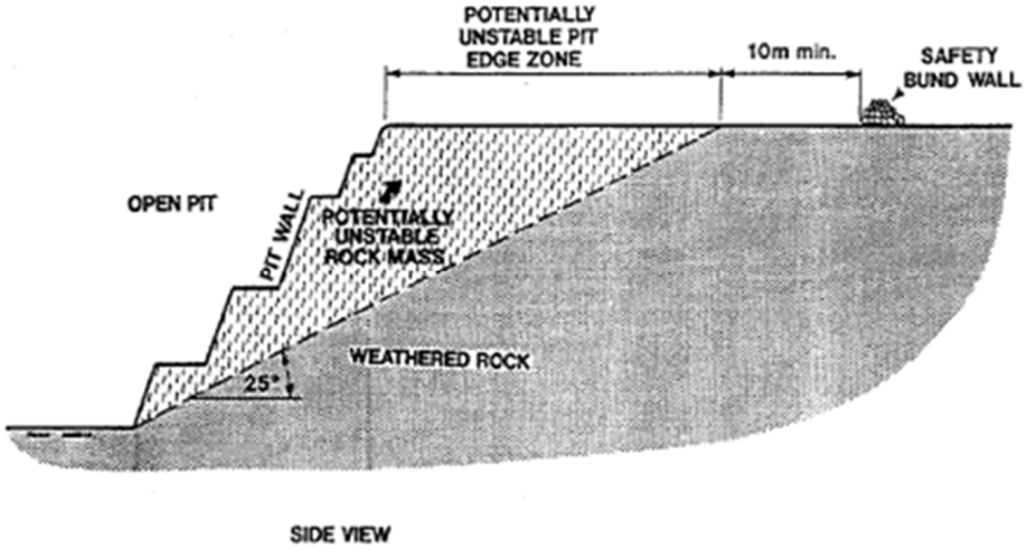

Figure 32: Example of zones of instability (Department of Industry and Resources, Safety Bund Walls Around Abandoned Open Pit Mines, December 1997)

There is no intent to reshape or rehabilitate in-pit areas, and the remaining pit walls will be retained in the same configuration as when mining ceases. It is recognised that there will be some degree of geotechnical instability, and that walls will have the potential to collapse in some areas.

The zones of instability are considered when siting new waste dumps, but existing waste dumps need to be verified as outside the ZOI. Geotechnical assessments for wall stability and ZOI are conducted as part of mine design reviews, as required. However, it is recognised that the true nature of the geology will only be understood once mining has been completed, and this could influence the stability of the pit wall.

A whole site review of all pit and dump interactions was used to check compliance to the angle method described in the DMP abandonment bund guideline, using the conservative assumption that all pit walls are embedded into weathered rock (i.e. the polygons are lines drawn at a 25° angle from the base of the pit). Further geotechnical evaluation is being undertaken, and may result in a reduction of the current polygons derived from default methodology documented in DMP guidelines.

19.3.2 Management of landforms within zones of geotechnical instability

Rio Tinto has committed to backfilling all pit voids at BS4 to prevent the formation of pit lakes; however, significant voids will still remain after closure. Pit 5 and Pit 17 will be backfilled close to the surface, and the backfilled pit floor is proposed to be rehabilitated where appropriate.

Geotechnical assessments of Pit 1 show the ZOI will intersect the Purlykuti Creek floodplain. It will be necessary to review the pit wall stability for Pit 1, and the proposed creek realignment will take the outcomes into consideration. Measures may be required to stabilise the western pit wall of Pit 1 – for example backfilled waste material that is stored within the pit may be utilised to buttress the wall and may be reshaped if required.

Additionally, the potential for water seepage from the creek diversion into the pit during a rainfall event and also water pondage behind the diversion bund shall be assessed for interaction with the adjacent pit wall, as part of future mine design reviews. The length of the pit wall adjacent to the diversion levee structure and engineered channel will be required to meet an elevated design acceptance criteria in terms of factor of safety of 1.5 or above, as these are permanent infrastructure. Further work is required to determine the pit stability risks as the existing hydrologic and hydrogeologic models are refined, and once the engineered levee and channel designs have been finalised.

Current designs indicate that DP6, DP9 and DP22 may sit inside or near to the ZOI. Refinements to designs will occur to move these dumps outside of the ZOI. However it should be noted that the ZOI is based only on pit floor, and refinements to the ZOI will be made once backfilling designs have been completed.

19.4 Management of public access

19.4.1 Risk of inadvertent access

For the majority of Rio Tinto iron ore operations the issue of public safety is mainly related to potential for public to inadvertently access pit voids (or areas of potential instability surrounding pits). Open pits are designed to be stable during the life of the mining operations, but may not be stable in the long term as materials weather and erode, leading to instability of sections of the pit walls. These failures would pose significant risks to people if they were to access these areas in vehicles or on foot where risk mitigation measures are not in place.

As with waste landforms, designs for restricting public access need to be considered on a case by case basis after considering a range of factors such as:

- Accessibility of the site (e.g. proximity to towns/major roads/areas of interest).
- Nature of surrounding landscape (e.g. pits abutting steep natural slopes, floodplains, water courses).
- Availability of suitable material to construct structures (e.g. material for abandonment bunds/ rock structures).
- Pit geology and geometry (e.g. natural stability of the pit, pit backfill, pit lake post closure).
- Post closure landuse (e.g. pastoral areas may require exclusion of cattle from pit voids).
- Location of heritage sites (e.g. sites may require access post closure).

In order to mitigate the risk of inadvertent public access, the following conceptual measures are proposed, with details to be agreed with the Department of Mines, Industry, Regulation and Safety Resources Safety Division as the site approaches closure:

- Rehabilitation of tracks that are not required for monitoring and/or maintenance post-closure, and installation of physical barriers (e.g. earthen bunds) where appropriate to prevent access.
- Rehabilitation of all access roads prior to relinquishment and installation of physical barriers (e.g. earthen bunds), unless the State wishes the roads to remain accessible for whatever reason.
- Installation of a locked gate on the main access road (and the alternative unsealed access road if it is required to remain post-closure) for the duration of the post-closure monitoring and maintenance period.
- A review of the potential visitors to access the site, and installation of additional control measures, including abandonment bunding around pits, where appropriate.

19.4.2 Management of inadvertent public access

BS4 is situated in a remote location, with no population centres or public roads in the immediate vicinity, or Aboriginal communities. It should be noted that public access is likely to be limited due to the remoteness of the site and the implementation of measures to actively discourage access. Furthermore, the final landform is not expected to contain any features, such as pit lakes, that would attract visitors.

At this stage there is uncertainty about the precise location of final pit shells for current deposits, and the potential for further currently unapproved deposits to be developed around those that currently exist. Bunds will be incorporated into the design and constructed for any new pits, but there are several existing pits that will need an abandonment bund design or risk based strategy completed. Precise abandonment bund locations have therefore not been proposed; however, they will be constructed:

- in accordance with the DMP guideline Safety Bund Walls Around Abandoned Open Pit Mines unless an alternative design is approved by the DMP;
- outside of the zone of instability around pit walls;
- with consideration of the implications for local site drainage; and
- around pit edges unless agreement is reached with the DMP that the risk of inadvertent access is sufficiently low in specific areas (e.g. due to natural topography or barriers in other locations).

Conceptual locations for abandonment bunds have been established based on the preliminary ZOI around each pit (Figure 33). Further refinement is required to allow for backfill, overlapping bunds and access requirements. Abandonment bunds may be one or a combination of – natural landforms, earthen/rock bund walls, rows of large rocks, fences, ditches etc. Proposed plans for post closure access will be developed and finalised prior to closure after discussion with key stakeholders.

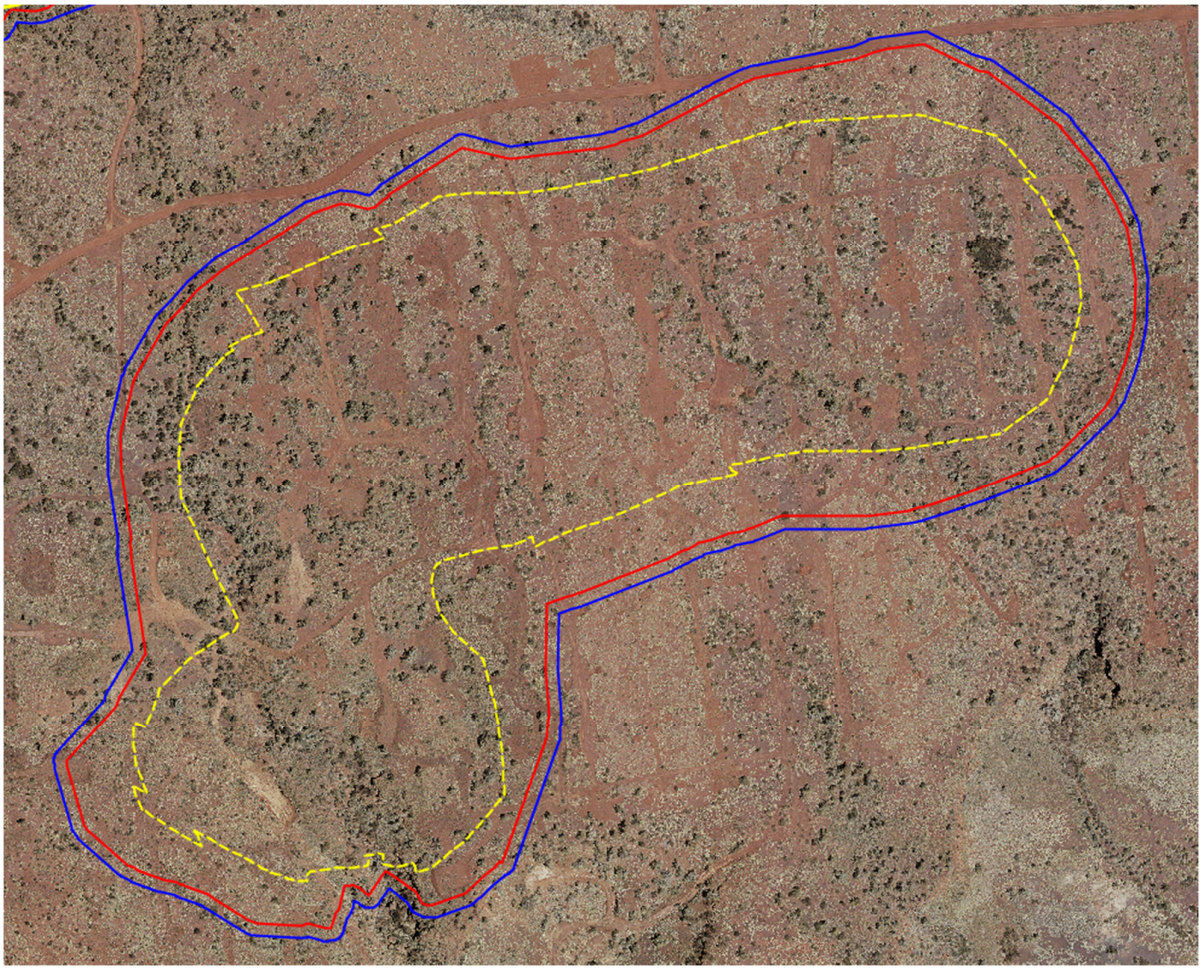

Figure 33: Example of abandonment bund placement (blue), outside the ZOI (red) and the pit crest (yellow)

The period immediately following the bulk earthworks rehabilitation phase is expected to require the highest level of maintenance, particularly in response to storm events, and may require rework of some sections as the landform materials settle and vegetation is established. At the completion of this phase, it is expected that further roads and tracks can be decommissioned and rehabilitated, leaving only those access routes deemed necessary for ongoing monitoring and in consultation with stakeholders and traditional owners.

It is noted that part of the site is on third-party pastoral lease, and access may be desired for pastoral and/or pastoral tourism activities. This may be a particular issue around the Pit 1 area, as this area connects the southern and northern portions of Cheela Plain Pastoral Station. This will be managed as site approaches closure.

19.5 Fibrous mineral waste

19.5.1 Fibrous material exposures

Control measures are employed during operations to reduce the potential health risk posed by exposure to fibrous material in line with the *Iron Ore (WA) Fibrous Minerals Management Plan*. These measures include responsibilities for ensuring as-built waste dump designs which contain fibrous material include 3D plans of the locations and volumes of fibrous material. It also outlines the procedure for encapsulating this material with an appropriate amount of inert material in designated waste dumps. This encapsulation methodology takes into account the final rehabilitation design of the landform to ensure that the material remains secure post closure. Where possible it is preferable for fibrous material dumps to be located in-pit to further reduce the risk of exposure (Figure 34).

The location and footprint should be selected considering the following criteria:

- The location should be such that the waste material should not require re-handling in the future.
- The location should be at a practicable distance from current and future operations such that restricted access can be implemented, and allowing for both the short-term control of operations and the long-term recording of the position.
- Ideal sites are areas which are not readily accessible by the public and/or site personnel, and which are not expected to be disturbed in the future.
- The footprint should incorporate lateral containment bunds to prevent potential contaminated sediment run off and further exposure.
- Designated hazardous waste shall not be disposed of in a location which receives runoff from surrounding areas and must not be sited in established drainage ways.
- In pit disposal should be considered a priority instead of the construction of above ground waste dumps.
- The number of sites containing designated hazardous waste and the footprint of the waste dumps should be kept to a minimum.
- The waste dump should be located near sources of inert waste material for the encapsulation process.

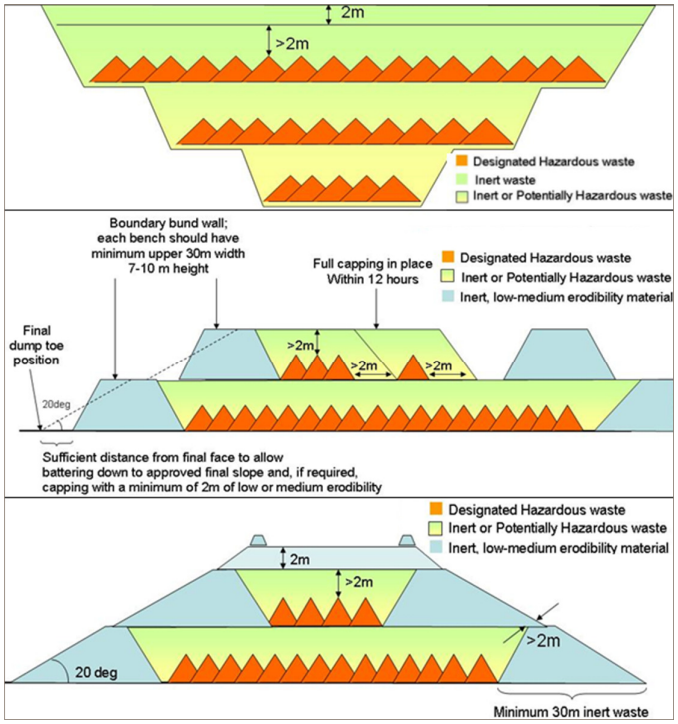

Figure 34: Example of in-pit and dump design for fibrous mineral encapsulation

19.5.2 Fibrous material management at BS4

Mineral waste characterisation has identified the presence of fibrous materials that will be exposed during operations at BS4 (main areas are listed in Section 10.4.3). Material that is classified as 'designated fibrous' is stored preferentially in-pit, but otherwise in ex-pit waste dumps and encapsulated with non-fibrous material.

In accordance with the mine plan, fibrous material will be encapsulated in cells within waste dump DP1 and DP4 with the exact location and geometry recorded. These cells will be dumped and encapsulated with inert material such that they are not exposed during final (post-closure) landform shaping. Detailed rehabilitation designs are currently being developed to support progressive rehabilitation of these dumps.

At this stage it is proposed that fibrous exposures in pit walls be assessed individually for potential health risks at closure, and strategies implemented based on this risk. Risk assessments will be completed progressively as exposures are mined. Where the risk is deemed acceptably low, no further measures will be taken. If a risk does present, control measures are employed to reduce the risk posed by this material in line with the *Brockman 4 Fibrous Minerals Management Procedure* which is guided by the *Iron Ore (WA) Fibrous Minerals Management Plan*. Current proposed backfill levels are shown in Table 18. It should also be noted that the likelihood of public exposure to fibrous minerals will be further reduced at BS4 due to its remote location and the measure taken to prevent inadvertent public access.

19.6 Design and management of surface water structures

19.6.1 Surplus water discharge during operations

Discharge of surplus water into nearby Boolgeeda Creek under the terms of MS 1000 extends the duration of creek flow within the naturally ephemeral creek system. The discharge is managed under the *Monitoring and Management Plan* (MMP) to ensure this does not cause long term impacts to the environmental and conservation values of the Boolgeeda Creek System. Extensive mapping of the riparian area (approximately 46 km of Boolgeeda Creek downstream of the approved discharge point) has been conducted to establish baseline data. The MMP details the monitoring and trigger levels for riparian vegetation health and abundance. The creek condition will continue to be monitored as outlined in Section 24.

Water will not be artificially sustained to the creeks after the cessation of mining. As mining activities draw to a close, the volume of discharge will gradually taper then cease at or prior to the end of mining, returning the impacted reach of the creek to its pre-existing ephemeral regime. After cessation of dewatering discharge, riparian vegetation is expected to gradually revert to a pre-impact condition (e.g. structural composition, functional behaviour, habitat elements and recruitment dynamics).

19.6.2 Diversion design and management

The proposed final pit shell of Pit 1 will extend into the 1% AEP floodplain of Purlykuti Creek, which has an approximate catchment area of 30 km^2. Prior to the extension of Pit 1, a creek realignment incorporating a levee structure and an engineered channel will be required for flood protection. Further information (including realignment designs) will be developed in future versions of this closure plan. Similarly, as flood protection options and designs for Pits S2 are developed further information will be incorporated into future versions of this closure plan.

Since the levee protection for Pit 1 is intended to be a permanent structure, it will be designed to detain large scale flooding events relevant to closure. As this realignment will be developed during operations, it is expected that any issues as a result of the realignment are remediated prior to closure. The area will likely be monitored post closure as part of standard monitoring programmes. Further work is required to determine the surface water risks at Pit 1 and the northern haul road access. The existing hydrologic and hydraulic models will be refined to increase the accuracy of the assessment of levee and creek realignment options and designs. The performance of the levee during a flood event will be assessed as the BS4 mine approaches closure, by which time there should be improved validation of model parameters.

Features at BS4 that will be within the 1% AEP flood extent will be assessed with respect to impacting landform stability. Areas within the 1% AEP flood extent will have erosion controls and abandonment bund construction requirements incorporated into the design to ensure flood protection.

19.7 Ground water management

While mining will leave the regional groundwater system intact, dewatering activities will impact the local aquifer system. As there are no shallow water table aquifers within the area, there are no zones of phreatophytic vegetation that will be impacted by mining operations. The degree and rate of recovery of this system at closure is difficult to anticipate, particularly due to the sporadic nature of intense rainfall events.

A detailed closure groundwater model has been developed for BS4 to determine post-closure recovery levels for the water table. This modelling suggests that previous backfilling assumptions are no longer appropriate, as the water table is unlikely to return to pre-mining levels. The groundwater in Brockman-style deposits is mostly compartmentalised and disconnected from regional aquifers. Previous backfilling levels were estimated based on pre-mining water table levels in individual pits, which varies across the site.

All final pits are expected to be voids; (Pit 5 and Pit 17 will be backfilled to near the surface). Hydrogeological modelling shows that all pit voids will act as groundwater sinks and are not expected to have a degrading effect on regional groundwater quality. Modelling suggests that groundwater will flow towards the pit/backfilled areas, containing any poor quality water within the immediate area. The closure strategy includes contingency to prevent formation of permanent pit lakes. Backfilling will ensure that no permanent pit lakes will develop by backfilling to above the pre-mining water table, although ephemeral pools may form intermittently after large rainfall events. Current proposed backfill levels are shown in Table 18.

PAF exposures in pit walls are discussed in Section 19.1.2. No PAF material is expected to be exposed on final pit shells, thereby reducing the risk of acid or metalliferous drainage and potential impacts to the groundwater at closure. The overall risk of AMD at the site is moderate; however, given appropriate controls during operations, groundwater quality is not expected to deteriorate during mining and dewatering is not expected to adversely impact regional groundwater systems.

Table 18: Recovery, PAF exposure and Fibrous exposure levels and proposed backfill levels

Deposit	Pit	Maximum pit crest (mRL)	Pre-mining water level (mRL)	Predicted water recovery level (mRL) [12][13]	Upper PAF exposure level (mRL)	Upper Fibrous exposure level (mRL)	Proposed backfill level (mRL)
BS4	1	660	493	460	470	640	492
BS4	2	630	490	430	490	N/R	482
BS4	3	670	495	460	490	610	492
BS4	4	640	500	490	490	N/R	492
BS4	5	540	488	430	490	N/R	515
BS4	6	570	494	460	490	N/R	482
BS4	7	600	495	461	490	N/R	495
BS4	8	620	495	N/R	N/R	N/R	N/R
BS4	9	620	500	N/R	N/R	N/R	N/R
BS4	10	580	488	TBC	N/R	N/R	TBC
BS4	11	580	502	460	N/R	N/R	492
BS4	12	550	502	460	N/R	N/R	492
BS4	13	650	500	N/R	N/R	N/R	N/R
BS4	14	620	519	N/R	N/R	N/R	N/R
BS4	15	590	519	N/R	N/R	N/R	N/R
BS4	16	590	519	TBC	N/R	510	TBC
BS4	17	670	522	511	N/R	490	592
BS4	18	620	502	462	500	N/R	504
BS4	19	560	522	TBC	N/R	N/R	TBC
BS4	21	620	502	462	N/R	N/R	N/R
BS4 MM	M1	590	535	N/R	N/R	N/R	N/R
BS4 MM	M2	610	533	N/R	N/R	N/R	N/R
BS4 MM	N1	580	506	N/R	N/R	510	N/R
BS4 MM	N2	590	515	N/R	N/R	N/R	N/R

[12] Recovery levels not required for AWT pits

[13] Some recovery levels are TBC due to a change in mine plan since modelling changing the depth to BWT, or being excluded from previous modelling

Deposit	Pit	Maximum pit crest (mRL)	Pre-mining water level (mRL)	Predicted water recovery level (mRL) [1213]	Upper PAF exposure level (mRL)	Upper Fibrous exposure level (mRL)	Proposed backfill level (mRL)
BS4 MM	O1	560	495	N/R	N/R	N/R	N/R
BS4 MM	O2	560	500	TBC	N/R	N/R	492
BS4 MM	O3	550	500	N/R	N/R	N/R	N/R
BS4 MM	O4	540	500	TBC	N/R	N/R	492
BS4 MM	O5	590	501	463	555	460	492
BS4 MM	Q2	570	494	460	480	N/R	492
BS4 MM	Q3	570	494	TBC	N/R	N/R	492
BS4 MM	Q4	570	495	492	N/R	N/R	N/R
BS4 MM	R	590	490	430	535	N/R	492
BS4 MM	S1	590	494	TBC	N/R	N/R	TBC
BS4 MM	S2	560	494	TBC	N/R	N/R	TBC
BS4 EN	Endeavour 49	TBC	502	TBC	TBC	TBC	TBC
BS4 EN	Endeavour 61	TBC	502	N/R	TBC	TBC	N/R
BS4 EN	Endeavour 67	TBC	502	TBC	TBC	TBC	TBC
BS4 EN	Endeavour 88	TBC	502	TBC	TBC	TBC	TBC
BS4 EN	Endeavour 134	TBC	502	TBC	TBC	TBC	TBC

CLOSURE IMPLEMENTATION

Rio Tinto uses closure domains to group areas with common features, rehabilitation and decommissioning requirements at closure. Detailed closure strategies for the rehabilitation and decommissioning of individual closure domains, beyond those of current standard management practices, will be documented in the Mine Closure Plan to be prepared as the site approaches closure. The closure measures identified below consider the methods used to manage key risks as discussed in the previous section.

20. Closure domains

Closure domains are used to group areas with common features, rehabilitation and decommissioning requirements. The distribution of closure domains are illustrated in Figure 35. BS4 domains include:

- Pits - includes currently operating or developing pits;
  - above water table (no backfill required);
  - below water table inert voids (backfill required); and
  - AMD risk (backfill required).
- Inert waste dumps – includes long term low grade material stockpiles that are not currently planned to be utilised in processing;
  - inert external waste dumps (low – medium erodibility);
  - inert external waste dumps (high erodibility);
  - external PAF material waste dumps;
  - fibrous waste dumps; and
  - stockpiles.
- Landbridges.
- Disturbed areas -all areas of disturbance that are not categorised by any of the above landform domain categories. This domain has been broken down into ‘high disturbance’, ‘moderate disturbance’ and ‘low disturbance’ sub-domains, based on the amount of earthworks that will be required during final landscaping, to allow for more accurate closure cost estimation.

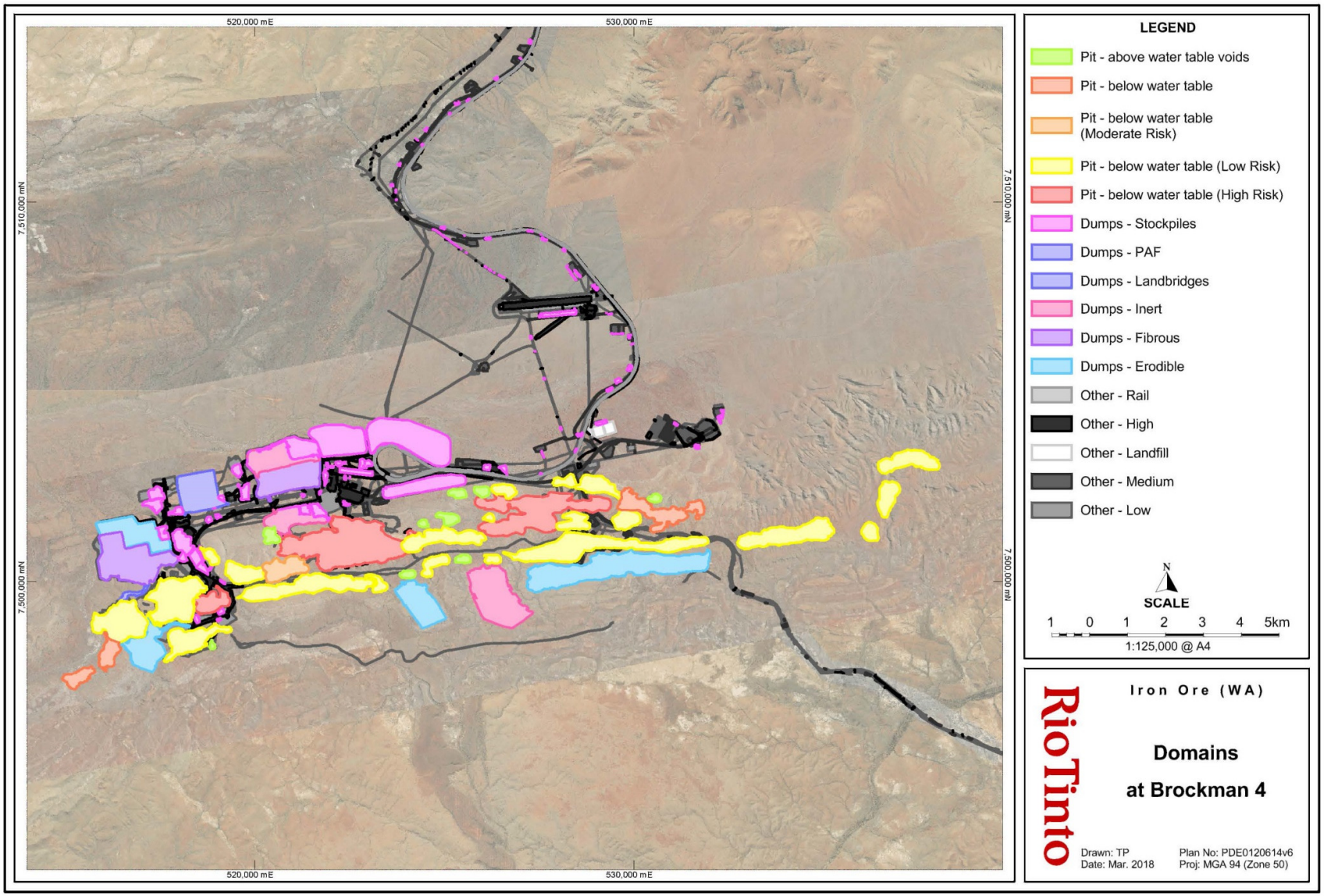

Figure 35: Brockman Syncline 4 closure domains

21. Closure implementation strategies

Proposed closure measures for each of the closure domains are included in Table 19. Designs and key criteria for all major landforms are included in Appendix F.

Table 19: BS4 general area implementation strategies by closure domain

Domain class	Domains	Closure measures
Pits		
Above water table (AWT) pits	Pit 8 Pit 9 Pit 13 Pit 14 Pit 15 Pit M1 Pit M2 Pit N1 Pit N2 Pit O1 Pit O3 Pit R AWT Endeavour 61	• Pits may be partially backfilled where possible to minimise the volume of waste remaining in waste landforms. • No rehabilitation proposed within pit footprint (unless backfilled to surface). • Prior to final closure, appropriate evaluation and implementation of measures to restrict public access will be undertaken. • Construct abandonment bunds around pit perimeters, outside of the zone of geotechnical instability.
Below water table pits (geochemical risk: low)	Pit 1 Pit 2 Pit 4 Pit 6 Pit 10 Pit 11 Pit 12 Pit 16 Pit 17 Pit 19 Pit O2 Pit O4 Pit O5 Pit Q2 Pit Q3 Pit Q4 Pit R BWT Pit S1 Pit S2 Endeavour 49 Endeavour 67 Endeavour 88 Endeavour 134	• Undertake post-closure backfill to prevent the formation of pit lakes[14]. • No rehabilitation proposed within pit footprint (unless backfilled to surface). • Prior to final closure, appropriate evaluation and implementation of measures to restrict public access will be undertaken. • Construct abandonment bunds around pit perimeters, outside of the zone of geotechnical instability.

[14] Below water table pits (indicated in yellow and orange in Figure 35) may not be backfilled uniformly across the entire surface. Sections of the pit may remain above water table during mining, and therefore not require backfill. All areas with a recovering water table at risk of forming a pit lake are backfilled (as indicated in green in Figure 37)

Domain class	Domains	Closure measures
Below water table pits (geochemical risk: medium)	Pit 7	• Undertake post-closure backfill to cover PAF wall exposures with inert and/or neutralising material. • Undertake post-closure backfill to prevent the formation of a pit lake. • No rehabilitation proposed within pit footprint (unless backfilled to surface). • Prior to final closure, appropriate evaluation and implementation of measures to restrict public access will be undertaken. • Construct abandonment bunds around pit perimeters, outside of the zone of geotechnical instability.
Below water table pits (geochemical risk: high)	Pit 3 Pit 5 Pit 18	• Undertake post-closure backfill to cover PAF wall exposures with inert and/or neutralising material. • Undertake post-closure backfill to prevent the formation of a pit lake. • No rehabilitation proposed within pit footprint (unless backfilled to surface). • Prior to final closure, appropriate evaluation and implementation of measures to restrict public access will be undertaken. • Construct abandonment bunds around pit perimeters, outside of the zone of geotechnical instability.
Waste dumps and stockpiles		
PAF waste dumps	DP2	• Segregation and encapsulation of PAF material as described in Section 19.1. • Installation of store and release cover. • Reshaping outer slopes to appropriate angles/profiles based on design criteria suitable for waste type (Appendix F). • Apply a 200 mm layer of topsoil (or subsoil where topsoil is unavailable) – High priority. • Rip and seed using appropriate native species.
Fibrous waste dumps	DP1 DP4	• Segregation and encapsulation of fibrous material as described in Section 19.5 • Reshaping outer slopes to appropriate angles/profiles based on design criteria suitable for waste type (Appendix F). • Apply a 200 mm layer of topsoil (or subsoil where topsoil is unavailable) – High priority. • Rip and seed using appropriate native species.
Inert waste dumps (low-moderate erodibility)	DP8 DP22	• Reshaping outer slopes to appropriate angles/profiles based on design criteria suitable for waste type (Appendix F). • Apply a 200 mm layer of topsoil (or subsoil where topsoil is unavailable) – Moderate priority. • Rip and seed using appropriate native species.
		•
		•
		•
		•

Domain class	Domains	Closure measures
Inert external waste dumps (high erodibility)	DP5 DP6 DP9	• Reshaping outer slopes to appropriate angles/profiles based on design criteria suitable for waste type (Appendix F). Conservative parameters used. • Apply a 200 mm layer of topsoil (or subsoil where topsoil is unavailable) – High priority. • Rip and seed using appropriate native species. • Construct sediment bunds as required.
Stockpiles	DP11 DP12	• Stockpile are planned to be removed prior to or during closure activities. • Rehabilitate final surface in accordance with standard procedures (as per infrastructure areas).
Other domains		
Landbridge	Landbridge, associated with Pit 1 access	• Specific closure strategies to be developed when designs are finalised. • Rehabilitate final surface in accordance with standard procedures (as per inert waste dumps). • Wrap waste dumps with competent material if required slope angles cannot be achieved due to constraints.
Haul roads	Haul roads	• Push slopes at either side of the haul road to a maximum gradient of 20 degrees with berms at 10 metre intervals (or based on design criteria for suitable waste type). • Install cross bunds where appropriate (at approximately 50 m to intervals if the gradient of the reshaped road corridor is less than 10 degrees). • Rehabilitate final surface in accordance with standard procedures (as per inert waste dumps).
ROM pad	ROM pad	• Remove infrastructure. • Rehabilitate final surface in accordance with standard procedures (as per inert waste dumps). • Utilise earthen mound for pit backfill if required.
Landfill	Landfill	• Undertake contaminated sites assessment and remediation measures, if required. • Cap landfill with a layer of competent inert material to a thickness of 2 m. • Rehabilitate final surface in accordance with standard procedures (as per infrastructure areas). • Shallow ripped only.
Infrastructure areas	Plant Maintenance Buildings Camp Airstrip Roads Laydown Conveyors (etc.)	• Retain or remove infrastructure in accordance with State Agreement requirements. • Undertake contaminated sites evaluation and clean up if required. • Where infrastructure requires removal, remove all structures and footings that are above surface or within 1 m of the final land surface. • Drain pipelines and remove hazardous materials (from pipelines and elsewhere across the site) in accordance with Controlled Waste Regulations. • Actively seek reuse and recycling opportunities for decommissioned infrastructure.

