

Report

Desktop Study of Rehabilitation Strategies in the Pilbara – Christmas Creek Approvals




Environmental Studies

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1. INTRODUCTION

Fortescue Metals Group (Fortescue) is an integrated business comprised of mines (Cloudbreak, Christmas Creek and Solomon hub), a rail network (main line and Hamersley line) and port operations (Port Hedland) based in the Pilbara region of Western Australia, with its head office located in Perth.

The Christmas Creek mine site in the eastern Pilbara was originally approved on 16 December 2005 as part of the *Stage B Project: An East-West Railway Line and Christmas Creek and Mindy Mindy mines* (Ministerial Statement 707, EPBC ref. 2004/1562).

As part of Christmas Creek's Life of Mine Approvals and expansion plans, the Environmental Protection Authority (EPA) has provided an Environmental Scoping Document (ESD) to define the requirements of the Public Environmental Review (PER) document to be prepared in accordance with the *Western Australian Environmental Protection Act 1986* (EP Act) and the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Christmas Creek proposes the modification/expansion or development of additional:

- Mine pits
- Ore stockpiles
- Remote crushing hubs and conveyors
- Ore processing facilities
- Remote crushing hubs and conveyors
- Ore processing facilities (OPF) and train loading facilities
- Waste rock storage facilities (WRSF)
- Tailings storage facilities (TSF)
- Growth medium storage areas
- Power lines
- Roads and borrow pits
- Surface Water management infrastructure
- Water bores, injection borefields, reticulation, transfer, storage and settlement ponds and evaporation basins
- Desalination plant
- Accommodation facilities and wastewater treatment plants

- Bulk and satellite fuel storage
- Laboratory, warehouses, laydown area, workshops, maintenance facilities, wash bay facilities
- Explosives and chemical storage
- Administration buildings
- Laydown and storage facilities.

The EPA considers rehabilitation and mine closure as one of several preliminary key environmental factors relevant to the proposal. The EPA objective is: “to ensure that premises can be closed, decommissioned and rehabilitated in an ecologically sustainable matter, consistent with agreed outcomes and land uses, and without unacceptable liability to the State.”

As part of the development of the PER document, the EPA has requested a desktop study of successful and unsuccessful rehabilitation strategies and outcomes in similar geologies and vegetation types in the Pilbara, including a discussion of the different methodology and success rates for the various proposed disturbance types, including:

- Created landforms (e.g. waste rock dump, tailings storage facility)
- Short term disturbances (e.g. borrow pits and access tracks)
- Long-term disturbances (e.g. construction camp, permanent accommodation village and administration buildings)
- Linear and/or fragmentation disturbances (e.g. roads, powerlines, borefields).

This document addresses these requirements and also provides a summary of how rehabilitation and revegetation is managed at Fortescue.

1.1 Site Description

1.1.1 Location

Christmas Creek is located 110 km north of Newman, in the Pilbara region of Western Australia (Figure 1).

Figure 1: Location of Christmas Creek

1.1.2 Climate

Christmas Creek is located in the Pilbara region, and the nearest Bureau of Meteorology (BoM) station is Newman Airport weather station, located approximately 110 km from the site. The Pilbara has an arid-tropical climate with two distinct seasons, a hot summer from October to April and a mild winter from May to September with a mean maximum temperature of 31.4°C and mean minimum temperature of 17.3°C. In summer, maximum daytime temperatures may reach 46°C, whilst in winter, minimum night time temperatures may fall to -2°C (BoM 2014), experiencing a temperature range of 48°C.

Rainfall in the Pilbara is often sporadic and may occur throughout the year (in summer and winter). Summer rainfall is typically associated with tropical storms in the north, or tropical cyclones that cross the coast and move inland.

1.1.3 Geology

The regional stratigraphy in the Pilbara region of Western Australia is relatively continuous, with similar geological processes occurring across the region. These processes have resulted in the enrichment of the iron deposits (Fortescue, 2009). The project area lies within the Hamersley Basin where granitoid rocks of the Pilbara Craton (2,800 – 3,500 Ma), are overlain by the Archaean Fortescue Group, which is overlain by the Archaean-proterozoic Hamersley Group of which the Marra Mamba Formation (MMF) is the lowermost unit (Environ Australia, 2005). Mineralisation is confined to the Nammuldi Member of the MMF, which is characterised by extensive, thick and podded iron enriched Banded Iron Formation, separated by equally extensive units of siliceous and carbonate rich chert and shale (Fortescue, 2009). The Nammuldi Member is overlain by various Tertiary detrital deposits of varying maturity which may also contain iron mineralisation.

The mineralogy of the ore units is dominated by iron oxides (>55 %) comprising goethite, hematite and to a lesser extent martite, together with ochreous goethite. Other minerals present are kaolinite (alumina <5%) with free and matrix quartz (silica <10%). High grade ore frequently occurs as lenses within low grade ore, often contains high levels of silica, and can be in contact with waste rock zones (Tetra Tech, 2012).

Overburden includes silts, clays, sands and shales (goethitic & hematitic) of the Nammuldi Member. The geochemistry of a range of mine waste samples from the Christmas Creek Deposit has previously been assessed by Graeme Campbell and Associates (GCA, 2005) with regard to the implications for mine waste management. Based on the results of this previous study, the regolith and waste-bedrocks to be excavated during open-pit mining is expected to be non-acid forming (NAF) sulfide minerals. Enrichment in minor elements from NAF lithotypes is expected to be low and soluble-salt concentrations low to moderate (GCA, 2005). The Roy Hill Shales, located below the ore zone, are classified as potentially-acid forming (PAF). However,

open-pit mining is not anticipated to extend to a depth where the Roy Hill Shales will be intersected (GCA, 2005).

1.1.4 Vegetation

Christmas Creek lies within the Fortescue Botanical District of the Eremaean Botanical Province. The vegetation of this province is typically open, and frequently dominated by spinifex, wattles and occasional eucalypt (Beard, 1975).

In the most recent Christmas Creek Life of Mine Flora and Vegetation Assessment (ENV, 2013), a total of 541 taxa including 14 Priority Flora and 20 weed species have been recorded in the survey area. Fifteen broad vegetation types and eleven vegetation associations have been mapped (Table 1).

Table 1: Vegetation Types (VT) and Vegetation Associations (VA) mapped in the Christmas Creek survey area

Habitat	Code	Description of Vegetation Type and Vegetation Association
Creek and Drainage Lines	VT1	Open Woodland of <i>Eucalyptus victrix</i> , <i>E. camaldulensis</i> with pockets of <i>Acacia coriacea</i> subsp. <i>pendens</i> over <i>Grevillea wickhamii</i> subsp. <i>aprica</i> , <i>Petalostylis labicheoides</i> and <i>A. tumida</i> over <i>Triodia longiceps</i> , <i>Chrysopogon fallax</i> , <i>Themeda triandra</i> and <i>Aristida</i> species.
	VT2	Low Woodland to Low Open Forest of <i>Acacia aneura</i> , <i>A. citrinoviridis</i> , <i>A. pruinocarpa</i> over <i>A. tetragonophylla</i> and <i>Psyrax latifolia</i> over <i>Chrysopogon fallax</i> , <i>Stemodia viscosa</i> , <i>Blumea tenella</i> , <i>Themeda triandra</i> and <i>Triodia</i> and <i>Aristida</i> species.
	VT8	Closed Scrub to Tall Shrubland of <i>Acacia pruinocarpa</i> , <i>A. tumida</i> , <i>A. ancistrocarpa</i> , <i>A. maitlandii</i> , <i>A. kempeana</i> , <i>A. tetragonophylla</i> with occasional <i>E. gamophylla</i> and <i>Corymbia</i> spp. over <i>Triodia epactia</i> , <i>Themeda triandra</i> and <i>Aristida</i> species.
	VT9	Closed Scrub to Shrubland of <i>Acacia ancistrocarpa</i> , <i>A. maitlandii</i> , <i>A. kempeana</i> , <i>A. monticola</i> , occasional <i>E. gamophylla</i> and <i>Corymbia deserticola</i> over <i>Senna</i> species, <i>Triodia basedowii</i> and <i>Aristida</i> species.
Flats and Broad Plains	VT3	Low Woodland to Low Open Forest of <i>Acacia aneura</i> , <i>A. pruinocarpa</i> , <i>A. tetragonophylla</i> , <i>A. tenuissima</i> , <i>Grevillea wickhamii</i> subsp. <i>aprica</i> , <i>Psyrax latifolia</i> over <i>Dodonaea petiolaris</i> and <i>Triodia</i> and <i>Aristida</i> species.
	VT4	Low Open Woodland of <i>Acacia aneura</i> , <i>Acacia pruinocarpa</i> , <i>Acacia xiphophylla</i> , <i>Acacia victoriae</i> over <i>A. tetragonophylla</i> , <i>Psyrax latifolia</i> and <i>Psyrax suaveolens</i> over <i>Ptilotus obovatus</i> and mixed <i>Maireana</i> and <i>Sclerolaena</i> species.
	VT10.1	Low Open Woodland of <i>Acacia xiphophylla</i> , <i>Acacia victoriae</i> , <i>Acacia aneura</i> var. <i>aneura</i> over <i>Acacia tetragonophylla</i> , <i>Ptilotus obovatus</i> and mixed <i>Senna</i> , <i>Maireana</i> and <i>Sclerolaena</i> species.
	VT10.2	Low Open Woodland of <i>Acacia xiphophylla</i> , <i>Acacia aneura</i> , <i>Eremophila platycalyx</i> subsp. <i>pardalota</i> over Low Open Shrubland of <i>E. cuneifolia</i> , <i>Maireana pyramidata</i> , <i>Senna artemisioides</i> subsp. <i>oligophylla</i> over sparse tussock grassland of mixed species.
	VT30.1	High open Shrubland of <i>Acacia synchronicia</i> with <i>Senna glaucifolia</i> (<i>Sclerolaena</i> spp. and other halophytes) over <i>Aristida</i> species.
	VT30.1 +10.1	Mosaic of VT30.1 and VT10.1, patches of vegetation were too small to map separately.
	VT30.1 +04	Mosaic of VT30.1 and VT4, patches of vegetation were too small to map separately.
	VT30.2	Scattered shrubs of <i>Acacia synchronicia</i> over low shrubland to low open shrubland of

Habitat	Code	Description of Vegetation Type and Vegetation Association
		<i>Eremophila spongiocarpa</i> , <i>Atriplex bunburyana</i> and <i>Sclerolaena cuneata</i> , over scattered tussock grasses of <i>Dactyloctenium radulans</i> , <i>Eragrostis pergracilis</i> and <i>Panicum decompositum</i> .
	VT30.3	Scattered tall shrubs of <i>Acacia synchronicia</i> over low open shrubland of <i>Senna artemisioides</i> subsp. <i>oligophylla</i> (thinly sericeous), <i>Atriplex bunburyana</i> and <i>Sclerolaena cuneata</i> over scattered tussock grasses of <i>Dactyloctenium radulans</i> .
Ranges, Hills and Hillslopes	VT16	Hummock Grassland of <i>Triodia basedowii</i> with pockets of <i>Triodia epactia</i> and <i>Triodia lanigera</i> with emergent patches of <i>Eucalyptus leucophloia</i> , <i>Corymbia deserticola</i> over <i>Acacia ancistrocarpa</i> , <i>Acacia hilliana</i> , <i>Acacia acradenia</i> , <i>Acacia pyrifolia</i> , <i>Hakea lorea</i> subsp. <i>lorea</i> over <i>Goodenia stobbsiana</i> and mixed <i>Senna</i> species.
	VT17	Hummock Grassland of <i>Triodia basedowii</i> with pockets of <i>Triodia epactia</i> and <i>Triodia lanigera</i> with emergent patches of <i>Eucalyptus leucophloia</i> , <i>Corymbia deserticola</i> over <i>Acacia ancistrocarpa</i> , <i>A. pyrifolia</i> , <i>Hakea lorea</i> subsp. <i>lorea</i> over <i>Goodenia stobbsiana</i> and mixed <i>Senna</i> and <i>Ptilotus</i> species.
Marsh Vegetation	VA1	<i>Tecticornia</i> sp. Christmas Creek, <i>T. auriculata</i> , <i>Muehlenbeckia florulenta</i> low closed heath over <i>Eragrostis pergracilis</i> , <i>E. tenellula</i> scattered tussock grasses and <i>Cullen cinereum</i> , <i>Nicotiana heterantha</i> , <i>Pterocaulon sphaeranthoides</i> open herbland.
	VA2	<i>Muehlenbeckia florulenta</i> shrubland to open heath over <i>Tecticornia indica</i> subsp. <i>bidens</i> low scattered shrubs to low open shrubland over <i>Eleocharis papillosa</i> , <i>Schoenoplectus dissachanthus</i> (very) open sedgeland with <i>Nicotiana heterantha</i> , <i>Marsilea hirsute</i> open herbland.
	VA3	* <i>Vachellia farnesiana</i> , <i>Acacia ampliceps</i> open scrub over <i>Tecticornia</i> sp. Christmas Creek (K.A. Shepherd & T. Colmer et al. KS 1063), * <i>Aerva javanica</i> and <i>Cullen cinereum</i> low open shrubland over * <i>Cenchrus setiger</i> , <i>Dactyloctenium radulans</i> and * <i>C. ciliaris</i> tussock grassland.
	VA4	<i>Melaleuca glomerata</i> open scrub over * <i>Aerva javanica</i> , <i>Tecticornia</i> spp. low open shrubland over <i>Cleome viscosa</i> , <i>Nicotiana heterantha</i> , <i>Swainsona kingii</i> herbland.
	VA5	<i>Acacia synchronicia</i> , <i>Melaleuca glomerata</i> , <i>Eremophila youngii</i> subsp. <i>lepidota</i> scattered tall shrubs over <i>Tecticornia indica</i> subsp. <i>bidens</i> , <i>Eremophila spongiocarpa</i> low open shrubland over <i>Sporobolus virginicus</i> , * <i>Cenchrus ciliaris</i> , <i>Dactyloctenium radulans</i> tussock grassland.
	VA6	<i>Tecticornia</i> sp. Dennys Crossing (K.A. Shepherd & J. English KS 552), <i>T. indica</i> subsp. <i>bidens</i> , <i>Muehlenbeckia florulenta</i> low open heath over <i>Eragrostis pergracilis</i> (very) open tussock grassland and <i>Cyperus bulbosus</i> scattered sedges with <i>Nicotiana heterantha</i> , <i>Swainsona kingii</i> scattered to very open herbland.
	VA7	<i>Tecticornia indica</i> subsp. <i>bidens</i> , <i>T. sp.</i> Dennys Crossing (K.A. Shepherd & J. English KS 552), <i>Eremophila spongiocarpa</i> low open heath to low closed heath over <i>Eragrostis</i> spp., <i>Enneapogon</i> spp., * <i>Cenchrus</i> spp. scattered tussock with <i>Nicotiana heterantha</i> , <i>Pterocaulon sphaeranthoides</i> , <i>Gomphrena kanisii</i> scattered herbs.
	VA8	<i>Tecticornia auriculata</i> (and <i>T. sp.</i> Dennys Crossing (K.A. Shepherd & J. English KS 552) open heath over <i>Eragrostis pergracilis</i> , <i>Chloris pectinata</i> tussock grassland and <i>Cyperus bulbosus</i> scattered sedges with <i>Swainsona kingii</i> , <i>Nicotiana heterantha</i> scattered herbs.
	VA9	<i>Acacia synchronicia</i> scattered tall shrubs over <i>Tecticornia indica</i> subsp. <i>bidens</i> , <i>Eremophila spongiocarpa</i> low open shrubland over <i>Eragrostis pergracilis</i> , * <i>Cenchrus ciliaris</i> tussock grassland with <i>Lawrenzia densiflora</i> , <i>Euphorbia australis</i> , <i>Goodenia forrestii</i> scattered herbs.
	VA10	<i>Acacia synchronicia</i> , <i>A. xiphophylla</i> high shrubland over <i>Eremophila</i> spp., <i>Enchylaena tomentosa</i> var. <i>tomentosa</i> , <i>Maireana pyramidata</i> scattered low shrubs over * <i>Cenchrus ciliaris</i> , <i>Eragrostis pergracilis</i> , <i>Triraphis mollis</i> very open tussock grassland and <i>Goodenia forrestii</i> , <i>Sclerolaena cornisheiana</i> , <i>Stemodia grossa</i> . scattered herbs.
	VA11	Lake bed likely to support annual herbs and grasses episodically.
Infrastructure	VT0	Areas cleared for mining, infrastructure and associated activities.