Domain class	Domains	Closure measures

		• Dispose of inert materials that are not retained, reused or recycled in an inert landfill area (may be a used pit area).
		• Where linear infrastructure is removed, reinstate drainage lines where appropriate.
		• Rehabilitate final surface in accordance with standard procedures, which includes:
		  ○ add a layer of topsoil where available and appropriate (Moderate – Low priority);
		  ○ deep rip the surface where required to address compaction; and
		  ○ revegetate with an appropriate mix of species of local provenance.

22. Post-mining and post-closure landforms

The post mining landform is the landform that would be generated as a result of implementation of the mine plan assuming no progressive rehabilitation activities are conducted. A conceptual image of the post mining landform is shown in Figure 36.

The post closure landform is the final expected landform at the completion of the closure measures outlined in Table 19 above. A conceptual image of landforms for BS4 is included in Figure 37.

Due to the conceptual nature of the Endeavour deposits, they have not been included on the post-mining or post-closure images. As pit designs are completed they will be included in future version of the closure plan.

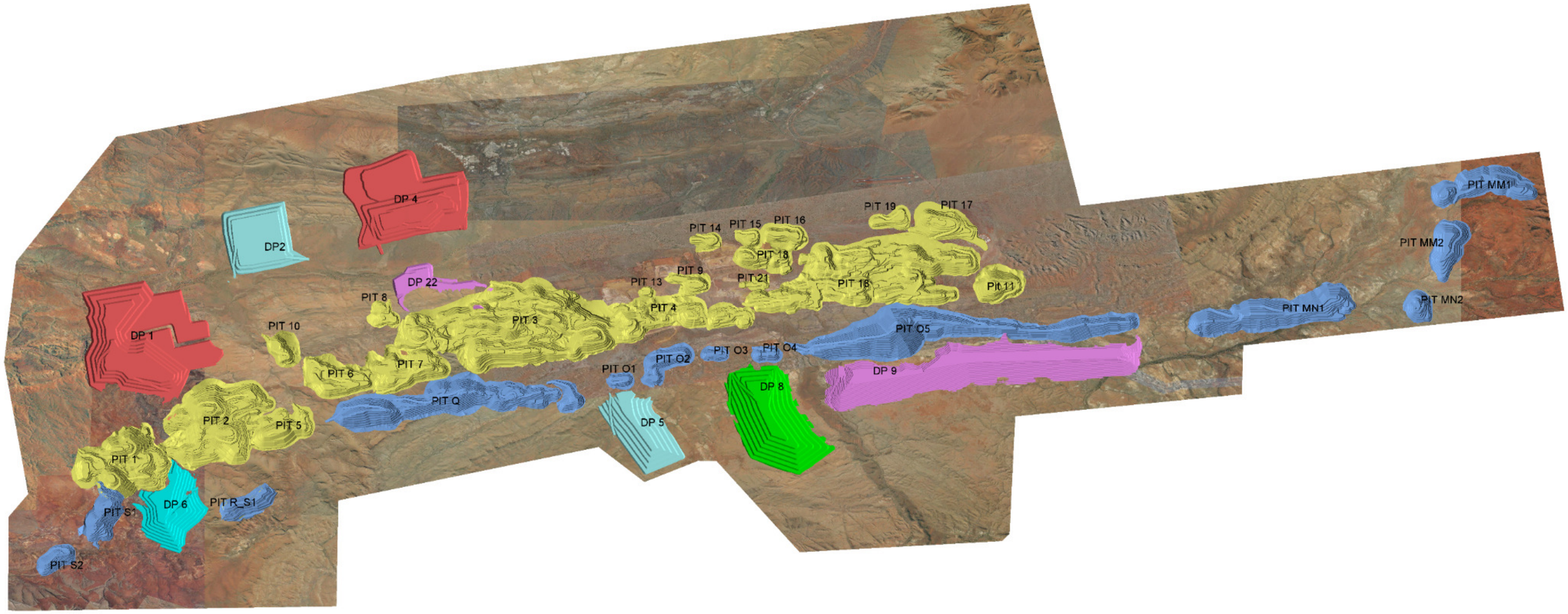

Figure 36: Conceptual layout of the site at completion of mining

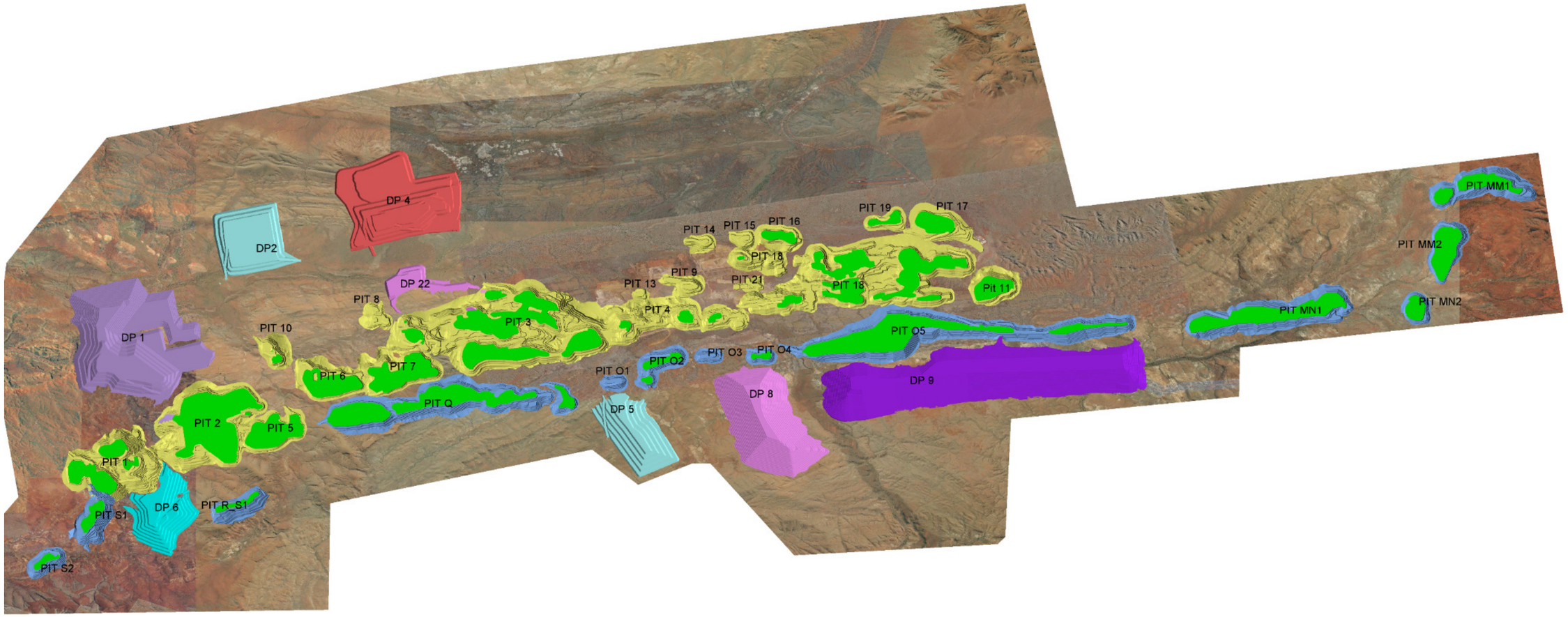

Figure 37: Conceptual layout of the site at completion of rehabilitation activities (reshaping and backfill)

23. Unexpected closure

The closure implementation schedule may be influenced by factors outside of the current mine plan. These factors include:

- suspension of operations under care and maintenance: this could occur if production costs exceed product value e.g. due to commodity price changes;
- unexpected closure: this could occur if there was major change in global demand for iron ore; and
- future proposals: these could occur if iron ore deposits of appropriate quality are identified adjacent to the existing deposits.

Whilst Rio Tinto considers the risk of unexpected closure to be minimal, there are numerous factors that could force early closure of one or several sites. Even if some level of contraction were to occur, it is reasonable to assume that the company would continue to operate in the Pilbara and that it could continue to manage closure of its sites. It should be noted that Hamersley Iron is one group within the global Rio Tinto group of companies, which further mitigates this risk.

23.1 Temporary care and maintenance

In the event of temporary closure, measures will be undertaken to transfer the site from operations into a care and maintenance regime and relevant authorities notified. A Care and Maintenance Plan would be developed prior to the care and maintenance period which demonstrates how on-going environmental obligations associated with the site will continue to be met during the period of care and maintenance. Social obligations and responsibilities will also be addressed in this plan.

23.2 Early permanent closure

The BS4 closure plan will naturally become more detailed as time progresses, but may not be of sufficient detail to facilitate closure implementation if the site closes unexpectedly. This would be the case particularly if the proposed closure strategies rely on the full mining sequence, and need to be revised accordingly. If sudden and unexpected closure occurs, the site would effectively be placed on a period of care and maintenance whilst studies and plans are developed to facilitate effective closure implementation. Final completion criteria would also be agreed with stakeholders during this period. Closure could be expected to be delayed by several years if production ceases unexpectedly.

Notwithstanding this, the most likely early closure scenario would involve a decision to cease production made several years in advance of the event, which would provide time for the closure plan to be updated sufficiently to facilitate more timely closure implementation.

CLOSURE MONITORING AND MAINTENANCE

24. Closure monitoring program

The primary purpose of closure monitoring is to assess whether closure criteria have been met for BS4. A specific monitoring program will be finalised as the site approaches closure, and this current plan outlines the principles that will be employed rather than specific details.

24.1 Phases of monitoring

For the purposes of this plan, monitoring is assumed to be conducted in several phases including:

- Baseline monitoring, which is conducted as operations expand into new mining areas. Results that are relevant to closure are summarised in the environment knowledge base;
- Operational monitoring, which occurs throughout the life of the mine, in line with regulatory requirements and the Rio Tinto operational standards. Results that are relevant to closure are incorporated in the environment knowledge base when it is reviewed;
- Pre-closure monitoring, which occurs as the site approaches closure to underpin assessment of post-closure performance;
- Closure monitoring, which is conducted during the period of active site closure (approximately two years following the cessation of mining); and
- Post-closure monitoring, which is conducted on a regular basis until either:
    - There is a demonstration that closure criteria have been met and that the site is able to be relinquished; or
    - Parameters being monitored reach a steady state.

This plan considers pre-closure, closure and post-closure monitoring.

24.2 Indicative monitoring program

The monitoring program will be finalised during development of a Final Closure Plan as the site approaches closure. Specific and appropriate monitoring will be conducted to ensure data is obtained to allow assessment of performance against completion criteria (Section 8). The monitoring programme is likely to contain specific monitoring of the following key areas, as a minimum.

24.2.1 Rehabilitation monitoring

The purpose of the rehabilitation monitoring program is to evaluate successional development of rehabilitation areas and thereby provide useful feedback for the improvement of rehabilitation techniques, and to help assess progress towards long term rehabilitation objectives.

Rehabilitation monitoring also provides vital information which can be used to set realistic and achievable completion criteria. This can be achieved by examining changes in key parameters over time, and by comparing results from the rehabilitation with those from corresponding reference sites. Reference sites, also known as Controls or Analogues, are positioned within local areas of uncleared native vegetation.

Rehabilitation monitoring occurs on a scheduled basis, aimed at establishing trends for the locations return to self-sustaining status. The rehabilitation development is compared to the reference site values. Data analysis is undertaken to assess progress towards an acceptable outcome and a report produced to document findings.

24.2.2 Water monitoring

Water monitoring during closure will focus on confirming groundwater recovery and quality and pit lake modelling predictions, and identification of any AMD issues. A specific program of monitoring will be developed prior to decommissioning.

24.3 Heritage surveys

Heritage assessments are undertaken prior to closure to ascertain potential cultural heritage impacts of closure implementation, and inform the development of alternative strategies if required. Assessments are also undertaken post-closure to confirm that implementation has been undertaken in an appropriate manner.

25. Post-closure maintenance

Post closure, maintenance will continue as required until it is determined that the closure objectives have been met or it is otherwise agreed with Government to allow relinquishment of the site.

FINANCIAL PROVISION FOR CLOSURE

Rio Tinto considers specifics of the closure cost estimate to be commercially sensitive information. This section outlines the general process used to develop the closure cost estimate.

26. Principles of Rio Tinto closure cost estimation

Closure cost estimates are determined based on methods outlined in the Rio Tinto Closure Standard and the Rio Tinto Accounting Policy. Closure costs are considered in two formats:

- a Present Closure Obligation (PCO) which is indicative of costs associated with closure of the mine given its current footprint, this accounts for the progressive development of a site over time; and
- a Total Projected Closure (TPC) cost which predicts the cost (in current terms) associated with closure at the end of the life of the mine. The TPC includes areas that are not currently approved, but that feature within the life of mine plan and that are considered likely to be developed in the future.

The cost estimates consider the following components[15]:

- decommissioning (i.e. removal of infrastructure)[16];
- final landform construction;
- rehabilitation and biodiversity management;
- heritage management;
- workforce management (i.e. training costs and redundancy payments)[17];
- monitoring costs;
- costs associated with the development of the final closure 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; and
- a contingency factor.

27. Closure cost estimation methods

The closure cost estimation methodology is based on methods outlined in the Rio Tinto Closure Standard and Rio Tinto Accounting Policy, with the level of accuracy increasing as the site approaches closure[18]. The closure cost estimates are conducted based on the most recent information of mine plans and infrastructure. Closure costs estimate are generally undertaken by specialist external consultants. The PCO estimate for each site is revised on an annual basis to account for incremental mine development during the year. The TPC estimate is revised whenever a formal closure plan review is conducted (usually 3-yearly) to capture any changes to life of mine design. As part of Rio Tinto assurance processes these costs are audited by external financial auditors annually to ensure adequate closure provisions are maintained.

Note that for commercial reasons the actual estimate is not documented in this closure plan.

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[15] Costs associated with decontamination are assessed during closure plan development but are costed separately as they are classified as operating costs, not closure costs.

[16] The decommissioning cost estimate assumes that infrastructure will be demolished and buried on site. The site is sufficiently remote that deconstruction for the purposes of materials salvage and recycling is likely to be cost prohibitive. However; opportunities for salvage and recycling will be sought as the site approaches closure.

[17] Workforce management costs have only been included in the TPC.

[18] The level of accuracy applied to Rio Tinto estimates is as follows:

- greater than 10 years from closure: ±30%;
- between 10 years and 5 years from closure: ±20%; and
- less than 5 years from closure: ±15%.

MANAGEMENT OF INFORMATION AND DATA

28. Data and information management

28.1 Iron Ore Document Management System (IODMS)

The Company operates a comprehensive document management system, with electronic records of all key information and data. The document system, known as Iron Ore Document Management System (**IODMS**) is linked to other business units within the Rio Tinto group of companies, and processes are in place to ensure that the data contained within this system is appropriately backed up and protected. Each document stored within this system is given a unique document number which identifies the document and enables it to be accessed. This system will continue to operate following site closure, and all relevant data will be retained according to appropriate data retention requirements.

An audit will be conducted prior to closure to ascertain whether there is any additional information stored in hard copy form at the site. Such data will be scanned and entered into IODMS to ensure that it is appropriately retained post-closure.

28.2 Closure knowledge base

The closure knowledge database is a knowledge management process designed to bring closure related research and monitoring outcomes together into one searchable location. It uses a single entry form to capture where the report is stored, and how and where the research can be applied for all new ongoing and completed closure related studies. This information is then managed by the Closure team within a secure database.

28.3 EnviroSys

EnviroSys is an environmental database that is used by Rio Tinto to manage environmental and hydrogeological data. The tool is used to store, monitor and analyse those parameters and report trends on data collections.

Data collected currently includes:

- groundwater – biological, chemical, field, levels, production;
- marine water – biological, chemical, field;
- soil chemistry;
- surface water – biological, chemical, field, levels, production;
- tonnes and moisture;
- rehabilitation;
- water meters; and
- weather (rainfall, temperatures etc.).

EnviroSys is used to support the building of closure knowledge bases, as well as ensure compliance with operating licenses pertaining to data management. At closure this data would be appropriately stored to allow for review of post closure completion criteria.

Appendix A – Register of key closure obligations

Ministerial Statement 1000 (Brockman Syncline 4 Iron Ore – Revised Proposal)	
Condition No.	**Closure conditions**
Condition 6-1	The proponent shall ensure that the proposal is decommissioned and rehabilitated in an ecologically sustainable manner, consistent with agreed outcomes and land uses, and without unacceptable liability to the State of Western Australia, through the implementation of the Mine Closure Plan required by condition 6-2.
Condition 6-2	The proponent shall prepare the Brockman Syncline 4 Mine Closure Plan in accordance with the Guidelines for Preparing Mine Closure Plans, June 2011 and any updates, to the requirements of the CEO on advice of the Department of Mines and Petroleum.
Condition 6-3	The proponent shall review and revise the Brockman Syncline 4 Mine Closure Plan required by condition 6-2 at intervals not exceeding three years, or as otherwise specified by the CEO.
Condition 6-4	The proponent shall implement the latest revision of the Brockman Syncline 4 Mine Closure Plan, which the CEO has confirmed by notice in writing, satisfies the requirements of condition 6-2.
Commitment No.	**Closure commitments**
Schedule 1, Table 2	Mine pits are to be backfilled so that the final surface levels are at a higher elevation than the pre-mining groundwater level to prevent the formation of pit lakes.

Part V Licence L8232/2008/2 (Brockman Syncline 4 Mine)	
Condition No.	**Closure conditions**
19	MANAGEMENT OF WASTE DUMP LANDFILL (ATTACHEMENT 4) The Licensee shall ensure that waste in the tipping area of the waste dump landfill is covered with a dense (at least 200 millimetres), inert and incombustible material at final landform design.

Native Vegetation Clearing Permits	
Permit No. CPS 2444	
Condition No.	**Closure conditions**
9	Retain and spread vegetative material and topsoil The Permit Holder shall: (a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. (b) within 12 months following clearing authorised under this Permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) laying the vegetative material and topsoil retained under Condition 9(a). (c) within 4 years of laying the vegetative material and topsoil on the cleared area in accordance with Condition 9(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition structure and density determined under Condition 9(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.

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Permit No. CPS 2447	
Condition No.	**Closure conditions**
4	Retain and spread vegetative material and topsoil The Permit Holder shall: (a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil within the area cross-hatched yellow on attached Plan 2447/2. (b) within 6 months following clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; (ii) laying the vegetative material and topsoil retained under Condition 4(a). (c) within 4 years of laying the vegetative material and topsoil on the cleared area in accordance with Condition 4(b) of this Permit: (i) determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition structure and density determined under Condition 4(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.

Permit No. CPS 2565	
Condition No.	**Closure conditions**
4	Retain and spread vegetative material and topsoil The Permit Holder shall: (a) Retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil within the area cross-hatched yellow on attached Plan 2565/2. (b) Within 12 months following clearing, revegetate and rehabilitate the area(s) that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) laying the vegetative material and topsoil retained under Condition 4(a). (c) Within 4 years of laying the vegetative material and topsoil on the cleared area in accordance with Condition 4(b) of this Permit: (i) determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition structure and density determined under Condition 4(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.

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Permit No. CPS 2978	
Condition No.	**Closure conditions**
5	Retain and spread vegetative material and topsoil The Permit Holder shall: (a) Retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil within the area cross-hatched yellow on attached plan 2978/2. (b) Within 12 months following clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) laying the vegetative material and topsoil retained under Condition 5(a). (c) Within 4 years of laying the vegetative material and topsoil on the cleared area in accordance with condition 5(b) of this Permit: (i) determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition structure and density determined under Condition 5(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.
Permit No. CPS 2992	
Condition No.	**Closure conditions**
5	Retain vegetative material and topsoil The Permit Holder shall retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared.
Permit No. CPS 3863	
Condition No.	**Closure conditions**
9	Retain and spread vegetative material and topsoil The Permit Holder shall: (a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. (b) within 12 months following clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) ripping the ground on the contour to remove soil compaction; and (ii) laying the vegetative material and topsoil retained under Condition 9(a). (c) within 4 years of laying the vegetative material and topsoil on the cleared area in accordance with Condition 9(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition, structure and density determined under Condition 9(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.

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Permit No. CPS 3894	
Condition No.	**Closure conditions**
4	Retain and spread vegetative material and topsoil The Permit Holder shall: (a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. (b) within 6 months following completion of clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) laying the vegetative material and topsoil retained under Condition 4(a). (c) within 4 years of laying the vegetative material and topsoil on the cleared area in accordance with Condition 4(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition structure and density determined under Condition 4(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.

Permit No. CPS 3982	
Condition No.	**Closure conditions**
9	Retain and spread vegetative material and topsoil The Permit Holder shall: (a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. (b) within 12 months following clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) laying the vegetative material and topsoil retained under Condition 9(a). (c) within 4 years of laying the vegetative material and topsoil on the cleared area in accordance with condition 9(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition, structure and density determined under Condition 9(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.

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Permit No. CPS 4114	
Condition No.	**Closure conditions**
4	Retain vegetative material and topsoil, revegetation and rehabilitation The Permit Holder shall: (a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. (b) within 6 months following completion of clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) ripping the ground on the contour to remove soil compaction; and (iii) laying the vegetative material and topsoil retained under Condition 4(a). (c) within 4 years of laying the vegetative material and topsoil on the cleared area in accordance with Condition 4(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition structure and density determined under Condition 4(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.

Permit No. CPS 4269	
Condition No.	**Closure conditions**
4	Retain and spread vegetative material and topsoil The Permit Holder shall: (a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. (b) within 12 months following clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) ripping the ground on the contour to remove soil compaction; and (ii) laying the vegetative material and topsoil retained under Condition 4(a). (c) within 4 years of laying the vegetative material and topsoil on the cleared area in accordance with Condition 4(b) of this Permit: (i) engage an environmental specialist to dete1mine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition structure and density determined under Condition 4(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.

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Permit No. CPS 4309	
Condition No.	**Closure conditions**
4	Retain vegetative material and topsoil, revegetation and rehabilitation The Permit Holder shall: (a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. (b) within six months following completion of clearing authorised under this Permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding five metres of uncleared land; and (ii) laying the vegetative material and topsoil retained under Condition 4(a). (c) within four years of laying the vegetative material and topsoil in accordance with Condition 4(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition structure and density determined under Condition 4(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.
Permit No. CPS 4549	
Condition No.	**Closure conditions**
7	Retain and spread vegetative material and topsoil The Permit Holder shall: (a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. (b) within 12 months following completion of clearing authorised under this Permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; (ii) ripping the ground on the contour to remove soil compaction; and (iii) laying the vegetative material and topsoil retained under Condition 7(a) on the cleared area. (c) within 4 years of laying the vegetative material and topsoil on the cleared area in accordance with Condition 7(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition structure and density determined under Condition 7(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.

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Permit No. CPS 4569	
Condition No.	**Closure conditions**
5	Retain and spread vegetative material and topsoil The Permit Holder shall: (a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. (b) within 12 months following clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) laying the vegetative material and topsoil retained under Condition 5(a). (c) within 4 years of laying the vegetative material and topsoil on the cleared area in accordance with Condition 5(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition structure and density determined under Condition 5(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.
Permit No. CPS 4771	
Condition No.	**Closure conditions**
9	Retain and spread vegetative material and topsoil The Permit Holder shall: (a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. (b) within 12 months following clearing authorised under this permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) laying the vegetative material and topsoil retained under Condition 9(a). (c) within 4 years of laying the vegetative material and topsoil on the cleared area in accordance with Condition 9(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition, structure and density determined under Condition 9(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.

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Permit No. CPS 4780	
Condition No.	**Closure conditions**
9	Retain and spread vegetative material and topsoil The Permit Holder shall: (a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. (b) within 12 months following clearing authorised under this Permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) laying the vegetative material and topsoil retained under Condition 9(a). (c) within 4 years of laying the vegetative material and topsoil on the cleared area in accordance with Condition 9(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition structure and density determined under Condition 9(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.
Permit No. CPS 4989	
Condition No.	**Closure conditions**
11	Retain and spread vegetative material and topsoil The Permit Holder shall: (a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. (b) within 12 months following clearing authorised under this Permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) laying the vegetative material and topsoil retained under Condition 11(a). (c) within 4 years of laying the vegetative material and topsoil on the cleared area in accordance with Condition 11(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition structure and density determined under Condition 11(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.

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Permit No. CPS 4993	
Condition No.	**Closure conditions**
10	Retain and spread vegetative material and topsoil, revegetation and rehabilitation The Permit Holder shall: (a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. (b) within 12 months following completion of geotechnical investigations, revegetate and rehabilitate areas not required for future scheduled and approved development, by: (i) ripping the ground on the contour to remove soil compaction; and (ii) laying the vegetative material and topsoil retained under Condition 10(a) on the cleared area. (c) within 2 years of laying the vegetative material and topsoil on the cleared area in accordance with Condition 10(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition structure and density determined under Condition 10(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.

Permit No. CPS 5139	
Condition No.	**Closure conditions**
11	Retain and spread vegetative material and topsoil, revegetation and rehabilitation The Permit Holder shall: (a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. (b) within 12 months following clearing authorised under this Permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) laying the vegetative material and topsoil retained under Condition 11(a). (c) within 4 years of laying the vegetative material and topsoil on the cleared area in accordance with Condition 11(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition structure and density determined under Condition 11(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.

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Permit No. CPS 5504	
Condition No.	**Closure conditions**
10	Retain and spread vegetative material and topsoil The Permit Holder shall: (a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. (b) within 12 months following clearing authorised under this Permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) laying the vegetative material and topsoil retained under Condition 10(a). (c) within 4 years of laying the vegetative material and topsoil on the cleared area in accordance with Condition 10(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition structure and density determined under Condition 10(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.

Permit No. CPS 5928	
Condition No.	**Closure conditions**
7	Retain and spread vegetative material and topsoil The Permit Holder shall: (a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. (b) within 12 months following completion of clearing authorised under this Permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; (ii) ripping the ground on the contour to remove soil compaction; and (iii) laying the vegetative material and topsoil retained under Condition 7(a) on the cleared area. (c) within 4 years of laying the vegetative material and topsoil on the cleared area in accordance with Condition 7(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition structure and density determined under Condition 7(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.

Permit No. CPS 6110	
Condition No.	**Closure conditions**
n/a	No conditions relevant to closure

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Permit No. CPS 6961

Condition No.	Closure conditions
11	Retain and spread vegetative material and topsoil, revegetation and rehabilitation The Permit Holder shall: (a) retain the vegetative material and topsoil removed by clearing authorised under this Permit and stockpile the vegetative material and topsoil in an area that has already been cleared. (b) within 12 months following clearing authorised under this Permit, revegetate and rehabilitate the areas that are no longer required for the purpose for which they were cleared under this Permit by: (i) re-shaping the surface of the land so that it is consistent with the surrounding 5 metres of uncleared land; and (ii) laying the vegetative material and topsoil retained under Condition 11(a) on the cleared area. (c) within 4 years of laying the vegetative material and topsoil on the cleared area in accordance with Condition 11(b) of this Permit: (i) engage an environmental specialist to determine the species composition, structure and density of the area revegetated and rehabilitated; and (ii) where, in the opinion of an environmental specialist, the composition structure and density determined under Condition 11(c)(i) of this Permit will not result in a similar species composition, structure and density to that of pre-clearing vegetation types in that area, revegetate the area by deliberately planting and/or direct seeding native vegetation that will result in a similar species composition, structure and density of native vegetation to pre-clearing vegetation types in that area and ensuring only local provenance seeds and propagating material are used.

Iron Ore (Hamersley) Agreement Act 1963

Clause No.	Closure obligations
11(d)	The parties hereto covenant and agree with each other.... that on the cessation or determination of this Agreement — (i) except as otherwise agreed by the Minister the rights of the Company to in or under this Agreement and the rights of the Company or of any assignee of the Company or any mortgagee to in or under the mineral lease and any other lease license easement or right granted hereunder or pursuant hereto shall thereupon cease and determine but without prejudice to the liability of either of the parties hereto in respect of any antecedent breach or default under this Agreement or in respect of any indemnity given hereunder AND the Company will without further consideration but otherwise at the request and cost of the State transfer or surrender to the State or the Crown all land the subject of any Crown Grant issued under the Land Act pursuant to this Agreement; (ii) the Company shall forthwith pay to the State all moneys which may then have become payable or accrued due.
11(e)	The parties hereto covenant and agree with each other.... that on the cessation or determination of any lease license or easement granted hereunder by the State to the Company or (except as otherwise agreed by the Minister) to an associated company or other assignee of the Company under clause 20 hereof of land for the Company's wharf for any installation within the harbour for the Company's railway or for housing at the port or port townsite the improvements and things erected on the relevant land and provided for in connection therewith shall remain or become the absolute property of the State without compensation and freed and discharged from all mortgages and encumbrances and the Company will do and execute such documents and things (including surrenders) as the State may reasonably require to give effect to this provision. In the event of the Company immediately prior to such expiration or determination or subsequent thereto deciding to remove its locomotives rolling stock plant equipment and removable buildings or any of them from any land it shall not do so without first notifying the State in writing of its decision and thereby granting to the State the right or option exercisable within three months thereafter to purchase at valuation in situ the said plant equipment and removable buildings or any of them. Such valuation shall be mutually agreed or in default of agreement shall be made by such competent valuer as the parties may appoint or falling agreement as to such appointment then by two competent valuers one to be appointed by each party or by an umpire appointed by such valuers should they fail to agree.

Mining Act 1978

Tenement No. L47/00139	
Condition No.	**Closure conditions**
18	On the completion of the life of mining operations in connection with this licence the holder shall: • remove all installations constructed pursuant to this licence; and • on such areas cleared of natural growth by the holder or any of its agents, the holder shall plant trees and/or shrubs and/or any other plant as shall conform to the general pattern and type of growth in the area and as directed by the District Inspector of Mines and properly maintain same until the Inspector advises regrowth is self-supporting; unless the Mining Registrar or Minister for State Development orders or consents otherwise.