2. DESKTOP ASSESSMENT OF REHABILITATION STRATEGIES IN THE PILBARA

2.1 Rehabilitation and Revegetation at Fortescue

Definitions applicable to this section include:

- **Closure domains:** landforms or infrastructure that has similar rehabilitation, decommissioning and closure requirements/objectives as defined in the *Guideline for Preparing Mine Closure Plans* (Department of Mines and Petroleum (DMP), 2011)
- **Controlled sites:** include sites that are under Fortescue's legal control including exploration sites, project sites, operational sites (sites that are managed and operated by Fortescue and sites that are managed by Fortescue but operated by contractors) and the Perth offices
- **Rehabilitation:** a return of disturbed land to a stable, productive and or self-sustaining condition, consistent with the post operational land used (DMP/Environmental Protection Authority (EPA), 2011).
- **Revegetation:** establishment of self-sustaining vegetation cover after earthworks have been completed, consistent with the post-operational land use (DMP/EPA, 2011).

Rehabilitation at Fortescue's controlled sites is undertaken under a *Rehabilitation and Revegetation Management Plan* (45-PL-EN-0023), which has been developed to satisfy the requirements of Ministerial Statements 690, 707, 771 and 899. The plan does not include exploration rehabilitation and revegetation activities, which are addressed separately in an *Exploration Environmental Management Plan* (E-PL-EN-0002), and *Exploration Drill Hole Stabilisation and Site Rehabilitation Procedure* (E-PR-EN-0010).

The following supporting documents guide Fortescue's rehabilitation and revegetation activities:

- *Borrow Pit Management Plan* (45-PL-EN-0018)
- *Design Specification for Mine Pit Backfill and Associated Surface Water Management Structures* (100-SW-EN-0046)
- *Groundwater Management Plan* (45-PL-EN-0029)
- *Overburden Management Re-Growth and Waste Procedure* (45-PR-EN-0012)
- *Planning for Closure – Design of Mineral Waste Rock Landforms* (100-PR-EN-1017)
- *Surface Water Management Plan* (45-PL-EN-0024)
- *Tailings Storage Facility Closure Management Guidelines* (CH-GU-OP-0001)
- *Vegetation Clearing and Topsoil Management Procedure* (45-PR-EN-0013)

- *Rehabilitation and Revegetation Monitoring Procedure* (45-PR-EN-0027)
- *Weed Management Plan* (45-PL-EN-0013)
- *Revegetation Management Plan: Cloudbreak* (CB-PL-EN-0026)
- *Solomon Mine Closure Plan* (SO-PL-EN-0002)
- *Christmas Creek Conceptual Mine Closure Plan* (100-RP-EN-9058)
- *Cloudbreak Mine Closure Implementation and Monitoring Plan* (CB-PL-EN-0030).

At Christmas Creek, it is anticipated that rehabilitation activities will take place over the life of mine at the following closure domains:

- Waste Rock Landforms
- Pits
- Tailings Storage Facilities
- Industrial Infrastructure
- Heavy Industrial Infrastructure
- Water Infrastructure
- Roads
- Haul Roads
- Rail
- Borrow Pits
- Exploration.

2.2 Industry Guidelines

The previous Commonwealth Department of Industry, Tourism and Resources produced two guidance documents as part of its Leading Practice Sustainable Development Program for the Mining Industry (DITR, 2006): *Mine rehabilitation* and *Mine Closure and Completion*. The documents outline the principles and practices of mine site rehabilitation and closure activities. The *Mine rehabilitation* document covers sustainable development, stakeholder consultation, materials characterisation and handling, landform construction, waste storage, vegetation establishment and closure activities including the development of criteria and rehabilitation monitoring.

The Environmental Protection Authority (WA) has developed a guidance document *Guidance for the Assessment of Environmental Factors – Rehabilitation of Terrestrial Ecosystems*

(EPA, 2006) to encourage best practice in setting appropriate and effective objectives for rehabilitation and assessing subsequent outcomes.

The Department of Mine and Petroleum has also developed the *Guidelines for Preparing Mine Closure Plans* (DMP, 2011).

2.3 Strategies and Case Studies

2.3.1 Characterisation of Soil Profiles and Waste Material

Waste characterisation is critical in order to assess the adequacy of the material's property as a rehabilitation material and to promote self sustaining native vegetation growth. Characterisation of soil materials and waste materials should occur as early as possible so as to enable adequate planning and selective placement of materials, and so as to avoid adverse effects on the closure process and rehabilitation performance (DITR, 2006).

Properties for testing typically include mineralogy, acidity, salinity, sodicity, erodibility, strength, water holding capacity, particle size distribution, potential for acid formation, nutrient and metal availability, hydraulic conductivity and biological components (Jasper and Braimbridge, 2006).

Erodibility describes the susceptibility of a given material to erosion and is essential to consider for the construction of waste landforms and tailings storage facilities (DITR, 2006). Erodibility can be predicted to some extent on the basis of material properties, or with greater accuracy using laboratory or field trials (Loch, 2000).

Fortescue has undertaken geochemical waste characterisation of mine waste samples (GCA, 2005), waste rock and tailings characterisations (Coffey, 2012 and Tetra Tech, 2012) and investigations into acid and metalliferous drainage potential (AMD) in mined materials as part of their closure and rehabilitation planning works.

2.3.2 Vegetation, topsoil and growth medium management

The management of growth media for rehabilitation purposes, which includes topsoil, subsoil, or combinations of soil material/rock/fertiliser; as well as vegetation grub, is a critical issue in the Pilbara. The extensive nature of iron ore deposits and the associated infrastructure footprint means that large areas need to be rehabilitated. In many cases, soil material is stored in stockpiles, and over time, this can reduce its viability as a growth medium. Several studies have been undertaken to determine practices that can enhance soil's structural and biological integrity over time.

In arid zones such as the Pilbara, soils contain limited organic matter. Topsoil, which can be defined as the top 200 mm of the soil profile which is biologically active (A horizon), contains a

seedbank which makes it a valuable resource for successful revegetation. Topsoil is an important resource as it has:

- High nutrient content relative to other sections of the soil profile;
- High water holding capacity;
- Structural and physical properties that aid plant growth; and
- Viable seed and organic material content

Subsoil, located beneath the topsoil zone, can also serve as a suitable growth medium although it is not as biologically active as topsoil.

Management of vegetation, topsoil and growth medium (e.g. topsoil + subsoil) can include, as a minimum:

- Adequate planning for all stages of land clearance, topsoil movement and data collection.
- Collection and recovery of topsoil, subsoil and vegetation material to an adequate depth, and soil storage in stockpiles nominally designated as two metres in current best management practice, (e.g. Ecologia, 2010 and Pilbara Iron, 2007).
- Hauling material directly to areas where direct return is feasible, as is usually preferred for optimum revegetation success (e.g. Chevron, 2012) or stockpiling in designated areas
- Spreading material from stockpiles onto the rehabilitated surface.

2.3.3 Reconstruction of soil profile

One of the critical components of successful rehabilitation and subsequent revegetation is the construction of a soil profile, which normally includes topsoil, subsoil and benign waste. In some cases, a clay barrier seal or capillary break layer may be required. Surface material may vary, depending on site by site availability and adequacy of material in terms of stability and potential to support plant establishment. Materials can include topsoil, oxidised waste rock, compacted silty sandy clay, clayey oxidised waste rock, tailings, waste rock with minimal fines and quarried rock with minimal fines (DITR, 2006).

Where topsoil is available, a freshly rehabilitated surface should ideally have a cover of 50 – 100 mm of topsoil over a subsoil material (DITR, 2006). On sloped surfaces, adequate protection is required by using rocky topsoil or incorporating rocky materials. Topsoil with high erodibility should only be used in shallow depths (e.g. 50 mm). The depth of topsoil used and underlying material also depends on the nature of the target vegetation community, in some cases; a thicker layer of topsoil in combination with a capillary break may be required. Trials

should be conducted to determine the optimum combination of materials, ripping depth and any soil amelioration or covers required.

For example, a waste landform at a Southern WA Goldfields site underwent a trial to compare a number of different cover treatments in terms of their effect on pH and EC of the cover profile. The cover materials used were topsoil, waste rock, road ballast and uncovered tailings. Over ten years, the data showed that a cover material was required to enable plant establishment, and that treatments involving both a layer of waste rock and topsoil is likely to result in the highest vegetative cover (Outback Ecology, 2012). Soil profile reconstruction at Bottle Creek Gold Mine in WA involved 500 mm of waste rock, topsoil spread to a depth of 100 mm and deep ripping along the surface of the contour (Anderson *et al.*, 2002).

Some approaches for tailings storage facility rehabilitation have been summarised in Lacy *et al.* (2004), including:

- Chemical amendments: altering the physical structure or chemical composition of the tailings to promote vegetation establishment and survival. This can include the use of gypsum, lime and fertilisers.
- Chemical stabilisation – can be used to stabilise surfaces by using sealants to produce a crust, preventing wind and water erosion. This includes adhesives, polymers, bitumen based compounds and cement.
- Physical stabilisation – the application of a cover to counter the effects of wind and water. Materials can include oxide waste rock, laterite waste rock, topsoil, competent fresh rock (non acid forming), mill scats and alluvial mining gravels.
- Vegetation stabilisation – vegetation growth on a tailings storage facility depends on the ability of the material to support plant growth. It has the same impact as a physical barrier.

An example of a soil profile that was designed to manage potentially acid-forming wastes (PAF) was the use of a store/release cover at the Mt McClure Gold Mine. A store/release cover is one suited to seasonal, moisture deficit climates such as the Pilbara, which stores rainfall infiltration during the wet season and subsequently releases it through evapotranspiration during the dry season (DITR, 2006). This is relevant in an arid/semi-arid setting as water availability is the rate determining factor for sulphide oxidation. In this study, water retention studies were conducted on benign waste material at the site and oxide regolith and caprock were selected and placed at 1000 and 1500 mm depth to minimise rainfall percolation to underlying wastes (Campbell, 2004).

2.3.4 Selecting appropriate species and seed management

Species selection should consider landform topography, the nature of the soil or growth medium used on the rehabilitated surface, the ability of species to colonise and establish and the target

vegetation community in the surrounding area. The species list should have both species diversity and structural diversity (e.g. species from various strata such as grasses and low lying shrubs for groundcover which provides landform stability, and taller shrubs and trees which can provide fauna habitat) and should consider keystone species of the area as well as any species that may be specifically required by site specific or legal commitments. Species lists should initially be developed from baseline flora and vegetation surveys. An example list of species found at Christmas Creek is listed in Appendix A (ENV Australia, 2013a, 2013b and Biota, 2004).

It is the intent that revegetation at Christmas Creek and Fortescue controlled sites will involve seeding with native, local provenance seed from a broad vegetation formation or community representative of the area that has been rehabilitated. Seed collection and management should be undertaken as per established guidelines, e.g. Florabank guidelines (Florabank, 1998-2010) and with research and development activities assisting in refining and improving the overall process.

Rio Tinto Iron Ore have a seed management and collection process involving provenance and priority flora seed collection, subsequent storage in a company-owned storage facility and involvement in collaborations with research institutions to further understanding about seed ecology and restoration (Pilbara Iron, 2007).

BHP Billiton Iron Ore has developed all aspects of their seed management process over several years, including (Stokes, 2014):

- Utilising baseline flora surveys to guide seed orders and final seed mixes,
- Seed collectors supplying information with all seed batches (covering collection location and specimen identification),
- Storage conditions that meet international standards,
- Targeted broadcast seeding of specific mixes to certain landform types within a rehabilitation project,
- Rehabilitation and Development programs, including the completed Pilbara Seed Atlas research and initiation of the Restoration Seedbank Initiative.