Tenement No. L47/00141	
Condition No.	**Closure conditions**
6	All topsoil that may be removed ahead of pipe laying operations to be stockpiled for replacement in accordance with the directions of the Inspector.
18	On the completion of the life of mining operations in relation to this licence the holder shall: • remove all installations constructed pursuant to this licence; • cover over all wells and holes in the ground to such degree of safety as shall be determined by the District Inspector of Mines; and • on such areas cleared of natural growth by the holder or any of its agents, the holder shall plant trees and/or shrubs and/or any other plant as shall conform to the general pattern and type of growth in the area and as directed by the Inspector and properly maintain same until the Inspector advises regrowth is self-supporting; unless the Warden or Minister responsible for the Mining Act 1978 orders or consents otherwise.
24	All topsoil being removed ahead of all mining operations from sites such as pit areas, waste disposal areas, ore stockpile areas, pipeline, haul roads and new access roads and being stockpiled for later respreading or immediately respread as rehabilitation progresses.
25	At the completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the Executive Director, Environment Division, DMP.
29	Placement of waste material must be such that the final footprint after rehabilitation will not be impacted upon by pit wall subsidence and zone of pit instability, to the satisfaction of the Executive Director, Environment Division, DMP.
30	On the completion of operations or progressively where possible, all waste dumps, tailings storage facilities, stockpiles or other mining related landforms must be rehabilitated to form safe, stable, non-polluting structures which are integrated with the surrounding landscape and support self-sustaining, functional ecosystems comprising suitable, local provenance species or alternative agreed outcome to the satisfaction of the Executive Director, Environment Division, DMP.

Tenement No. L47/00152	
Condition No.	**Closure conditions**
4	All topsoil that may be removed ahead of pipe laying operations to be stockpiled for replacement in accordance with the directions of the Inspector.
12	On the completion of the life of mining operations in relation to this licence the holder shall: • remove all installations constructed pursuant to this licence; • cover over all wells and holes in the ground to such degree of safety as shall be determined by the District Inspector of Mines; and • on such areas cleared of natural growth by the holder or any of its agents, the holder shall plant trees and/or shrubs and/or any other plant as shall conform to the general pattern and type of growth in the area and as directed by the Inspector and properly maintain same until the Inspector advises regrowth is self supporting; unless the Mining Registrar or Minister for State Development orders or consents otherwise.

Mining Act 1978

Tenement No. L47/00153	
Condition No.	**Closure conditions**
6	All topsoil that may be removed ahead of pipe laying operations to be stockpiled for replacement in accordance with the directions of the Inspector.
13	On the completion of the life of mining operations in relation to this licence the holder shall: • remove all installations constructed pursuant to this licence; • on such areas cleared of natural growth by the holder or any of its agents, the holder shall plant trees and/or shrubs and/or any other plant as shall conform to the general pattern and type of growth in the area and as directed by the District Inspector of Mines and properly maintain same until the Inspector advises regrowth is self-supporting; unless the Warden or Minister responsible for the Mining Act 1978 orders or consents otherwise.
19	All topsoil and vegetation being removed ahead of all mining operations and being stockpiled appropriately for later respreading or immediately respread as rehabilitation progresses.
20	At the completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the Director, Environment Division, DMP.
Tenement No. L47/00161	
Condition No.	**Closure conditions**
13	On the completion of the life of mining operations in connection with this licence the holder shall: • remove all installations constructed pursuant to this licence; and • on such areas cleared of natural growth by the holder or any of its agents, the holder shall plant trees and/or shrubs and/or any other plant as shall conform to the general pattern and type of growth in the area and as directed by the District Inspector of Mines and properly maintain same until the Inspector advises regrowth is self-supporting; unless the Warden or Minister responsible for the Mining Act 1978 orders or consents otherwise.
Tenement No. L47/00178	
Condition No.	**Closure conditions**
n/a	No conditions relevant to closure
Tenement No. L47/00184	
Condition No.	**Closure conditions**
13	On the completion of the life of mining operations in connection with this licence the holder shall: • remove all installations constructed pursuant to this licence; and • on such areas cleared of natural growth by the holder or any of its agents, the holder shall plant trees and/or shrubs and/or any other plant as shall conform to the general pattern and type of growth in the area and as directed by the Environmental Officer, Department of Industry and Resources and properly maintain same until the Environmental Officer advises regrowth is self-supporting; unless the Warden or Minister responsible for the Mining Act 1978 orders or consents otherwise.
Tenement No. L47/00185	
Condition No.	**Closure conditions**
8	All topsoil and vegetation being removed ahead of all mining operations and being stockpiled appropriately for later respreading or immediately respread as rehabilitation progresses.
10	All rubbish and scrap is to be progressively disposed of in a suitable manner, to the satisfaction of the Executive Director, Environment Division, DMP.
Tenement No. G47/01225	
Condition No.	**Closure conditions**
n/a	No conditions relevant to closure

Mining Act 1978	
Tenement No. G47/01227	
Condition No.	**Closure conditions**
n/a	No conditions relevant to closure
Tenement No. G47/01232	
Condition No.	**Closure conditions**
10	All topsoil being removed ahead of all mining operations from sites such as pit areas, waste disposal areas, ore stockpile areas, pipeline, haul roads and new access roads and being stockpiled for later respreading or immediately respread as rehabilitation progresses.
11	At the completion of operations, all buildings and structures being removed from site or demolished and buried to the satisfaction of the Director, Environment Division, DoIR.
13	At the completion of operations, or progressively where possible, all waste dumps, tailings storage facilities, stockpiles or other mining related landforms must be rehabilitated to form safe, stable, non-polluting structures which are integrated with the surrounding landscape and support self-sustaining, functional ecosystems comprising suitable, local provenance species or an alternative agreed outcome to the satisfaction of an Environmental Officer, DMP.

Relevant Legislation	
Closure planning and implementation requires consideration of general legislative requirements beyond those that apply to a specific site. A list of potentially relevant legislation is provided below, but is not necessarily exhaustive. A comprehensive legal review will be required as closure approaches to ensure that all relevant legislative requirements are identified.	
Australian Commonwealth Legislation	**Western Australian State Legislation**
Environmental Protection and Biodiversity Conservation Act 1999	*Environmental Protection Act 1986*
Native Title Act 1993	*Environmental Protection Regulations 1987*
Aboriginal and Torres Strait Islander Heritage Protection Act 1984	*Environmental Protection (Controlled Waste) Regulations 2004*
Workplace Relations Act 1996	*Environmental Protection (Unauthorised Discharges) Regulations 2004*
	Contaminated Sites Act 2003
	Contaminated Sites Regulations 2006
	Conservation and Land Management Act 1984
	Mining Act 1978
	Mining Regulations 1981
	Parks and Reserves Act 1895
	Rights in Water and Irrigation Act 1914
	Wildlife Conservation Act 1950
	Aboriginal Heritage Act 1972
	Aboriginal Affairs Planning Authority Act 1972
	Mines Safety and Inspection Act 1994
	Mines Safety and Inspection Regulations 1995
	Occupiers Liability Act 1985
	Criminal Code Compilation Act 1913

Relevant Guidelines and Standards

Closure planning and implementation requires consideration of relevant guidelines and standards, some of which may have regulatory consequence through being referenced in regulatory documents. A list of key guidelines and standards that are routinely considered is provided below, but is not exhaustive due to the breadth of the closure planning discipline. This closure plan has been prepared so as to be considered with relevant content of these guidelines and standards.

Guideline or Standard	Author
Guidelines for the Preparation of Mine Closure Plans (2015)	Western Australian Department of Mines and Petroleum and Environmental Protection Authority
Mine Closure: Leading Practice Sustainable Development Program for the Mining Industry (2016)	Commonwealth Department of Industry, Innovation and Science
Mine Rehabilitation Handbook (1998)	Minerals Council of Australia
Guideline for the Assessment of Environmental Factors: Rehabilitation of Terrestrial Ecosystems (2006)	Western Australian Environmental Protection Authority
Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)	Agriculture and Resource Management Council of Australia and New Zealand and the Australian and New Zealand Environment and Conservation Council
Mine Void Water Resource Issues in Western Australia (2003)	Western Australian Water and Rivers Commission
Contaminated Sites guideline series	Western Australian Department of Environment Regulation
Environmental Notes on Mining: Acid Mine Drainage (2009)	Western Australian Department of Mines and Petroleum
Environmental Notes on Mining: Waste Rock Dumps (2009)	Western Australian Department of Mines and Petroleum
Safety Bund Walls Around Abandoned Open Pit Mines (1997)	Western Australian Department of Industry and Resources
Global Acid Rock Drainage Guide (2014)	International Network for Acid Prevention
Australian Standard 2601: The Demolition of Structures (2001)	Standards Australia
Australian Standard 4976: The Removal of Underground Petroleum Storage Tanks (2008)	Standards Australia
Demolition Work Code of Practice (2015)	Safe Work Australia

Appendix B – Communications Register

Stakeholder	Date	Subject	Summary of discussion relevant to closure	Response
Environmental Protection Authority Service Unit	2004	Hamersley referral to the EPA	Formal referral of the Brockman Syncline 4 Project under Section 38 of the EP Act.	
Environmental Protection Authority Service Unit	2004	EPA feedback on Draft Scope	Mine closure can be expected to be an important issue for the EPA assessment. Sufficient information will need to be included in the PER document for the EPA to be confident that mine closure is being considered as an integral part of mine planning. In particular, the process for determining location and design of artificial landforms needs to be describes and there needs to be justification as to whether the final void lake needs to be backfilled.	Noted.
Environmental Protection Authority Service Unit	2005	Hamersley referral to the EPA	Environmental scoping document is approved	
Department of Environment (Perth)	2005	Response to draft PER	Need to backfill to 2 m above the pre-mining water level.	Will be undertaken.
Department of Environment (Karratha)	2005	Response to draft PER	Include closure objectives and principles in the PER e.g. progressive rehabilitation, backfilling of final mine pits to above the water table.	Closure and rehabilitation objectives stated.
Department of Industry & Resources	2005	Response to draft PER	Give general approach to waste dump rehabilitation. Take into account waste characterisation in rehabilitation and slope.	10 m lifts, 10 m wide berms, 20deg slopes. Some work has been undertaken, and additional work will be done during the operation.
Environmental Protection Authority Service Unit	2005	PER		Closure measures include backfilling pits to above the water table, reshaping and rehabilitating external waste dumps to make safe and stable, and to research priority species for inclusion in the rehabiltation seed mixes.
Department of Environment (Perth)	2005	Submission during PER	• An additional objective may be required to ensure a similar diversity and quality of habitats exists after rehabilitation. • As in pre-mining surveys, data needs to be evaluated in context of its likely uses. • Additional site specific surveys may be required for local species list used for re-vegetation. It is also recommended that floristic surveys analysis data from adjacent plots or transects is used to determine species turn over within vegetation types that will require re-vegetation.	Noted.
Department of Conservation and Land Management	2005	Submission during PER	• Supports Hamersley Iron's planned research into re-establishment of Priority species in rehabilitated areas. • Supports HI's planned closure and rehabilitation of the existing track through the Ptilotus sp. "Brockman" population and associated P11 vegetation community.	Noted.
Wildflower Society	2005	Submission during PER	Concerns about the Closure Assumptions made in Section 4.4 of the Plan: • All open pits and final voids will not require rehabilitation (ie. ripping and seeding) to meet statutory requirements, unless backfilled with waste rock. Where backfilled it is assumed that open pit and final voids slopes will not require rehabilitation and that the final backfilled surface will be rehabilitated the same as waste rock dump surfaces; and, • All closure activities, except monitoring, will be completed within two years of cessation of operations. An additional objective is required to ensure that there is a similar diversity and quality of habitats for plants and animals after rehabilitation	Noted. This is a plan and rehabilitation measures and completion criteria will be revised and refined over time.
Environmental Protection Authority Service Unit	2006	Bulletin 1214	The EPA accepted that the mining proposal could be managed to meet environmental objectives provided that specified conditions were met. These evolved into the project's Ministerial Statement conditions. With respect to closure, the main issues relevant to the assessment were: • Continual revision of closure plans; • Progressively backfill pits; and • Re-establish Priority flora species in rehabilitated areas.	
Environmental Protection Authority Service Unit	2006	Acceptance of MS717	Formal acceptance of all conditions on Ministerial Statement 717.	
Department of Industry & Resources	2006	Comments on the Notice of Intent	1. It states in the PER that some Potentially Acid Forming (PAF) waste rock may be encountered during the mining of the BS4 Pits and that if this occurs, it will be encapsulated in designated and appropriately designed waste dumps to minimise the potential for acid rock drainage (ARD). I would encourage Hamersley to ensure that any PAF material generated reports as backfill to pits and where possible, be placed beneath the permanent water table level so that it remains stable and will not be impacted upon by free air/water (reducing environment). This will ensure any potential ARD is minimised. 3. I note that within the Preliminary Rehabilitation and Closure Management Plan dated 30 May 2005 (Appendix G), it states that the land bridges will remain and be rehabilitated the same as the other waste dumps on site. Hamersley needs to ensure that these structures remain safe/stable and free draining for the long term. Also, the initial design of these structures needs to reflect these requirements. 5. It is noted that there is no mention of the final location of the proposed borrow pits which will be utilised for the construction of the rail spur line to BS4. Hamersley should site, construct and rehabilitate the borrow pits in the same manner as those along their Yandicoogina Rail Line using their standard procedure. DolR requires that the final locations/extent/design of the proposed borrow pits should be forwarded to the Department. 6. Whilst the design parameters of the outer pit waste dumps have been suggested in the PER, during operations, Hamersley need to commit to carrying out site specific studies on the waste rock so as to determine their physical and chemical properties. Only at this time should the final design parameters of the waste dumps be committed to so as to produce safe/stable landforms. As the life of BS4 is approximately 30 years, Hamersley need to commit to initiate such trials early in the life of the Project so as to best determine the final design of the out of pit waste dumps. 7. It is noted that Hamersley have committed to backfilling all pits to above the pre-mine water table so as to prevent the creation of permanent inpit lakes. DolR recommends that as much waste rock as possible reports back to mined voids so as to limit the amount of waste rock which reports to out of pit waste dumps. 9. I note that there is an undertaking in the Preliminary Rehabilitation and Closure Management Plan, dated 30 May 2005 (Appendix G), that the Plan will be fully reviewed based on final design and rehabilitation requirements once the Project is initiated. Also, it will be reviewed on a regular basis. Learning's from activities both on site and at each of Hamersley's other operating sites should be included in this plan.	1. Mine planning and pit design processes being applied for BS4 by Hamersley are expected to avoid Mt McRae shale. Therefore, BS4 mining is unlikely to encounter P AF material. Hamersley' s cun-ent procedures are to encapsulate P AF material in waste dumps. If PAF material is encountered after backfilling commences, placement of such material in-pit and below final water table will be undertaken where it is feasible. 3. Noted. 5. Noted. Should the current borrow pit procedure (as applied to the Yandicoogina rail line) be updated before construction commences, the updated procedure will be applied to BS4. 6. Hamersley will apply geotechnical expe1tise from internal specialists or external consultants toward finalising the design of the BS4 out-of-pit waste dumps. In addition, Hamersley has undertaken trials and studies over many years on waste dumps containing a range of physical and chemical prope1ties at other operations; the outcomes of this work will be applied to BS4. If considered warranted, Hamersley may undertake site specific studies on the waste rock (eg rehabilitation trials or erosion susceptibility assessments) before finalising site specific waste dump designs. Po1tions of some out-of-pit waste dumps are likely to be re-handled for backfilling toward the end of project life, negating the need for fmal rehabilitation in some areas. 7. Additional waste rock material may be directly placed in the mine voids at levels above the water table toward the end of mining operations. Relevant factors in determining whether additional waste rock will be placed in mine voids at levels above the water table include economics, haul distance, haul gradients, mine schedules, ore presentation and environmental considerations. Out-of-pit waste dumps are unlikely to be rehandled to be placed back into mine voids above backfilled levels that are already above pre-mine water table. 9. Noted.

Stakeholder	Date	Subject	Summary of discussion relevant to closure	Response
Environmental Protection Authority	2007	Change to MS717	Site layout; including rail, powerlines, waste dumps, airstrip and camp	Section 45C
Environmental Protection Authority	2008	Change to MS717	Powerline rerouting	Section 45C
Environmental Protection Authority	2008	Change to MS717	Increased throughput and associated layout changes	Section 45C
Department of State Development	2010	Response to State Agreement reports 2009	No significant comments. DMP Comments: Areas displaying Improvements: • The establishment of reference sites to be used for the development of conceptual completion criteria at operating sites • The commencement of a 5 year seed science programme • Corrective actions requested as part of the 2008 DMP inspection have been completed or progressed Areas deficient in information / area of concern at several sites: • Limited progressive rehabilitation was noted • Although there was an improvement from the previous AER, for most sites there was limited information on rehabilitation monitoring results • Limited detail of erosion monitoring results	Positive aspects noted. • For concerns regarding limited progressive rehabilitation, a rehabilitation and closure team has been formed and is working to improve our planning and implementation of progressive rehabilitation projects. • Whilst there may not of been earthworks conducted at an individual site, a large proportion of works are involved in the planning stage for rehabilitation, including making improvements to historic designs, haulage of clean inert waste fill to enable future rehabilitation projects and a range of research and development activities to inform and guide future rehabilitation programs. • RTIO operations will not be able to demonstrate rehabilitation works being conducted at every site every year, due to the large and long time frames in which our operational areas remain active. • Identification and scheduling of areas available for rehabilitation across our operations are conducted over a 5 year time frame. This 5 year plan is updated through the 5 year mine planning and quarterly mine planning processes.
Department of Mines & Petroleum	2011	Brockman 4 Inspection 2011	A key concern in relation to the issue of closure at this site is whether adequate planning is being conducted to ensure that the site can be progressively rehabilitated, and that mining activities are conducted within the broad vision of how the mine will be closed. As mine waste is being stockpiled amongst ore stockpiles there was limited opportunity for this material to be progressively rehabilitated. When onsite personel were queried about the rehabilitation at Brockman 4, it was indicated that progressive rehabilitation of waste rock would not be occurring in the short term, and would be scheduled in the next 5 year mine plan. If progressive rehabilitation and closure planning is not conducted during the early stages of mine life, opportunities to create synergies between mine and closure planning (which are likely to result in both economic and environmental benefits) will be reduced. It is acknowledged that Brockman 4 is a new site and the final footprint of the mine is unlikely to be reached for a number of years, however a closure plan must be developed for the site, so that future mining is conducted with consideration for the final closure and rehabilitation of the site. There appeared to be limited inclusion of site personnel (environmental and planning) in minesite rehabilitation/closure plans. Further work on incorporating planning for the closure of this site into everyday mining operation and the inclusion of onsite personnel in this process, is required.	
Department of State Development	2011	Response to State Agreement reports 2010	No significant comments. DMP Comments: A number of areas of improvement were noted across the RTIO sites. These include: • The Land Data Improvement Project continued during 2010, aiming to improve assessment and monitoring of disturbance footprints and rehabilitation areas; • The commencement of investigations into alternative growth mediums. The concerns include: • RTIO are not planning to develop completion criteria for the closure of sites during the early stages of project development. The DMP encourages completion criteria to be developed during the early stages of the project because it sets a goal for the rehabilitation of the site and ensures closure is considered during the construction and operational phases of the project. It is acknowledged however, that during the early stages of project development the criteria can be quite conceptual and be further developed and refined as the project progresses. • Progressive rehabilitation is being carried out at some sites, with plans for future rehabilitation works noted. However a greater commitment to progressive rehabilitation should be achievable across most sites. It should be noted that progressive rehabilitation not only involves achieving actual rehabilitation on the ground but also includes researching knowledge gaps which may include setting up rehabilitation trials, gaining a better understanding of material characterisation etc.	RTIO agrees that completion criteria need to be developed and agreed prior to closure implementation (including progressive rehabilitation undertaken during the course of operations), but considers that any criteria drafted early in the development of a long-life mine need to be considered indicative only. RTIO is currently undergoing a project to develop criteria to measure the success of progressive rehabilitation, the status of which was included in the overview section of the report. RTIO has included indicative completion criteria in closure plans submitted to Government since publication of the new closure plan reporting guidelines, and will continue to do so. Over the past 3 years RTIO has increased the amount of rehabilitation planning, earthworks and research and development projects considerably. Areas available for progressive rehabilitation are identified for the RTIO business and scheduled as part of mine planning and business planning processes. The RTIO approach for sign off on rehabilitation areas ensures a reduction in the areas of rehabilitation being re-disturbed. This planned approach means that only areas that are scheduled for closure will undergo rehabilitation, thus not all sites will have rehabilitation occurring every year. RTIO is also planning on the achievement of quality hectares of rehabilitation rather than achieving hectares which may require rework in future. The RTIO closure planning and rehabilitation efforts and procedures are being informed by the learning's from our rehabilitation.
Office of the Environmental Protection Authority	2012	Annual Audit Compliance Report 2011		Condition 10-1: Temporary construction areas have been decommissioned and rehabilitated, however rehabilitation for mining related areas has not been required to date. Refer to the 2011 Brockman 4 AER for further information on rehabilitation details. The current Closure Management Plan is scheduled to be reviewed in 2012.
Department of Environment & Conservation	2013	RTIO Priority Species Project	The purpose of the meeting was to discuss the existing commitments, work to date and a proposed process for the project and consultations going forward. A list of priority species for the various project areas was reviewed. Of the 26 species identified, 13 were selected as being potentially suitable for establishment in rehabilitation based on habitat, abundance, taxonomy, growth form and likelihood of being removed from the priority species list. Further work proposed includes germination and phrenology studies, and collection of seed.	
Office of the Environmental Protection Authority	2013	Annual Audit Compliance Report 2012		Condition 10-1: Not required at this stage. Site has not entered a decommissioning phase. Condition 10-2: Operations commenced in 2010 and hence this is not required yet. The rehabilitation plan will be reviewed within the five year time frame.

Stakeholder	Date	Subject	Summary of discussion relevant to closure	Response
Puutu Kunti Kurrama and Pinikura (PKKP)	2013	Local Implementation Committee Meeting	Presented on the closure process through life of mine, decommissioning and monitoring phases. Included clsoure timings based on current mine plan, but noted the lieklihood of these dates changing with updated knowledge and changing markets and business decisions. An update to the closure plan is scheduled.	
Department of State Development	2014	Response to State Agreement reports 2012	No significant comments. DMP Comments: DMP is very supportive of the proposed and existing research projects, including the seed provenance study, and request that updates and results relating to these projects are included in future TERs.	Noted.
Office of the Environmental Protection Authority	2014	Hamersley referral to the EPA	Formal referral of the Brockman Syncline 4 Project - Revised Proposal under Section 38 of the EP Act.	
Cheela Plains Pastoral Station	2014	Consultation on referral of revised proposal	Cheela Plains raised concerns about the level of assessment based on impacts from dewatering discharge.	
Office of the Environmental Protection Authority	2014	Annual Audit Compliance Report 2013		Condition 10-1: Not required at this stage. Site has not entered a decommissioning phase. Condition 10-2: Operations commenced in 2010 a review of the Preliminary Rehabilitation and Closure Management Plan will be completed before 2015.
Office of the Environmental Protection Authority	2014	General correspondence from the OEPA regarding a joint BHP Billiton and Rio Tinto rehabilitation presentation	Correspondence from OEPA commending BHP Billiton and Rio Tinto on their joint presentation on rehabilitation success in the Pilbara. In its letter OEPA recognised that mine closure and rehabilitation is an important strategic issue and recognised the significant challenges remaining in this area. The OEPA referred to the Department of Mines and Petroleum/EAP Joint Mine Closure Guidelines as the primary document guiding mine closure and rehabilitation across all land tenures and sought written confirmation from both companies that they would abide by any contemporary version of the guidelines, irrespective of what the current Ministerial Statement conditions required in regard to closure and rehabilitation, or similarly what State Agreement Act conditions require on the same matter. OEPA indicated its desire to discuss the updating of existing Ministerial Statements to ensure they are contemporary with respect to mine closure and rehabilitation with both parties in future.	Rio Tinto acknowledged the feedback form OEPA and indicated it looked forward to continued involvement with government and industry partners in developing sustainable, long term improvements for rehabilitation and closure in Western Australia. In response to the request for mine closure plans to conform to the contemporary version of the Department of Mines and Petroleum/EAP Joint Mine Closure Guidelines, it is noted that Rio Tinto iron ore closure plans drafted to support new proposals are prepared in accordance with the Guidelines. These plans are prepared in consultation with the Department of Mines and Petroleum and other key stakeholders. To date eight closure plans have been prepared in accordance with the Guidelines and submitted to Government. Rio Tinto iron ore will continue with this process going forward. For existing Ministerial Statements, closure planning is undertaken in accordance with approval conditions and Rio Tinto standards. Of particular note, compliance to the Rio Tinto standard is required irrespective of what the current Ministerial Statement conditions and State Agreement requirements are on this matter. Rio Tinto's standards require the preparation of closure plans for each aspect of an iron ore operation, and plans are revised at a frequency that is appropriate to the life and scale of the operations, and take into consideration the objectives and intended outcomes of the contemporary Guideline. We will continue our closure planning in accordance with our approval conditions, and Rio Tinto standards. This process will ensure that our plans are progressively updated to align with contemporary Guidelines. Rio Tinto iron ore considers this a practical approach which is consistent with requirements for closure planning in Western Australia. (Our reference: RTIO-HSE-0229340).
Department of State Development	2014	Response to State Agreement reports 2013	No significant comments. DMP Comments: It should be mentioned that the information provided relating to rehabilitation monitoring offers a good overview of the progression of historical rehabilitation.	Noted.
Office of the Environmental Protection Authority	2014	Bulletin 1531	The EPA recommends that the rehabilitation and closure condition (condition 7) is updated to the contemporary rehabilitation and closure condition, which requires the proponent to implement the mine closure plan consistent with the Guidelines for Preparing Mine Closure Plans (June 2011) and any updates, on advice from the DMP. Condition 7 also provides for the periodic revision of the mine closure plan every three years, or as specified by the CEO of the Office of the EPA.	
Office of the Environmental Protection Authority	2014	Appeals against the API and Bulletin 1531	Cheela Plains Pastoral Station raised further concerns about the discharge footprint and it's impacts during operations and closure, including tenure and licencing, consultation and environmental impacts of changed vegetation, permanent water, invasive species and feral animals.	The Proponent does not agree that the proposal should be remitted to the EPA for reassessment. However, to avoid any misinterpretation, the Proponent has no objection to: • the replacement of the word "extent" with the words "lineal distance" in Table 2 of Schedule 1 • amending to the word "Watercourses" to the word "Watercourse" in column 3 of Table 2
Office of the Environmental Protection Authority	2015	Submission of 2014 BS4 Closure Plan	Concerns included: • Ability to rehabilitate backfilled pits • Thickness of topsoil to mitigate the proposed site deficit • Clairty of waste inventories • Development of a design for DP9 • Conducting groundwater modelling, including contamination • PAF exposures should be inundated • Lack of stakeholder communication • Zone of instability surrounding Pit 2 affecting DP1 • Broadness of completion criteria • Progressive rehabilitation and trials	• Example at Tom Price provided. Rehabilitation only to occur if close to surface • The difficulty of spreading topsoil to <200mm is restrictive, however good rehabilitation can occur without topsoil (example at Channar provided) • Information about waste stored in each dump is provided and is more instructive • Design for DP9 is now included • Modelling has been completed and is now included • Managed by backfilling of pits • Noted. More details included. Additional communication will now occur with an up to date knowledge base, mine plan and risk assessment • Polygons of ZOI reviewed. Management of dumps inside the ZOI is outlined in the plan • Completion criteria updated • Noted
Office of the Environmental Protection Authority	2015	Acceptance of the B4CP to satisfy Condition 10 of MS717	The Brockman 4 Closure Plan was considered to satisfy Condition 10 of MS717 as the current closure plan.	
Office of the Environmental Protection Authority	2015	Acceptance of MS1000	Formal acceptance of all conditions on Ministerial Statement 1000.	
Office of the Environmental Protection Authority	2015	Change to MS1000	Change to condition numbers.	No submission required.
Office of the Environmental Protection Authority	2015	Annual Audit Compliance Report 2014		Condition 10-1: Not required at this stage. Site has not entered a decommissioning phase. Condition 10-2: Operations commenced in 2010; a Revised Closure Plan was submitted for approval in August 2014. The revised Brockman 4 Rehabilitation and Closure Plan was accepted by the OEPA on 18 August 2014. Our reference: RTIO-HSE-0250930 OEPA reference: AC05-2014- 055.