BHP Billiton Iron Ore's research and development programs focus on each aspect of the seed management cycle, and together with the analysis of the rehabilitation monitoring results, both contribute to the adaptive management approach and continuous improvement of seed management (Stokes, 2014).

2.3.5 Vegetation Establishment

Establishment of a vegetation community can involve one or more of the following (DITR, 2006):

- Direct topsoil return
- Seeding
- Hydroseeding
- Planting of seedling, including those from tissue culturing
- Translocation
- Habitat transfer and natural re-colonisation.

Direct seeding involves sowing seed directly into prepared ground, either by hand for small areas or otherwise inaccessible areas, or through mechanical seeding, in which a specialised seeder is usually mounted onto earthworks machinery and seed can be distributed during ripping. Direct seeding is usually more efficient in terms of time, cost and labour compared to tubestock planting, and allows for a more diverse seed mix, but relies on the availability of seed, and the properties of the growth medium. Several sites in arid Australia have used a combination of direct topsoil return, seeding and natural recolonisation, such as iron ore sites at Rio Tinto Iron Ore (Pilbara Iron, 2007).

The planting of seedlings (or tubestock) is not commonly conducted in arid land mine rehabilitation due to the high costs associated in acquiring and planting tube stock and ongoing irrigation requirements (BHP Billiton, 2009). Hydroseeding, although not commonly used in the Pilbara, can be used in highly erosive conditions and is done by applying seed mixed with a tackifier and fertiliser if required directly on to the surface (Florabank, 1999).

2.3.6 Completion Criteria

The development of acceptable and achievable completion criteria is a necessary part of mine closure planning. Completion criteria are defined as agreed standards or levels of performance, which demonstrate successful closure of a site (DITR, 2006). Once achieved, they demonstrate to the mining company, regulators and other stakeholders that financial assurances and liabilities can be removed and/or lease relinquishment can ultimately occur.

The first stage of the development of competition criteria is the setting of rehabilitation objectives. In Australia, post mining objectives are generally related to creating safe, stable and non-polluting landforms, capable of sustaining an agreed post-mining land use (DMP and EPA, 2011). A common desired post mining outcome is the achievement of a self sustaining ecosystem that exhibits comparable characteristics to the local natural environment (e.g. Osborne and Brearley, 2000, Jasper *et al.*, 2003). From these broad objectives, more specific criteria can be identified, which are complimented by appropriate monitoring tools and quantitative standards. Criteria can cover aspects ranging from physical elements, such as drainage and erosion, to biological aspects, such as vegetation and fauna habitat (Outback Ecology, 2011).

Mining operations typically operate on a shorter time frame than that of ecosystem development and this creates a need for an agreed framework in which all stakeholders can assess the acceptability of rehabilitation, at an early stage. Completion criteria which focus on the essential foundations of the ecosystem can provide this framework. In general, the first priority should be to establish an appropriate physical foundation, followed by appropriate biological components, then finally post-closure management. The proposed criteria can be defined by the SMART acronym, in that they are intended to be specific, measurable, achievable, relevant, and timely.

Generally a framework is proposed in which broad rehabilitation objectives are supported by more-specific criteria. Each criteria in turn is supported by an appropriate monitoring tool and where possible a quantitative standard. Overall objectives for rehabilitation, as well as specific targets and standards, should only represent what can be achieved (Nichols *et al.*, 2005) and should be related to ecosystem functionality and processes, not simply composition. Criteria to assess rehabilitation success need to be simple, objective, and easy to measure if they are to be regularly used for management of the rehabilitation areas, even if the ecosystem processes involved are complex (Bellairs, 1998).

Once developed, the criteria will provide a focus for rehabilitation monitoring, and may lead to refinements to the current monitoring approach. A monitoring program should be designed and implemented that feeds the “adaptive learning loop” (Tongway and Ludwig, 2011) and feedback is implemented until rehabilitation can be seen on track toward the rehabilitation objectives. A monitoring program must be designed to provide the required data, should be suited to the host environment and must take into account the scale and variability of an area, and should monitor parameters that are directly linked to the criteria. In general, the cessation of the monitoring can occur when the rehabilitation area demonstrates that it has become self-sustaining and is resilient in the face of stochastic events. The area should also have met and/or exceeded the defined criteria for a number of successive monitoring events and have achieved a set threshold level.

An example of completion criteria for a site in the Kimberley of Western Australia included criteria based on:

- Percent of native perennial grasses
- Traditional Owner species of interest, and
- Re-sprouter (fire tolerant) plants.

In this site, as with many Pilbara sites, stability of waste rock landforms was a critical aspect of rehabilitation success, indicated by a criterion for establishing a set percentage of native perennial grass cover, and site specific requirements required the inclusion of traditional owner selected species and species capable of tolerating a regular fire regime (Yanez *et al.*, 2012).

2.3.7 Rehabilitation and Revegetation Monitoring

The selection of parameters to monitor, and how frequently, depends on what information the parameter provides, how sensitive its response, its correlation with known ecosystem processes and predictability, its ease and cost of measurement and repeatability or degree of subjectivity, and suitability for monitoring data relevant to the established completion criteria. The choice of monitoring parameters is quite extensive but should include those that are known or expected to be most limiting to rehabilitation success (DITR, 2006).

Typically, monitoring of rehabilitation can include:

- an assessment of surface and slope stability
- the performance of constructed covers (where installed over mine or mineral processing wastes)
- properties of the soil or root zone media (chemistry, fertility and water relations)
- plant community structural attributes (such as cover, woody species density and height)
- plant community composition (such as presence of desired species, weeds)
- selected indicators of ecosystem functioning (such as soil microbial biomass)
- photographic monitoring of the area.

Monitoring may also extend, where required, to surveys of selected fauna groups to assess their colonisation (including mammals and avifauna) or as bioindicators of broader ecosystem trends (e.g. ants).

Various monitoring tools have been used in the Pilbara, and include:

- Ecosystem Function Analysis (EFA): developed by CSIRO, it provides a monitoring approach that has been adapted from its original use in rangeland ecosystems for use in mine sites. Described in Tongway (2001), it consists of the main component of landscape function analysis (LFA) which uses soil surface feature to estimate indices of soil stability, infiltration and nutrient cycling. EFA includes LFA plus measures of vegetation dynamics and habitat complexity. Using the LFA, it is possible to define and rapidly record the influence of vegetation along with non-vegetation based indices toward completion criteria (for stability, infiltration and nutrient cycling), and therefore, assess rehabilitation success or help to identify areas performing below expectation. Transects are also used to monitor erosion through mean bank erosion. EFA monitoring tool has been used in Pilbara sites including Rio Tinto Iron Ore (Pilbara Iron, 2007).

- The Point Centre Quarter method is most commonly used in low rainfall areas where the vegetation is naturally sparse such as in a mulga or chenopod shrubland in arid and semi-arid areas. PCQ has been determined to be the most effective monitoring program in some areas as the PCQ method allows for efficient monitoring in these sparse conditions and provides accurate data for plant cover, density and species richness (Mitchell, 2007). The method is also flexible and can be tailored to suit different vegetation requirements, for example criteria for multiple layers of vegetation in the dry tropics of Northern Queensland and specific species information for invasive perennials in the Northern tropics. PCQ also uses actual measurements rather than estimations by eye and plants can be any distance from the transect within the monitoring area (Outback Ecology, 2011). Disadvantages to this method include the exclusion of the quantitative analysis of annual plant species. The PCQ method, however, is commonly used in climatic regions where perennial plant species provide permanent functions in the landscape, while annual plants are only temporary and are not seen as providing a strong, lasting effect on the landscape, with the exception of providing nutrients, particularly in desiccation.
- Alternatively, the quadrat method assesses both perennial and annual plant cover and density and is commonly used in a variety of environments such as the dry tropics of the Pilbara and tropical and sub-tropical climates of the Kimberley. The quadrat method can be applied to areas with various plant cover and density; however the main disadvantages of this method include its reliance on visual assessments for cover and propensity to human error (Floyd and Anderson, 1987). Quadrats can be used as small quadrats along a transect or a large (e.g. 50 x 50 m) quadrat used to capture data.
- Numerous other methods exist and are being used to monitor vegetation cover, such as the ground cover determination using the point-intercept methodology (Viert *et al.*, 2010) used for reclamation monitoring at a Goldfields site. Regardless of the method, it is critical to recognise the benefits and flaws of each particular method and to select a method that best balances the type and quality of information collected against cost, efficiency and timeliness, and that the monitoring method provides the relevant information required to measure rehabilitation progress against the defined criteria.
- LiDAR (Light Detecting and Ranging) techniques are being developed, which allow for a wide variety of applications, through airborne scanners and ground based scanners, to monitor data such as topography, plant height, cover and landform stability (Mangan and Pratt, 2014).

2.3.8 Potential Rehabilitation Strategies for Christmas Creek closure domains

Table 2 shows a summary of rehabilitation strategies for Christmas Creek's closure domains, as proposed in the Christmas Creek Conceptual mine closure plan (100-RP-EN-9058).

Table 2: Potential Closure and Rehabilitation Strategies for selected Christmas Creek closure domains

Closure Domain	Closure and Rehabilitation Strategies
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Closure Domain	Closure and Rehabilitation Strategies
Landforms (waste rock dump, tailings storage facility)	<ul style="list-style-type: none"> Waste landform and tailings storage facility rehabilitation design to be conducted in alignment with company waste landform design guidelines and industry best practice. Clear vegetation and soil from disturbed areas. Progressively batter waste rock dump slopes to <20 degrees and contour to blend with topography. Include back sloping berms in design. Establish water diversion works where required. Use adequate capping material and growth media where required, particularly for tailings storage facilities. Investigate and use optimum waste rock and topsoil cover to establish a stable water shedding surface with a suitable native seed mix. Direct replace cleared soil where practical or respread stockpiled soil and vegetation material where available. Deep rip on contour. Seed with local provenance seed. Monitor landform stability, ecosystem function and vegetation establishment.
Short term disturbances (borrow pits, access tracks)	Borrow Pits <ul style="list-style-type: none"> Rehabilitation for borrow pits to be conducted in alignment with internal borrow pit management plan. Clear vegetation and soil from all disturbed areas for use in rehabilitation. Backfill borrow pits where sufficient material is available. Batter and contour pit walls to <20 degrees to resemble surrounding topography where practicable. Ensure ponding is minimised in borrow pits and other artificially created depressions through self drainage or by ensuring surface water flows or drainage lines are directed around the pit or depressions. Spread soil and vegetation material on the surface where available. Deep rip the borrow pit floor to relieve compaction and assist with infiltration of water. Seed with local provenance seed if practical. When directly downstream from a road, the road must have surface water drainage channels to divert water away from borrow pits. Monitor landform stability, ecosystem function and vegetation establishment.
	Access Tracks <ul style="list-style-type: none"> Where topsoil has been removed, rehabilitate access track by pushing in windrows and re-spreading soil and vegetative material. Re-establish natural landform and drainage patterns. Deep rip the surface. Allow to revegetate naturally. Monitor ecosystem function and vegetation establishment.
Long term disturbances (construction camps, villages, administration buildings)	<ul style="list-style-type: none"> Liaise with required stakeholders where relevant in case any infrastructure needs to be retained. Power, water and drainage systems to be shut off and buildings and infrastructure decommissioned and removed from site. Remove scrap metal from site. Bury remaining inert scrap materials. Excavate and remove and/or bury concrete material. Remove any hydrocarbon contaminated soils for remediation. Contour area to restore natural drainage patterns. Rip surface to alleviate compaction and encourage regrowth of native vegetation. Selected areas may be designated for hand seeding. Monitor landform stability, ecosystem function and vegetation establishment.
Linear/Fragmentation disturbances (roads, powerlines, borefields)	Haul Roads and Access Tracks <ul style="list-style-type: none"> Stakeholder consultation to determine future post- operational use for haul roads, roads and access tracks. Those roads and tracks not required by the company will be rehabilitated. Remove culverts and other associated infrastructure.

Closure Domain	Closure and Rehabilitation Strategies
	<ul style="list-style-type: none"> • Remove any hydrocarbon contaminated soils for remediation. • Contour to restore natural drainage. • Re-spread stockpiled topsoil and vegetation material where available. • Deep rip surface to alleviate compaction and encourage re-growth of native vegetation. • Seed with local native vegetation if necessary. • Restrict access. • Monitor ecosystem function and vegetation establishment.
	<p>Powerlines</p> <ul style="list-style-type: none"> • Dismantle and remove all power generation equipment, associate infrastructure and transmission lines from site. • Remove scrap metal and bury remaining inert scrap materials which are not suitable for sale or recycling. • Excavate and remove or bury concrete. • Remove any hydrocarbon contaminated soils for remediation. • Contour to restore natural drainage. • Rip surface to alleviate compaction and encourage re-growth of native vegetation. • Monitor ecosystem function and vegetation establishment.
	<p>Borefields</p> <ul style="list-style-type: none"> • Selected water supply bores will be retained for post decommissioning monitoring. • Those bores not required for ongoing monitoring will be shut down, bore casings cut off below ground surface and holes plugged. • Above ground pipelines and pumps to be flushed and removed from site. • Below ground pipes will be cut off below ground surface and remain buried. • If excessively disturbed, areas around the bores and pipeline route will be contoured, ripped and seeded with suitable species.