Stakeholder	Date	Subject	Summary of discussion relevant to closure	Response
Office of the Environmental Protection Authority	2015	Change to MS1000	Change to layout of pits, waste dumps and stockpiles.	No submission required.
Cheela Plains Pastoral Station	2015	Notification of B4MM		An Order of Magnitude Study has commenced into the B4 Marra Mamba deposits. This includes options for additional dewatering, with surplus water possibly being discharged to Boolgeeda Creek.
Department of Mines & Petroleum	2015	Notification of B4MM	DMP request consideration of: • Zones of instability • Waste characterisation • Tenure boundaries - especially where third party tenure is adjacent) • Built landforms within drainage lines or flood areas	A future proposal for BS4 will likely be submitted under S38 of EP Act. A revised closure plan will be submitted with the proposal.
Department of State Development	2015	Response to State Agreement reports 2014	No significant comments. DMP Comments: It is positive to note that all the AER's provide information on rehabilitation monitoring and offer a good overview of the progress of rehabilitation towards analogue sites. It is also positive to note the continuation of research and trials, including (but not limited to): • The Seed Provenance Study in collaboration with the Department of Parks and Wildlife for collection of material occurred in 2014 and it is noted that support from a second Pilbara mining company was secured for the project. DMP supports a collaborative and targeted research approach; • Final Landform Project; • Priority Flora Species establishment; • Native Pivot Trial; and • Pit Void Guidance.	
Puutu Kunti Kurrama and Pinikura (PKKP)	2015	Local Implementation Committee Meeting	Presented on the results of recent rehabilitation monitoring, and the priority species trial.	
Office of the Environmental Protection Authority	2015	Provision of rehabilitation data		Rehabilitation areas by ministerial statement is provided.
Department of Water	2016	Notification of B4MM	DMP request consideration of: • Sensitive receptors including stygofauna and water level in Boolgeeda Creek • Accuracy of previous models • Cumulative impacts of surrounding operations	A future proposal for BS4 will likely be submitted under S38 of EP Act. A revised closure plan will be submitted with the proposal. A change was discussed about wording of backfilling strategy to change from "above pre-mining water table" to "preventing formation of pit lakes".
Office of the Environmental Protection Authority	2016	Annual Audit Compliance Report 2015		Condition 6-1: The proposal is in operational phase and not decommissioning. Condition 6-2: Mine Closure Plan required to be prepared prior to 11 March 2018. Condition 6-3: Initial Mine Closure Plan is required to be prepared prior to 11 March 2018, as per 6-2. Condition 6-2: Project is in an operational phase.
Department of State Development	2016	General mine closure plan discussions held with DSD. (Formal written communication from Rio Tinto to DSD dated 11th July 2016).	DSD held discussions and sent various correspondence to Rio Tinto requesting that all State Agreement proponents: • Prepare and submit mine closure plans in accordance with the Guidelines for Preparing Mine Closure Plans (compliant mine closure plans) for all mine operations, including those where there is no current legal obligation to do so; and • Report land disturbance data consistent with Mining Rehabilitation Fund (MRF) categories in our State Agreement Annual Environmental Reports (AER).	In relation to mine closure plans Rio Tinto indicated that it was willing to voluntarily provide the State with the material requested on the following basis: • A timeframe of at least three years to progressively prepare and lodge compliant mine closure plans for operations where modern closure conditions do not currently apply; • Assurance that Mine Closure Plans will only be reviewed on a triennial basis by the Department of Mines and Petroleum (DMP) in accordance with the Guidelines; and • Confirmation that mine closure plans will not be connected in any formal way with the operation of our State Agreement mining approvals, such that changes to our mine plan will not mandate the need for revision of our mine closure plans, except at the regular triennial review period. As part of this Rio Tinto provided a suggested submission schedule which was subsequently agreed to by the DSD. Mesa A was nominally planned for submission in 2017.
Department of Mines & Petroleum	2016	Abandonment bund placement prior to disturbance	Comment that abandonment bund placement and actual installation need to be considered early in mine planning and mine development to ensure they are not precluded from being installed at closure	RTIO acknowledged closure plans would reflect current requirements.
Department of Mines & Petroleum	2016	PMP/PMF modelling for closure planning	DMP acknowledged that achieving stability of large waste landforms is challenging, even under current 'reasonable climatic conditions'. DMP has observed many cases across the Pilbara and the State more broadly where rehabilitation areas have performed poorly or failed, often over a reasonably short time frame. Guidance is expected to be risk based and not a 'one size fits all' approach. It was suggested that high risk dumps (e.g. those containing designated fibrous or PAF waste) may need to be designed to withstand larger or more intense rainfall events than small, inert, low risk waste dumps.	RTIO will wait for the landform design document which will include guidance on the PMP/PMF issue.
Department of Mines & Petroleum	2016	Public safety risk mitigation requirements for closed mine sites	Environmental inspectors regulate safety through Mining Regulations 1981 Regulation 28 "…all holes, pits, trenches and other disturbances to the surface of the land made whilst mining which in the opinion of an environmental officer are likely to endanger the safety of any person or animal will be filled in or otherwise made safe to the satisfaction of the environmental officer". The DMP intends to revise its abandonment bund guidance to become less prescriptive and more outcomes focused. There would not be an expectation to batter down and rehabilitate large faces – abandonment bunds to prevent inadvertent access would be more appropriate. Vegetation on a slope would help prevent access, but should not be relied upon as a primary control as it could be lost to fire etc. Similarly, fences should not be considered a permanent control.	RTIO is considering options.
Office of the Environmental Protection Authority	2016	Change to MS1000	Change to layout of pits, waste dumps and stockpiles.	Section 45C

Stakeholder	Date	Subject	Summary of discussion relevant to closure	Response
Cheela Plains Pastoral Station	2016	B4MM Proposal	Concerns included: • Recovery of local water table • Timing of rehabilitation • Boolgeeda Creek impacts • Access track to the noth near Pit 1	A change to the backfill strategy for the authorised and proposed pits means that there may be less backfill. This is due to the post-mining water table not recovering to pre-mining levels due to the local geology. This will affect post-mining land use by reducing the amount of land suitable to be returned to pastoral. Closure objectives will focus on safety. Boolgeeda Creek is covered in the closure plan under the water sections. Closure timing will depend on mine planning, but currently extends past 2030. The access track is likely to be affected. Further consultation is required.
Department of State Development	2016	Response to State Agreement reports 2015	DMP supports the inclusion of rehabilitation monitoring data and photographs. Rehabilitation appears to be progressing well with only a small number of sites yielding poor results. Rework should be monitored for success and an update provided in future AERs and TERs.	
Department of Mines & Petroleum	2015	Brockman 4 Inspection 2016	A diverted drainage channel was observed in close proximity to the toe of the DP1 waste dump (Plate 01). It is understood that the waste dumps at the Brockman 4 site are largely of a temporary nature, with waste material to be used in pit backfilling activities. However, it is important to consider the location of the waste dumps in relation to drainage channels during construction, ensuring that temporary waste dumps will not be significantly impacted by 1:100 year annual recurrence interval (ARI) flood events and that permanent waste dumps are located and designed with consideration given to Probable Maximum Flood (PMF) events. In the case of the DP1 waste dump, should further lifts occur and the waste dump is to become a permanent landform, it is likely that the Waste Dump will be battered down into the drainage channel therefore impacting on the integrity of the drainage channel as well as the potential long term stability of the waste dump.	
Department of Environmental Regulation	2017	Contaminated Sites		Contaminated sites are managed as an operational issue, using a risk based approach. Closure is considered in the risk rating based on estimated closure dtae. Focus is currently on the higher risk areas, with 19 locations to be investigated and managed in the next five years.
Puutu Kunti Kurrama and Pinikura (PKKP)	2017	Local Implementation Committee Meeting	Presented on the results of 2016 rehabilitation monitoring, and closure planning - next steps and general information on closure strategies for pits and dumps.	
Office of the Environmental Protection Authority	2017	Annual Audit Compliance Report 2016		Condition 6-1: The proposal is in operational phase and not decommissioning. Condition 6-2: Mine Closure Plan required to be prepared prior to 11 March 2018. Condition 6-3: Initial Mine Closure Plan is required to be prepared prior to 11 March 2018, as per 6-2. Condition 6-2: Project is in an operational phase.
Department of Water and Environmental Regulation	2017	Submission of 2017 BS4 Closure Plan	BS4 Mine Closure Plan submitted.	
Department of Jobs, Tourism, Science and Innovation	2017	Voluntary submission of MCP	BS4 Mine Closure Plan submitted.	
Department of Water and Environmental Regulation	2017	General Closure Plan schedule	Overview provided of closure plans that Rio Tinto (iron ore) is currently working on in 2017 and planning for 2018 to either support approvals in process, for compliance purposes or to meet commitments made to the Department of State Development in 2016 to submit closure plans for all operations over a three year period. These include: - Silvergrass East - Hope Downs 1 - Mesa A hub - Mesa J hub - Paraburdoo - Tom Price - Brockman 4 - Hope Downs 4 - Eastern Range - Channar	
Department of Water and Environmental Regulation	2018	Submission of 2017 BS4 Closure Plan	DWER provided feedback on the submission of the BS4 mine closure plan. They required additional information to be included and some edits made. Comments were in the area of completion criteria, PAF and Fibrouds materials management, ground water recovery and progressve rehabilitation.	RTIO acknowledged the feedback from DWER and provided a response addressing each item. Where information was available it was provided and an updated closure plan submitted with the response to each comment.
Deoartment of Water and Environmental Regulation	2018	Acceptance of the B4CP to satisfy Condition 10 of MS717	The Brockman 4 Closure Plan was considered to satisfy Condition 6 of MS1000 as the current closure plan.	
Department of Water and Environmental Regulation	2018	Hamersley referral to the DWER	Formal referral of the Brockman Syncline 4 Project under Section 38 of the EP Act.	

Appendix C – Closure knowledge database (Confidential)

Rio Tinto Brockman 4 closure knowledge database

The closure knowledge database is a summary of the technical reports that directly or indirectly contribute to the development of the closure plan. These documents do not form part of the report and are for indicative purposes only.

The knowledge and understanding of closure issues and management strategies evolve and improve over time, coincident with the development of the mining operation. As a result, some components of some reports and studies may be superseded by new research or studies. While the closure plan addresses the current state of understanding and strategy for closure, the closure knowledge database captures the historical development of closure knowledge, and demonstrates how experience and knowledge developed at other Rio Tinto sites has been considered during the development of the closure plan and across the life of the operation. Accordingly, some information presented in the closure knowledge database may be obsolete.

Technical reports supporting the closure of the operation will be presented as part of the last plan produced prior to the implementation of closure (also known as the Decommissioning Plan).

Climate

Climate Change Adaptation Project, Rio Tinto Climate Change Impacts in the Tom Price – Paraburdoo Region of the Pilbara, Western Australia **2007**

This study was undertaken to provide a future climate analysis, spanning the period from 2000 to 2060 for the inland west Pilbara region of Western Australia, with particular emphasis given to the Tom Price region.

Internal reference: RTIO-HSE-0046946

Over the coming decades out to the year 2060, the numbers of tropical cyclones do not appear to change dramatically, with the magnitude of the inter-decadal climate variability overshadowing the slight changes in the frequency of the total numbers of tropical cyclones for this region. The modelling points to an increased likelihood of more intense tropical cyclones forming over the waters off the Pilbara coast. Extreme maximum temperatures are expected to rise by at least 4.4oC for the summer season. Annual rainfall is predicted to decline by 30% from 1970 values. The impact is likely to increase the frequency of drier years, but with further extreme heavy rainfall events. The lengthening of the return periods for the extreme rainfalls can be attributed to the predicted gradual decline in the frequency of tropical cyclone events near this location and a reduction in the frequency of the middle level cloud bands during the autumn and winter months. Potential for increased severe thunderstorm activity, particularly in the form of severe wind squalls was also identified.

Geochemical characterisation

Review of Waste Rock Geochemistry a) General Overview of Acid Base Accounting **2006**

This report contains a general overview of acid base accounting and a summary of the geochemical test work that has been previously completed for various sites and lithologies.

Internal reference: RTIO-PDE-0021130

There are large discrepancies in the total sulfur concentration measured using XRF and LECO machines. The XRF machine underestimates the sulfur concentration at values greater than 2%. Materials with total sulfur concentrations less than 0.1% can contain low capacity PAF material, however, it is considered only to be low additional acid and metalliferous risk if the boundary for inert material and potentially acid forming material is shifted from 0.02%S to 0.1%S. A paste pH result of less than 7 should be sent to the black shale dump and a paste pH result of greater than 7 can be sent to an inert material waste dump.

Geochemical Characterisation of Brockman Syncline 4 Samples **2008**

Geochemical characterisation was undertaken on 126 samples taken from nine bore holes at Brockman Syncline 4. Samples were mainly comprised of McRae Shale and Footwall Zone materials.

Internal reference: RTIO-PDE-0047330

Samples sourced from the footwall zone, or described as weathered or bleached shales, were classed as non-acid forming, of ‘black shale’ samples from the Mt McRae Shale formation approximately the same amount classified as non acid forming as were potentially (PAF) and two massive chert samples from the McRae Shale were classed as PAF. In at least some of samples Ag, As, Au, B, Bi, C, Cd, Fe, Hg, N, Pb, S, Sb, Se where enriched. The elements found to be present in leachable form were Cd, Co, Cr, Cu, Mo. Ni, Se, U, Zn.

Mineralogical Analysis of Potentially Acid Forming Materials **2008**

Quantitative mineralogy (QEM-Scan) for samples of rock collected from Tom Price, Channar, West Angelas, Brockman, Paraburdoo, East Extension, Western Turner Syncline and Hope Downs 1 North was undertaken. Comparisons were made between two methodologies use to characterise potentially acid forming materials; acid base accounting and mineralogical analysis.

Internal reference: RTIO-PDE-0053725

All samples contained elevated total sulfur concentrations and the lithologies were either shale, banded iron formation or dolomite. Pyrite was the dominant mineral contributing to acidity and the dominant sulfate secondary mineralisation consisted of alunite and jarosite.

Determination of ARD potential of Rio Tinto Iron Ore (WA) Waste Rock Samples **2008**

Internal reference: RTIO-PDE-0051613

This report investigates the use of mineralogy to predict acid and metalliferous drainage potential. Analysis of numerous rocks was undertaken using QEM-SCAN.

Areas of waste rock which have underdone oxidation can be identified where sulfur-bearing minerals vary between samples in the form of pyrite, alunite and jarosite. The variability of gangue mineral phases suggest that some areas of composite waste rock pile may provide some neutralising potential while other areas will have no neutralising potential. Variable textural and mineralogical controls on sulfide mineral occurrence result in decreased accessibility of pyrite to oxidising fluids.

Geochemical Characterisation of Brockman Syncline 4 **2009**

Internal reference: RTIO-PDE-0070757

This report documents the findings of geochemical characterisation test work conducted on 32 drill samples sourced from the Mount McRae Shale stratigraphic unit at Brockman 4.

Many of the samples contained stored acidity (pH < 5). The acid neutralising capacity of the samples was generally low. Elements that were enriched in all samples were As, Sb and Se and Au, Bi, Hg and S were enriched in some samples. Static leach tests indicate elements of concern that have potential to impact on human or livestock health are Al, Co, Fe, Mn, Ni, S and Se.

Brockman Syncline 4 ARD and Geochemical Risk Assessment **2010**

Internal reference: RTIO-PDE-0072290

To review and update the existing acid rock drainage (ARD) risk assessment for Brockman Syncline 4.

The report concludes that the main sulfide risk in the BS4 area occurs in the black shale of the McRae Shale (MCS) member. The overall ARD risk for Brockman 4 is moderate with individual pit risks assessed as high in Pits 3 and 18 and moderate in Pit 7. Pit 5 poses a very high ARD risk. Sulfidic MCS will be exposed on these final pit shell walls at closure. Minor volumes of category 2 and 3 material are also expected in Pits 2 (Stage 4), 4,6 and 11 however relative to Pit 3 and 5 they do not pose a high AMD risk. The southern Marra Mamba deposit was assessed as low AMD risk. Several metals were identified as enriched but not likely soluble under neutral conditions however there was some elevated Fe, Mn and Zn concentrations. There will need to be further geochemical characterisation of the Elevated Sulfur material at the site. In terms of water quality modelling in the vicinity of PAF waste dumps and in-pit, the following elements (jn additional to the standard suite) should be closely monitored in surface water and ground water: Al, Cd, Co, Fe, Mn, S, and Se. During operations, encapsulation of AMD material with inert waste is required, and material should be readily available. Upon closure of the PAF waste dump, a store and release cover is required; ensuring this material is available in proximity to the PAF dump should be planned for.

Environmental Status of Selenium (Se) in the Pilbara Region of Western Australia – Potential Risk from Iron Ore Mining **2011**

Internal reference: RTIO-PDE-0103857

This report includes information about Selenium geochemistry, distribution in the environment, occurrence in rocks in the Pilbara and potential risks to the environment.

The Selenium (Se) content of shales containing significant pyrite should be recorded as part of the overall risk assessment for acid and metalliferous mine drainage. However, it should also be noted Se solubility is far less constrained by pH than in the case of metals and near neutral drainage may contain significant Se concentrations in solution. It would be most useful to study the Selenium budget of the wetlands in the Pilbara as, apart from the chance poisoning of livestock from the consumption of plants that have taken up high concentrations of Selenium, impacts are most likely to be felt in wetlands receiving mine site drainage.

Contaminant Leaching from Non-Sulfidic Waste Material **2011**

Internal reference: RTIO-HSE-0145041

The available leach extract data and information pertaining to the distribution of metals and metalloids in non sulfur materials at neutral pH was reviewed. Based on this review conceptual models for controls on their leaching and mobility were developed.

The review found that contaminant leaching from non-sulfidic materials was generally very limited. Usually the pH in leach tests was near-neutral (pH 6 to 8), and dissolved contaminant concentration were at or below detection limits. It is believed that a primary leachable contaminant source is the oxidation of sulfide minerals. Release from oxidising sulfides leads to release of soluble reaction products. Under neutral pH conditions, there is the potential for release of these contaminants when those products dissolve.

Contaminant Leaching from Low-Sulphur Waste Minerals (Summary) **2011**

Internal reference: RTIO-PDE-0090689

RTIO's Geochemical Database was reviewed and based upon this data, conceptual models for controls on the leaching and mobility of a range of metals and metalloids were developed. This summary also describes potential controls on the amount of dissolved element that may be released. This is a summary of a comprehensive report RTIO-PDE-0100104.

For most contaminants, dissolved concentrations at circum neutral pH (pH 6 to 8) were very low, typically at or below detection limit. Geochemical modelling indicates that water-rock interactions are controlled by equilibrium, for salt, carbonates and sulphates this equilibrium is often source term limited whilst hydroxyl-sulphates and hydroxides are solubility controlled. Results also indicate that sorption plays an important role in solute concentration; weak (but detectable) sorption occurred for selenium and zinc whilst the strongest sorption was evident for cobalt. The review suggested that storage waste facilities containing low-sulfur materials pose a low level of environmental risk however, there is a small risk of increased in mobility of some contaminants if acidic conditions arise. Acidic conditions can sometimes arise from the interactions between iron and aluminium hydroxyl-sulphates and hydroxides.

Geochemical Assessment of Tailings from Yandi, Paraburdoo, Tom Price, Brockman 4 and Mesa J **2014**

This report presents the results from geochemical testing and saline solution extraction of tailings samples from Yandi, Paraburdoo, Tom Price, Brockman 4 and Mesa J deposits.

Internal reference: RTIO-PDE-0123030

Overall the tailings from these operations are unlikely to generate acid and are not expected to leach significant levels of metals under oxidising or saline conditions.

Oxidation and solute accumulation in dewatered pit wall rocks **2014**

Dewatering and removing the water table may result in de-saturation of sulphide-bearing lithologies. This study was undertaken to review how oxygen ingress and consequent sulphide oxidation of Mount McRae Shales could impact water quality when the groundwater table rebounds after mining.

Internal reference: RTIO-PDE-0109045

Large Scale Column Construction Procedure and Initial Chemistry **2014**

Large scale column experiments have been constructed to examine the reactivity of hot and cold black shale material in an operational environment. The memo describes the construction of the columns and the first geochemistry data collected after small rainfall events at Rhodes Ridge.

Internal reference: RTIO-PDE-0123894

Initial results suggest that effluent water retains the chemistry of the incident rainfall. Constituents to note in the initial chemistry include nitrate and ammonia detected in the hot black shale effluent. This study provides an important comparison between laboratory characterisation studies and field reactivity of waste rock. Data from the large scale column tests can be applied to reactivity of in pit waste/talus as well as waste rock dumps. It can be used as an intermediate to predict long term reactivity of waste rock.

Brockman Syncline 4 Marra Mamba AMD Risk Assessment **2015**

A review of the AMD risk assessment has been completed to support the development of a closure plan focusing on the Brockman 4 Marra Mamba expansion mining and project areas. This update is based the latest (2015) available drillhole data and proposed final pit shells.

Internal reference: RTIO-PDE-0153432

The BS4 MM deposits ara is expected to pose low AMD risk based on the current pit designs.

Brockman Syncline 4 - Geochemical characterisation of samples from the Marra Mamba deposits **2015**

Ongoing geochemical characterisation of samples from various RTIO mining operations. The overall purpose of the geochemical characterisation programme is to provide guidance for waste rock management in particular with respect to managing and limiting acid generation and metalliferous drainage.
The current programme involved characterisation of 48 waste rock samples from four stratigraphies at the Marra Mamba deposit of the BS4 project.

Internal reference: RTIO-PDE-0138130

Total sulfur content was generally low, less than 0.1%. Eight samples contained between 0.13 and 2.13 % total sulfur. For seven of the eight samples, surlfur speciation was dominated by sulfate sulfur. The majority of samples (41) were classified as non-acid forming (NAF) with an additional six samples classified as uncertain. Leach testing generally resulted in circum neutral leaches, pH 6.6 to 8.

Brockman Syncline 4 Geochemical Characterisation of Mount McRae Shale Samples **2016**

SRK were engaged to undertake kinetic testing on black MCS samples from Brockman 4. A total of 19 samples were collected and submitted for static tests with three samples selected to undergo Kinetic testing

Internal reference: RTIO-PDE-0146721

Total sulfur contents ranged between 0.02% and 10.3%, comprising sulfide (pyrite) and sulfates (alunite, jarosite and butlerite).
ANC values were generally low (<10 kg H2SO4/t)
Of the 19 samples – 7 were classified as Potentially Acid Forming (PAF) (S values ranged from 0.5% to 10%), 7 were classified as non-acid forming (NAF) and 5 as uncertain (UC). One UC samples was reclassified after kinetic tests to PAF as the sample generated acidic leachate.
Eight (8) samples underwent static leach tests yielding leach pH values of between 2.3 and 8.5. The most acidic leaches corresponded with the three samples with the highest total sulfur values. The remaining five samples were circum neutral pH.

Physical characterisation

Net solute load response to the installation of infiltration limiting dry cover systems over acid forming waste piles **2014**

This work was conducted to verify the central design concept of store-and-release covers over sulfidic above water table waste dumps that is, whether limiting net percolation volume through the cover results in a lesser sulfate and acidity load being realised generated and passing through the dump.

Internal reference: RTIO-PDE-0128431

The results from this thesis project confirm that the central aim of store-and-release covers to reduce net percolation volume is a valid measure for reducing the net loading of sulfate and acidity. The mechanism through which decreasing net percolation (applied water volume) results in a lesser sulfate and acidity load was identified, however further work in a site context is needed to assess how this relationship between percolation volume and loading persists in the real-world environment.

Growth Media Characterisation **2016**

Internal reference: RTIO-HSE-0298702

This study was undertaken to interpret material characterisation data from 53 samples and their review their potentials as growth mediums.

53 samples were assessed has been classified as ‘suitable’ or ‘not suitable’ for use as a growth medium. This report should be used as a guide to assist in selecting materials that can be considered for use in rehabilitation activities, provide that these other factors are also included as part of the rehabilitation plan. Several materials have properties that were invariably suitable. In some cases, materials have some properties that are suitable and others unsuitable. In others, serval of the properties are problematic. Suitable materials represent those that have base properties that are not likely to impede vegetation. Marginal materials are those that are likely to support vegetation but that have some properties that may limit establishment and growth. Unsuitable materials are those that have properties that are likely to significantly impact on vegetation growth either through being saline, prone to dispersion, and having pH values quite different to those typically observed.

Groundwater

Brockman 4 Hydrogeology Pre-Feasibility Report **2005**

Internal reference: RTIO-HSE-0201124

This report outlines the findings of the hydrogeological investigation programme for mine dewatering and water supply options and the likely environmental impacts (on the groundwater system) associated with development of Brockman 4.

The report provides specific information on the hydrogeology of the area and outlines a conceptual groundwater model of the area which is used to model dewatering requirements during operations and predict changes in the regional groundwater regime that may be associated with groundwater abstraction. The report concludes that in-pit dumping of waste rock to backfill pits to above the regional water table at cessation of mining will facilitate sustainable aquifer recovery and ensure no significant permanent impacts (namely from concentration of salts) on groundwater quality.

Brockman Syncline 4 Dewatering and Water Supply Bore Installation **2007**

Internal reference: RTIO-PDE-0071770

This completion report details the drilling, construction, installation and testing of the Brockman Syncline 4 Mine Dewatering Bores and the Water Supply Bores.

Groundwater was intercepted at varying levels in each of the bores drilled. Analysis of groundwater showed it met acceptable values for analytes according to the Australian Drinking Water Guidelines.

Brockman Syncline 4 Life of Mine Water Supply Options **2010**

Internal reference: RTIO-PDE-0073403

This report outlines a review of the Brockman 4 life of mine water supply options. This review was based on the Brockman Syncline 4 mine area borefield performance during Phase I mine construction and a hydrogeological assessment of alternative sources. It used the 2004 Brockman 4 and the 2009 Nammuldi below water table groundwater models as its basis.

The validation of the groundwater model indicates that the hydraulic properties and conceptual assumptions used in 2004 were relatively conservative. It is likely the original model underestimated total groundwater stored, and hence water supply availability. Conversely it likely that the model has under-predicted the dewatering required. However, significant changes (order of magnitude) in abstraction are not expected, as overall the system appears to remain hydraulically isolated from any significant regional aquifer. It is still anticipated that an alternative make up water supply will be required by operations, with Nammuldi remaining the preferred option for this supply.

Brockman Syncline South Marra Mamba (BSSM) Groundwater Investigations 2011 Hydrogeological Report **2012**

Internal reference: RTIO-PDE-0093283

This document summarises the findings of a drilling and testing program undertaken at the Brockman Syncline South Marra Mamba (BSSM) deposits, designed to gather additional groundwater information to either enable the existing groundwater model for the region to be updated or facilitate development of a separate model for this area. This work was considered a critical risk mitigation to allow planning flexibility in the event of a delay at the Nammuldi project, which was originally intended to supply water to Brockman 4 long term.

At BSSM groundwater occurs in the fractured or mineralised Mount Newman Member and in the weathered Wittenoom Formation underlying the valley to the north. The two stratigraphic units are hydraulically connected and form a major aquifer. The BSSM aquifer is bound by low permeability BIF and shale units belonging to MacLeod and Nammuldi member to the south and Mount Sylvia and Mount McRae Shale Formation to the north. Where detrital sediments occur below the water table, they form a minor aquifer. The groundwater table is generally deep (about 50m below ground level). Annual recharge is considered negligible at about 0.5% of annual average rainfall. Based on the geology, structures and groundwater levels observed in the area it is assumed that the Brockman Iron Formation is not in direct hydraulic connection with the BSSM aquifer (Marra Mamba and Wittenoom Formation). Water flows from east to west. Groundwater elevations at the east of Deposit O are 502m AHD and at 486m AHD in the central part of Deposit Q. The water quality is generally potable with a pH 7 and salinity (TDS) between 490 and 610 mg/L. However concentrations of bicarbonates are slightly elevated according to Australian drinking water guideline limit.

Brockman Syncline 4 Phase III Marra Mamba Dewatering **2012**

Internal reference: RTIO-PDE-0097674

This memo details the current understanding of dewatering requirements at the Brockman Syncline 4 Marra Mamba Iron Formation below water table bodies - Deposits R, Q and O (collectively referred to as Brockman 4 Phase 3).

The report largely is concerned with investigations to determine dewatering requirements to facilitate mining progression. Of relevance to closure planning is the conclusion that the area has four separate hydrogeological zones with negligible groundwater flow from one zone to the next. Since monitoring commenced in 2007 there has been a lack of evident recharge of the aquifers. The report finds that if these deposits are brought into the Brockman 4 mine plan, the site will experience a surplus of water beyond operational requirements and will need to discharge this surplus. This would negate the need for operational water to be supplied via pipeline from nearby Nammuldi operations (a commitment which was made as part of the Nammuldi Environmental Approval).

BS4 - BSSM Groundwater Modelling Report **2013**

Internal reference: RTIO-PDE-0105955

This report describes the most recent numerical groundwater model built for the Boogleeda Valley, Brockman Syncline 4 and Brockman Syncline South Marra Mamba (BSSM) deposits.

This latest model is the 5th update to the regional Brockman 4 Groundwater Model. Along the Boolgeeda Valley, groundwater gradients are higher and water levels vary approximately between 480mRL in the southwest and 575mRL in the northeast. The water levels in the Southern Strike Valley range between 488mRL along the fault zone between the Central and Western deposits, and 504mRL in the east. Significant water level changes either side of structural features (e.g. dolerites or faults) indicate that some degree of hydraulic compartmentalisation in the orebody is expected. Groundwater recharge rates appear lower than the expected range for the Pilbara, and are estimated at less than 1% of the annual average rainfall volume (over a 4.5 year monitoring period, little evidence of recharge was apparent with the exception of bores in Zone 1, located near Boolgeeda Creek). Several assumptions have been made in the conceptualisation of the model and require validation in future site investigations. One such assumption of particular relevance to closure is the fact that the orebody aquifers in the BS4 and BSSM deposits were identified from the geological block models, which focus on the definition of the SOP resources. The orebody aquifers could be more extensive and some isolated mineralised resources could be hydraulically connected.

Brockman 4 Operation Groundwater Operating Strategy **2013**

Internal reference: RTIO-HSE-0051547

Prepared for the Department of Water, this Operating Strategy covers dewatering, potable water, water supply bores and borefields for Brockman 4 Operations and replaces previous Borefield Operating Strategies used during initial construction and operations at Brockman 4.

This report identifies that once dewatering to meet mine requirements is complete, operational water will be sourced via pipeline from the Nammuldi Borefield (Note: this strategy is now defunct due to an underestimation of dewatering requirements at Brockman 4). Hydrogeological studies of the main mining area show that the static water levels in the orebody aquifers are 33 to 100 mbgl and therefore unlikely to support any groundwater dependent vegetation.

BS4 and BS4 MM Groundwater Modelling report **2015**

Internal reference: RTIO-PDE-0134681

A numerical groundwater model was built for the BS4 and BSSM deposits to reproduce the regional groundwater flow, on the basis of the latest hydrogeological information available for the study area. The previous groundwater model was required to be replaced as its domain did not include the BSSM deposits M and N which were added to the 2014 LoM plan.

The purpose of the current work was to build a new regional groundwater model that had an extended domain to include the BSSM M and N deposits and was calibrated to all available water level and abstraction data. This numerical model included additional dolerite dykes, identified through increased abstraction at Pit 2, 3 and 5, believed to act as hydraulic barriers.

BS4 and BS4 MM Groundwater Modelling for Closure and Backfill Options **2015**

Internal reference: RTIO-PDE-0137785

To support the proposed change to backfill strategy. The report assesses whether a blanket backfill to above premining water table is necessary to achieve the objective of no permanent pit lakes or whether a lesser level of backfill would achieve the same objective.

Overall the modelling result suggest that, as a result of the altered landform, the post mining equilibrium water level will not be the same as the pre-mining groundwater level and that a much lower level of backfilling is adequate to prevent the formation of permanent pit lakes. Modelling results show that no permanent pit lakes will be formed for the modelled backfill levels options. The predicted water table remains within the backfilled material (although near to the surface in many instances). Based on this report in all scenarios the pit areas will act a sink post closure with groundwater flowing towards the pit/backfilled areas as they are the low point. The modelling suggests any poor quality water would remain within this area (if there is any).

Brockman 4 water quality review 2015 **2016**

Internal reference:
RTIO-PDE-0139776

To evaluate historical and current geochemical data from groundwater monitoring locations at the Brockman 4 mine site. The focus of this report is on water quality monitoring related to potential acid and metalliferous generation and major changes from background water quality. In particular, this will focus on changes in chemistry for the period of 2014 to 2015, since the previous water quality review.

The majority of bores exhibit consistently circum-neutral pH. The majority of bores at Brockman 4 show a decreasing trend in field pH over time, most apparent in bores from the Eastern, Central, SSV and Western borefields. It cannot be determined if this is also occurring in many other bores which do not have a complete or long term data set (eg. Boolgeeda regional bores). In general, this trend is not matched by any trend in lab pH, which is generally scattered but within the same range. This disparity is likely due to increasing proportions of dissolved CO2 in groundwater, which reduces the pH. Lab samples have time to equilibrate and degass CO2 and therefore produce higher pH readings.

Brockman Syncline Hydrogeological Conceptual Model **2017**

Internal reference:
RTIO-PDE-0152486

This report presents the results of the groundwater desktop study of the Brockman Syncline in the West Pilbara.

An analysis of the structural / geological and hydrogeological data available at the time of the study has been performed to allow establishing a regional hydrogeological conceptual model on the study area. The conceptual model is used to derive a groundwater level map on a regional scale of aquifers important to below watertable open cut iron ore mines. It represents the current understanding of the natural dynamics of the hydrogeological system. The watertable map excludes any dynamics induced by human influence; as such it represents the natural hydrogeological context pre-mining conditions. In the whole report, 'groundwater' will refer to groundwater in natural conditions discarding any human influence.

This Project comprises understanding the hydrogeological context under natural conditions of the following three aquifers units:
- Brockman Iron Formation orebody
- Tertiary Detritals and underlying dolomite of the Paraburdoo Member of the Wittenoom Formation
- Marra Mamba Iron Formation orebody.

The BS4 deposit occurs along an E-W orientated ridge of Brockman Iron Formation which is flanked to the north by the broad and flat valley of Boolgeeda Creek. To the south, the deposit is flanked by a narrow valley (South Strike Valley) developed between the outcropping Brockman Iron Formation and a parallel ridge of Marra Mamba Iron Formation.

Both Brockman and Marra Mamba Formations are cross-cut by NW-SE trending normal dip-slip faults and numerous NW-SE vertical dolerite dykes. The average dykes spacing is 600 m. They appear to be near vertical and quite linear. Most of the dykes display no fault displacement and many dykes are discontinuous (eg : dyke between BS4 Pits 6 and 7). Some dykes are associated with major normal fault structures such as the dyke / fault between Deposit S and BS4 West, or between Pits 2/5 and Pit 6, or between the western and the central part of Brockman 4 deposit. The dykes are interpreted as having intruded along pre-existing fault structures (GDSR 5041).

Preliminary Conceptualisation of Pools at Brockman 4 Marra Mamba Deposits M and N **2017**

Internal reference:
RTIO-PDE-0151860

In support of the Part IV environmental approval process, flora and fauna surveys were conducted in August and December 2015. A key outcome of the surveys was the identification of a Pilbara Leaf-nose Bat (PLNb) roost, located in the ridge behind the Brockman 4 and Nammuldi Villages as well as three pools. An assessment of the PLNb roost (Bat Call WA, 2017) indicated at least two of the pools are water sources for the PLNb.

Whilst the pools occur outside the current study envelope of the BS4MM project, the significance to the PLNb and the unknown heritage value means there is a requirement to understand their mode of occurrence and an assessment be conducted to determine the potential for impact.

Ridge Pool is most likely fed by surface water which collects after rainfall events in a hollow in the low permeability Dales Gorge Member of the Brockman Iron Formation. The water in the pool is then protected from evaporation by an overhanging rock shelf.

At present there is insufficient information to determine whether Plunge Pool is fed solely by surface water or whether groundwater is a component.

The following actions are recommended to continue to build understanding of the water pools at BS4 and to establish baseline data:
• Continue sampling monthly at Plunge Pool for deuterium and oxygen 18 isotopes and chloride;
• Six monthly downloading of logger data at Plunge Pool for level and EC data; and
• Installation of monitoring bores in planned resource holes to the north of Plunge Pool for more accurate comparison of water levels and better understanding of the geology of the area.

Surface water

Brockman 4 Surface Water Management Strategy — 2011

Internal reference: RTIO-PDE-0106723

This report outlines the interaction between natural surface water runoff, the local environment and the Brockman 4 mine. It describes the expected climate and rainfall characteristics, delineates local catchment areas that contribute to the surface water runoff within the mine area and whose flood waters may impact on site infrastructure and describes the current surface water management strategy for the mine area.

The site is located on the regional catchment divide of the Beasley River and Boolgeeda Creek catchments, with no major river systems passing through the mining area. The majority of pits are located on the southern side of the divide, within the Beasley River Catchment. The remaining pits and most of waste dumps sit to the north within the Boolgeeda Creek catchment. The 100 year flood extent has been modelled and the waste dumps and the majority of the proposed pits are located outside this flood extent. However the most westerly pit (Pit 1) intersects the 100 year ARI flood plain. Of particular significance are the two sensitive communities located to the south of the operations, the local endemic snail and Ptilous sp Brockman. The hydrologic regime of these two communities will be modified by mining activities. The main impact on both communities is a reduction in catchment area contribution and therefore a reduction in water flow volumes. However both of these communities have been identified elsewhere in the region. Tom Price rainfall records are assumed to more accurately depict Brockman 4 than Brockman 2 records as local rainfall intensity decreases with the distance south from the Hamersley Range. Annual average potential evaporation rates in Tom Price, estimated from a dry bulb average of 5.15mm/day observed from site data is 2800 mm/yr.

Baseline Hydrology Assessment for Brockman 4 Discharge at Boolgeeda Creek — 2013

Internal reference: RTIO-HSE-0188700

Boolgeeda Creek is the preferred option for discharge of surplus water at Brockman 4 operations. This baseline hydrological/hydraulic assessment was carried out to characterise the reaches of Boolgeeda Creek, to describe the movement of discharged water along Boolgeeda Creek and to predict the likely behaviour of the released water for various discharge volumes.

Future expansion of the Brockman 4 operation below the water table will generate surplus water. Changes to the mine plan have also resulted in reduced water consumption on the mine site. Discharge to Boolgeeda Creek is identified as the preferred option for management of this surplus water over Boolgeeda Creek. Surplus water is proposed to be released at an outlet 3.1 km northwest of the site transfer tank into a tributary of Boolgeeda Creek. A discharge footprint of 37 km was estimated for a peak discharge volume of 17.5 ML/day. Water released into Boolgeeda Creek is likely to be contained within the channel, with overtopping of the creek banks not expected. The likely environmental outcome of surplus water discharge into Boolgeeda creek is the development of constant, shallow stream flow and transient pools in local depressions in the creek.

Hydrogeology Input for Brockman 4 Discharge Approval — 2013

Internal reference: RTIO-PDE-0110395

Changes to the water balance for Brockman 4 have resulted in predicted surplus water. This memo outlines the proposed management strategy for this surplus and is intended to assist the approvals process associated with obtaining a surplus water discharge licence.

Dewatering requirements have been modelled using an updated groundwater model completed for the site in March 2013. Boolgeeda Creek is the preferred option for surplus water discharge over Beasley River for a number of reasons including its predicted lower discharge footprint, the fact it is not already subject to discharge from other sources and hence low risk or cumulative environmental impacts and it is lower cost (due to a shorter pipeline requirement).

Baseline Hydrology Assessment for BM4 Discharge at Boolgeeda Creek or Beasley River System - Option Study — 2013

Internal reference: RTIO-HSE-0188699

This memo outlines the work undertaken to determine the preferred option for discharge of surplus water at Brockman 4 operations.

Two hydrological features namely Boolgeeda Creek and Beasley River exist in proximity to Brockman 4 which could be utilised as discharge outlets for surplus water. Two key factors of this assessment were the minimum distance surface water will consistently flow along the surface of the creek bed, where the creek bed will be constantly saturated, and the maximum possible extent of surface water expression of any artificial discharge downstream of the outlet (maximum surface water inundation) or discharge footprint. As a result Boolgeeda Creek was the recommended preferred discharge option. This option also has other additional benefits, namely it is lower cost and has a lower potential risk of future cumulative effects associated with other projects in the area.

Flora

Monitoring of unmined hillslope vegetation at Tom Price, Paraburdoo and Marandoo — 2001

Internal reference: RTIO-HSE-0016088

This study obtained baseline information on various parameters from unmined hillslopes in the West Pilbara areas of Marandoo, Tom Price and Paraburdoo, to facilitate comparison of vegetation established on sloping rehabilitation areas.

Vegetation on hillslopes fell into three broad structural groups: slopes dominated by a spinifex hummock grassland with an open cover of scattered shrubs; slopes supporting a relatively dense shrubland over a moderate amount of spinifex; or slopes supporting a tall shrubland (usually dominated by Mulga) over large amounts of annual grasses with little or no spinifex. There was considerable variability in the floristic composition of unmined hillslope vegetation, with none of the transects showing any particular trend. Fire appears to be the dominant influence, with unburnt transects grouping out as dissimilar from burnt transects.

A Vegetation and Flora Survey of the Brockman Syncline 4 Project Area, near Tom price **2005**

A pre-mining vegetation and flora survey undertaken to support project approval for Brockman 4.

Internal reference:
RTIO-HSE-0094270

One vegetation type, Acacia synchronicia, was identified as high conservation significance and a further 13 vegetation types of moderate conservation significance were identified and mapped. The Brockman 4 project area has a moderate species richness, which is neither atypically high nor low. No Declared Rare Flora were recorded in the project area. Five Priority flora species were recorded including the Priority 1 species, Ptilotus sp. Brockman (E. Thoma & A. Joder ET & AJ 145).

A Flora Survey of the Brockman Syncline 4 Rail and Infrastructure Corridor **2007**

This report documents the outcomes of a flora survey conducted to support project approval for Brockman 4.

Internal reference:
RTIO-HSE-0094271

The Brockman 4 rail and infrastructure corridor has a moderate species richness. The families and genera with the greatest number of species were those that are typically predominant in the vegetation of the central Pilbara.

Brockman 4 Rehabilitation Monitoring Report 2010 **2010**

Ten borrow pits rehabilitated at Brockman 4 in 2008-09 were selected for rehabilitation monitoring in 2010. This report describes the findings from analysis of the monitoring data for the following sites: three Borrow Pits along White Quartz Road (WQRBP06, 37 and 41), three Borrow Pits adjacent to the railway line (BLE06 and 07; BP 19A,B,C), two camp sites (Fly Camp and Camp BA03) and general site Borrow Pits BP17B and ANFO BP51.

Internal reference:

For each disturbed area, topsoil was returned, available vegetative material respread over the surface and sites were ripped or scarified while a pad foot roller was used at site BP17B. No seeding was carried out so any vegetation established is from seed stored in topsoil, seed in vegetative material or natural colonisation. The topsoil used would have been stockpiled for under 18 months. No reference sites were established at the site at the time of monitoring, so it was only possible to evaluate the rehabilitation in relation to the operational methods used at each site. The rehabilitation is young and rainfall had been low. This has resulted in vegetation that has fewer species and plants than would usually be the case. As well as this, no seeding was carried out and some sites had evidence of grazing. Nevertheless, from a stability and earthworks perspective, these sites should be capable of developing into successful rehabilitation. Topsoil quality aspects such as the initial seed store may have influenced early rehabilitation success.

Brockman 4 Rehabilitation Monitoring Report 2011 **2011**

This report summarises the monitoring results of ten borrow pits rehabilitated at Brockman 4 in 2008-09 and initially monitored in 2010. It also details two control sites which were established along White Quartz Road.

Internal reference:

Although the rehabilitation at Brockman 4 is still relatively young and varies between the sites, monitoring results for most sites have shown promising development with increasing numbers of species and perennial plants, as well as increasing cover. Rehabilitation at the three White Quartz Road sites varied, with the best overall establishment in 4681 V and very few plants in 4681 AI. Results suggested that rehabilitation at sites 4681 V and 4681 AM will continue to develop towards that of the reference site, while for site 4681 AI, it is too early to conclude how good the rehabilitation will be. Rehabilitation at the three railway sites has improved since 2010, with higher numbers of species and increases in plant densities and cover, although spinifex was only present in BP19ABC and BP19ABC New in small numbers. The two rehabilitated camp sites remain different to each other, with Fly Camp considered likely to continue to develop over time, while at Camp BA03, values for most of the measured parameters were higher than those in the reference site with the exception of cover, which was also increasing. It was concluded that in a few years, rehabilitation at the site is likely to be of a comparatively good standard. Rehabilitation establishment in borrow pits BP 17B and ANFO BP51 also varied, with most parameters for BP 17B well below those in reference site C2, while total plant numbers, including spinifex, were higher in ANFO BP51 and at this stage, the site appears likely to develop into rehabilitation that resembles reference site C2. Overall, it can be concluded that rehabilitation in most borrow pits has started to develop well, however the sites are too young to determine likely rehabilitation success with any degree of confidence. No seeding was carried out at any of the sites, and monitoring in 2010 noted low rainfall after establishment as well as grazing in some sites; this is likely to have affected initial plant establishment. All rehabilitated sites monitored through rehabilitation monitoring appear to be stable with no erosion visible.

Brockman 4 Priority Flora Seed Collection **2012**

This report documents the outcomes of survey work aimed at observing flowering and seed development in four Priority species around Brockman 4 and to collect seeds from these species. This report forms part of an ongoing Priority Species investigation project.

Internal reference:
RTIO-HSE-0169704

Seeds were collected from the following species: Indigofera sp. Bungaroo Creek, Ptilotus subspinescens, Sida sp. Barlee Range. Only a small amount of seed was collected for Acacia bromilowiana species. As a result of this work, optimal seed collection methods and timing for these species is better understood. This work was required in accordance with one of the Brockman 4 project approval conditions from the Office of the Environmental Protection Authority to collect seed and material of Priority flora species within the disturbance area to be later used in rehabilitation works in the re-establishment of these species.

Brockman 4 Rehabilitation Monitoring Report 2012 **2013**

Internal reference:

This report summarises the 2012 monitoring results of ten borrow pits rehabilitated at Brockman 4 in 2008-09 and two control sites established in 2011. Assessment of fauna habitat was also undertaken for the first time in 2012.

Although the rehabilitation at Brockman 4 is still relatively young and varies between the sites, monitoring results show an increasing numbers of species and perennial plants, as well as increasing cover and emergence of spinifex species. Some sites however did have relatively high densities of buffel grass and some bare areas. For site 4681 AI, rehabilitation is showing no signs of improving. In terms of stability, erosion gullies were noted on slopes at sites 4681 AI and BP17B, indicating that assessment of surface stability will be required at these sites in future. Of the four species recorded in the two reference sites, two were recorded in rehabilitated sites and two (Senna species) were not. The absence of these species from rehabilitation may reflect pre-disturbance site differences as well as rehabilitation establishment and survival rates. Other species were present in rehabilitation but not in reference sites. Acacias appear to establish easily in the rehabilitation as would be expected following disturbance. The rehabilitated sites range in fauna habitat suitability, depending on the species or fauna group concerned, and their habitat requirements. Many sites were comparable to unmined reference sites in relation to fauna habitat components, while others possess poor quality fauna habitat.

Brockman 4 Rehabilitation Reference Site Establishment and Monitoring **2014**

Internal reference:
RTIO-HSE-0211447

This report summarises data collected at 7 reference sites installed at Brockman 4 in 2013. Transect sites were installed in three representative landscape units; flat, midslope and hilltop.

Key findings at the reference sites include: - 42 plant taxa from 19 plant genera and nine plant families were recorded. - The majority of taxa recorded were in the Fabaceae (17 taxa) and Malvaceae (10 taxa) families. - Triodia wiseana was the dominant species with 2026 individual plants recorded. - No priority flora, declared species or introduced species were recorded. - The density of live plants was low on the flat landscape unit compared to the hilltop landscape unit. - The density of plants on the midslope landscape unit varied between the two transects. - There was no clear difference in foliage cover between landscape units. - Bare ground was highest on the flat landscape unit, followed by the hilltop then the midslope. - Soils were generally classed as sandy clay loams, with high coarse material. - Soil chemical parameters were as expected for the area, with the exception of transect C6 which recorded salinity, nitrate N and plant-available sulphur values higher than the other soils sampled.

Brockman 4 - Rehabilitation Monitoring Report 2014 **2014**

Internal reference:
RTIO-HSE-0266713

To record the vegetation, erosion and fauna habitat in eleven rehabilitation sites and six reference sites. Eight of the rehabilitated sites were rehabilitated in 2009, while the other three were rehabilitated in 2012.

Although the rehabilitation at Brockman 4 is still relatively young and quality varies between the sites, monitoring results for many sites have shown promising development with increasing numbers of species and perennial plants, as well as increasing cover. Overall, it can be concluded that rehabilitation in most of the rehabilitated sites is developing well, however there is some variability between sites and most are too young to determine likely rehabilitation success with any degree of confidence.

Boolgeeda Creek Riparian Vegetation Extension Survey **2015**

Internal reference:
RTIO-HSE-0271210

To support the environmental impact assessment required to obtain Ministerial Statement 1000, mapping of the riparian vegetation was undertaken along approximately 41 km of Boolgeeda Creek immediately downstream of the approved discharge point. Ecological Australia Pty Ltd was engaged by Rio Tinto to extend this mapping and identify any features of potential environmental significance to support environmental approval of a proposed extension of the discharge footprint.

A total of 109 native and eight introduced flora taxa were identified within the study area. The taxa comprised 35 families and 88 genera. The most commonly occurring families were Fabaceae (22 taxa), Poaceae (16 taxa) and Malvaceae (11 taxa). Acacia (Fabaceae) was the most common genus with eight taxa. None of the vegetation units identified within the study area are listed as Threatened Ecological Communities or Priority Ecological Communities or were inferred to be representative of Threatened Ecological Communities or Priority Ecological Communities. One Department of Parks and Wildlife listed Priority 3 flora taxon was recorded during the survey: Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301). This taxon was recorded from 352 locations within the study area comprising approximately 2,837 individuals.

Brockman Syncline 4 - Level 2 Vegetation and Flora Survey **2016**

Internal reference:
RTIO-HSE-0274626

A Level 2 flora survey of the previously unsurveyed section of the BS4 Marra Mambas ore body study area. Additional work was required to enhance the level of knowledge at the locality scale, and to ensure that flora and vegetation data and reporting met the current Environmental Protection Authority expectations for botanical surveys for environmental impact assessment.

A total of 33 vegetation types were described from the study area, which is an expected number given the size and geomorphic diversity of the study area. The majority of the vegetation was ranked as being in Excellent condition, however some creeklines were ranked as Poor or Very Poor due to invasion by the aggressive weed **Cenchrus ciliaris* (Buffel Grass). A clustering analysis indicated that all of the floristic groups in the study area occurred more broadly outside the study area.
None of the vegetation units are formally listed as Threatened Ecological Communities or Priority Ecological Communities.

Fauna

Fauna Habitats and Fauna Assemblage of the Brockman No.4 Project Area **2005**

Report outlines the methodology and outcomes of fauna survey work undertaken at Brockman 4 to support project approval.

Internal reference: RTIO-HSE-0013547

Five fauna habitats were identified in the area. 123 taxa of terrestrial vertebrate were recorded, including two priority listed species; Australian Bustard Ardeotis australis and Notoscincus butleri Notoscincus butleri, both Priority 4 at the time of the survey. Three key groups of invertebrates (pulmonata, diplopoda and mygalomorphae) were also recorded.

Brockman Syncline 4 Project Baseline Stygofauna Assessment **2005**

This report outlines the findings of stygofauna surveys in the Brockman 4 area to support the environmental approval process for the project.

Internal reference: RTIO-HSE-0094276

Only one of the 27 bores sampled during the first phase yielded a single stygofauna specimen and subsequent sampling yielded no specimens. Further sampling was recommended to confirm these findings.

Fauna Assemblage of the Brockman Syncline 4 Project, near Tom Price July 2005 **2005**

Final report outlining the findings of fauna survey work undertaken across the Brockman 4 area to support project approval.

Internal reference: RTIO-HSE-0094273

Six primary fauna habitats were identified in the area. A total of 159 taxa of terrestrial vertebrate were recorded, including four Priority 4 listed species. Three key groups of invertebrates (pulmonata, diplopoda and mygalomorphae) were also recorded, as per the previous survey report in January (RTIO-HSE-0013547).

Brockman Syncline 4 Boolgeeda Creek Stygofauna Survey **2007**

This report outlines the findings of an additional stygofauna survey in the alluvial creek systems (the Boolgeeda borefield area) in the valley north of the Brockman 4 project area.

Internal reference: RTIO-HSE-0094277

No further stygofauna were recorded during this survey, indicating that no action is required to manage stygofauna population impacts at this site.

Brockman Syncline 4 Marra Mambas Level 2 Fauna Survey **2016**

A Level 2 terrestrial fauna survey of the previously unsurveyed section of the BS4 Marra Mambas ore body study area. The resulting report was to include both new and historical fauna records and fauna habitat information for the entire study area. The primary purpose of this report is to highlight potential conservation issues that may require specific consideration or management measures. Its intended use is as a supporting document for the EIA of the proposed BS4 Marra Mambas development.

Internal reference: RTIO-HSE-0275787

The survey recorded a total of 100 vertebrate fauna species, comprising 11 ground-dwelling mammal species, 30 reptile species, one amphibian species, nine bat species and 49 bird species. With the inclusion of records from previous surveys conducted within the study area, a total of 133 vertebrate fauna species have been recorded within the study area to date. Of these, the following five species are formally listed as being of conservation significance:

1. Pilbara Leaf-nosed Bat, Rhinonicteris aurantia (Schedule 3, Vulnerable)
2. Ghost Bat, Macroderma gigas (Schedule 3, Vulnerable)
3. Western Pebble-mound Mouse, Pseudomys chapmani (Priority 4)
4. Rainbow Bee-eater, Merops ornatus (Schedule 5, Migratory)
5. Fork-tailed Swift, Apus pacificus (Schedule 5; Migratory)

Brockman Syncline 4 Marra Mambas Subterranean Fauna Assessment report by Biota Environmental Sciences detailing Phase 1 troglofauna and stygofauna sampling of the Brockman Syncline 4 Marra Mamba deposits during 2015 **2016**

As part of the environmental impact assessment of the proposed BS4 MM development, Biota undertook an assessment of subterranean fauna and subterranean habitats within the study area to describe and characterise subterranean fauna habitats within the study area; conduct a subterranean fauna sampling programme to document troglofauna and stygofauna present within the study area; and place the recorded fauna into regional context and discuss their potential conservation significance.

Internal reference: RTIO-HSE-0298268

A total of 16,131 invertebrate specimens were recorded during the troglofauna sampling component of this study, representing 12 orders belonging to six phyla. The specimens included 29 potential troglobites from eight orders and two phyla. The orders Blattodea and Schizomida were the most commonly collected, comprising over 55% of all recorded specimens. Potential troglobitic fauna were recorded from 11 sites, located in the central and eastern portion of the study area, in colluvium and Marra Mamba banded iron formation (BIF) geological units, including hydrated portions of the BIF, which has been shown to be habitat for troglofauna elsewhere. Molecular analysis of selected troglofauna groups (Schizomida, Diplura, Blattodea, Isopoda and Pseudoscorpiones) was conducted to obtain species level identification and place the study area taxa into regional context. Two of the 11 troglofauna species recorded are considered to be SRE fauna (the pseudoscorpion Chernetidae sp. ‘marra mamba’; and the schizomid Paradraculoides sp. ‘marra mamba’) and six are potential SRE fauna, with the remaining three taxa unlikely to be SREs.

BS4 MM Echolocation Survey of Pilbara leaf-nosed Bat Activity **2016**

Internal reference: RTIO-HSE-0275792

A possible colony of Pilbara Leaf-nosed Bats (Rhinonicteris aurantia) has been inferred close the Rio Tinto Brockman Syncline 4 iron ore mine west of Tom Price in the Pilbara, Western Australia. The colony is one of less than 20 known from the Hamersley Range. During previous surveys in the region, PLNb were recorded at a number of sites close to the proposed expansion named Brockman Syncline 4 Marra Mambas.

During the survey, bat echolocation activity was measured at seventeen sites. PLNB were detected at only seven. Activity levels at six of the seven were low with less than twenty calls per night. High activity levels were detected at only one site, a permanent pool on an unnamed tributary creek, 7km south of the current mining operations. No evidence of a PLNB roost close to the BS4 MM deposit was found.

Location of Upper Beasley River Pilbara leaf-nosed bat diurnal roost **2017**

Internal reference: RTIO-HSE-0305540

During previous surveys in the region, Pilbara Leaf Nosed Bats were recorded at a number of sites close to the Brockman Syncline 4 site. Based on data up to November 2015, an area along a 25km length of ridge line centred on the Marra Mambas deposit had been indicated as a likely location of the roost. The study details the searches for the roost and associated survey results.

The location of the roost cave and its nearby permanent water hole were confirmed in December 2016. In addition, a second permanent waterhole approximately 6 km to the east has also been shown to be important for the presence of the species in the area, in particular during dry seasons following wet seasons with little rainfall. Continuous detection of PLNb in the district since 2009 has confirmed that the roost is permanent and therefore is assumed to be maternal.

Biodiversity improvement studies

Evaluation of mine waste materials as alternative rehabilitation growth medium **2010**

Internal reference: RTIO-HSE-0109961

This study reviewed the physical and chemical properties of soil, tailing and mineral waste from select Pilbara mining operations, to identify waste material and material combinations for use as a topsoil substitute or supplement.

The study showed plant-available nutrients held within the waste materials, although variable, was characteristically low and comparable to natural soils in the region. The majority of the waste materials had macro and micro nutrient concentrations within the range or above the levels measured in benchmark Pilbara topsoil and rehabilitated soils. The pH and phosphorus buffering index of most waste materials were also comparable to that of the benchmark topsoil materials. However, some of the waste types and tailings may need to be mixed with rocky material due to poor physical / erodibility characteristics.

Genetic diversity in Eucalyptus leucophloia across the Pilbara: Provenance zone implications **2011**

Internal reference: RTIO-HSE-0108843

This study was undertaken to define the provenance seed collection zones for a common species of the Pilbara, Eucalyptus leucophloia (Snappy Gum). This report details information on genetic analysis conducted on E. leucophloia. Collections of E. leucophloia were made from 20 populations across the Pilbara bioregion and genetic analysis was conducted using microsatellite markers.

Genetic diversity in E. leucophloia was high and was typical of that found in other eucalypt species with wide spread distributions. Across the species the level of population differentiation was low and the majority of the diversity was maintained within populations with only 6% of variation partitioned between populations. Genetic variation in E. leucophloia showed little structure across the Pilbara with no clustering of populations based on any geographical proximity or in association with obvious topographical, physiogeographical or geological features such as the Hamersley or Chichester Ranges. Populations towards the edges of the species distribution within the Pilbara showed greater levels of differentiation from populations within the species main range. The high levels of genetic diversity and low levels of differentiation within E. leucophloia implies that seed resources for rehabilitation can be selected from a wide range within the Pilbara.

Genetic diversity in Acacia ancistrocarpa across the Pilbara: Provenance zone implications **2011**

Internal reference: RTIO-HSE-0119260

This study was undertaken to define the provenance seed collection zones for Acacia ancistrocarpa (Fitzroy Wattle). This report details information on genetic analysis conducted on Acacia ancistrocarpa. Collections were made from 24 populations across the Pilbara bioregion and genetic analysis was conducted on 16 populations using microsatellite markers.

Genetic diversity in A. ancistrocarpa was high but lower than that in E. leucophloia, another widespread species in the Pilbara. Across the species Pilbara range the level of population differentiation was low and the majority of the diversity was maintained within populations with only 3% of variation partitioned between populations. Genetic variation in A. ancistrocarpa showed little structure across the Pilbara with no clustering of populations based on geographical proximity or in association with obvious topographical, physiogeographical or geological features. Populations towards the edges of the species distribution within the Pilbara showed greater levels of differentiation from populations within the species main range. The high levels of genetic diversity and low levels of differentiation within A. ancistrocarpa implies that seed resources for land rehabilitation and mine-site revegetation programs can be selected from a wide range within the Pilbara

Root hydraulic conductance and aquaporin abundance respond rapidly to partial root-zone drying events in a riparian Melaleuca species **2011**

Internal reference: RTIO-HSE-0252171

This study examined partial root zone drying (PRD) responses of Melaleuca argentea.

The results demonstrate that PRD can induce rapid changes in root hydraulic conductance and aquaporin expression in roots, which may play a role in short-term water uptake adjustments, particularly in species adapted to heterogeneous water availability.

Baseline Terrestrial Fauna Assessment of Pilbara Rehabilitation Areas **2012**

Internal reference: RTIO-HSE-0134168

In 2011 a fauna survey was conducted within established rehabilitation areas at Brockman 2 and Tom Price mine sites, with the aim of identifying whether fauna is recolonising rehabilitation sites in assemblages comparable to reference sites.

The study found that at least 85 species of native vertebrate fauna, as well as representatives from each of six major groups of invertebrate fauna, are using rehabilitation areas at Brockman 2 and Tom Price, with species compositions that were broadly similar to reference sites. Ant collections were typical of the Pilbara bioregion, with an absence of invasive ant species. The study found greater data correlation between monitoring sites at a particular mine site (Tom Price or Brockman 2) than between rehabilitation and reference sites, indicating the importance of selecting local reference sites. The study concluded that the best candidates for bio-indicators are ants and reptiles.

Hay Project – Native Seed Orchard **2012**

Internal reference: RTIO-HSE-0141263

Commencing in 2011 (and still ongoing), a trial irrigated seed orchard was established at the Hamersley Agriculture Project (Marandoo). The purpose of the trial was to identify an alternate method of addressing seed deficits. If successful, the project may be implemented at other Rio Tinto operations, such as the Nammuldi agriculture project.

Genetic diversity in Aluta quadrata:Implication for management and provenance zone **2012**

Internal reference: RTIO-HSE-0156732

This study was undertaken to define the provenance seed collection zones for Aluta quadrata. This report details information on genetic analysis conducted on Aluta quadrata. Collections were made from 8 populations across the Pilbara bioregion and genetic analysis was conducted using microsatellite markers.

Genetic diversity in A. quadrata was moderate and lower than in the other two more widespread Pilbara species, E. leucophloia and A. ancistrocarpa. The findings suggest that its populations may have fluctuated significantly in size over time with genetic drift and possibly inbreeding resulting in a reduction in genetic variability, particularly in rare alleles. Despite the narrow geographic range, the level of population differentiation in A.quadrata was relatively high with 25% of the genetic variation maintained between populations and 19% due to differences between the three different locations. This significant genetic structure indicates that A. quadrata consists of three conservation or management units, Western Ranges, Pirraburdoo and Howie's Hole.

Genetic diversity in Acacia atkinsiana across the Pilbara: Provenance zone implications **2012**

Internal reference: RTIO-HSE-0187256

This study was undertaken to define the provenance seed collection zones for Acacia atkinsiana (Atkins wattle). This report details information on genetic analysis conducted on Aluta quadrata. Collections were made from 16 populations across the Pilbara bioregion and genetic analysis was conducted using microsatellite markers.

Genetic diversity in A. atkinsiana was low and lower than that observed in its congener Acacia ancistrocarpa, a widespread species across northern Australia. The level of population differentiation was high and 30% of the diversity was partitioned between populations across the range of A. atkinsiana. Genetic variation in A. atkinsiana showed some structure across the Pilbara with clustering of populations in the western part of the distribution and from the Hamersley Range, along with other populations that were divergent from these groups. The low levels of genetic diversity and high levels of differentiation within A. atkinsiana implies that seed for land rehabilitation and mine-site revegetation programs should be restricted to specific zones. For rehabilitation of sites within the Hamersley Range we recommend seed collections be restricted to that region. Similarly, for rehabilitation in the part of the distribution west of Pannawonica, seed collections should be restricted to that area.

Rehabilitation Quality Metric (RQM) Project **2012**

Internal reference: RTIO-HSE-0164020

Western Australia has no formal process to measure habitat quality and as such RTIO has needed to design its own customised metrics. Vegetation condition scoring has previously been developed by RTIO through a Biodiversity Net Positive Impact Assessment, but a more precise metric was needed. The Rehabilitation Quality Metric (RQM) project was developed to provide a repeatable method to assess rehabilitation quality against pre-determined reference sites, on a site by site basis, to predict rehabilitation ecosystem quality at the time of relinquishment.

The RQM methodology employs seventeen parameters to characterise the landscape, including vegetation, fauna habitat, fauna presence, erosion, and ecosystem function. Parameters are tailored to be an applicable measure for both rehabilitation and native vegetation (reference sites). Parameters are scored, based on measured or observed characteristics, with a value between 0 and 1, with 1 being functional (terrestrial ecosystem is functioning for the maintenance of biodiversity values at a local or property scale) and 0 being dysfunctional (terrestrial ecosystem is failing; indicators of ecosystem function have scored below acceptable levels). Both rehabilitation areas and reference sites are scored. Scores are subsequently determined for the entire mine lease, based on the condition of the land before mining (extrapolated from the reference sites, area weighted) and the likely post-mining conditions (extrapolated from the rehabilitation areas and expected closure domain distribution, area weighted, ie pits with no rehabilitation score 0). The difference between the pre-mining and post-mining scores represents the residual impact of mining.

Propagation of Pilbara spinifex (Triodia sp.) **2012**

Internal reference: RTIO-HSE-0169744

Triodia has often been observed to have very poor establishment from broadcast seed. This project investigated alternatives to growing Triodia (spinifex) from seed, focussing on ways to propagate seedlings from wild harvested material.

The project found the most successful propagating material was stolons. Greatest propagation success was achieved when Triodia were collected when semi to fully dormant (mid Winter-Spring). The 'Moist Root Induction Method' recommended by previous researchers was less successful than the standard propagation techniques employed in this project. Success varied notably between populations. Consequently, any future collections of propagating material should target multiple populations to maximise potential for success.

Pilbara Seed Science Project, Part 2 Final Report Jan 2012 **2013**

Internal reference: RTIO-HSE-0174944

Undertaken between 2009-2012, this seed research investigated germination, biology, dormancy classification and treatments for dormancy alleviation for a range of species from the Pilbara.

The *Acacia atkinsiana, Indigofera monophylla and Sida echinocarpa* seed lots have physical dormancy. Heat treatments and mechanical scarification improved germination on dormant seeds, however, heat treatments killed non-dormant seeds. The treatments used for *Goodenia stobbsiana* seeds failed to overcome dormancy, suggesting deep physiological dormancy. The *Hakea lorea/ chordophylla* seed lots were found to be non-dormant, with very high germination results in the controls. As such, they will not require any pre-treatments prior to direct seeding. The florets surrounding the *Triodia pungens* and *T. wiseana* seeds were found to restrict germination, however, many of the freshly extracted seeds out of the florets were found to be physiologically dormant. Treatments for dormancy include mechanical scarifier to rupture seed coat, hot water (noting potential damage to immature or non-dormant seeds) and increases to germination through wet / dry cycling and / or temperature cycling.

Morphological variation in the western rainbowfish (Melanotaenia australis) among habitats of the Pilbara region of northwest Australia. **2013**

Internal reference: RTIO-HSE-0252169

The aim of this honours thesis was to determine and quantify the extent of morphological variation present in M. australis and relate this to environmental variables, which will provide the first step to understanding how the species copes with environmental change.

This results of this thesis found that there was limited evidence that fish morphology correlated with environmental variables

Patterns of water use by the riparian tree Melaleuca argentea in semi-arid northwest Australia **2013**

Internal reference: RTIO-HSE-0249538

This thesis examines the water use physiology of the riparian tree Melaleuca argentea, and the ways in which this species may respond to anthropogenic disturbances to hydrologic processes.

M. argentea displays highly plastic root-level responses to heterogeneous water availability and to waterlogging, facilitating high rates of water use and growth in the riparian wetland habitats of the Pilbara. Mature M.argentea trees appear to tolerate groundwater drawdown of at least several metres, most likely by employing the same plastic root strategies to access deeper water. M.argentea can also withstand short periods of severe drought, by adopting a 'waiting' strategy of ceasing growth and shedding leaves to avoid moisture loss, a state from which they can then recover. M. argentea populations are unlikely to thrive under large and prolonged reductions in water availability.