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Appendix 1: Example list of species found at Christmas Creek

Habitat	Species	Dominant
Creeklines and Drainage Lines	<i>Abutilon amplum</i>	
	<i>Abutilon cryptopetalum</i>	
	<i>Abutilon fraseri</i>	
	<i>Abutilon lepidum</i>	
	<i>Abutilon macrum</i>	√
	<i>Acacia acradenia</i>	
	<i>Acacia</i> aff. <i>aneura</i> (long, flat, recurved; FMR 35.3)	√
	<i>Acacia</i> aff. <i>aneura</i> (narrow fine veined; site 1259)	√
	<i>Acacia ancistrocarpa</i>	√
	<i>Acacia aneura</i>	√
	<i>Acacia ayersiana</i>	√
	<i>Acacia coriacea</i> subsp. <i>pendens</i>	√
	<i>Acacia cowleana</i>	
	<i>Acacia maitlandii</i>	√
	<i>Acacia monticola</i>	
	<i>Acacia paraneura</i>	√
	<i>Acacia pruinocarpa</i>	√
	<i>Acacia pyrifolia</i>	√
	<i>Acacia pyrifolia</i> var. <i>pyrifolia</i>	√
	<i>Acacia rhodophloia</i>	
	<i>Acacia synchronicia</i>	
	<i>Acacia tetragonophylla</i>	√
	<i>Acacia trachycarpa</i>	√
	<i>Acacia tumida</i> var. <i>pilbarensis</i>	√
	<i>Achyranthes aspera</i>	
	<i>Aeschynomene indica</i>	
	<i>Alternanthera angustifolia</i>	
	<i>Alternanthera denticulata</i>	
	<i>Alysicarpus muelleri</i>	
	<i>Amaranthus centralis</i>	
	<i>Amaranthus interruptus</i>	
	<i>Amaranthus undulatus</i>	
	<i>Ammannia baccifera</i>	
	<i>Ammannia multiflora</i>	
	<i>Amphipogon sericeus</i>	
	<i>Androcalva luteiflora</i>	
	<i>Anthobolus leptomerioides</i>	
	<i>Aristida contorta</i>	√
	<i>Aristida inaequiglumis</i>	√
	<i>Aristida obscura</i>	
	<i>Aristida pruinosa</i>	
	<i>Atalaya hemiglauca</i>	√

Habitat	Species	Dominant
	<i>Atriplex bunburyana</i>	
	<i>Blumea tenella</i>	
	<i>Boerhavia burbridgeana</i>	
	<i>Boerhavia coccinea</i>	√
	<i>Boerhavia paludosa</i>	
	<i>Bonamia</i> sp. Dampier (A.A. Mitchell PRP 217)	
	<i>Bothriochloa bladhii</i> subsp. <i>bladhii</i>	
	<i>Brachyachne convergens</i>	
	<i>Brachyachne prostrata</i>	
	<i>Bulbostylis barbata</i>	
	<i>Bulbostylis turbinata</i>	
	<i>Calandrinia ptychosperma</i>	
	<i>Calotis porphyroglossa</i>	
	<i>Centipeda minima</i> subsp. <i>macrocephala</i>	
	<i>Cheilanthes austrotenuifolia</i>	
	<i>Chloris pectinata</i>	√
	<i>Chrysopogon fallax</i>	√
	<i>Cleome oxalidea</i>	
	<i>Cleome viscosa</i>	
	<i>Clerodendrum floribundum</i> var. <i>anfustifolium</i>	
	<i>Commelina ensifolia</i>	
	<i>Convolvulus angustissimus</i> subsp. <i>angustissimus</i>	
	<i>Corchorus lasiocarpus</i> subsp. <i>parvus</i>	√
	<i>Corchorus parviflorus</i>	√
	<i>Corchorus tridens</i>	√
	<i>Corymbia candida</i> subsp. <i>candida</i>	√
	<i>Corymbia deserticola</i> subsp. <i>deserticola</i>	√
	<i>Corymbia ferriticola</i> subsp. <i>ferriticola</i>	
	<i>Corymbia hamersleyana</i>	√
	<i>Crotalaria dissitiflora</i> subsp. <i>benthamiana</i>	
	<i>Crotalaria medicaginea</i> var. <i>neglecta</i>	√
	<i>Cucumis maderaspatanus</i>	
	<i>Cullen cinereum</i>	
	<i>Cullen leucanthum</i>	
	<i>Cymbopogon ambiguus</i>	
	<i>Cymbopogon procerus</i>	√
	<i>Cyperus iria</i>	
	<i>Cyperus squarrosus</i>	
	<i>Cyperus vaginatus</i>	
	<i>Dactyloctenium radulans</i>	
	<i>Dampiera candidans</i>	√
	<i>Dichanthium sericeum</i> subsp. <i>humilius</i>	

Habitat	Species	Dominant
	<i>Dicladanthera forrestii</i>	
	<i>Digitaria ctenantha</i>	
	<i>Dodonaea coriacea</i>	
	<i>Dodonaea petiolaris</i>	
	<i>Duperreya commixta</i>	
	<i>Dysphania rhadinostachya</i>	
	<i>Dysphania rhadinostachya</i> subsp. <i>rhadinostachya</i>	
	<i>Ehretia saligna</i> var. <i>saligna</i>	
	<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>	
	<i>Enneapogon lindleyanus</i>	
	<i>Enneapogon polyphyllus</i>	
	<i>Enneapogon robustissimus</i>	
	<i>Eragrostis cumingii</i>	√
	<i>Eragrostis desertorum</i>	
	<i>Eragrostis leptocarpa</i>	√
	<i>Eragrostis tenellula</i>	√
	<i>Eragrostis xerophila</i>	√
	<i>Eremophila cuneifolia</i>	
	<i>Eremophila forrestii</i> subsp. <i>forrestii</i>	√
	<i>Eremophila lanceolata</i>	√
	<i>Eremophila latrobei</i> subsp. <i>filiformis</i>	√
	<i>Eremophila longifolia</i>	
	<i>Eremophila spongiocarpa</i>	
	<i>Eremophila youngii</i> subsp. <i>lepidota</i>	√
	<i>Eriachne lanata</i>	√
	<i>Eriachne mucronata</i>	
	<i>Eriachne pulchella</i> subsp. <i>dominii</i>	
	<i>Eriachne pulchella</i> subsp. <i>pulchella</i>	√
	<i>Eriachne tenuiculmis</i>	
	<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>	√
	<i>Eucalyptus victrix</i>	√
	<i>Euphorbia alsiniflora</i>	
	<i>Euphorbia biconvexa</i>	
	<i>Euphorbia boophthona</i>	
	<i>Euphorbia tannensis</i> subsp. <i>eremophila</i>	
	<i>Evolvulus alsinoides</i> var. <i>decumbens</i>	
	<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>	
	<i>Fimbristylis microcarya</i>	
	<i>Gomphrena cunninghamii</i>	
	<i>Gomphrena kanisii</i>	
	<i>Goodenia forrestii</i>	
	<i>Goodenia lamprosperma</i>	

Habitat	Species	Dominant
	<i>Goodenia microptera</i>	
	<i>Goodenia nuda</i>	
	<i>Goodenia prostrata</i>	
	<i>Goodenia stobbsiana</i>	
	<i>Gossypium robinsonii</i>	√
	<i>Grevillea wickhamii</i> subsp. <i>hispidula</i>	
	<i>Hakea chordophylla</i>	
	<i>Hakea lorea</i> subsp. <i>lorea</i>	
	<i>Haloragis gossei</i>	
	<i>Hibiscus coatesii</i>	
	<i>Hibiscus sturtii</i> var. <i>aff. grandiflorus</i>	
	<i>Hibiscus sturtii</i> var. <i>campylochlamys</i>	
	<i>Hybanthus aurantiacus</i>	√
	<i>Indigofera monophylla</i>	√
	<i>Indigofera monophylla</i> (PAN57-9)	
	<i>Ipomoea coptica</i>	
	<i>Ipomoea muelleri</i>	√
	<i>Ipomoea polymorpha</i>	
	<i>Iseilema membranaceum</i>	
	<i>Iseilema vaginiflorum</i>	
	<i>Jasminum didymum</i> subsp. <i>lineare</i>	
	<i>Keraudrenia nephrosperma</i>	
	<i>Lepidium muelleri-ferdinandii</i>	
	<i>Lipocarpha microcephala</i>	
	<i>Maireana planifolia</i>	
	<i>Maireana planifolia</i> x <i>villosa</i>	
	<i>Maireana pyramidata</i>	√
	<i>Maireana tomentosa</i>	
	<i>Maireana triptera</i>	
	<i>Maireana villosa</i>	
	<i>Marsilea hirsuta</i>	
	<i>Melaleuca glomerata</i>	√
	<i>Melaleuca linophylla</i>	√
	<i>Mollugo molluginea</i>	
	<i>Nicotiana occidentalis</i> subsp. <i>obliqua</i>	
	<i>Nicotiana occidentalis</i> subsp. <i>occidentalis</i>	
	<i>Nicotiana rosulata</i> subsp. <i>rosulata</i>	
	<i>Notoleptopus decaisnei</i> var. <i>Orbicularis</i>	
	<i>Operculina aequiseipala</i>	
	<i>Panicum decompositum</i>	
	<i>Paraneurachne muelleri</i>	√
	<i>Paspalidium clementii</i>	

Habitat	Species	Dominant
	<i>Paspalidium tabulatum</i>	
	<i>Perotis rara</i>	√
	<i>Petalostylis labicheoides</i>	√
	<i>Phyllanthus maderaspatensis</i>	
	<i>Pluchea dunlopii</i>	
	<i>Pluchea rubelliflora</i>	
	<i>Plumbago zeylanica</i>	
	<i>Polycarpaea corymbosa</i> var. <i>corymbosa</i>	
	<i>Polycarpaea holtzei</i>	
	<i>Polycarpaea longiflora</i>	
	<i>Polymeria calycina</i>	
	<i>Portulaca pilosa</i>	
	<i>Psydrax latifolia</i>	
	<i>Psydrax suaveolens</i>	
	<i>Pterocaulon sphacelatum</i>	
	<i>Ptilotus astrolasius</i>	
	<i>Ptilotus auriculifolius</i>	
	<i>Ptilotus calostachyus</i>	√
	<i>Ptilotus clementii</i>	
	<i>Ptilotus fusiformis</i>	
	<i>Ptilotus gomphrenoides</i> var. <i>gomphrenoides</i>	
	<i>Ptilotus helipteroides</i>	
	<i>Ptilotus macrocephalus</i>	
	<i>Ptilotus nobilis</i>	
	<i>Ptilotus obovatus</i>	√
	<i>Ptilotus polystachyus</i>	
	<i>Ptilotus schwartzii</i>	√
	<i>Rhagodia eremaea</i>	
	<i>Rhagodia</i> sp. Hamersley (M. Trudgen 17794)	
	<i>Rhynchosia minima</i>	
	<i>Rostellularia adscendens</i> var. <i>clementii</i>	
	<i>Rostellularia adscendens</i> var. <i>latifolia</i>	
	<i>Scaevola spinescens</i>	
	<i>Schoenoplectus laevis</i>	
	<i>Sclerolaena cornishiana</i>	
	<i>Sclerolaena costata</i>	
	<i>Sclerolaena cuneata</i>	
	<i>Sclerolaena tetragona</i>	
	<i>Senna artemisioides</i> subsp. <i>helmsii</i>	√
	<i>Senna artemisioides</i> subsp. <i>oligophylla</i>	
	<i>Senna artemisioides</i> subsp. <i>oligophylla</i> x <i>helmsii</i>	
	<i>Senna glaucifolia</i> x <i>ferraria</i>	

Habitat	Species	Dominant
	<i>Senna glaucifolia</i>	√
	<i>Senna glaucifolia</i> x aff. <i>oligophylla</i>	√
	<i>Senna glutinosa</i> subsp. <i>glutinosa</i>	√
	<i>Senna glutinosa</i> subsp. <i>glutinosa</i> x <i>stricta</i>	
	<i>Senna glutinosa</i> subsp. <i>luerssenii</i> x <i>stricta</i>	
	<i>Senna glutinosa</i> subsp. <i>luerssenii</i>	√
	<i>Senna glutinosa</i> subsp. x <i>luerssenii</i>	
	<i>Senna notabilis</i>	√
	<i>Senna</i> sp. Karijini (M.E. Trudgen 10392)	
	<i>Senna venusta</i>	√
	<i>Sesbania cannabina</i>	
	<i>Setaria dielsii</i>	
	<i>Sida ectogama</i>	√
	<i>Sida fibulifera</i>	√
	<i>Sida platycalyx</i>	
	<i>Sida</i> sp. dark green fruit (S. van Leeuwen 2260)	
	<i>Sida</i> sp. verrucose glands (F.H. Mollemans 2423)	
	<i>Solanum horridum</i>	
	<i>Solanum lasiophyllum</i>	
	<i>Solanum phlomoides</i>	√
	<i>Solanum sturtianum</i>	
	<i>Sporobolus australasicus</i>	√
	<i>Stemodia grossa</i>	
	<i>Streptoglossa bubakii</i>	
	<i>Striga squamigera</i>	
	<i>Tephrosia densa</i>	
	<i>Tephrosia rosea</i> var. Fortescue creeks	
	<i>Tephrosia supina</i>	
	<i>Themeda triandra</i>	√
	<i>Trachymene oleracea</i>	
	<i>Trachymene oleracea</i> subsp. <i>oleracea</i>	
	<i>Tragus australianus</i>	
	<i>Trianthema glossostigma</i>	
	<i>Trianthema triquetra</i>	
	<i>Tribulus astrocarpus</i>	
	<i>Tribulus hirsutus</i>	
	<i>Tribulus suberosus</i>	
	<i>Trichodesma zeylanicum</i>	
	<i>Triodia basedowii</i>	
	<i>Triodia epactia</i>	√
	<i>Triodia longiceps</i>	√
	<i>Triodia pungens</i>	