Priority Species Seed Quality and Germination Final Report **2013**

Internal reference:
RTIO-HSE-0207487

This study investigated the quality and germination biology of a range of priority and keystone (Triodia) plant species from the Pilbara.

Eremophila magnifica subsp. Magnifica has physical & physiological dormancy. Propagation methods other than seed may be more successful. Geijera salicifolia and Olearia mucronata has physiological dormancy. Temperature cycling may be required to stimulate germination. Indigofera ixiocarpa and Indigofera sp. Bungaroo Creek has physical dormancy or is non-dormant. Mechanical scarification may be required. Ptilotus subspinescens is non-dormant and will germinate easily without removal from the perianth sheath. However, seed is likely to lose viability with a few years. Sida echinocarpa and Sida sp. Barlee Range has physical dormancy. Seeds should be removed from the mericarp and then scarified in order to germinate. Triodia pungens has T. wiseana non-deeep or deep physiological dormancy. Germination of de-husked seeds can be improved by applying gibberellic acid or 1% smoke water and wet/dry cycling.

Early physiological flood-tolerance and extensive morphological changes are followed by slow post-flooding root recovery in the dryland tree Eucalyptus camaldulensis subsp. Refulgens **2014**

Internal reference:
RTIO-HSE-0252170

This study investigated physiological and morphological response to flooding and recovery in Eucalyptus camaldulensis subsp. Refulgens, a riparian tree species from a dryland region prone to intense episodic flood events.

E. camaldulensis subsp. Refulgens underwent considerable morphological changes during flooding, including extensive adventitious root production, increased root porosity and stem hypertrophy. Physiologically, net photosynthesis and stomatal conductance were maintained for at least 2 weeks of flooding before declining gradually. Despite moderate flood-tolerance during flooding and presumably high environmental selection pressure, recovery of reduced root mass after flooding was poor.

Priority Species Project Progress Report 2013 **2014**

Internal reference:
RTIO-HSE-0207486

The Priority Species Project, initiated in 2012, aims to improve knowledge of priority plant species and develop methods to successfully germinate and establish priority species, to enable priority plant species to be integrated into Rio Tinto rehabilitation programmes. This work is being undertaken in conjunction with the Department of Parks and Wildlife.

13 plant species were selected as being potentially suitable for establishment in rehabilitation: Eremophila magnifica subsp. magnifica, Indigofera sp. Bungaroo Creek, Indigofera sp. gilesii, Acacia bromilowiana, Sida sp. Barlee Range, Ptilotus subspinescens, Ptilotus mollis, Acacia subtiliformis, Isotropis parviflora, Grevillea sp. Turee, Hibiscus sp. Canga, Themeda sp. Hamersley Station, and Aluta quadrata. Indigofera sp. Bungaroo Creek and Ptilotus subspinescens were found to readily germinate in laboratory conditions, and a field trial was established at Brockman 4 late in 2013.

Regional Variation in Metal Concentrations of Pilbara Fish in Relation to Concentrations in Water and Sediments **2014**

Internal reference:
RTIO-HSE-0216967

This study aimed to characterise and document natural, background metal concentrations in freshwater fishes from different locations across the Pilbara in order to understand how local geology may affect baseline metal levels in fish tissues and surface waters. Metal concentrations were analysed from water, sediment and muscle and liver tissues from fish collected from up to 13 sites as yet unimpacted by mining across the Pilbara during October (dry season) of 2012.

Levels of dissolved metals from water samples were generally low. However, some elevated concentrations of Boron, Copper and Zinc were recorded. Concentrations of heavy metals in sediments were variable across the Pilbara. Generally, sediment concentrations were well below the Interim Sediment Quality Guidelines (ISQG). However, metal concentrations in excess of ISQG TVs were recorded for Chromium and Copper at some sites. There was no relationship between metal concentrations in sediment and those in water. Metal concentrations in fish tissue (muscle and liver) varied between species with some significantly higher in some particular species. The study concluded that variation in metal concentrations in water, sediment and fish across pools in the Pilbara was likely to be mainly dictated by the local geological setting in which the pool occurs.

Progress Report 2014, Ecological responses of native fishes to dynamic water flows in northwest arid Australia **2014**

Internal reference:
RTIO-HSE-0246021

This three year Australian Research Council linkage Project commenced in 2013 and aims to increase understanding of the effects of altered stream flows on the Pilbara freshwater aquatic environment. Project aims: 1. Quantifying fish biodiversity and population structure in relation to hydrological and environmental parameters to identify thresholds of ecological concern for water management; 2. Determine the fundamental physiological, morphological and behavioural adaptations of fishes to variations in water quality using experimental manipulations; and 3. Examine spatial scales of gene flow to determine if increased flows increase genetic connectivity relative to natural-flow sites.

To date work has focuses on characterisation of baseline physicochemical parameters across aquatic habitats within the Fortescue River catchment (Aim 1), analysis of variation in rainbow fish morphometrics and mechanosensory lateral line systems in response to geographic region and water management regime (Aim 2), and extraction of DNA samples from 17 populations across the Fortescue River catchment (Aim 3). The project will culminate in the development of a predictive model for stream restoration relevant to future closure scenarios for above and below-groundwater mines. Results from an honours thesis indicate that rainbow fish body shape varies according to geographic region but fish from a dewatered site (WW Ck) were more streamlined than other populations from the upper Fortescue catchment. This statement of results has been superseded by the results of the actual thesis report RTIO-HSE-0252169.

Landform design

Results of flume investigations of the stability of rock mulches — 1998

Internal reference: RTIO-HSE-0109221

This study assessed the potential for rock mulches to be stripped from the soil surface by overland flows.

Although 150-300mm diameter BIF was not removed by simulated overland flows, even for 100mm/hr simulated runoff on 55% gradients, considerable scour of the spoil between the rocks was observed, indicating potential for long-term development of rills or gullies if the level of rock cover was less than 100%. Large reductions in sediment concentrations were observed when finer rocks were mixed with BIF. The data indicate that it is crucial for any rock mulch to cover a wide range of particle diameters, including a component of finer rocks. The resulting mixed rock created a framework of large rocks that resist movement by flows, while the smaller rocks reduce erosion being anchored within the larger (framework) rock. For rock mulches with a mixture of rock diameters, 80% cover produced acceptable erosion rates. Sediment loads were slightly higher for 40% cover by rock of mixed diameters, and it was speculated that this may also achieve acceptable erosion rates with the addition of vegetation.

Final Landform Design Criteria for Use During Mine Planning — 2012

Internal reference: RTIO-PDE-0159989

Rio Tinto Iron Ore WA have historically designed closure landforms for waste materials with berms ~10 m, lifts ~20 m and ad hoc alterations to batter gradients where erosion rates have been perceived to be unacceptably high. This report integrates recent advances in characterisation and modelling of materials, climate and erosion processes to provide appropriate final landform batter characteristics for key Pilbara mineral wastes and soils.

Material properties of mineral wastes were assessed and classified for the range of mineral wastes found across Rio Tinto Pilbara sites. Climate sequences were used to model and test potential erosion rates for a range of batter configurations (shapes (linear, concave), heights, gradients, berm capacity) and validated against existing slopes for which material and climate data were available. This information was used to develop a searchable waste dump batter database for all major mineral wastes and soils, intended for use during mine planning design.

Memo Regarding Black Shale Management via Dump DP2 at Brockman 4 — 2013

Internal reference: RTIO-HSE-0205523

This report outlines the proposed strategy for managing potentially acid forming (PAF) material expected to be intercepted in mining operations by Q2 2015 at Brockman 4.

Pit 1, 2, 3 and 5 contain PAF material which is expected to be commence mining in Q2 2015 (from Pit 5 initially). Dump DP2 has been identified as being suitable to contain this material in accordance with the Rio Tinto Acid Rock Drainage and Spontaneous Combustion Management Plan. This memorandum outlines the design considerations for this dump to ensure PAF material is appropriately managed, including understanding the rehabilitation requirements at closure. The dump will be constructed in stages. Stage 1 includes construction of a foundation of inert material with thickness no less than 5 metres. Stage 2 will have Category S (cold black shale) placed in a single 5m lift and three 10 metre lifts. It will also have SR (hot black shale) dumped in six 2.5m lifts, each separated by a 2.5m layer of inert material. The two categories will be separated by at least 1m of inert waste. The dump has capacity for 18.8Mt of Category S and 2.4Mt of Category SR waste. The ends of the foundation will be left free of shale material so that the no black shale material is exposed on the final slope. Stage 3 will involve encapsulation of these cells with a layer of inert waste material and (Stage 4) low grade ore will be stockpiled on the east and west sides of the waste dump. The design has considered these stockpiles so that final rehabilitation will not uncover black shale material regardless of if these stockpiles are reclaimed prior to final rehabilitation or not.

Contamination

Impact of Nitrogen from Explosives on Mine Site Water Quality — 2008

Internal reference: RTIO-PDE-0054638

The likely issues associated with the use of nitrogen based explosives on mineral waste and any leachate water are explored in this report. The amounts of explosives used on site are described, along with nitrogen chemistry and toxicity. Nitrogen concentrations for various mine sites and specific lithologies are presented which includes concentration in rock assays and liquid extracts.

It was concluded that the largest risk of nitrogen contamination is likely to arise from the discharge of surface waters that have been in contact with blasted materials and are discharged off site into creeks or waterways. This becomes a more significant issue if the water is also acidic. Algae (ie cyanobacteria) plumes have been identified in acidic water at Tom Price

Control Measures for Potentially Acid Forming Pit Wall Rocks — 2010

Internal reference: RTIO-PDE-0079541

Desktop study of potential strategies to manage exposed sulfidic materials and find viable options for management was conducted with a focus on the Hope Downs 1 and Tom Price sites.

Chemical treatments have the potential to be effective only in the short-term and only for minor water quality issues. Grouting of the pit walls is expected to have limited applicability, although grout curtains behind the wall may have success (untested). Cover technologies have the greatest potential to be effective over the long term, but would need to be resistant to puncture by underlying rocks, resistant to weathering and UV damage ie shotcrete, geomembranes. For long term performance the exposed surface need to be as stable and free of loose material as possible. Treatment effectiveness will also depend on the site conditions, eg chemical less effective at Tom Price.

Workshop Summary and Desktop Review: Dewatering and Sulfate Accumulation **2012**

Internal reference: RTIO-PDE-0101903

This is a summary of a workshop held to determine the risks of dewatering sulphides within the pit wall. The outcomes from this workshop will be used to develop models to estimate the mass of sulfate produced as a consequence of dewatering activities.

There are many processes that contribute to poor pit water quality. Most of these processes are known and accounted for in existing models. However, the science of fluid flow in fractured rock is not well developed and this lack of knowledge restricts the outcomes of studies on pit water quality. There is a general lack of empirical data for estimating parameters used in models, creating a large degree of uncertainty in predictive models. Sensitivity analysis can be used to overcome some of these challenges.

Brockman 4 Fibrous Minerals Management Procedure **2012**

Internal reference: RTIO-HSE-0098477

This document outlines Brockman 4 site specific procedures, accountabilities and controls for the management of fibrous minerals.

Relevant to closure and rehabilitation, this procedure includes responsibilities for ensuring as built waste dump designs which contain fibrous or potentially fibrous material include 3D plans of the locations and volumes of fibrous material, and that pit face surveys map exposures of fibrous material for removal. It also outlines the procedure for encapsulating this material with an appropriate amount of inert material in the designated waste dumps.

Development of a conceptual model: Sulfate accumulation as a consequence of pit dewatering activities, memo **2012**

Internal reference: RTIO-PDE-0101903

Mine dewatering and the consequent lowering of the water table may result in desaturation of sulfide bearing lithologies. The objective of this work was to develop a conceptual model of the associated processes: where sulphide bearing rock intersects the pit walls, and where the sulphide bearing rock is located behind the pit walls but not directly exposed on the pit wall face.

The conceptual model developed estimates the mass of sulfate produced as a consequence of dewatering activities, considering processes during operations and after operations cease, and using sensitivity analysis where parameter inputs are uncertain. The model output provides the basis for an assessment of potential impacts on water quality for general risk assessment applications. Further work was identified to improve parameterisation of the model, including the collection of additional empirical data for pit wall fracturing, saturation of pit wall fractures and sulfide oxidation rates in talus and on pit walls.

BS4 - Black MCS surface exposure modelling related to acid water treatment options for Pit 3, Pit 5, Pit 7 and Pit 18 **2013**

Internal reference: RTIO-PDE-0114003

This memo documents the methodology and results related to the modelling of bench-by-bench black Mount McRae Shale (MCS) surface exposures expected in the Brockman Syncline 4 mining area, including Pit 3, Pit 5, Pit 7 and Pit 18 throughout the life of the mine.

Black shale is expected to be exposed during mine operation and on the final pit shell upon closure in Pit 3, Pit 5, Pit 7 and Pit 18. This information provides the basis for a more in-depth assessment of the water quality expected over the mine life of these pits.

Ethnographic or archaeological values

Report of An Ethnographic Heritage Survey Brockman 4 (AML70/004; E47/053; E47/1037) Near Mount Brockman Pilbara **2003**

Internal reference: RTIO-CR-0123715

The report details the results of an ethnographic survey of the Puutu Kunti Kurrama and Pinikura area of the proposed exploration drilling program at Brockman Syncline 4.

This report is not registered with the Aboriginal Heritage Inquiry System (AHIS) Database and is therefore considered confidential.

A Report of An Aboriginal Archaeological Survey of the Proposed Brockman Syncline Section 4 Exploration Drilling Program Area, Western Australia (Puutu Kunti Kurrama and Pinikura Section) **2004**

Internal reference: RTIO-CR-0123643

The report details the results of an archaeological survey of the Puutu Kunti Kurrama and Pinikura area of the proposed exploration drilling program at Brockman Syncline 4.

An area approximately 2.1 km (N/S) by 14km (E/W) was surveyed, with a total of 24 Aboriginal archaeological sites of varying significance identified and recorded. In addition, a total of 31 isolated flaked stone artefacts were recorded. The report is registered with the Aboriginal Heritage Inquiry System (AHIS) Database: Report ID 23426.

Results of An Ethnographic Heritage Survey of the Brockman 4 Syncline Pre-Feasibility Study and Evaluation Drilling Program **2007**

Internal reference: RTIO-CR-0045661

The report details the results of an ethnographic survey of the Puutu Kunti Kurrama and Pinikura area of the proposed exploration drilling program at Brockman Syncline 4.

This report is not registered with the Aboriginal Heritage Inquiry System (AHIS) Database and is therefore considered confidential.

Report of An Aboriginal Archaeological Survey of the Proposed Brockman 4 Railway Link with Associated Infrastructure (Eastern Guruma Section) Pilbara Western Australia **2007**

This report outlines the results of a staged archaeological survey of the (at the time) proposed Brockman 4 Syncline deposit to Brockman 2 Mine railway corridor, with associated infrastructure including upgrades to the existing Brockman 2 mine to Rosella railway and the White Quartz Road.

Internal reference: RTIO-CR-0188448

This report is not registered with the Aboriginal Heritage Inquiry System (AHIS) Database and is therefore considered confidential.

Report of an Aboriginal Archaeological Survey of the Proposed Brockman Syncline 4 infrastructure Survey Areas (Puutu Kunti Kurrama and Pinikura Section) Pilbara Western Australia. **2007**

This report outlines the results of an archaeological survey for the proposed railway corridor and infrastructure areas associated with the Brockman 4 project.

Internal reference: RTIO-CR-0188454

This report is not registered with the Aboriginal Heritage Inquiry System (AHIS) Database and is therefore considered confidential.

Results of an Ethnographic Heritage Survey of the Brockman Syncline 4 Evaluation Drilling and Mine Infrastructure Development Program **2007**

This report details the outcomes of an ethnographic heritage survey commissioned to record Aboriginal sites, features or places of cultural or historic significance within the survey area and also to provide comment on the previously identified sites within the survey area that will be subject to applications under Section 18 of the Western Australia Aboriginal Heritage Act 1972.

Internal reference: RTIO-CR-0045671

This report is not registered with the Aboriginal Heritage Inquiry System (AHIS) Database and is therefore considered confidential.

Report of Archaeological Survey and Excavation at the proposed Brockman 4 Syncline Project, Pilbara Region, Western Australia **2008**

This report discusses the results of eight archaeological surveys completed by Scarp Archaeology at the Brockman 4 syncline project, over both the PKKP and Eastern Guruma Native Title Claimant group areas.

Internal reference: RTIO-CR-0188458

This report is not registered with the Aboriginal Heritage Inquiry System (AHIS) Database and is therefore considered confidential.

Brockman 4 Site Re-Recording and S16 Excavation Program **2008**

This report summarises archaeological survey results to date as well as describing the results of archaeological investigations at 42 Aboriginal sites within the Rio Tinto Brockman 4 tenement.

Internal reference: RTIO-CR-0045677

Of the sites recorded, most (thirty) are considered to be of low archaeological significance, nine are considered to be of medium significance, and three are assessed as being of high archaeological significance. These sites are located in areas where avoidance by mine development is not possible. High significance sites include Brock-20, Brock- 21 (both artefact scatter - rockshelters) and BS4-07-83 (a siltstone quarry site). The report is registered with the Aboriginal Heritage Inquiry System (AHIS) Database: Report ID 23425.

Preliminary Advice of archaeological survey at Brockman 4, Mara Mamba, PKKP survey, Pilbara, Western Australia. **2009**

This report outlines the results of three archaeological surveys within the Brockman 4 project area.

Internal reference: RTIO-CR-0046563

This report is not registered with the Aboriginal Heritage Inquiry System (AHIS) Database and is therefore considered confidential.

Report of Archaeological Avoidance Levels Surveys Brockman 4 Mara Mamba and Beasley River Pilbara Western Australia **2010**

This report discusses the results of three archaeological surveys completed by Scarp Archaeology at the Brockman 4 syncline project.

Internal reference: RTIO-CR-0188067

This report is not registered with the Aboriginal Heritage Inquiry System (AHIS) Database and is therefore considered confidential.

Water and Indigenous People in the Pilbara: A Preliminary Study, CSIRO: Water for a Healthy Country **2011**

Water resources are vital to Indigenous identities, beliefs, environmental philosophies and livelihoods. This report provides a broad-scale scoping study of Indigenous relationships to water in the Pilbara and considers the potential impacts of Indigenous water values.

Internal reference: RTIO-HSE-0218222

Indigenous belief systems perceive water as an elemental part of the broader cultural landscape, held and managed under customary systems of law. Water sources were derived during the Dreaming and are the most important features in the Pilbara cultural landscape. Interviews raised issues of long term drying, obstruction of water flow, over-extraction, inappropriate discharge from de-watering and access restrictions.

Final Report on the Results of Archaeological Testing of PKKP B4 06-11 and Further recording of PKKP B4 06-10 at Brockman 4 Pilbara WA **2011**

This report details investigation works associated with two archaeological sites at Brockman 4 proposed for a Section 18 notice under the Aboriginal Heritage Act 1972.

Internal reference:
RTIO-CR-0045692

Artefact scatters and rockshelters with stone artefacts dominate archaeological sites in the area. Site PKKP B4 06-11 yielded a low frequency of flaked stone artefacts and it was recommended that surface artefacts were salvaged prior to the site being impacted by development. Site PKKP B4 06-10 was confirmed to be of low scientific significance. The report is registered with the Aboriginal Heritage Inquiry System (AHIS) Database: Report ID 27292.

Aboriginal archaeological assessment of the Brockman 4 Phase 3 mine expansion, Pilbara, Western Australia. **2012**

This report outlines the results of an archaeological survey covering 5.8 km2, associated with Phase 3 of the Brockman 4 project.

Internal reference:
RTIO-CR-0188358

This report is not registered with the Aboriginal Heritage Inquiry System (AHIS) Database and is therefore considered confidential.

Site Identification Assessment For S18. Report for the PKKP Survey: Brockman 4 Pit 1 Ethnographic Site Identification Survey 2013 being YMAC PKK122-45/ RTIO 51_B4 Pit1 s18_2013 **2013**

This report documents the results of the S18 ethnographic survey assessment conducted for the Brockman 4 Pit 1.

Internal reference:
RTIO-CR-0233834

As a result of this work, PPKP representatives requested further excavation works of several sites and artefact salvage at two sites. Salvaged artefacts from these four sites were to be deposited at Site Brock 25, an artefact scatter which would not be directly affected by mine construction. Discussion with the PKKP representatives during the survey and subsequently has verified the high significance of the Purlikuti and Jukaan area to the group, as supported by the longevity of the rockshelter occupation here. The proximity of these sites to the Purlikuti creek support their significance from an ethnographic perspective. Purlikuti is the corridor that people have walked for millennia in order to reach their significant art and archaeology places to the north and south of the range south of Boolgeeda River. Puutu Kunti Kurrama identify this as the place from where they took their name and the report indictated this should be recorded as a place of high ethnographical significance. The report is registered with the Aboriginal Heritage Inquiry System (AHIS) Database: Report ID 27981.

Results of an Ethnographic Heritage Survey for the Puutu Kunti Kurruma and Pinikura Peoples. Brockman 4 Phase 3, Heartbreak Ridge, Bourne Highway, Pinarra and Vivash. **2013**

This report discusses the results of an ethnographic survey conducted over 5 proposed exploration areas held by Rio Tinto including Brockman 4 Phase 3.

Internal reference:
RTIO-CR-0234496

This report is not registered with the Aboriginal Heritage Inquiry System (AHIS) Database and is therefore considered confidential.

Appendix D – Closure risk assessment

Risk Type (T=Threat)	Ref. Category	Ref. Subcategory	Ref. Item	Risk Description: Threat Title	Potential causes (Triggers / Indicators)	Existing Controls and Commitments	Risk Management Cla	Detailed Action Descriptions
T	A			**Planning and knowledge**				
T	A	01		**Contaminated sites**				
T	A	01	02	Under-estimated acid and / or metalliferous drainage management requirements during operations (pre-closure) & decommissioning phase	• Potential for acid / alkaline / metalliferous / neutral / saline drainage generation during operation of mine • Water management, storage and monitoring practices • Water quality prior to return to environment e.g. via infiltration or discharge	• Geochemical characterisation of waste material • Mineral Waste Management Work Practice • SCARD management plan • PAF waste stored in cells within waste dumps • Wet season management plans used to control run off. • Groundwater operating management plan to monitor groundwater quality • Water Discharge Monitoring and Management Plan	III	1. Undertake groundwater flow / water quality modelling for AMD at closure for high risk pits - Pit 3, Pit 5, Pit 7 and Pit 18. [BK19] 2. Complete an AMD risk assessment for BS4MM deposit S and deposit T and BS4 Endeavour deposit. [BK42]
T	A	01	03	Acid and / or metalliferous drainage generation (after closure) creates a contaminated site	• Interaction of water and mineral waste could generate acid / alkaline levels that leach metals / salts from the mineral waste or local environment • Presence of temporary or permanent open water bodies, enabling evapoconcentration to occur with creation of alkaline / hypersaline water quality • Ability of metals / salts to move through environment to impact a sensitive receptor, to meet definitions in Contaminated Sites Act 2003	• Geochemical characterisation of waste material • SCARD management plan provides specifications for PAF cover • Waste dump design specficiations based on material erodibility parameters • Pits will be backfilled to AWT	III	1. Predict backfill levels that will prevent pit wall exposure of PAF material from generating AMD. [BK20]
T	A	01	04	Human health impacts from in situ fibrous material exposures	• Hazardous fibres exposed in situ by mining, mined and moved to encapsulated areas or naturally present in soils disturbed by mining / rehabilitation activities • Erosion of materials containing hazardous fibres post-closure	• Physical materials characterisation, some fibres present in mineral waste materials, surface alluvials and associated with infrastructure installation (cuts through non-mined geology) • Fibrous materials management plan enacted	III	1. Assess Pit 1 and Pit 3 for pit wall exposures of fibrous minerals post-closure, and the potential for associated health impacts. [BK08]
T	A	02		**Void management**				
T	A	02	01	Void has undesirable impacts on downstream ecosystem function	• Open water bodies in Pilbara naturally attract fauna (feral and native species) for food/ water/ refuge, safe access to water required • Concentration of natural groundwater or mineral waste derived salts through evapoconcentration in open water bodies • Release of metals from natural geology or mineral waste into water (infiltration or groundwater flow) • Water provides opportunity for plant /weed growth, good and bad (toxic algal blooms, noxious weeds) • Certain plant / animal species bio-accumulate / magnify toxic metals • Instability associated with saturated, unconsolidated ground, can be increased by high trafficability	• Void closure management guidance • All pits will be backfilled to a level that prevents formation of a permanent pit lake • Multi-discipline review of new pit and dump designs (MDAS), includes review by surface water team• Approvals request process includes review and sign off by biodiversity/environmental disciplines	II	1. Model groundwater recovery to determine the extent (RL) to which pits need to be backfilled to prevent pit lake formation. [BK03] 2. Evaluate impacts of Pit 1 mining through the Purlykuti Creek. [BK21]
T	A	02	04	Pit wall stability compromises closure outcomes	• Influence of erosion, subsidence, seismicity, wall slip • Influence of groundwater recovery and surface water flow on stability. • Creek system neighbouring or within zone of instability, potential stream capture • Geotechnical assessment incorrectly defines the zone of instability	• Geotechnical assessments for wall stability and zone of collapse as part of mine design reviews, as required • New pit walls design factor of safety 1.2, geotechnical assessment show zone of collapse for high risk locations (near creeks, infrastructure etc.)	III	1. Redesign DP1 and Pit 2 to remain outside zone of instability. [BK28] 2. Determine abandonment bund strategy and conceptual strategy. [BK22] 3. Undertake predictive modelling of pit wall stability for Pit 1 creek interception. [BK30]
T	A	03		**Closure landforms**				
T	A	03	01	Built landforms (excluding mine void areas) erode and / or collapse	• Physical material properties considered in design • Drainage and erosion management • Construction of landforms / waste dumps to design requirements • Sensitive receptors identified downstream	• Physical materials characterisation completed for common waste types • Backfill of some pits proposed • Multi-disciplinary pit and waste dump design sign-off process exists (MDAS), considers landform design guidelines and provides rehabilitation designs where appropriate • RTIO Rehabilitation handbook used for general rehabilitation activities • Rehabilitation designed to be stable without vegetation where practical to do so	III	1. Assess stability of landforms under parameters greater than 1:100 ARI – for example 1:1000ARI. Where there are relevant risks consider Probable Maximum Precipitation and Probable Maximum Flood conditions. [BK31] 2. Determine abandonment bund strategy and conceptual strategy. [BK22]
T	A	03	02	Surface treatment on landforms limits vegetation growth	• Availability of top soil stockpile soil / poor stockpile management e.g. soil washed away • Low moisture retention i.e. hydrophobic soils development, very rocky materials • Chemical properties of materials on waste dump / rehab surface e.g. salt circulation, alkalinity	• Physical and geochemical materials characterisation complete. Material is inert and general expected to be acceptable growth media. • Rehabilitation handbook provides direction on surface treatment options • Annual stockpile reconciliation of top soil and sub soil stockpiles, return of 200mm to create quality surface growth media • Wetland rehabilitation trial established, will provide feedback on general waste erosion performance, will look at value of adding mulch	II	1. Undertake general research and monitoring data analysis to guide future species selection, alternative growth media identification and application and use of topsoil. Progress to field trial if relevant. [General RTIO action, not assigned to BS4 and may occur elsewhere]

Risk Type (T=Threa	Ref. Category	Subcategory	Item	Risk Description Threat Title	Potential causes (Triggers / Indicators)	Existing Controls and Commitments	Risk Management Cla	Detailed Action Descriptions
T	A	03	03	Vegetation does not meet completion criteria	• Vegetation established, but does not re-seed in same abundance • Weed competition • Species selection / insufficient species diversity • Animal interference i.e. feral animals eating new growth • Changes to soil water conditions e.g. salinity, water logging etc.Vegetation is not self-sustainingVegetation does not provide suitable habitat for local fauna • Availability of top soil stockpile soil / poor stockpile management e.g. soil washed away • Low moisture retention i.e. hydrophobic soils development, very rocky materials • Chemical properties of materials on waste dump / rehab surface e.g. salt circulation, alkalinity	• Rehabilitation handbook provides guidance on seed selection for appropriate diversity • Top soil stockpiles provide seed bank • Invasive species management plan will be developed as part of decommissioning activities • Seeds tested for germination as standard. Seeds sourced from reliable suppliers. • Seeds R&D programs carried out. • Rehabilitation monitoring carried out to determine progress of rehab towards completion criteria. • Allowance for rework at year 5 as part of closure cost provision.	II	1. Undertake general research and monitoring data analysis to guide future species selection, alternative growth media identification and application and use of topsoil. Progress to field trial if relevant. [General RTIO action, not assigned to BS4 and may occur elsewhere] 2. Forecast closure seed requirements and develop procurement strategy. [BK41]
T	**A**	**04**		**Other regional considerations**				
T	A	04	01	Access through area post-closure poses public liability risk	• Post-closure access / land-use requirements, e.g. for stock, people, heritage, environmental monitoring, adjacent mining activities etc. • Potential for general public to create their own access if appropriate access not provided.	• Regular review and integration of stakeholder feedback into closure plan updates.	IV	1. Determine abandonment bund strategy and conceptual strategy. [BK22] 2. Confirm post-closure access expectations with Cheela Plains. [BK34]
T	A	04	02	Closure outcomes do not meet stakeholder(s) / community expectations	• Absence of rehabilitation trial or data to support predicted outcomes, closure activities fail to achieve completion criteria • Communication of anticipated closure outcomes and post-closure land use needs i.e. wrong plant species established • Unrealistic expectations for economic potential opportunities / post-closure land use capability • Consultation fails to identify stakeholder concerns • Large number of stakeholders in the project • Clarity of explanation / prediction of closure outcomes, communication styles, long term engagement of agreed outcomes through generational change. • Stakeholder expectations change over time, due to changing global benchmarks for mine rehabilitation success, intergenerational change, regulatory changes etc. • Stakeholders do not endorse site closure as their issues / concerns were not addressed	• RTIO stakeholder engagement practice with key stakeholders • Monitoring established for rehabilitation areas	II	No additional closure actions required at this time on the basis that RTIO will continue to engage with stakeholders regarding post closure land use objectives and expectations
T	A	04	03	Adverse impact to flora or fauna with conservation status or wider regional impact to high value environment	• Scheduled, listed or declared rare and / or threatened species of flora or fauna present in/adjacent to site • Downstream regional area of high value • Environmental conditions post-closure differ significantly from pre-mining conditions • Post-mining land use differs from pre-mining land use	• Internal ground disturbance approval request system to prevent inadvertent disturbance • Baseline biological / ecosystem health surveys and existing monitoring to define post-mining status • GIS system includes results from all flora, fauna, vegetation surveys • Operational management plan for discharge includes actions relating to water quality and discharge extent targets (proximity to Fortescue Marsh), to ensure environmental issues are managed during operations • Significant species management plan implemented during operation to minimise impact to select species • Vegetation management plan implemented during operations to monitor and manage impacts to vegetation (riparian, understorey and weeds)	II	1. Undertake modelling to predict the extend of impacts of groundwater draw down on the PLNb roost & pools. [BK24] 2. Evaluate whether the post-closure cone of depression has the potential to impact stygofauna. [BK25]
T	A	04	04	Heritage site condition / cultural value is degraded as a result of implementing the closure plan	• Previously unidentified heritage sites, not considered in existing assessment, discussions, agreements or with authority to disturb • Changes to landforms on closure have potential to alter conditions at downstream sites, e.g. consider drainage, landform footprint, erosion implications • Cessation of maintenance of / to heritage site	• Internal ground disturbance approval request system • GIS system includes results from heritage surveys • Heritage sites within mine area, S18 application etc. prior to disturbance • Ongoing consultation with Traditional Owners	II	No additional closure actions required at this time on the basis that RTIO will continue to engage with stakeholders regarding post closure land use objectives and expectations
T	**B**			**Stakeholders**				
T	**B**	**01**		**Stakeholder expectations**				
T	B	01	2	Closure outcomes do not meet stakeholder(s) / community expectations	• Absence of rehabilitation trial or data to support predicted outcomes, closure activties fail to achieve completion criteria • Communication of anticipated closure outcomes and post-closure land use needs i.e. wrong plant species established • Unrealistic expectations for economic potential opportunities / post-closure land use capability i.e. aquiculture in pit lakes	• RTIO stakeholder engagement practice with key stakeholders • Monitoring established for water, rehabilitation trials started • Numerical completion criteria established for some aspects	IV	1. Confirm final land use with Cheela Plains pastoral station. [BK36]

Risk Type (T=Threa	Ref. Category	Subcategory	Item	Risk Description Threat Title	Potential causes (Triggers / Indicators)	Existing Controls and Commitments	Risk Management Cla	Detailed Action Descriptions
T	B	01	03	A stakeholder's expectations conflict with that of another stakeholder, causing delays to plan approval and / or closure	• Conflicting stakeholder expectations or areas of authority e.g. different regulators for environment, heritage, health, economic, tourism • Conflicting legal obligations e.g. State Agreement and EPA • Interactions between catchment land uses, including mining developments, at different points in time	• RTIO stakeholder engagement practice with key stakeholders	I	No action required at this time on the basis that no specific stakeholder conflicts have been identified to date.
T	B	01	04	Closure strategy prevents or limits future exploitation of resources	• Backfill sterilises ore reserves • Lakes or habitat restoration prevent / limit future access to adjacent resources	• RTIO stakeholder engagement practice with key stakeholders	III	No specific actions have been identified to mitigate this risk. The standard practice of undertaking ongoing updates of the closure plan will allow a response to any changes in ore body knowledge or operational mining strategy.
T	**C**	**01**		**Agreements and commitments**				
T	C	01	01	Closure is not implemented in accordance with the approved closure plan	• Mine development changes prevent closure plan from being implemented as planned • Closure plan proves to be overly challenging to implement or implementation results in a different outcome than anticpated	• Integration of closure plan with LoM report • Involvement of broad range of internal stakeholders in development of closure plan	II	No specific actions have been identified to mitigate this risk. The standard practice of undertaking ongoing updates of the closure plan will allow a response to any changes in ore body knowledge or operational mining strategy.
T	**C**	**03**		**Governance (internal only)**				
T	C	03	01	Management of closure related issues during life of mine leads to increased closure complexity	• Unsafe working conditions evolve prior to rehabilitation e.g. reduce maintenance, pit / landform stability changes over time, groundwater recovery prior to completion of in pit closure activities, hazardous fibres exposed with erosion, sulphides gases • Lack of experience, i.e. staff skills or trial areas/activities, use of inefficent management processes / practice, high degree of re-work • Ambiguity of risk / issue / action ownership to appropriately resource & resolve prior to key mining decisions, increased cost & lost opportunities	• Mine safety inspections • Operational pit permitting system • Development of risk register	III	No specific actions have been identified to mitigate this risk. The standard practice of undertaking ongoing updates of the closure plan will allow a response to any changes in ore body knowledge or operational mining strategy.
T	**D**	**09**		**Safety**				
T	D	09	01	Access to the area post-closure poses a public liability risk.	• Post-closure access / land-use requirements, e.g. for stock, people, heritage, environmental monitoring, adjacent mining activities etc. • Potential for general public to create their own access if appropriate access not provided. • Long term integrity of abandonment bunds. • Decommissioning of infrastructure not implemented effectively. • Some roads retained for post-closure access. • Water bores potentially retained.	• Complete removal of infrastructure excluding buried services below 1m depth. • Abandonment bunds where appropriate. • No pit lakes expected	III	1. Determine abandonment bund strategy and conceptual strategy. [BK22]

Appendix E – Task, Research and Trial Activities Schedule

Ref	Task
BK03	Model groundwater recovery to determine the extent (RL) to which pits need to be backfilled to prevent pit lake formation.
BK08	Assess Pit 1 and Pit 3 for pit wall exposures of fibrous minerals post-closure, and the potential for associated health impacts.
BK19	Undertake groundwater flow / water quality modelling for AMD at closure for high risk pits - Pit 3, Pit 5, Pit 7 and Pit 18.
BK20	Predict backfill levels that will prevent pit wall exposure of PAF material from generating AMD.
BK21	Evaluate impacts of Pit 1 mining through the Purlykuti Creek.
BK22	Determine abandonment bund strategy and conceptual strategy.
BK24	Undertake modelling to predict the extent of impacts of groundwater draw down the PLNb roost & pools.
BK25	Evaluate whether the post-closure cone of depression has the potential to impact stygofauna.
BK28	Redesign DP1 and Pit 2 to remain outside zone of instability.
BK30	Undertake predictive modelling of pit wall stability for Pit 1 creek interception.
BK31	Assess stability of landforms under parameters greater than 1:100 ARI – for example 1:1000ARI. Where there are relevant risks consider Probable Maximum Precipitation and Probable Maximum Flood conditions.
BK34	Confirm post-closure access expectations with Cheela Plains.
BK36	Confirm final land use with Cheela Plains pastoral station.
BK41	Forecast closure seed requirements and develop procurement strategy.
BK42	Complete an AMD risk assessment for BS4MM deposit S and deposit T and BS4 Endeavour deposit.

Appendix F – Landform design criteria

The following tables provide summaries of the key design criteria (where available) of the waste landforms associated with BS4.

Please note that these are interim rehabilitation designs and will be refined as the dump approaches rehabilitation.

DP1 - Low grade ore (LGO), waste

Waste volume (Mm^3)	101.5 Mm^3 – LGO: 37.6Mm^3, Waste: 63.4Mm^3	
Erodibility ranking	46% low, 49% moderate, 5% high	
Classification	Inert ☒	Capping required at closure:
	PAF ☐	-
	Fibrous minerals ☒	0 Mm^3
	WFSF ☐	-
Overall height (m)	90m	
Topsoil required (Mm^3)	0.543 Mm^3	

	Construction Specifications	**Rehabilitation Specifications**
Slope angle (deg)	Waste 37°, LGO 37°	Waste 20°, LGO 20°
Lift height (m)	20m to 560mRL, 15m above	Waste: 20m to 560mRL, 15m above. LGO: 5m
Berm width (m)	Waste: 40m+ to 560mRL, 32m above. LGO: 65m	Waste: 16m+ to 560mRL, 13m above. LGO: 10m
Berm slope (deg)	0°	-10°
Footprint (ha)	270	275

Comments:

DP1 is a mix of low grade concentrate (LGC) material, waste and LGO. LGC will be reclaimed prior to closure and therefore has no rehabilitation design.

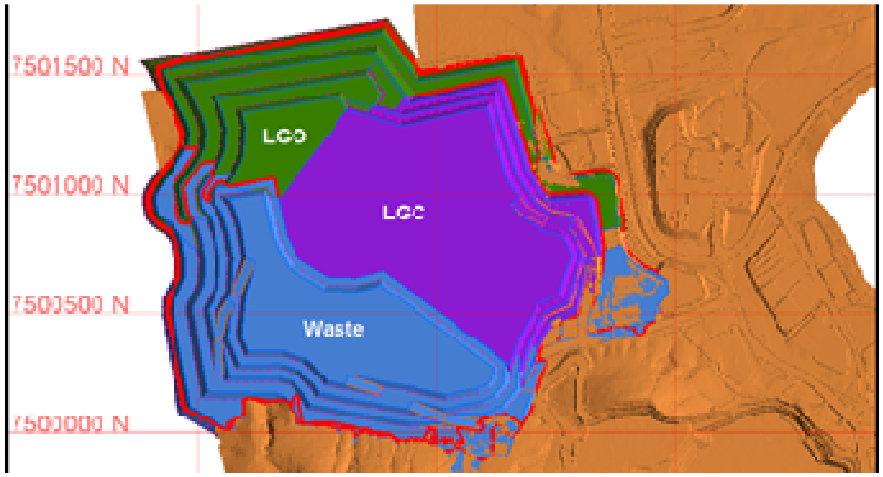
Waste material will be dumped in separate cells (LGO is separated). Fibrous material will be encapsulated in cells within the dump with the exact location and geometry recorded. These cells will be dumped and encapsulated with inert material such that they are not exposed during final (post-closure) landform shaping.

The dump has been designed as per erodibility class of material. Design is indicative and refinements will be made (ie ramp removal from designs). The final design will also revaluate the intersection with Pit 2's ZOI.

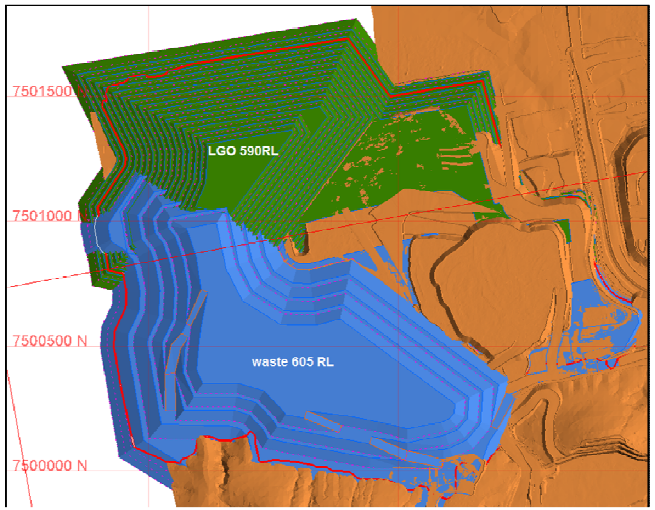
Based on the predominance of moderate to high erodibility material, the rehabilitation specifications for this waste dump were recently modified to reduce the proposed final lift heights to 15m. The sequencing of LGO material has influenced the 5m lifts.

The waste portion of DP1 has been redesigned to stay outside of the 100 year flood plain. The rehabilitation design was also updated to ensure it did not encroach on the 100 year flood plain.

Construction Design



Rehabilitation Design



DP2 - Low grade ore, waste, PAF material

Waste volume (Mm^3)	16.2 Mm^3	
Erodibility ranking	39% low, 55% moderate, 7% high	
Classification	Inert ☒	Capping required at closure:
	PAF ☒	0 Mm^3
	Fibrous minerals ☐	-
	WFSF ☐	-
Overall height (m)	40m	
Topsoil required (Mm^3)	0.340 Mm^3	

	Construction Specifications	**Rehabilitation Specifications**
Slope angle (deg)	37°	20°
Lift height (m)	20m	10m
Berm width (m)	40m	TBC
Berm slope (deg)	0°	-10°
Footprint (ha)	146	~148

Comments:

Waste dumps DP2 is a designated PAF dump. DP2 extends into Cheela Plains; however an appropriate standoff (~50m) is adopted to ensure PAF cells are not located on Cheela Plains.

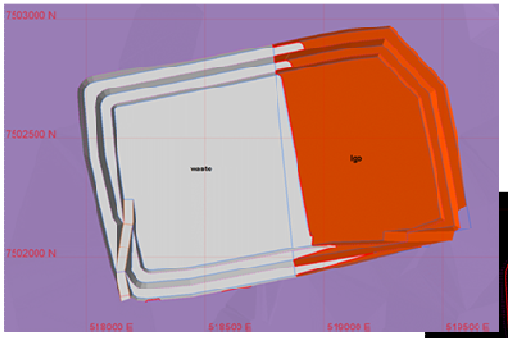
DP2 will encapsulate 1 Mm^3 of PAF material (0.84 Mm^3 cold black shale, 0.16 Mm^3 hot black shale). PAF material will not be stored under waste dump slopes. The PAF cells and the dump will be covered with a store and release cover, as stipulated in Section 18.1

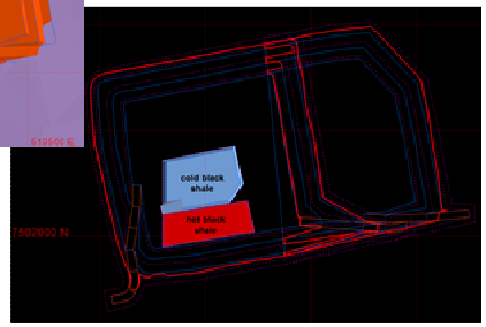
Adequate material for store/release cover is available and will be separately stockpiled for application at completion of the landform

Waste material will be dumped in separate cells (LGO is separated from waste).

Please note that the rehabilitation design will be refined as the dump approaches rehabilitation.

Construction Design





Rehabilitation Design

TO BE CONFIRMED

DP4 - Low grade ore, waste

Waste volume (Mm^3)	36.4 Mm^3	
Erodibility ranking	46% low, 50% moderate, 4% high	
Classification	Inert ☒	Capping required at closure:
	PAF ☐	-
	Fibrous minerals ☒	-
	WFSF ☐	-
Overall height (m)	40m	
Topsoil required (Mm^3)	0.464 Mm^3	

	Construction Specifications	**Rehabilitation Specifications**
Slope angle (deg)	37°	20°
Lift height (m)	20m	10m
Berm width (m)	40m	Various
Berm slope (deg)	0°	-10°
Footprint (ha)	220	~222

Comments:

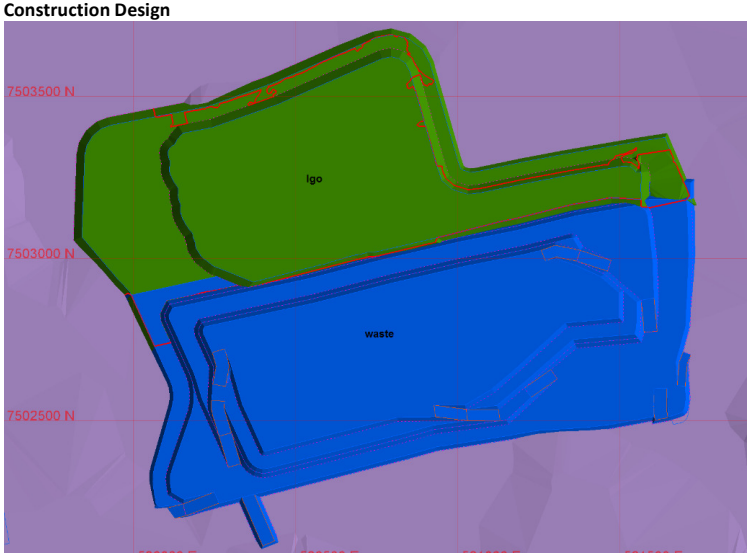
Waste material will be dumped in separate cells (LGO is separated from waste). LGO will be factored in to future design reiterations.

Fibrous material will be encapsulated in cells within the dump with the exact location and geometry recorded. These cells will be dumped and encapsulated with inert material such that they are not exposed during final (post-closure) landform shaping.

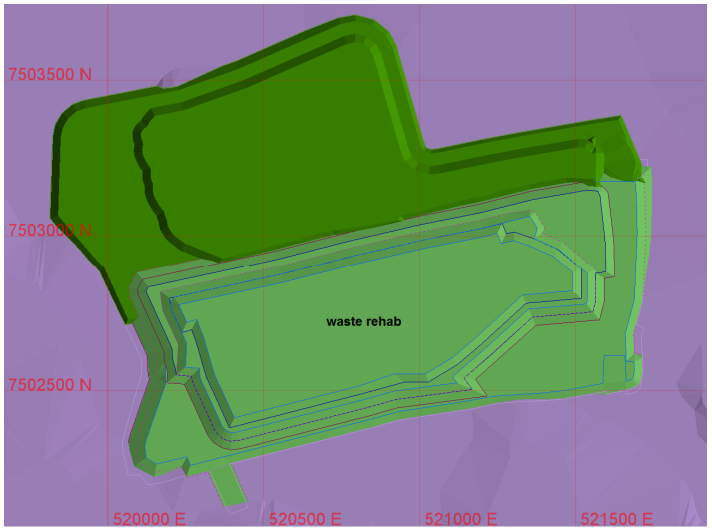
Adequate topsoil and material for cover is available and will be separately stockpiled for application at completion of the landform.

Detailed rehabilitation designs are currently being developed to support progressive rehabilitation of several faces of the dump.

Construction Design



Rehabilitation Design



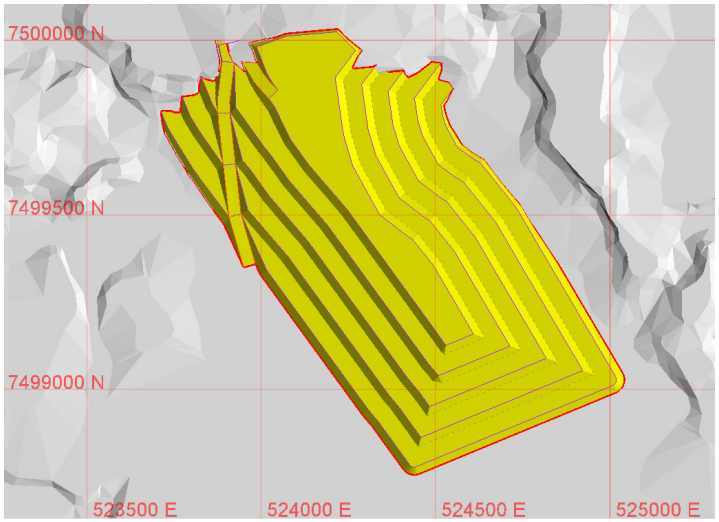
DP5 - Waste

Waste volume	31,891,642 m3	
Erodibility ranking		
Classification	Inert ☒	Capping required at closure:
	PAF ☐	-
	Fibrous minerals ☐	-
	WFSF ☐	-
Overall height (m)	75 m	
Topsoil required (Mm^3)	0.198 Mm^3	

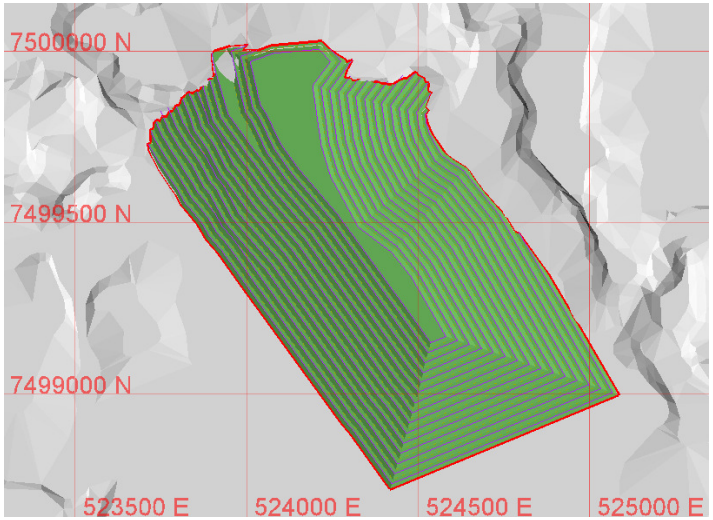
	Construction Specifications	**Rehabilitation Specifications**
Slope angle (deg)	34°	20°
Lift height (m)	15 m	5 m
Berm width (m)	50 m	10 m
Berm slope (deg)	0°	0°
Footprint (ha)	91.2 ha	96.3 ha

Comments:

Construction Design



Rehabilitation Design



DP6 - Waste

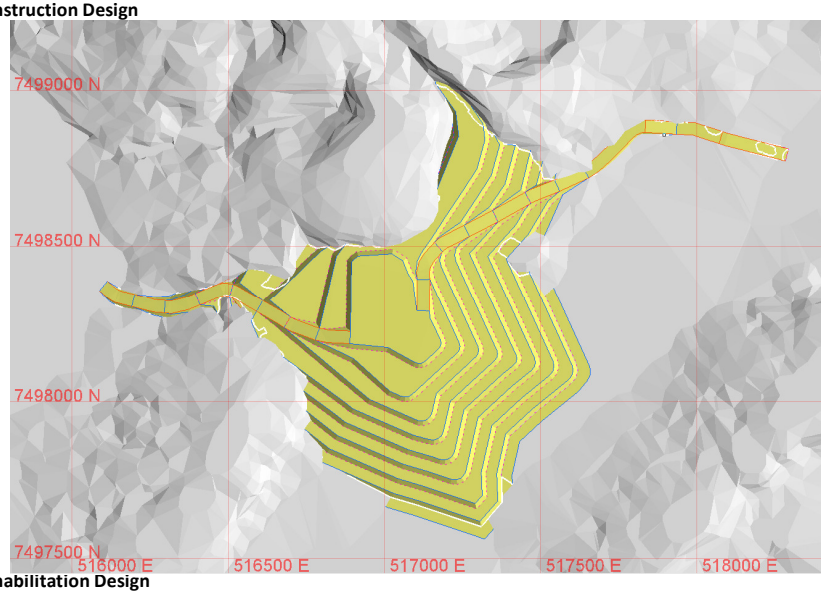
Waste volume	23,545,246 m^3	
Erodibility ranking		
Classification	Inert ☒	Capping required at closure:
	PAF ☐	-
	Fibrous minerals ☒	-
	WFSF ☐	-
Overall height (m)	80 m	
Topsoil required (Mm^3)	~ 0.183 Mm^3	

	Construction Specifications	**Rehabilitation Specifications**
Slope angle (deg)	34°	°
Lift height (m)	10 m	
Berm width (m)	35 m	
Berm slope (deg)	0°	°
Footprint (ha)	87.96 ha	

Comments:

No rehab design at the moment as this is an interim design. Area surrounding the dump is undergoing changes at the moment (additional mineralisation found, but not included in pit shell yet)

Construction Design



Rehabilitation Design

DP8 – Waste

Waste volume	74.2 Mm^3	
Erodibility ranking	50% low, 24% moderate, 26% high	
Classification	Inert ☒	Capping required at closure:
	PAF ☐	-
	Fibrous minerals ☒	-
	WFSF ☐	-
Overall height (m)	95m	
Topsoil required (Mm^3)	~0.353 Mm^3	

	Construction Specifications	**Rehabilitation Specifications**
Slope angle (deg)	34°	20°
Lift height (m)	15m	5m
Berm width (m)	50m	TBC
Berm slope (deg)	0°	-10°
Footprint (ha)	167	TBC

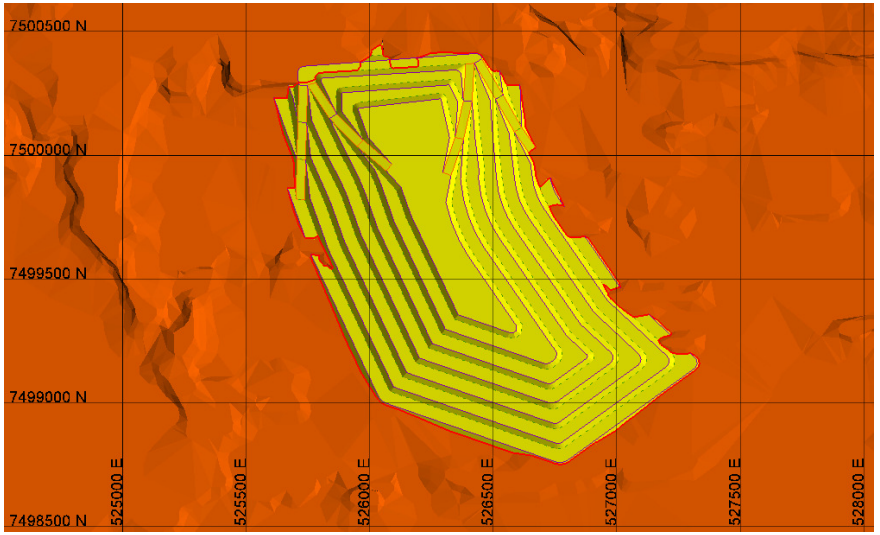
Comments:

The waste material designated to this dump is considered low and moderate erodible and the batter selector tool was used to determine the required tip to and rehabilitation dump parameters.

The 5m lift height and 10m berm width configuration will address erosion risks, however more work is underway to optimise this rehabilitation design.

Adequate topsoil is available and will be separately stockpiled for application at completion of the landform.

Construction Design



Rehabilitation Design

TO BE CONFIRMED

DP9 - Waste

Waste volume	91.8 Mm^3	
Erodibility ranking	20% low, 26% moderate, 54% high	
Classification	Inert ☒	Capping required at closure:
	PAF ☐	-
	Fibrous minerals ☐	-
	WFSF ☐	-
Overall height (m)	95m at construction	
Topsoil required (Mm^3)	0.745 Mm^3	

	Construction Specifications	**Rehabilitation Specifications**
Slope angle (deg)	34°	20°
Lift height (m)	5m	5m
Berm width (m)	19m	10m
Berm slope (deg)	0°	0°
Footprint (ha)	361	365

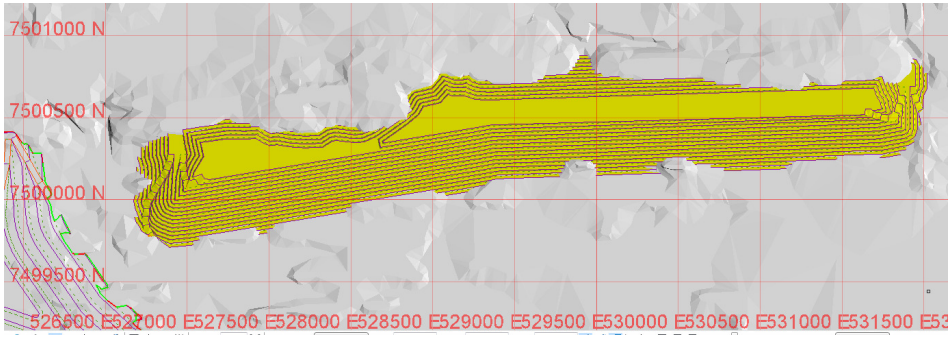
Comments:

The waste material designated to this dump is considered highly erodible and the batter selector tool was used to determine the required tip to and rehabilitation dump parameters.

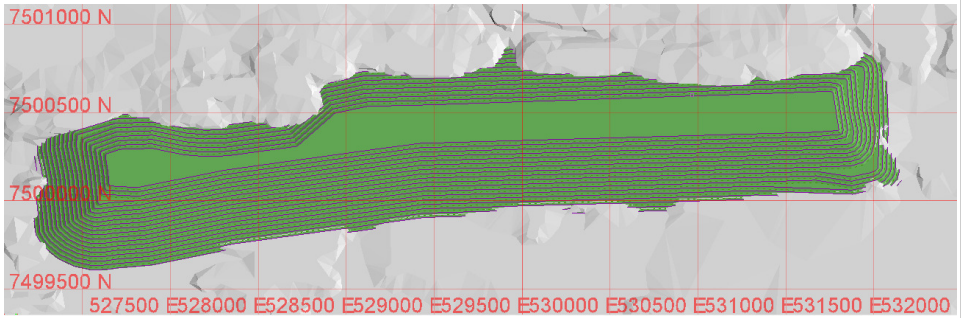
The 5m lift height and 10m berm width configuration will address erosion risks.

Adequate topsoil is available and will be separately stockpiled for application at completion of the landform.

Construction Design



Rehabilitation Design



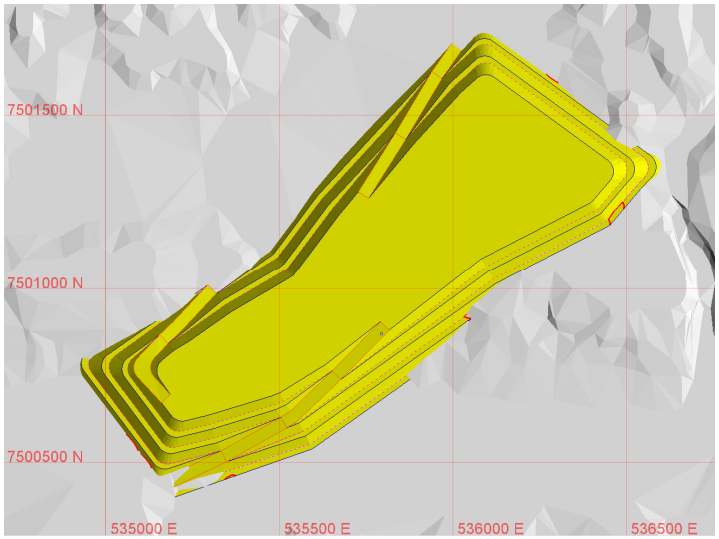
DP12 - Waste

Waste volume	39,214,848 m3	
Erodibility ranking	high	
Classification	Inert ☒	Capping required at closure:
	PAF ☐	-
	Fibrous minerals ☒	-
	WFSF ☐	-
Overall height (m)	80	
Topsoil required (Mm³)	0.209 Mm³	

	Construction Specifications	**Rehabilitation Specifications**
Slope angle (deg)	37°	°
Lift height (m)	20 m	
Berm width (m)	15 m	
Berm slope (deg)	0°	°
Footprint (ha)	97.3	

Comments:

Construction Design



Rehabilitation Design

A stable final landform could not be developed due to the erodibility of the material. The material is not suitable for long term storage outside of a pit void.

DP22

Waste volume	12.5 Mm^3	
Erodibility ranking	46% low, 50% moderate, 4% high	
Classification	Inert ☒	Capping required at closure:
	PAF ☐	-
	Fibrous minerals ☐	-
	WFSF ☐	-
Overall height (m)	50	
Topsoil required (Mm^3)	TBC Mm^3	

	Construction Specifications	**Rehabilitation Specifications**
Slope angle (deg)	37°	20°
Lift height (m)	50m	10m & 20m
Berm width (m)	40m	TBC
Berm slope (deg)	0°	10°
Footprint (ha)	62.6	~65

Comments:

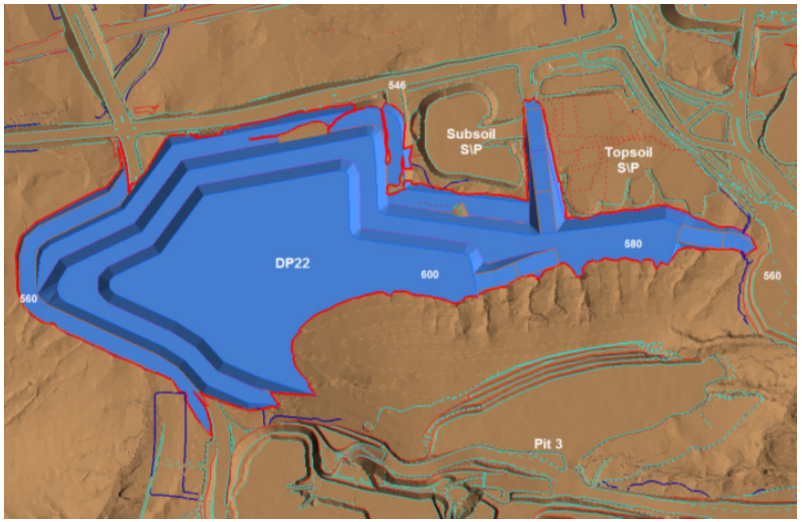
DP22 has a maximum height of ~50m above surrounding topography

The dump may not be required to be constructed to final height as material may be utilised for in-pit backfilling.

The dump has been design to allow rehabilitation in the future and meet the RTIO final landform standards.

A maximum of 20m high lifts, 37° batters and 40m wide berms will allow a final rehab slope of 20° and 10m berms to be established if required.

Construction Design



Rehabilitation Design

TO BE CONFIRMED

Attachment 2: Terrestrial Fauna Summary

The following provides a summary of the key terrestrial fauna values of the Brockman Syncline 4 Marra Mambas Proposal area. For the purposes of this summary, the Proposal area aligns with the area defined by the 'Proposed Extension to Development Envelope' polygon in Figure 1.

The summary is taken mostly from the following survey reports, which are provided as attachments to this summary:

- Biota 2016, Brockman Syncline 4 Marra Mambas Level 2 Fauna Survey; and
- Bat Call WA 2017, Brockman Syncline 4 Marra Mambas, Pilbara WA, Location of Upper Beasley River Pilbara Leaf-nosed Bat Diurnal Roost 2016 – 2017.

These reports should be referred to for further detail.