Habitat	Species	Dominant
	<i>Triodia</i> sp. Shovellana Hill	√
	<i>Triraphis mollis</i>	
	<i>Triumfetta clementii</i>	
	<i>Urochloa occidentalis</i>	
	<i>Zaleya galericulata</i>	
Flats and Broad Plains	<i>Abutilon fraseri</i>	
	<i>Abutilon lepidum</i>	
	<i>Abutilon macrum</i>	
	<i>Abutilon otocarpum</i>	
	<i>Abutilon oxycarpum</i> subsp. <i>prostratum</i>	
	<i>Acacia</i> aff. <i>aneura</i>	√
	<i>Acacia</i> aff. <i>aneura</i> (long, flat, recurved; FMR 35.3)	√
	<i>Acacia</i> aff. <i>aneura</i> (narrow fine veined; site 1259)	√
	<i>Acacia ancistrocarpa</i>	√
	<i>Acacia aneura</i>	√
	<i>Acacia aneura</i> (grey bushy form; MET 15 732)	√
	<i>Acacia ayersiana</i>	√
	<i>Acacia bivenosa</i>	
	<i>Acacia coriacea</i> subsp. <i>pendens</i>	√
	<i>Acacia maitlandii</i>	√
	<i>Acacia marramamba</i>	√
	<i>Acacia paraneura</i>	√
	<i>Acacia pruinocarpa</i>	√
	<i>Acacia pteraneura</i>	√
	<i>Acacia pyrifolia</i> var. <i>pyrifolia</i>	
	<i>Acacia sericophylla</i>	√
	<i>Acacia sibirica</i>	
	<i>Acacia synchronicia</i>	√
	<i>Acacia tenuissima</i>	
	<i>Acacia tetragonophylla</i>	√
	<i>Acacia trachycarpa</i>	
	<i>Acacia tumida</i> var. <i>pilbarensis</i>	
	<i>Acacia xiphophylla</i>	√
	<i>Aeschynomene indica</i>	
	<i>Alternanthera angustifolia</i>	
	<i>Alternanthera denticulata</i>	
	<i>Alternanthera nana</i>	
	<i>Alysicarpus muelleri</i>	
	<i>Amaranthus interruptus</i>	
	<i>Androvalca luteiflora</i>	
	<i>Anthobolus leptomerioides</i>	
	<i>Aristida contorta</i>	√

Habitat	Species	Dominant
	<i>Aristida holathera</i> var. <i>holathera</i>	
	<i>Aristida inaequiglumis</i>	√
	<i>Aristida latifolia</i>	
	<i>Aristida obscura</i>	
	<i>Aristida pruinosa</i>	√
	<i>Atalaya hemiglauc</i>	√
	<i>Atriplex bunburyana</i>	
	<i>Atriplex codonocarpa</i>	
	<i>Austrobryonia pilbarensis</i>	
	<i>Blumea tenella</i>	
	<i>Boerhavia burbridgeana</i>	
	<i>Boerhavia coccinea</i>	
	<i>Boerhavia paludosa</i>	
	<i>Bonamia rosea</i>	
	<i>Bothriochloa bladhii</i> subsp. <i>bladhii</i>	
	<i>Brachyachne prostrata</i>	√
	<i>Bulbostylis barbata</i>	√
	<i>Bulbostylis turbinata</i>	
	<i>Calandrinia Ptychosperma</i>	√
	<i>Calotis porphyroglossa</i>	
	<i>Calotis squamigera</i>	
	<i>Centipeda minima</i> subsp. <i>macrocephala</i>	
	<i>Cheilanthes austrotenuifolia</i>	
	<i>Cheilanthes sieberi</i> subsp. <i>sieberi</i>	√
	<i>Chloris pectinata</i>	√
	<i>Chrysocephalum gilesii</i>	
	<i>Chrysopogon fallax</i>	√
	<i>Cleome oxalidea</i>	
	<i>Cleome viscosa</i>	
	<i>Commelina ensifolia</i>	√
	<i>Convolvulus angustissimus</i> subsp. <i>angustissimus</i>	
	<i>Corchorus lasiocarpus</i> subsp. <i>lasiocarpus</i>	
	<i>Corchorus lasiocarpus</i> subsp. <i>parvus</i>	
	<i>Corchorus parviflorus</i>	√
	<i>Corchorus tridens</i>	√
	<i>Corymbia candida</i> subsp. <i>dipsodes</i>	
	<i>Corymbia hamersleyana</i>	√
	<i>Crotalaria dissitiflora</i> subsp. <i>benthamiana</i>	
	<i>Crotalaria medicaginea</i> var. <i>neglecta</i>	
	<i>Cucumis maderaspatanus</i>	
	<i>Cullen cinereum</i>	
	<i>Cymbopogon ambiguus</i>	√

Habitat	Species	Dominant
	<i>Cymbopogon oblectus</i>	
	<i>Cyperus iria</i>	
	<i>Cyperus rigidellus</i>	
	<i>Dactyloctenium radulans</i>	√
	<i>Dichanthium sericeum</i>	
	<i>Dichanthium sericeum</i> subsp. <i>humilius</i>	
	<i>Digitaria brownii</i>	
	<i>Digitaria ctenantha</i>	√
	<i>Dodonaea petiolaris</i>	√
	<i>Duperreya commixta</i>	
	<i>Dysphania rhadinostachya</i>	√
	<i>Dysphania rhadinostachya</i> subsp. <i>rhadinostachya</i>	
	<i>Ehretia saligna</i> var. <i>saligna</i>	√
	<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>	
	<i>Enneapogon caerulescens</i> var. <i>caerulescens</i>	
	<i>Enneapogon polyphyllus</i>	√
	<i>Enneapogon robustissimus</i>	√
	<i>Enteropogon ramosus</i>	√
	<i>Eragrostis cumingii</i>	√
	<i>Eragrostis desertorum</i>	√
	<i>Eragrostis dielsii</i>	√
	<i>Eragrostis eriopoda</i>	
	<i>Eragrostis leptocarpa</i>	√
	<i>Eragrostis pergracilis</i>	
	<i>Eragrostis tenellula</i>	√
	<i>Eragrostis xerophila</i>	√
	<i>Eremophila cuneifolia</i>	√
	<i>Eremophila forrestii</i> subsp. <i>forrestii</i>	√
	<i>Eremophila lanceolata</i>	√
	<i>Eremophila latrobei</i>	√
	<i>Eremophila latrobei</i> subsp. <i>filiformis</i>	√
	<i>Eremophila latrobei</i> x <i>forrestii</i>	√
	<i>Eremophila longifolia</i>	
	<i>Eremophila platycalyx</i> subsp. <i>pardalota</i>	√
	<i>Eremophila spongiocarpa</i>	
	<i>Eremophila youngii</i> subsp. <i>lepidota</i>	√
	<i>Eriachne benthamii</i>	√
	<i>Eriachne helmsii</i>	
	<i>Eriachne mucronata</i>	√
	<i>Eriachne pulchella</i> subsp. <i>dominii</i>	√
	<i>Eriachne pulchella</i> subsp. <i>pulchella</i>	√
	<i>Eucalyptus gamophylla</i>	√

Habitat	Species	Dominant
	<i>Euphorbia</i> aff. <i>australis</i> var. 1 (MET 12 337)	
	<i>Euphorbia alsiniflora</i>	
	<i>Euphorbia boophthona</i>	
	<i>Euphorbia tannensis</i> subsp. <i>eremophila</i>	
	<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>	
	<i>Frankenia setosa</i>	
	<i>Glycine canescens</i>	
	<i>Gomphrena affinis</i> subsp. <i>pilbarensis</i>	
	<i>Gomphrena cunninghamii</i>	√
	<i>Gomphrena kanisii</i>	
	<i>Goodenia forrestii</i>	
	<i>Goodenia lamprosperma</i>	
	<i>Goodenia microptera</i>	
	<i>Goodenia muelleriana</i>	
	<i>Goodenia nuda</i>	
	<i>Goodenia prostrata</i>	√
	<i>Goodenia stobbsiana</i>	
	<i>Gossypium australe</i>	
	<i>Grevillea berryana</i>	√
	<i>Grevillea wickhamii</i> subsp. <i>hispidula</i>	√
	<i>Hakea chordophylla</i>	√
	<i>Hakea lorea</i> subsp. <i>lorea</i>	
	<i>Heliotropium heteranthum</i>	
	<i>Hibiscus burtonii</i>	
	<i>Hibiscus coatesii</i>	
	<i>Hibiscus sturtii</i> var. aff. <i>grandiflorus</i>	
	<i>Hibiscus sturtii</i> var. <i>campylochlamys</i>	
	<i>Hibiscus sturtii</i> var. <i>grandiflorus</i>	
	<i>Hybanthus aurantiacus</i>	√
	<i>Indigofera colutea</i>	√
	<i>Indigofera monophylla</i>	
	<i>Ipomoea coptica</i>	
	<i>Ipomoea lonchophylla</i>	
	<i>Ipomoea muelleri</i>	√
	<i>Ipomoea polymorpha</i>	
	<i>Iseilema dolichotrichum</i>	
	<i>Iseilema macrathrum</i>	
	<i>Iseilema membranaceum</i>	
	<i>Jasminum didymum</i> subsp. <i>lineare</i>	
	<i>Keraudrenia nephrosperma</i>	√
	<i>Lepidium oxytrichum</i>	
	<i>Lepidium phlebopetalum</i>	

Habitat	Species	Dominant
	<i>Lepidium platypetalum</i>	
	<i>Maireana amoena</i>	
	<i>Maireana carnososa</i>	
	<i>Maireana georgei</i>	
	<i>Maireana planifolia</i>	√
	<i>Maireana planifolia</i> x <i>villosa</i>	
	<i>Maireana pyramidata</i>	√
	<i>Maireana tomentosa</i>	
	<i>Maireana triptera</i>	
	<i>Maireana villosa</i>	
	<i>Marsdenia australis</i>	
	<i>Marsilea hirsuta</i>	
	<i>Melaleuca glomerata</i>	√
	<i>Mimulus gracilis</i>	
	<i>Mollugo molluginea</i>	√
	<i>Muehlenbeckia florulenta</i>	√
	<i>Neptunia dimorphantha</i>	
	<i>Nicotiana heterantha</i>	
	<i>Nicotiana occidentalis</i> subsp. <i>obliqua</i>	
	<i>Notoleptopus decaisnei</i> var. <i>orbicularis</i>	
	<i>Oldenlandia crouchiana</i>	
	<i>Operculina aequiseipala</i>	
	<i>Panicum effusum</i>	
	<i>Panicum laevinode</i>	
	<i>Paraneurachne muelleri</i>	√
	<i>Paspalidium clementii</i>	
	<i>Paspalidium clemetii</i>	√
	<i>Perotis rara</i>	√
	<i>Petalostylis labicheoides</i>	
	<i>Phyllanthus erwinii</i>	
	<i>Phyllanthus maderaspatensis</i>	
	<i>Pluchea dunlopia</i>	
	<i>Pluchea rubelliflora</i>	
	<i>Pluchea tetranthera</i>	
	<i>Polycarpaea corymbosa</i> var. <i>corymbosa</i>	√
	<i>Polycarpaea holtzei</i>	√
	<i>Polycarpaea longiflora</i>	
	<i>Polygala isingii</i>	
	<i>Portulaca cyclophylla</i>	
	<i>Portulaca pilosa</i>	
	<i>Psydrax latifolia</i>	√
	<i>Psydrax suaveolens</i>	√

Habitat	Species	Dominant
	<i>Pterocaulon serrulatum</i>	
	<i>Pterocaulon sphacelatum</i>	
	<i>Ptilotus aervoides</i>	
	<i>Ptilotus astrolasius</i>	
	<i>Ptilotus auriculifolius</i>	
	<i>Ptilotus calostachyus</i>	
	<i>Ptilotus clementii</i>	
	<i>Ptilotus exaltatus</i>	
	<i>Ptilotus gaudichaudii</i>	
	<i>Ptilotus gomphrenoides</i> var. <i>gomphrenoides</i>	
	<i>Ptilotus helipteroides</i>	
	<i>Ptilotus macrocephalus</i>	
	<i>Ptilotus nobilis</i>	
	<i>Ptilotus obovatus</i>	√
	<i>Ptilotus polystachyus</i>	
	<i>Ptilotus schwartzii</i>	
	<i>Rhagodia eremaea</i>	√
	<i>Rhagodia</i> sp. Hamersley (M. Trudgen 17794)	
	<i>Rhynchosia minima</i>	
	<i>Rostellularia adscendens</i> var. <i>clementii</i>	
	<i>Scaevola spinescens</i>	
	<i>Schizachyrium fragile</i>	
	<i>Sclerolaena cornishiana</i>	
	<i>Sclerolaena costata</i>	
	<i>Sclerolaena cuneata</i>	√
	<i>Sclerolaena densiflora</i>	
	<i>Sclerolaena diacantha</i>	
	<i>Sclerolaena eriacantha</i>	
	<i>Sclerolaena glabra</i>	
	<i>Senna artemisioides</i> subsp. <i>helmsii</i>	√
	<i>Senna artemisioides</i> subsp. <i>oligophylla</i>	√
	<i>Senna artemisioides</i> subsp. <i>oligophylla</i> x <i>helmsii</i>	
	<i>Senna ferraria</i> x <i>glaucifolia</i>	
	<i>Senna glaucifolia</i>	√
	<i>Senna glutinosa</i> subsp. <i>glutinosa</i>	√
	<i>Senna glutinosa</i> subsp. <i>glutinosa</i> x <i>stricta</i>	√
	<i>Senna glutinosa</i> subsp. <i>luerssenii</i>	√
	<i>Senna glutinosa</i> subsp. x <i>luerssenii</i>	
	<i>Senna hamersleyensis</i>	
	<i>Senna hamersleyensis</i> X sp. Karijini(M.E. Trudgen 10392) .	
	<i>Senna notabilis</i>	√

Habitat	Species	Dominant
	<i>Senna</i> sp. Karijini (M.E. Trudgen 10392)	
	<i>Senna</i> sp. Meekatharra (E. Bailey 1-26)	
	<i>Senna stricta</i>	
	<i>Senna stricta</i> x <i>glutinosa</i>	
	<i>Setaria dielsii</i>	
	<i>Sida ectogama</i>	√
	<i>Sida fibulifera</i>	√
	<i>Sida platycalyx</i>	√
	<i>Sida</i> sp. dark green fruits (S. Van Leeuwen 2260)	
	<i>Sida</i> sp. verrucose glands (F.H. Mollemans 2423)	
	<i>Solanum horridum</i>	
	<i>Solanum lasiophyllum</i>	√
	<i>Solanum phlomoides</i>	√
	<i>Spermacoce brachystema</i>	
	<i>Sporobolus australasicus</i>	√
	<i>Stenopetalum nutans</i>	
	<i>Streptoglossa bubakii</i>	√
	<i>Streptoglossa cylindriceps</i>	
	<i>Synaptantha tillaeacea</i> var. <i>tillaeacea</i>	
	<i>Tecticornia indica</i> subsp. <i>bidens</i>	
	<i>Tephrosia rosea</i> var. Fortescue creeks	
	<i>Tephrosia supina</i>	
	<i>Themeda triandra</i>	
	<i>Trachymene oleracea</i>	
	<i>Trachymene oleracea</i> subsp. <i>oleracea</i>	
	<i>Tragus australianus</i>	√
	<i>Trianthema glossostigma</i>	√
	<i>Trianthema triquetra</i>	
	<i>Trianthema turgidifolia</i>	
	<i>Tribulus astrocarpus</i>	√
	<i>Tribulus suberosus</i>	
	<i>Trichodesma zeylanicum</i>	
	<i>Triodia epactia</i>	√
	<i>Triodia longiceps</i>	√
	<i>Triodia pungens</i>	√
	<i>Triodia</i> sp. Shovelanna Hill	√
	<i>Triodia wiseana</i>	
	<i>Urochloa occidentalis</i>	
	<i>Urochloa pubigera</i>	
	<i>Vigna</i> sp. central (M.E. Trudgen 1626) PN	
	<i>Wahlenbergia tumidifructa</i>	
	<i>Xerochloa laniflora</i>	

Habitat	Species	Dominant
Ranges, Hills and Hillslopes	<i>Abutilon cunninghamii</i>	
	<i>Acacia acradenia</i>	√
	<i>Acacia adsurgens</i>	
	<i>Acacia</i> aff. <i>aneura</i> (long, flat, recurved; FMR 35.3)	√
	<i>Acacia</i> aff. <i>aneura</i> (narrow fine veined; site 1259)	√
	<i>Acacia ancistrocarpa</i>	
	<i>Acacia ayersiana</i>	
	<i>Acacia colei</i> var. <i>colei</i>	
	<i>Acacia inaequilatera</i>	
	<i>Acacia pruinocarpa</i>	√
	<i>Acacia pyrifolia</i> var. <i>pyrifolia</i>	
	<i>Acacia synchronicia</i>	
	<i>Acacia tetragonophylla</i>	
	<i>Acacia tumida</i> var. <i>pilbarensis</i>	√
	<i>Amphipogon sericeus</i>	
	<i>Aristida contorta</i>	
	<i>Aristida holathera</i> var. <i>holathera</i>	
	<i>Atalaya hemiglauca</i>	√
	<i>Boerhavia coccinea</i>	
	<i>Bonamia</i> sp. Dampier (A.A. Mitchell PRP 217)	
	<i>Brachyachne prostrata</i>	
	<i>Bulbostylis barbata</i>	
	<i>Calytrix carinata</i>	
	<i>Cheilanthes austrotenuifolia</i>	
	<i>Cleome viscosa</i>	
	<i>Clerodendrum floribundum</i> var. <i>angustifolium</i>	√
	<i>Corchorus lasiocarpus</i> subsp. <i>lasiocarpus</i>	√
	<i>Corchorus lasiocarpus</i> subsp. <i>parvus</i>	
	<i>Corchorus parviflorus</i>	
	<i>Corymbia candida</i> subsp. <i>dipsodes</i>	√
	<i>Corymbia hamersleyana</i>	√
	<i>Cucumis maderaspatanus</i>	
	<i>Cymbopogon ambiguus</i>	
	<i>Dampiera candidans</i>	
	<i>Dodonaea coriacea</i>	
	<i>Dodonaea pachyneura</i>	
	<i>Dodonaea petiolaris</i>	
	<i>Duperreya commixta</i>	
	<i>Dysphania rhadinostachya</i>	
	<i>Dysphania rhadinostachya</i> subsp. <i>rhadinostachya</i>	
	<i>Dysphania sphaerosperma</i>	
	<i>Enneapogon polyphyllus</i>	

Habitat	Species	Dominant
	<i>Enneapogon robustissimus</i>	
	<i>Eremophila forrestii</i> subsp. <i>forrestii</i>	
	<i>Eremophila lanceolata</i>	
	<i>Eremophila latrobei</i> subsp. <i>filiformis</i>	
	<i>Eriachne lanata</i>	√
	<i>Eriachne mucronata</i>	√
	<i>Eriachne pulchella</i> subsp. <i>dominii</i>	
	<i>Eriachne pulchella</i> subsp. <i>pulchella</i>	
	<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>	√
	<i>Euphorbia alsiniflora</i>	
	<i>Fimbristylis dichotoma</i>	
	<i>Fimbristylis simulans</i>	
	<i>Gomphrena cunninghamii</i>	
	<i>Gomphrena kanisii</i>	
	<i>Goodenia microptera</i>	
	<i>Goodenia stobbsiana</i>	√
	<i>Goodenia triodiophila</i>	
	<i>Gossypium robinsonii</i>	√
	<i>Grevillea wickhamii</i> subsp. <i>hispidula</i>	√
	<i>Hakea chordophylla</i>	√
	<i>Hakea lorea</i> subsp. <i>lorea</i>	
	<i>Hibiscus coatesii</i>	
	<i>Hibiscus goldsworthii</i>	√
	<i>Hibiscus</i> sp. <i>Gardneri</i>	
	<i>Hibiscus sturtii</i> var. <i>campylochlamys</i>	
	<i>Hibiscus sturtii</i> var. <i>truncatus</i>	
	<i>Hybanthus aurantiacus</i>	
	<i>Indigofera monophylla</i>	√
	<i>Iseilema membranaceum</i>	
	<i>Jasminum didymum</i> subsp. <i>lineare</i>	
	<i>Maireana georgei</i>	
	<i>Maireana planifolia</i> x <i>villosa</i>	
	<i>Maireana villosa</i>	
	<i>Mollugo molluginea</i>	
	<i>Notoleptopus decaisnei</i> var. <i>Orbicularis</i>	
	<i>Oldenlandia crouchiana</i>	
	<i>Paraneurachne muelleri</i>	
	<i>Paspalidium clementii</i>	
	<i>Perotis rara</i>	
	<i>Pluchea tetranthera</i>	
	<i>Polycarpaea corymbosa</i> var. <i>corymbosa</i>	
	<i>Polycarpaea holtzei</i>	

Habitat	Species	Dominant
	<i>Polycarpaea longiflora</i>	
	<i>Polygala isingii</i>	
	<i>Psydrax latifolia</i>	
	<i>Pterocaulon sphacelatum</i>	
	<i>Ptilotus aervoides</i>	
	<i>Ptilotus astrolasius</i>	
	<i>Ptilotus auriculifolius</i>	
	<i>Ptilotus calostachyus</i>	√
	<i>Ptilotus clementii</i>	
	<i>Ptilotus fusiformis</i>	
	<i>Ptilotus helipteroides</i>	
	<i>Ptilotus incanus</i>	
	<i>Ptilotus nobilis</i>	√
	<i>Ptilotus obovatus</i>	
	<i>Ptilotus rotundifolius</i>	√
	<i>Ptilotus schwartzii</i>	
	<i>Rhagodia</i> sp. Hamersley (M. Trudgen 17794)	
	<i>Santalum lanceolatum</i>	
	<i>Schizachyrium fragile</i>	
	<i>Senna artemisioides</i> subsp. <i>oligophylla</i> x <i>helmsii</i>	
	<i>Senna ferraria</i> x <i>glaucifolia</i>	
	<i>Senna glutinosa</i> subsp. <i>glutinosa</i>	√
	<i>Senna glutinosa</i> subsp. <i>glutinosa</i> x <i>luerssenii</i>	
	<i>Senna glutinosa</i> subsp. <i>luerssenii</i>	
	<i>Senna glutinosa</i> subsp. <i>pruinosa</i>	
	<i>Senna glutinosa</i> subsp. x <i>luerssenii</i>	
	<i>Senna notabilis</i>	√
	<i>Senna sericea</i>	
	<i>Sida arenicola</i>	
	<i>Sida ectogama</i>	
	<i>Sida</i> sp. <i>Excedentifolia</i>	
	<i>Sida</i> sp. Pilbara	
	<i>Solanum horridum</i>	
	<i>Solanum lasiophyllum</i>	
	<i>Solanum phlomoides</i>	√
	<i>Solanum sturtianum</i>	
	<i>Sporobolus australasicus</i>	
	<i>Streptoglossa bubakii</i>	
	<i>Tephrosia oxalidea</i>	
	<i>Tephrosia spechtii</i>	
	<i>Themeda triandra</i>	
	<i>Trachymene oleracea</i>	

Habitat	Species	Dominant
	<i>Trachymene oleracea</i> subsp. <i>oleracea</i>	
	<i>Trianthema glossostigma</i>	
	<i>Trianthema triquetra</i>	
	<i>Tribulus suberosus</i>	
	<i>Trichodesma zeylanicum</i>	
	<i>Triodia basedowii</i>	√
	<i>Triodia epactia</i>	√
	<i>Triodia longiceps</i>	
	<i>Triodia pungens</i>	√
	<i>Triodia</i> sp. Shovelanna Hill (S. van Leeuwen 3835)	√
Fortescue Marsh Vegetation Associations	<i>Abutilon cryptopetalum</i>	
	<i>Abutilon macrum</i>	
	<i>Abutilon otocarpum</i>	
	<i>Acacia ampliceps</i>	
	<i>Acacia aptaneura</i>	√
	<i>Acacia coriacea</i> subsp. <i>pendens</i>	√
	<i>Acacia synchronicia</i>	√
	<i>Acacia tetragonophylla</i>	√
	<i>Acacia xiphophylla</i>	√
	<i>Aeschynomene indica</i>	
	<i>Alternanthera nodiflora</i>	
	<i>Amaranthus undulatus</i>	
	<i>Ammannia multiflora</i>	
	<i>Angianthus tomentosus</i>	
	<i>Aristida contorta</i>	
	<i>Atriplex bunburyana</i>	
	<i>Atriplex flabelliformis</i>	
	<i>Bergia perennis</i> subsp. <i>obtusifolia</i>	
	<i>Boerhavia coccinea</i>	
	<i>Boerhavia paludosa</i>	
	<i>Bothriochloa bladhii</i> subsp. <i>bladhii</i>	
	<i>Centipeda minima</i> subsp. <i>macrocephala</i>	
	<i>Chenopodium auricomum</i>	√
	<i>Chloris pectinata</i>	√
	<i>Cleome viscosa</i>	
	<i>Cressa australis</i>	
	<i>Cullen cinereum</i>	
	<i>Cyperus bulbosus</i>	√
	<i>Cyperus iria</i>	
	<i>Dactyloctenium radulans</i>	√
	<i>Digitaria brownii</i>	
	<i>Dysphania plantaginella</i>	

Habitat	Species	Dominant
	<i>Dysphania rhadinostachya</i> subsp. <i>rhadinostachya</i>	
	<i>Eleocharis papillosa</i>	√
	<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>	
	<i>Enneapogon caerulescens</i>	√
	<i>Enneapogon polyphyllus</i>	√
	<i>Enteropogon ramosus</i>	
	<i>Eragrostis desertorum</i>	
	<i>Eragrostis elongata</i>	
	<i>Eragrostis pergracilis</i>	√
	<i>Eragrostis tenellula</i>	
	<i>Eremophila forrestii</i> subsp. <i>forrestii</i>	
	<i>Eremophila spongiocarpa</i>	√
	<i>Eremophila youngii</i> subsp. <i>lepidota</i>	√
	<i>Eriachne benthamii</i>	
	<i>Eriachne pulchella</i> subsp. <i>dominii</i>	
	<i>Eucalypus victrix</i>	
	<i>Euphorbia australis</i>	
	<i>Evolvulus alsinoides</i> var. <i>decumbens</i>	
	<i>Frankenia ambita</i>	
	<i>Glycine canescens</i>	
	<i>Gnephosis arachnoidea</i>	√
	<i>Gomphrena kanisii</i>	
	<i>Goodenia forrestii</i>	
	<i>Heliotropium pachyphyllum</i>	
	<i>Hibiscus sturtii</i> var. <i>platychlamys</i>	
	<i>Ipomoea coptica</i>	
	<i>Ipomoea muelleri</i>	
	<i>Iseilema vaginiflorum</i>	
	<i>Lawrencina densiflora</i>	√
	<i>Leptochloa fusca</i> subsp. <i>fusca</i>	
	<i>Lotus cruentus</i>	
	<i>Maireana amoena</i>	
	<i>Maireana carnosia</i>	
	<i>Maireana integra</i>	
	<i>Maireana luehmanii</i>	
	<i>Maireana pyramidata</i>	
	<i>Maireana triptera</i>	
	<i>Marsilea hirsuta</i>	
	<i>Melaleuca glomerata</i>	√
	<i>Mimulus repens</i>	√
	<i>Muehlenbeckia florulenta</i>	√
	<i>Muellerolimon salicorniaceum</i>	

Habitat	Species	Dominant
	<i>Neptunia dimorphantha</i>	
	<i>Nicotiana heterantha</i>	√
	<i>Panicum decompositum</i>	
	<i>Paspalidium clementii</i>	
	<i>Peplidium</i> sp. E Evol. Fl. Fauna Arid Aust (A.S. Weston 12768)	
	<i>Peripleura obovata</i>	
	<i>Pluchea dunlopil</i>	√
	<i>Pluchea rubelliflora</i>	√
	<i>Polycarpaea corymbosa</i> var. <i>corymbosa</i>	
	<i>Portulaca pilosa</i>	
	<i>Pterocaulon sphaeranthoides</i>	√
	<i>Ptilotus auriculifolius</i>	
	<i>Ptilotus helipteroides</i>	
	<i>Ptilotus nobilis</i> subsp. <i>nobilis</i>	
	<i>Rhagodia eremaea</i>	
	<i>Samolus repens</i> var. <i>floribundus</i>	
	<i>Scaevola spinescens</i>	
	<i>Schoenoplectus dissachanthus</i>	√
	<i>Sclerolaena cornishiana</i>	
	<i>Sclerolaena cuneata</i>	√
	<i>Sclerolaena densiflora</i>	√
	<i>Sclerolaena diacantha</i>	
	<i>Senna artemisioides</i> subsp. <i>oligophylla</i>	
	<i>Senna</i> sp. Karijini (M.E. Trudgen 10392)	
	<i>Setaria dielsii</i>	
	<i>Sida fibulifera</i>	
	<i>Sida rohlenae</i> subsp. <i>rohlenae</i>	
	<i>Solanum horridum</i>	√
	<i>Solanum lasiophyllum</i>	√
	<i>Solanum sturtianum</i>	
	<i>Sporobolus australasicus</i>	√
	<i>Sporobolus virginicus</i>	
	<i>Stemodia grossa</i>	
	<i>Streptoglossa bubakii</i>	√
	<i>Streptoglossa decurrens</i>	
	<i>Streptoglossa odora</i>	
	<i>Swainsona kingsii</i>	
	<i>Tecticornia auriculata</i>	
	<i>Tecticornia globulifera</i>	√
	<i>Tecticornia indica</i> subsp. <i>bidens</i>	√
	<i>Tecticornia medusa</i>	