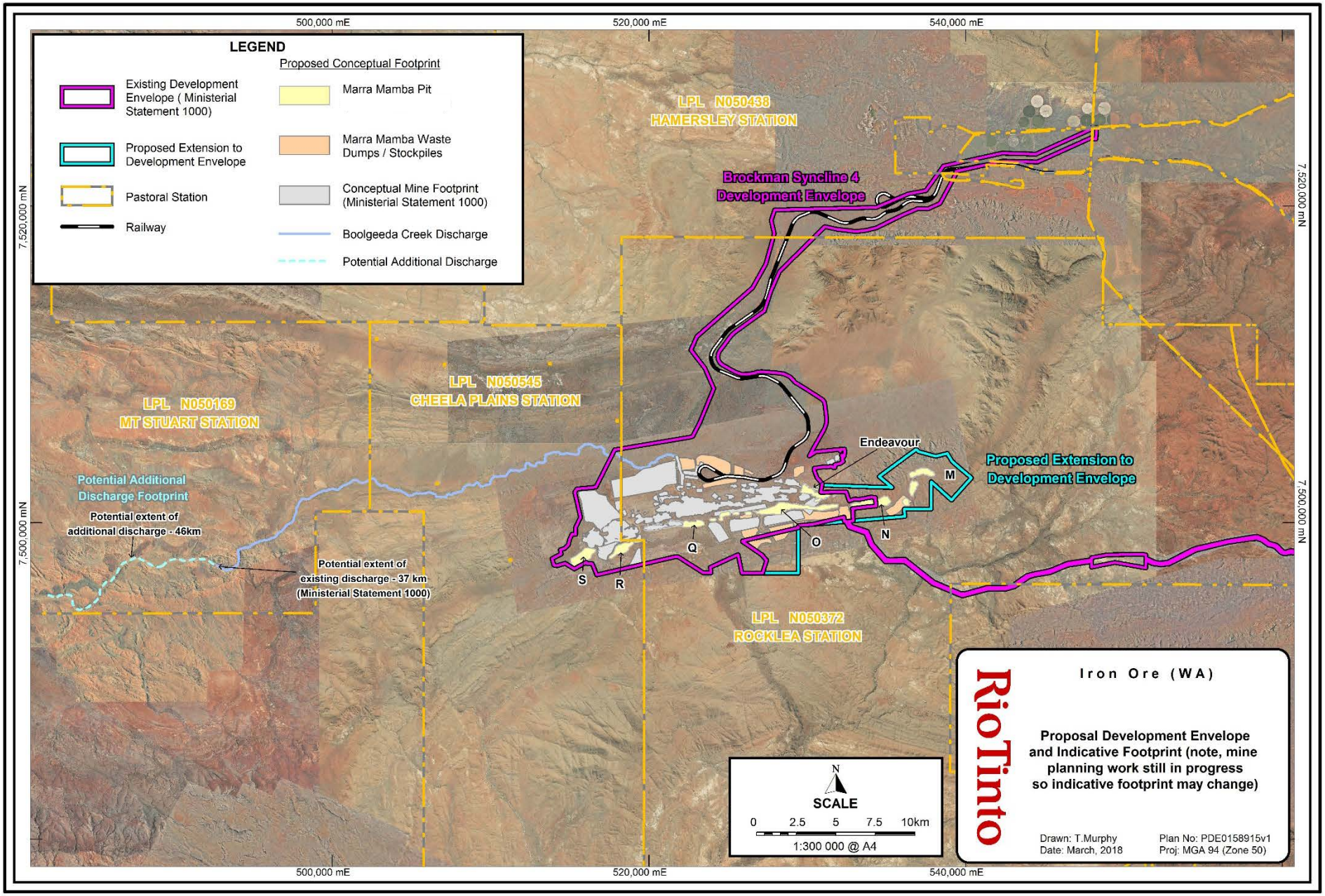


Figure 1: Proposal area

1. Terrestrial Fauna Survey Effort

Report Title and Author	Area (ha)	Survey Dates	Survey Methods and Sites Overlapping the Proposal Area	Results
Biota (2016) *Brockman Syncline 4 Marra Mambas Level 2 Fauna Survey* This survey report is provided	2,436	30 July – 9 August 2015	Single phase Level 2 fauna survey: 10 trapping sites 6 bat sampling sites 8 motion sensitive camera sites 9 avifauna census sampling sites 11 SRE search sites	This survey covers the Proposal area and is identified as 'survey area' and 'study area' in Figure 2. A total of 132 vertebrate fauna species have been recorded within the survey area (100 from the field survey) including five species of conservation significance: Ghost Bat *Macroderma gigas* (S3, VU); Pilbara Leaf-nosed Bat *Rhinonicteris aurantia* (S3, VU); Western Pebble-mound Mouse *Pseudomys chapmani* (P4), Rainbow Bee-eater *Merops ornatus* (S5, Mi)* and Fork-tailed Swift *Apus pacificus* (S5, Mi). A total of 41 invertebrate specimens were recorded during the survey, comprising three Nemesiid and one Barychelid mygalomorph spider specimens, and 37 live snails of the genus *Rhagada*. Short-range endemism is common in both of the recorded families of mygalomorph spider (Barychelidae and Nemesiidae), as well as in the land snail genus *Rhagada*. On this basis, and without any molecular sequencing to provide further resolution, all recorded taxa were considered to represent potential SREs.
Bat Call WA (2018) *Brockman Syncline 4 Marra Mambas, Pilbara WA, Location of Upper Beasley River Pilbara Leaf-nosed Bat Diurnal Roost 2016 – 2017* This survey report is provided	2,473	23-28 June 2016; 10-18 July 2016; 29 August-1 September 2016; 3-6 October 2016; 3-4 December 2016; 13-18 December 2017	Targeted Pilbara Leaf-nosed Bat survey: 42 bat sampling sites	This survey covers the Proposal area. A previously unidentified colony, named Upper Beasley River Roost (UBRR) of Pilbara Leaf-nosed Bats (PLNB) was identified in the region but not within the Marra Mamba deposit. A focussed search was carried out in 2016 to locate the diurnal roost and confirm its status as permanent, and therefore, maternal. Further work was completed in 2017 to measure ongoing presence and usage of nearby waterholes to assess the stability of the colony. Echolocation recordings were conducted at 130 sites. The PLNB roost cave was located approximately 1.5 km north of the deposit and 1.5 km southeast of the Nammuldi / Brockman 4 mine village, along with three pools.

Report Title and Author	Area (ha)	Survey Dates	Survey Methods and Sites Overlapping the Proposal Area	Results
				Continuous detection of PLNB in the district has confirmed that the roost is permanent and therefore is assumed to be maternal. During the targeted 2016 survey Ghost Bats were also detected at four cave entrances and one waterhole. All calls were isolated and represented foraging bats. No evidence of a Ghost Bat diurnal roost cave was indicated by the data.
Bat Call WA (2016) *Brockman Syncline 4 Marra Mambas, Pilbara WA, December 2015: Echolocation Survey of Pilbara Leaf-nosed Bat Activity*	5,.379	11-13 December 2015	Targeted Pilbara Leaf-nosed Bat survey – 3 bat sampling sites	This survey covers the Proposal area. Bat echolocation activity was measured at 17 sites within the Brockman Syncline 4 Marra Mambas (BS4 MM) deposit to try to locate a Pilbara Leaf-nosed Bat roost. A possible colony of PLNB has been inferred close to the BS4 mine from previous surveys. High PLNB activity levels were detected at only one site, a permanent pool on an unnamed tributary creek, 7 km south of the current mining operations. No evidence of a PLNB roost close to the BS4 MM deposit was found.
Astron (2014) *Brockman Syncline Marra Mamba Biological Assessment*	153	18 – 23 September 2014	Level 1 survey – No overlapping sites	A total of 33 vertebrate fauna species, comprising one reptile species, 29 bird species and three mammal species were recorded. One fauna species of conservation significance was recorded: Western Pebble-mound Mouse *Pseudomys chapmani* (P4).
Biota (2014) *Brockman 4 Eastern Edge Native Vegetation Clearing Permit Report*	337	24 – 28 July 2014	Level 1 survey - 1 bat sampling site	Three conservation significant fauna species were recorded: Pilbara Leaf-nosed Bat *Rhinonicteris aurantia* (S3, VU); Western Pebble-mound Mouse *Pseudomys chapmani* (P4) and Fork-tailed Swift *Apus pacificus* (S5, Mi).

Report Title and Author	Area (ha)	Survey Dates	Survey Methods and Sites Overlapping the Proposal Area	Results
Biota (2013a) *Brockman Syncline 4 Marra Mamba Targeted Fauna Survey*	1,921 ha	28 August – 4 September 2012	Targeted vertebrate and SRE fauna survey – No overlapping sites (6 Elliott trapping sites, 6 bat sampling sites and 15 SRE search sites within existing Development Envelope)	No vertebrate fauna of conservation significance were recorded. Six potential SRE invertebrate species were recorded during the survey: two mygalomorph spider species, two land snail species and two pseudoscorpion species.
Biota (2013b) *Marra Mamba West Native Vegetation Clearing Permit Report*	325	14 – 18 September 2013	Level 1 survey – No overlapping sites	The study area comprised four fauna habitats: stony plains; creeklines and floodplains; stony hillslopes and crests; and rocky gorges. One fauna species of conservation significance was recorded: Western Pebble-mound Mouse *Pseudomys chapmani* (P4).
Biota (2009) *Beasley River Limonites Baseline Fauna Survey*	4,162	21 – 31 May 2009	Single phase Level 2 fauna survey – No overlapping sites (3 trap sites and 5 SRE search sites within existing Development Envelope)	A total of 86 vertebrate fauna species, comprising one frog, 29 reptiles, 45 birds and 14 mammals, were recorded. Four species of conservation significance were recorded: Pilbara Olive Python *Liasis olivaceus barroni* (S3, VU); Pilbara Leaf-nosed Bat *Rhinonicteris aurantia* (S3, VU), Short-tailed Mouse *Leggadina lakedownensis* (P4) and Rainbow Bee-eater *Merops ornatus* (S5, Mi)*.
Biota (2005) *Fauna Habitats and Fauna Assemblage of the*	11,796	18 – 30 October 2004 12 – 21 April 2005	Dual phase Level 2 fauna survey – No overlapping sites (14 trapping sites within existing Development Envelope)	A total of 159 vertebrate fauna species, comprising two frogs, 54 reptiles, 83 birds and 20 mammals, was recorded.

Report Title and Author	Area (ha)	Survey Dates	Survey Methods and Sites Overlapping the Proposal Area	Results
Brockman Syncline 4 Project, near Tom Price				Four fauna species of conservation significance were recorded: Western Pebble-mound Mouse *Pseudomys chapmani* (P4); Australian Bustard *Ardeotis australis* (P4)*; Bush Stone-curlew *Burhinus grallarius* (P4)* and the skink *Notoscincus butleri* (P4). Six taxa belonging to groups known to, or potentially supporting, SREs were recorded: the camaenid land snail *Rhagada* sp. "Mt Brockman", a polydesmid millipede, a polyzoniid millipede and a spirobolid millipede, and two mygalomorph spiders belonging to the taxa *Aname* "WA sp. 09" and *Synothele* "WA sp. 01".

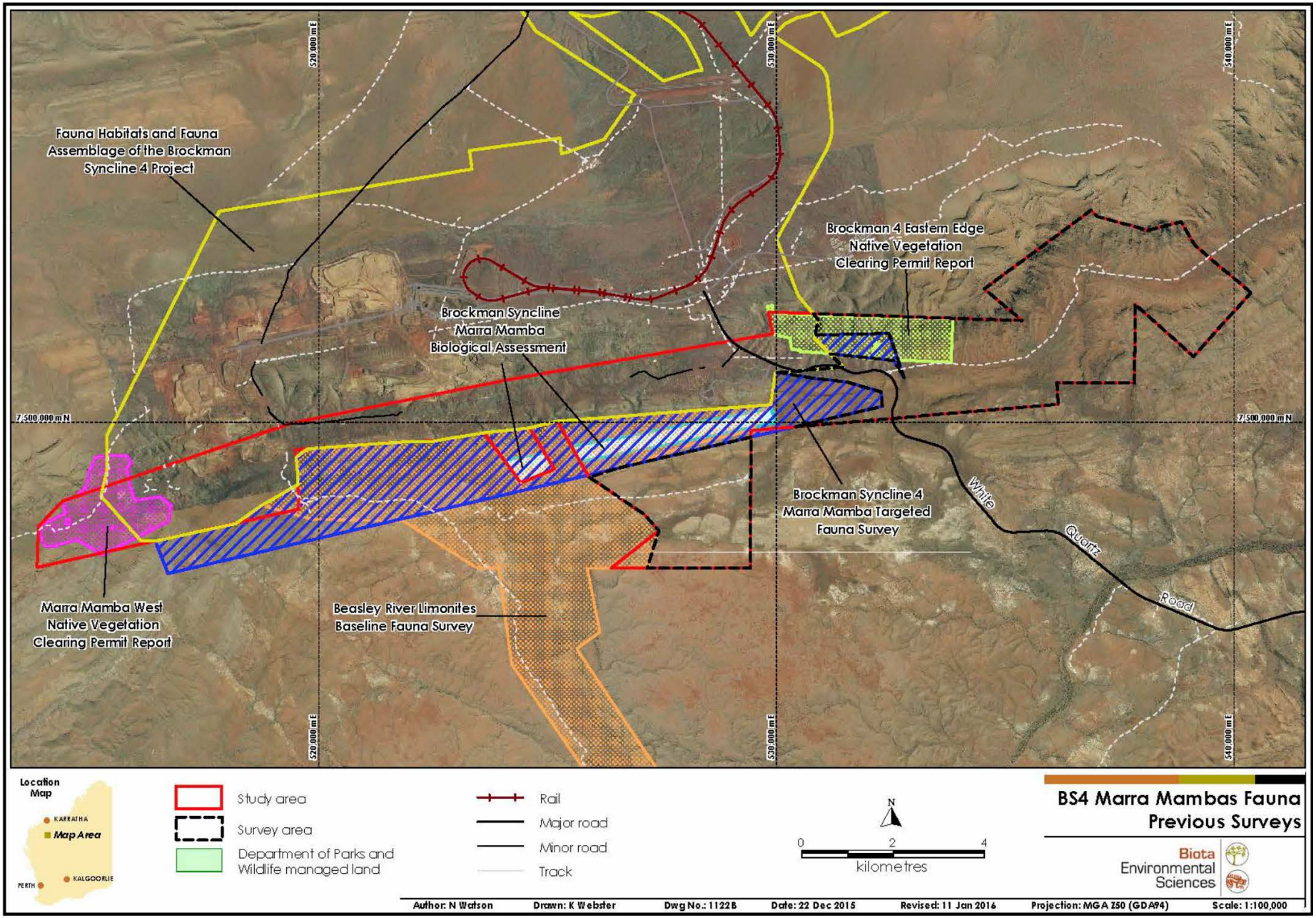


Figure 2: Location of the key terrestrial fauna surveys in the vicinity of the Proposal area (from Biota 2016)

2. Habitats

Eight broad fauna habitats, consolidated from the landscape and functional landform mapping by Biota (2016), occur within the Proposal area (Figure 3):

Habitat Type	**Functional Landform as Mapped by Biota (2016)**	**Distinguishing Characteristics**	**Habitat Value**	**Area Mapped within the Proposal Area (ha)** (representation within Proposal area)
Alluvial Plain	Alluvial Plain	Flat land area adjacent to a drainage line, composed of unconsolidated sedimentary deposits (alluvium) and subject to periodic inundation by the drainage line. Characterised by open shrubland of mixed *Acacia* species and open hummock (*Triodia epactia*) grassland.	**Low –** habitat is widespread in the Pilbara region and does not exclusively support any conservation significant species within the Proposal Area.	15.9 (0.6%)
Wona Colluvial Plain	Wona Colluvial Plain	Undulating plain with cracking clay soils. Vegetation consists of *Acacia xiphophylla* low open woodland over *Senna artemisioides* subsp*. oligophylla* x subsp. *helmsii*, *Sida fibulifera* low open shrubland over *Triodia longiceps* hummock grassland.	**Medium –** has the potential to support a unique fauna assemblage not seen elsewhere within the Proposal Area. It is also predicted to support the Short-tailed Mouse (*Leggadina lakedownensis*).	117.8 (4.3%) The Proposal disturbance footprint (based on the current mine plan) does not intersect this habitat type
Major Creekline	Major Creekline	The southwestern section of the Proposal area intersects a drainage feature supporting riparian vegetation dominated by *Eucalyptus camaldulensis*.	**High –** provides an important foraging and dispersal habitat for many species, including potentially the Northern Quoll, Pilbara Olive Python (*Liasis olivaceus barroni*), Ghost Bat, Pilbara Leaf-nosed Bat and Lined Soil-crevice Skink (*Notoscincus butleri*).	45.3 (1.7%)
Minor Creekline	Minor Creekline; Creek Line and Drainage	Linear, generally sinuous open depressions forming the floor of a minor drainage channel. Generally dominated by *Acacia* spp. shrubland over *Triodia* spp. hummock grassland, sometimes with *Eucalyptus* or *Corymbia* spp. scattered low trees.	**Low –** habitat is common and widespread in the Pilbara region and does not exclusively support any conservation significant species within the Proposal Area.	76.2 (2.8%)

Habitat Type	**Functional Landform as Mapped by Biota (2016)**	**Distinguishing Characteristics**	**Habitat Value**	**Area Mapped within the Proposal Area (ha)** (representation within Proposal area)
Stony Hill Slopes and Pediments	Footslope; Gently Sloping Rise; Midslope/Upper Slope; Pediment Slope; Stony Hill Slopes and Pediments	Habitat tends to be open and structurally simple and dominated by *Eucalyptus* or *Corymbia* spp. woodlands, *Acacia* and *Grevillea* spp. scrublands and *Triodia* spp. low hummock grasslands.	**Medium –** provides habitat for the Western Pebble-mound Mouse (*Pseudomys chapmani*), which is largely restricted to this habitat. Also provides potential foraging habitat for Northern Quoll, Pilbara Leaf-nosed Bat and Ghost Bat.	2,368.5 (86.6%)
Gorges and Gullies	Gorges/Gullies and Free Faces; Rocky Gorges	In the eastern section of the Proposal Area, the hills and ranges of the Brockman Syncline Range in the north and the Marra Mamba hills in the south contain narrow gorges, gullies, free faces, caves and waterholes. The Brockman Syncline Range in the northern section represents the steepest landform within the Proposal Area.	**High –** has the greatest potential to support mesic habitats of importance for fauna, such as narrow gorges, gullies, free faces, caves and waterholes. Provides potential denning habitat for the Northern Quoll and Pilbara Olive Python and potential roosting habitat for the Pilbara Leaf-nosed Bat and Ghost Bat.	73.0 (2.7%)
Mulga Open Woodland	Mulga Open Woodland	Woodlands in which Mulga (*Acacia aneura*) is dominant over *Triodia epactia* and *T. wiseana* hummock grasslands on plains.	**Medium –** has the potential to support a relatively unique and diverse fauna assemblage, with some species restricted to this habitat type.	3.4 (0.1%)
Plateau	Plateau	Relatively flat terrain that is raised significantly above the surrounding area, often with one or more sides with steep slopes. The tallest hills in the Proposal area are 820 m above sea level. Habitat tends to be open and structurally simple and dominated by *Triodia* spp. hummock grasslands.	**Medium** – provides potential foraging habitat for the Northern Quoll and potential foraging habitat for the Pilbara Leaf-nosed Bat and Ghost Bat. However, this habitat does not exclusively support any conservation significant species within the Proposal Area.	34.0 (1.2%) The Proposal disturbance footprint (based on the current mine plan) does not intersect this habitat type

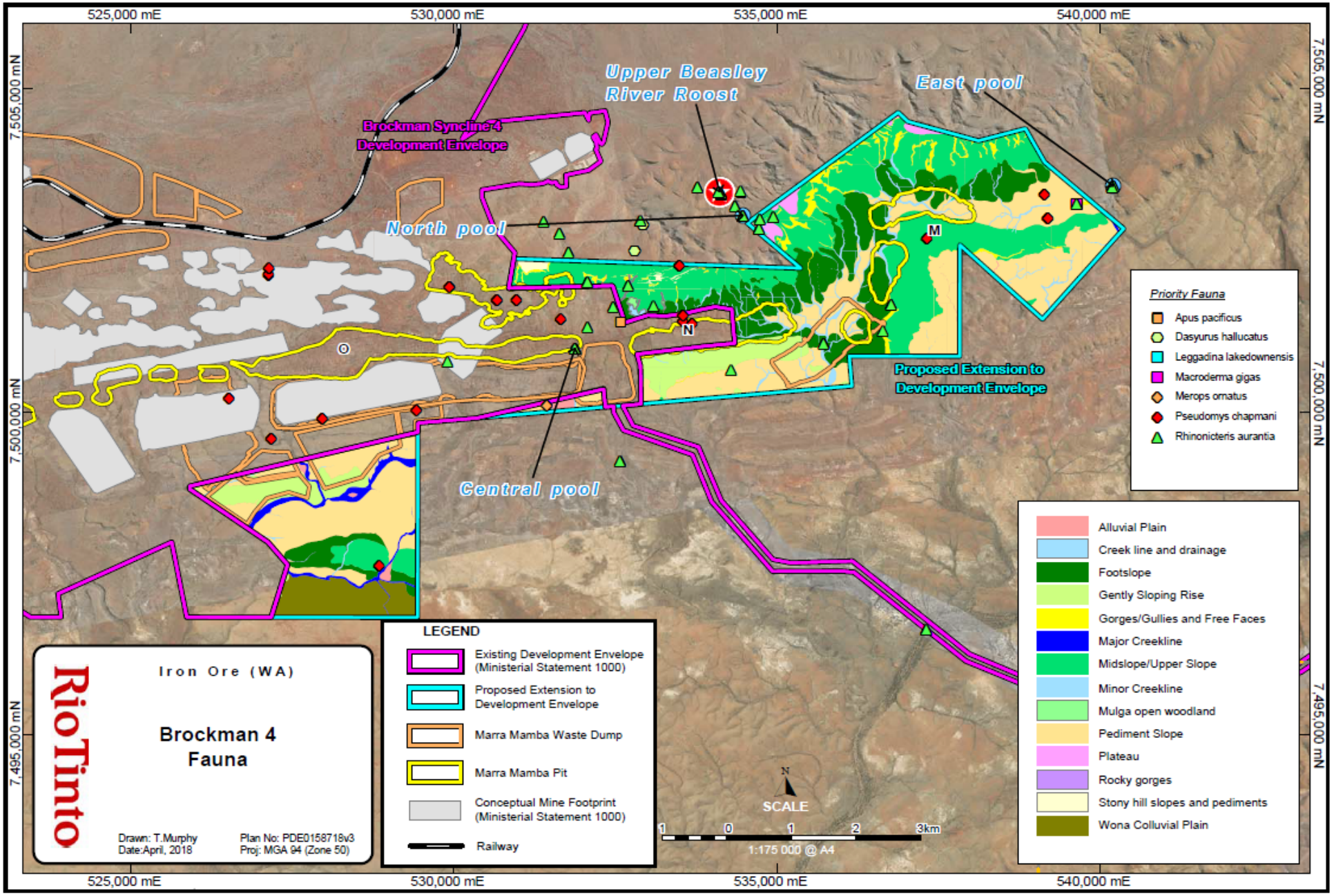


Figure 3: Habitats mapped in the Proposal area

3. Conservation Significant Species

Four species of conservation significance have been recorded from the Proposal area:

- Pilbara Leaf-nosed Bat, *Rhinonicteris aurantia* (EPBC Vulnerable, WC Act Vulnerable);
- Ghost Bat, *Macroderma gigas* (EPBC Vulnerable, WC Act Vulnerable);
- Western Pebble-mound Mouse, *Pseudomys chapmani* (DBCA Priority 4); and
- Fork-tailed Swift, *Apus pacificus* (EPBC Migratory, WC Act International Agreement).

Four species of conservation significance are considered likely to occur within the Proposal area:

- Northern Quoll, *Dasyurus hallucatus* (EPBC Endangered, WC Act Endangered);
- Short-tailed Mouse, *Leggadina lakedownensis* (DBCA Priority 4);
- Pilbara Olive Python, *Liasis olivaceus barroni* (EPBC Vulnerable, WC Act Vulnerable); and
- Lined Soil-crevice Skink, *Notoscincus butleri* (DBCA Priority 4).

The Night Parrot, *Pezoporus occidentalis* (EPBC Endangered, WC Act Critically Endangered), is unlikely to occur in the Proposal area due to an absence of records from the locality and a lack of core habitat in or near the Proposal area. The most recent record of the Night Parrot was at Minga Well, in the Chichesters/ Fortescue Marsh (approximately 200 km to the east of the Proposal area). The nearest recorded to Boolgeeda Creek is a “moderately certain” record from 100 km to the south in 1967 (according to NatureMap).

In addition, a targeted Night Parrot survey was undertaken in 2017 in the Proposal area (in locations considered to represent the best potential Night Parrot habitat) using seven autonomous recording units totalling 47 recording nights – no Night Parrot calls were recorded during the targeted survey.

Species	Conservation Status	Habitat	Distribution Within and Outside the Proposal Area	Likelihood of Occurrence and Justification
Recorded within the Proposal Area				
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	EPBC Vulnerable, WC Act Vulnerable	Roosts are restricted to caves (or adits) which maintain elevated temperatures and humidity. These caves occur in rocky habitat with the majority of roosts occurring within 6 km of permanent water. Foraging habitat is diverse however includes *Triodia* hummock grasslands, watercourses, gorges, hills and plains. Permanent and semi-permanent water is also important.	Recorded from 11 locations in Proposal area from calls. All records of the Pilbara Leaf-nosed Bat have been categorised as 'low activity' and as foraging away from a roost site. A confirmed roost is located approximately 670m outside the Proposal area to the north (and approximately 2 km from the closest mining area – proposed Marra Mamba Pit N) (denoted as 'Upper Beasley River Roost' in Figure 3). Two surface water pools considered important to this species are also located outside the Proposal Area (North pool and East pool), with one small ephemeral pool (Central pool) of reduced importance is located within the existing Development Envelope (Figure 3).	**Recorded –** Calls recorded within the Proposal area and a confirmed roost located 670 m to the north of the Proposal area boundary and approximately 2 km from the closest mining area (proposed Marra Mamba Pit N). This roost is located on the northern side of the Brockman Syncline Range with the mining areas located in the valley to the south of this range, therefore, mining activities are expected to pose a negligible risk of impact to this species. Pilbara Leaf-nosed Bat calls have been recorded at three pools within the vicinity of the Proposal area (Figure 3). Two of these pools are considered to be important to the species, North pool (located in the ridge close to the bat roost – this pool persists into January due to shading from over hanging rock face) and East pool (a permanent pool) – these two pools are located outside the Proposal area and will not be impacted by the Proposal (either directly or indirectly). The third pool, Central pool, is located in the existing Development Envelope and is a small surface water fed ephemeral pool – the pool measured approximately 4 m x 1.5 m and 0.2 m deep in October 2016. The current mine plan has the eastern most extent of the proposed Marra Mamba Pit O intersecting this pool. Given small number of bat calls recorded at this pool and the physical/hydrological features of the pool, this pool represents only a very minor drinking resource for the roosting Pilbara Leaf-nosed Bats and removal of the pool is considered to pose a negligible risk to the persistence of the roosting bat colony.

Species	Conservation Status	Habitat	Distribution Within and Outside the Proposal Area	Likelihood of Occurrence and Justification
Ghost Bat (*Macroderma gigas*)	EPBC Vulnerable, WC Act Vulnerable	Rocky gorges and breakaways that support caves and crevices used as maternity roosts. Requires habitats that provide a selection of roosting opportunities with night roosts or feeding sites and at least one deep cave with characteristics of a maternity roost. Productive foraging area nearby; usually a significant riparian community.	Single call recorded at the eastern end of the Proposal area in 2016 (Biota 2016). During the targeted Pilbara Leaf-nosed Bat survey work in 2016, Ghost Bats were also detected at five locations through echolocation recordings (four cave entrances and at one waterhole) (Bat Call WA 2018). Two of these locations were within the Proposal area. All calls were isolated and represented foraging bats. No evidence of a Ghost Bat diurnal roost cave was indicated by the data.	**Recorded –** Isolated calls recorded from three locations and potential roosting habitat (Gorge and Gully habitat) exits within the Proposal area. However, this species has failed to be recorded with any high activity levels and extensive search efforts failed to record any potential roosting caves. All calls were isolated and represented foraging bats.
Western Pebble-mound Mouse (*Pseudomys chapmani*)	DBCA Priority 4	Typically found on stony hillsides with *Triodia* hummock grasslands.	Four mounds have been recorded within the Proposal area and 18 mounds within the existing Development Envelope, as well as one individual captured in 2016 within the Proposal area.	**Recorded –** One individual was captured in 2016 within Stony Hill Slopes and Pediments habitat. Numerous mounds have been recorded within Stony Hill Slopes and Pediments habitat throughout the Proposal area, as well as the broader locality.
Fork-tailed Swift (*Apus pacificus*)	EPBC Migratory, WC Act International Agreement	Almost exclusively aerial in Australia, occurring over dry or open habitats such as inland plains, foothills, farmland or in coastal areas.	Single record of one individual over-flying a minor creekline on the edge of the Proposal area boundary in 2014.	**Recorded –** This species is considered to be locally uncommon and not restricted to the Proposal area. This species is also almost entirely aerial and also forages aerially. The Proposal area is not considered to represent critical habitat for this species.
Likely to Occur within the Proposal Area				
Northern Quoll (*Dasyurus hallucatus*)	EPBC Endangered, WC Act Endangered	Rocky habitats such as ranges, escarpments, mesas, gorges, breakaways and boulder fields. Also major drainage lines or tree-lined drainage systems that are structurally diverse and contain large diameter trees, termite mounds or hollow logs.	Despite targeted searches and ~4,800 trap nights (systematic trapping and motion sensitive cameras) within the Greater Brockman locality, with at least 672 trapping nights within the Proposal area, the Northern Quoll has not been recorded within the Proposal Area. Scats have been recorded at only two locations approximately 600 m and 1 km north of the Proposal	**Likely to occur** – It is expected a low occurrence within the Proposal area. Potential denning habitat is likely to occur within the Gorge and Gully habitat. Potential foraging habitat is likely to occur within the Major Creekline and Stony Hill Slopes and Pediments habitats.

Species	Conservation Status	Habitat	Distribution Within and Outside the Proposal Area	Likelihood of Occurrence and Justification
			area and outside the existing Development Envelope in 2016.	Presence of this species in the Proposal area is most likely to comprise transient males as opposed to resident females.
Short-tailed Mouse (*Leggadina lakedownensis*)	DBCA Priority 4	Cracking clay, native grasslands and surrounding habitats.	This species has been recorded approximately 3.5 km southwest of the Proposal area and existing Development Envelope in 2009.	**Likely to occur –** The species is predicted to occur in the southwestern portion of the Proposal area where suitable vegetation and cracking clay soils occur on the Wona Colluvial Plain landform.
Pilbara Olive Python (*Liasis olivaceus barroni*)	EPBC Vulnerable, WC Act Vulnerable	Rocky habitat such as gorges, escarpments and breakaways along with drainage lines including or in close proximity to permanent or semi-permanent water holes.	Not recorded within the Proposal area during the 2016 survey but it has been recorded once (skin slough) within the existing Development Envelope at Beasley River from a previous survey, approximately 2.8 km from the Proposal area.	**Likely to occur –** Suitable habitat exists within the Proposal area and it has been recorded (skin slough) within the existing Development Envelope.
Lined Soil-crevice Skink (*Notoscincus butleri*)	DBCA Priority 4	Areas dominated by *Triodia* spp. near creek and river margins.	Recorded within the existing Development Envelope (Biota 2005) but not within the Proposal area.	**Likely to occur –** Given it has been recorded within the existing Development Envelope (Biota 2005) and suitable habitat (Major and Minor Creeklines) exists within the Proposal area.

4. Short Range Endemic Species

Four mygalomorph spider taxa have been recorded within the Proposal Area to date:

- Aname sp. N126 (Biota 2013a);
- Barychelidae sp.;
- Nemesiidae sp. 'sock'; and
- Aname sp. 'hooded' (Biota 2016).

An additional taxon, Aname sp. N19, has also been recorded within the existing Development Envelope (Biota 2013a). It is possible that the Nemesiid specimens recorded from the current survey represent the same species recorded by Biota (2013a), and these may therefore be distributed outside of the Proposal Area. Similarly, the Barychelidae sp. taxon may also have been recorded previously outside of the Proposal Area.

One Rhagada land snail species was recorded within the Proposal Area (Biota 2016). The Rhagada specimens recorded may correspond to the lineages previously recorded in the existing Development Envelope (Rhagada sp. 'Panna' and 'Tom Price/Beasley' (Biota 2013a)) and therefore have distributions extending outside of the Proposal Area.