Habitat	Species	Dominant
	<i>Tecticornia</i> sp. Christmas Creek (K.A. Shepherd & T. Colmer et al. KS 1063)	√
	<i>Tecticornia</i> sp. Dennys Crossing (K.A. Shepherd & J. English KS 552)	√
	<i>Tragus australianus</i>	
	<i>Trianthema glossostigma</i>	
	<i>Trianthema triquetra</i>	
	<i>Tribulus occidentalis</i>	
	<i>Triraphis mollis</i>	
	<i>Typha domingensis</i>	
	<i>Xerochloa laniflora</i>	

Plan

Mine Closure Plan

Christmas Creek Operations

Fortescue Metals Group Ltd

6 January 2015
CC-PL-EN-0012



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Mine Closure Plan: Christmas Creek Operations		CC-PL-EN-0012
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Status	IFU - ISSUED FOR USE	
Author	SRK Consulting	6/01/2015
Checked	Andrew Bartleet	6/01/2015
Approved	Brett McGuire	6/01/2015
Confidentiality	PUBLIC USE (ACCESS TO ALL)	<input type="checkbox"/> Yes <input type="checkbox"/> No
Review Date	31/12/2017	

This document was prepared on behalf of Fortescue Metals Group Limited by:

 **srk consulting** 

Approved by Fortescue:	Tony Swiericzuk	6/01/2015
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MINE CLOSURE PLAN CHECKLIST

Question No	Mine Closure Plan Checklist	Y/N or N/A	Page No.	Comments
1	Has the MCP Checklist been endorsed by a senior representative within the tenement holder/operating company? (See bottom of Checklist)	Y	7	Endorsed by the General Manager Christmas Creek Operations.
2	How many copies were submitted to the DMP	Hard copies = 2 Electronic copies = 1		
Cover Page, Title and Contents				
3	Does the cover page include:			
	Project Title	Y	Cover	
	Company Name	Y	Cover	
	Contact Details (including telephone numbers and email addresses)	Y	7	
	Document ID and Version Number	Y	2	
	Date of Submission (must match the date on this checklist)	Y	2	
4	Has a Table of Contents been provided?	Y	9-14	
Scope and Project Summary				
5	State why is the MCP submitted	Y	16	
6	Does the project summary include:			
	Land ownership details	Y	21	
	Location of the project	Y	15	
	Comprehensive site plan(s)	Y	-	Figures
	Background information on the history and status of the project	Y	15	
Legal Obligations and Commitments				
7	Has a consolidated summary or register of closure obligations and commitments been included?	Y	24	Summary of generic and site-specific commitments is provided in Section 3.
Data Collection and Analysis				
8	Has information relevant to mine closure been collected for each domain or feature (including baseline studies, environmental and other data)?	Y	41	Section 7 provides a summary of baseline data.
9	Has a gap analysis been conducted to determine if further information is required in relation to closure of each domain or feature?	Y	61	Table 9 provides a gap analysis.
Stakeholder Consultation				
10	Have all stakeholders involved in closure been identified?	Y	29	
11	Has a summary or register of stakeholder consultation been provided, with details as to who has been consulted and the outcomes?	Y	29	Additional detail is available in the two PER documents.

Question No	Mine Closure Plan Checklist	Y/N or N/A	Page No.	Comments
Final Land Use(s) and Closure Objectives				
12	Does the MCP include:			
	agreed post-mining land use(s),	Y	32	
	closure objectives	Y	31	
	conceptual landform design diagram?	Y	65, 66	Additional detail including conceptual diagrams for WRDs and TSFs is provided in the referenced Fortescue Guidelines.
13	Does the MCP identify all potential (or pre-existing) environmental legacies, which may restrict the post-mining land use (including contaminated sites)?	Y	56	
Identification and Management of Closure Issues				
14	Does the MCP identify all key issues impacting mining closure objectives and outcomes?	Y	57	Refer also the tables on subsequent pages
15	Does the MCP include proposed management or mitigation options to deal with these issues?	Y	57	Refer also the tables on subsequent pages
16	Have the process, methodology, and rationale been provided to justify identification and management of the issues?	Y	57	Refer also the tables on subsequent pages
Closure Criteria				
17	Does the MCP include an appropriate set of specific closure criteria and/or closure performance indicators?	Y	34	
Closure Financial Provisioning				
18	Does the MCP include costing methodology, assumptions and financial provision to resource closure implementation and monitoring?	Y	74	
19	Does the MCP include a process for regular review of the financial provision?	Y	74	
Closure Implementation				
20	Does the reviewed MCP include a summary of closure implementation strategies and activities for the proposed operations or for the whole site?	Y	63	
21	Does the MCP include a closure work program for each domain or feature?	Y	63	Refer also the subsections on subsequent pages
22	Have site layout plans been provided to clearly show each type of disturbance?	Y	-	Figures

Question No	Mine Closure Plan Checklist	Y/N or N/A	Page No.	Comments
23	Does the MCP contain a schedule of research and trial activities?	Y	55	This process is described in Section 7.10 and additional information including a detailed schedule is available in the referenced documentation, specifically 45-GU-EN-0008.
24	Does the MCP contain a schedule of progressive rehabilitation activities?	N	-	No specific schedule has been included. However Fortescue has committed to progressive rehabilitation (Page 67) at Christmas Creek. Given the size and complexity of Christmas Creek Operations, annual progressive rehabilitation schedules are developed in Fortescues Life of Mine and 5 year plans and these can result in changes to the planned rehabilitation strategy.
25	Does the MCP include details of how unexpected closure, and care and maintenance, will be handled?	Y	69	
26	Does the MCP contain a schedule of decommissioning activities?	N	-	This information will be provided within 5 years of planned closure as described in Section 2.4.
27	Does the MCP contain a schedule of closure performance monitoring and maintenance activities?	Y	70	Additional detail is available within the referenced documents
Closure Monitoring and Maintenance				
28	Does the MCP contain a framework, including methodology, quality control and remedial strategy, for closure performance monitoring, including post-closure monitoring and maintenance?	Y	70	Additional detail is available within the referenced documents
Closure Information and Data Management				
29	Does the MCP contain a description of management strategies, including systems and processes, for the retention of mine records?	Y	76	
30	Confidentiality	Y	N/A	The information presented in this MCP is not of a confidential nature and will be made publically available as part of the PER public review process.

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CORPORATE ENDORSEMENT

"I hereby certify that to the best of my knowledge, the information within this Mine Closure Plan and checklist is true and correct, and addresses all the requirements of the Guidelines for the Preparation of a Mine Closure Plan.

Name: Tony Swiericzuk

Signed: 

General Manager Christmas

Position: Creek Mine

Date: 

(NB: The corporate endorsement must be given by tenement holder(s) or a senior representative authorised by the tenement holder(s), such as a Registered Manager or Company Director).

Contacts

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1. INTRODUCTION

1.1 Project Background

The Christmas Creek Operations are part of a continued expansion of Fortescue Metals Group Limited (Fortescue) operations along the southern slopes of the Chichester Range. Development of the Christmas Creek Operations and the expansion of the mine dewatering rate were approved under Ministerial Statement 707 and 871 respectively. All operations associated with the development of the Chichester Range Iron Ore Deposits and associated rail and port infrastructure are governed by the following two State Agreement Acts:

- *Railway and Port (The Pilbara Infrastructure Pty Ltd) Agreement Act 2004* – covering the planning, construction and operation of the railway and port facilities
- *Iron Ore (FMG Chichester Pty Ltd) Agreement Act 2006* – covering the mining aspects of the project.

Both The Pilbara Infrastructure Pty Ltd and FMG Chichester Pty Ltd are wholly owned subsidiaries of Fortescue. Given the operations are governed by State Agreement Acts, development of these deposits is regulated by the Department of State Development (DSD), with environmental management and reporting regulated principally through the Environmental Protection Authority (EPA) under the *Environmental Protection Act 1986* (the EP Act), and not through the Department of Mines and Petroleum (DMP), under the *Mining Act 1978* (the Mining Act).

The Christmas Creek Operations are located approximately 270 km south-east of Port Hedland and 100 km north of Newman, approximately 40 km to the east of the existing Cloudbreak Operations. Mining at Christmas Creek commenced in 2009 (within the 5 year development requirement set out in Ministerial Statement 707) and employs conventional open pit drill and blast, load and haul methods for the removal of overburden, and the use of excavators and continuous miners for ore removal. The ore is delivered to the various run of mine (ROM) pads by truck, from where it is sent for crushing, either at a Remote Crushing Hub (RCH) or at crushing facilities near the Christmas Creek Ore Processing Facilities (OPF's). Once crushed, screened and processed to various product specifications, ore is railed to Port Hedland. The Christmas Creek Operations occupy 68 tenements, and a full list of these is provided in Table 2.

The original Public Environmental Review (PER) (ENVIRON, 2005) for Christmas Creek was released in September 2005, and approval was granted on 16 December 2005 under Ministerial Statement 707. Fortescue is currently proposing to expand the current Christmas Creek Operations from an approved disturbance footprint of 10,135 hectares (ha) to approximately 17,956 ha, within a 33,000 ha development envelope. The current modelled life of mine (LOM) is 14 years (to 2028); however, a mine life of up to 40 years (to 2054) is predicted for this site.

The Environmental Scoping Document (ESD) (EPA, 2014) for this proposal was approved by the EPA on 17 April 2014 and a Preliminary Draft Christmas Creek Expansion Proposal PER

(Fortescue, 2014a) covering the expansion plans was submitted to the OEPA for review on 4 August 2014, with review comments issued on 20 October 2014 (Assessment No. 1989).

1.2 Purpose of Plan

The Christmas Creek Mine Closure Plan (MCP) covers closure-related aspects associated with the mining of the iron ore bodies at Christmas Creek and the operations of the mine site, including mine pits and post mine landforms, and deals with the way in which the operations will be rehabilitated and closed in accordance with the DMP / EPA current and draft *Guidelines for Preparing Mine Closure Plans* (DMP 2011, 2014) and Fortescue's *Planning for Closure Standard* (100-ST-EN-0001). All relevant Fortescue management plans are listed in Table 1 and in pertinent sections throughout the document.

Fortescue recognises the importance of mine closure to the successful and environmentally acceptable operation of the Project, and that mine closure together with excellence in managing environmental responsibilities should be an integral part of mine development and operations. The purpose of the MCP is to provide a strategic planning and implementation framework for the closure of the Project by:

- Identifying those aspects relating to decommissioning and closure which may impact on the environment, health and safety, and may be of concern to regulatory agencies;
- Providing a basis for consultation with regulators and identified stakeholders regarding the post-mining land uses of the project area and agreed completion criteria;
- Developing management strategies to be implemented as part of the project's design, construction and operation to minimise impacts and site closure requirements;
- Identifying closure costs to establish adequate financial provisions;
- Providing details of the management strategies to be implemented by Fortescue to the appropriate regulatory agencies to confirm completion criteria are met.

The MCP is a dynamic 'living' document which will be reviewed regularly to consider changes in site conditions, operations, technology, and community expectations. Fortescue have committed to a range of studies to further investigate the environmental risks and closure aspects of their operations and the results from these studies will be incorporated into future iterations of this MCP document. As required by the *Guidelines for Preparing Mine Closure Plans* (DMP 2011, 2014), this MCP will be submitted for review by the OEPA every three years.

1.3 Environmental Management System

Fortescue is committed to environmentally responsible mining in the Pilbara. This commitment is recognised, communicated and achieved through the implementation of Fortescue's Environmental Management System (EMS). This EMS is consistent with *ISO 14001:2004* and is guided by Fortescue's Environmental Policy which governs all of its operations such that they:

- Respect the need to protect the environment in which they operate to minimise, mitigate and remediate impacts of its operations.
- Strive to achieve effective and acceptable environmental outcomes through disciplined environmental management. This includes the consideration of innovative environmental management techniques in project development, operations and rehabilitation.
- Comply with all relevant environmental laws and obligations as the minimum standard to which Fortescue operates and the minimum requirement against which environmental performance is measured.
- Acknowledge that environmental protection is a cornerstone of Fortescue's success and sustainability. This success benefits not just Fortescue but its families, communities and future generations.

Through this EMS, rehabilitation and closure aspects across all of its operations are addressed by:

- Environmental risks are identified, analysed and evaluated, and controls established.
- Responsibility for meeting environmental objectives, targets and obligations, and the implementation of controls are clearly communicated.
- Regular checks are undertaken to determine whether environmental objectives, targets, obligations and controls are being met.
- Environmental performance is monitored and reviewed to ensure continuous improvement.

A key aspect to the function of the EMS is the development and implementation of Environmental Management Plans (EMPs), which at a site level are realised through Procedures and Standard Work Instructions (SWI) – the overall Fortescue EMS hierarchy is shown in Plate 1. These EMPs effectively detail how baseline environmental data is collected, utilised and interpreted against relevant criteria, how rehabilitation and closure performance is monitored and how this monitoring data is to be applied to assess compliance against relevant conditions, and whether closure is achieved.

Key EMPs relevant to the rehabilitation and closure of mine pits, waste rock landforms (WRLs) and tailings storage facilities (TSFs), covered under this MCP, are included in Table 1.

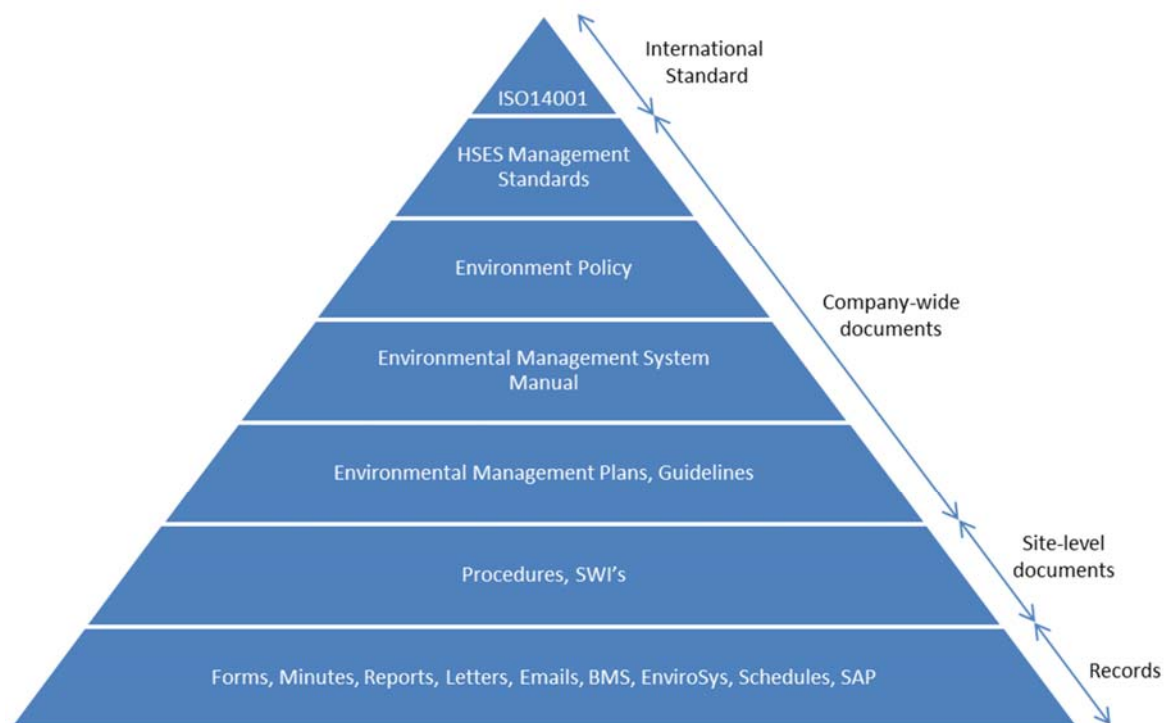


Plate 1: EMS Document Hierarchy

Table 1: Key EMPs Relevant to the Rehabilitation and Closure of Domains Covered by this MCP

Closure Domain	Closure Tenet	Rehabilitation and Closure Aspect	Relevant EMP
Mine Pits	Physically safe and geotechnically stable	Stability (geotechnical and erosion)	Ground Control Management Plan (CC-PL-OP-0005) Standard Engineering specifications for Drainage and Flood Protection (100-SP-CL-0004) Design Specification for Mine Pit Backfill and Associated Surface Water Management Structures (100-SW-EN-0046)
	Geochemically non-polluting & non-contaminating	Geochemistry Hydrology Hydrogeology	Groundwater Management Plan (100-PL-EN-1009) Characterisation of Mineral Waste Rock and Soils (100-GU-EN-0018) Acid and Metalliferous Management Plan (100-PL-EN-1016) Guideline for Re-Establishing Major Watercourses Across Backfilled Pits (CH-GU-EN-0002) Surface Water Management Plan (45-PL-EN-0024)
	Sustainable	Monitoring	Vegetation Health Monitoring and Management Plan (CC-PL-EN-0004) Rehabilitation and Revegetation Management Plan (100-PL-EN-0023)
WRL	Physically safe and geotechnically stable	Stability (geotechnical and erosion)	Ground Control Management Plan (CC-PL-OP-0005) Waste Rock Design Guideline (CH-GU-EN-0002) Standard Engineering specifications for Drainage and Flood Protection (100-SP-CL-0004)
	Geochemically non-polluting and non-contaminating	Geochemistry Hydrology Hydrogeology	Characterisation of Mineral Waste Rock and Soils (100-GU-EN-0018) Acid and Metalliferous Management Plan (100-PL-EN-1016) Surface Water Management Plan (45-PL-EN-0024) Groundwater Management Plan (100-PL-EN-1009)
	Sustainable	Rehabilitation Monitoring	Vegetation Clearing and Topsoil Management Procedure (45-PR-EN-0013) Overburden Management Re-Growth and Waste (45-PR-EN-0012) Rehabilitation and Revegetation Management Plan (100-PL-EN-0023) Weed Monitoring Guidelines (45-PL-EN-0013)
TSF	Physically safe and geotechnically stable	Stability (geotechnical and erosion)	Tailings Storage Facility Closure Management Guideline (CH-GU-OP-0001)
	Geochemically non-polluting and non-contaminating	Geochemistry Hydrology Hydrogeology	Characterisation of Mineral Waste Rock and Soils (100-GU-EN-0018) Acid and Metalliferous Management Plan (100-PL-EN-1016) Surface Water Management Plan (45-PL-EN-0024) Groundwater Management Plan (100-PL-EN-1009)
	Sustainable	Rehabilitation Monitoring	Rehabilitation and Revegetation Management Plan (100-PL-EN-0023)

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2. PROJECT SUMMARY

2.1 Ownership

The Christmas Creek Operations are currently situated within 68 tenements. These operations are conducted by Fortescue.

The contact details for Fortescue are:

Fortescue Metals Group Ltd,
Level 2,
87 Adelaide Terrace,
East Perth WA 6004

2.2 Tenure

Christmas Creek is located within the Hillside, Roy Hill and Bonney Downs Pastoral Leases and falls within tenements dedicated under the *Iron Ore (FMG Chichester Pty Ltd) Agreement Act 2006*. A list of these leases and licences is provided in Table 2.

Table 2: Tenure

Lease Category	Reference Numbers
Mining Lease	M46/320, M46/321, M46/322, M46/323, M46/324, M46/325, M46/326, M46/327, M46/328, M46/329, M46/330, M46/331, M46/332, M46/333, M46/334, M46/335, M46/336, M46/337, M46/338, M46/339, M46/340, M46/341, M46/342, M46/343, M46/344, M46/345, M46/346, M46/347, M46/348, M46/349, M46/350, M46/351, M46/352, M46/353, M46/354, M46/355, M46/402, M46/403, M46/405, M46/406, M46/412, M46/413, M46/414, M46/415, M46/416, M46/417, M46/418, M46/419, M46/420, M46/421, M46/422, M46/423, M46/424
Miscellaneous and Exploration Licences	L46/49, L46/54, L46/55, L46/56L46/58, L46/66, L46/86, L46/87, L46/99, L46/100 E46/566, E46/610, E46/611, E46/612
General Purpose Lease	G46/7

2.3 Overview of Operations

Mining commenced at Christmas Creek in 2009. Existing mine operations at Christmas Creek are being undertaken in accordance with Ministerial Statements 707 and 871.

Mining at Christmas Creek is carried out using open pit mining. Approximately 50 Mtpa of fines ore product is produced along with 213 Mtpa of waste rock and 9.5 Mtpa of tailings. Ore is transported to various ROM pads by truck, from where it is sent for crushing, either at an RCH or at crushing facilities near the OPFs, and transported to Port Hedland via the existing Fortescue rail network. Waste rock is either backfilled into the open pit voids or deposited into WRLs. Tailings are deposited into on-site TSFs. Up to 50GL/a of dewatering is undertaken, with up to 42.5 GL/a injected into the aquifers.

Fortescue is currently seeking approval to increase the rate of ore production to allow peaks of up to 85 Mtpa (Fortescue, 2014a). Mine life has been modelled for 14 years to 2028, and the mine footprint is proposed to expand from 10,135 ha to approximately 17,956 ha within a 33,000 ha Development Envelope by 2054. Abstraction and injection of up to 110 GL/a of groundwater is proposed (an increase of up to 60 GL/a) along with the construction of additional TSFs and WRLs, to support the expanded operations.

A LOM of up to 40 years (to 2054) is predicted for this site.

A plan of the site is given in Figures 1 and 2. Further details of the overall mine process are described in Fortescue's Preliminary Draft Christmas Creek Expansion Proposal PER (Fortescue 2014a).

2.4 Closure Domains

The major closure domains identified for this project currently comprise:

- active pits
- waste dumps
- tailings storage facilities.

As operations continue to expand in accordance with the mine plan, operational areas associated with the three domains listed above will increase in number.

Due to the long project life, these three landform features will comprise the majority of ongoing environmental work (e.g. rehabilitation and monitoring) during operations, and therefore provide the focus for this MCP. All other domains on site, which primarily consist of mine support infrastructure which cannot be subjected to progressive rehabilitation, will be addressed in a decommissioning plan to be developed within 5 years of the planned completion of operations.

2.4.1 Active Mine Pits

Open pit mining is the method currently used at the six operational pits at Christmas Creek, which are:

- Windich
- Flinders
- Mokare
- Eyre
- Young
- Baudin.

2.4.2 Waste Rock Landforms

A total of ten WRLs are currently present at Christmas Creek:

- Vasse NW
- Vasse SW
- Flinders
- Windich West
- Windich East
- Mokare NE
- Mokare South
- Eyre
- Young
- Baudin.

Christmas Creek WRL footprints are detailed in Table 7 of Fortescue's annual environmental review (Fortescue, 2014e).

2.4.3 Tailings Storage Facilities

Fortescue currently operate three TSFs at Christmas Creek:

- Vasse TSF
- Windich TSF1
- Windich TSF2

All existing TSFs are constructed within mined-out pits. Vasse TSF currently stores tailings both below and above pre-mining ground level, while the Windich TSFs currently provide below-ground storage of tailings.

2.5 Closure Planning Process

Closure planning at Christmas Creek is governed by Fortescue's overarching *Planning for Closure Standard* (100-ST-EN-0001).

3. CLOSURE OBLIGATIONS AND COMMITMENTS

Closure obligations and commitments occur at two levels:

- Generic obligations and commitments, which are typically set by legislation and best-practice guidelines, and are developed to promote environment stewardship within industry.
- Site or activity-specific obligations and commitments, which are generally set by individual regulatory agencies to ensure environmental compliance and that all activities are undertaken in an environmentally sound manner.

Closure obligations and commitments pertinent to the Christmas Creek Operations are provided below.

3.1 Generic Closure Obligations and Commitments

3.1.1 Environmental Protection Act 1986

Rehabilitation and mine closure is regulated by the EPA under Part IV of the EP Act. The EPA applies the following objective to the assessment of mine closure and rehabilitation:

To ensure that premises can be closed, decommissioned and rehabilitated in an ecologically sustainable manner, consistent with agreed outcomes and land uses, and without unacceptable liability to the State.

The EPA has developed policies to assist with achieving its objective. These include policies and guidance notes on the use of the precautionary principle, consideration of intergenerational equity, the conservation of biological diversity and ecological integrity, and waste minimisation.

The following regulatory position and guidance statements set the framework for the management of rehabilitation and mine closure:

- DMP and EPA ((2011);(2014)) *Guidelines for Preparing Mine Closure Plans*.
- EPA (2006) *Guidance Statement No 6: Rehabilitation of Terrestrial Ecosystems*.
- EPA (2013a) *Environmental and water assessments relating to mining and mining related activities in the Fortescue Marsh management area*.

The following position and guidance statements are relevant to the management of rehabilitation and mine closure:

- EPA Guidance Statement Number 33: *Environmental Guidance for Planning and Development* (2008).

- EPA Position Statement Number 2: Environmental Protection of Native Vegetation in Western Australia (2000).
- EPA Position Statement Number 5: Environmental Protection and Ecological Sustainability of the Rangelands in Western Australia (2004b).
- EPA Position Statement Number 7: Principles of Environmental Protection (2004a).
- EPA Position Statement Number 8: Environmental Protection in Natural Resource Management (2004c).

3.1.2 Iron Ore (FMG Chichester Pty Ltd) Agreement Act 2006

Christmas Creek Operations are also subject to the State Agreement which does not exempt Fortescue from compliance with any requirement in connection with the protection of the environment that may be made by or under the EP Act (clause 2(3)). Fortescue must report on disturbance on its Mining Tenements to the DSD in accordance with its obligation under the State Agreement on an annual basis (Clause 12(6)(a)).

3.1.3 Mining Act 1978

As the Christmas Creek Operations are located within tenements dedicated to the State Agreement, the *Mining Act 1978* has limited application in terms of rehabilitation and mine closure.

3.1.4 Regulatory Approvals

Iron ore mining and processing operations at the existing Christmas Creek Operations are subject to the following approvals:

- works approvals and licences under Part V of the EP Act, including environmental operating licence L8454/2010/1
- groundwater abstraction licences under the *Rights in Water and Irrigation Act 1914*
- approval to disturb Aboriginal sites under section 18 of the *Aboriginal Heritage Act 1972*.

3.1.5 Closure Standards and Guidelines

Fortescue have applied the following closure standards and guidelines to ensure environmentally sound development of the Christmas Creek Operations:

- *Strategic Framework for Mine Closure*. This handbook was prepared by the Minerals Council of Australia, and the Australian and New Zealand Minerals and Energy Council (ANZMEC and MCA) in 2000. It outlines strategic framework concepts associated with

stakeholder involvement, planning, financial provision, implementation, standards, and relinquishment. Examples of best practice are also included.

- *Mine Closure and Completion.* This document was prepared by the Department of Industry, Tourism and Resources (DITR) in October 2006 (DITR 2006a) as part of an Australian Government initiative - Leading Practice Sustainable Development Program for the Mining Industry. The publication addresses sustainable development and closure, mine life phases, planning during the operational phase and mine completion and relinquishment, including case studies.
- *Managing Acid and Metalliferous Drainage.* This handbook is one within the Leading Practice Sustainable Development in Mining Series, and was prepared by the DITR in February 2007 (DITR 2007). It encompasses social, economic and environmental aspects of the various mining phases, addressing the decision making, regulatory framework, identification and prediction, risk, minimisation, control and treatment, monitoring and performance evaluation and management processes of acid and metalliferous drainage (AMD). Case studies are also included.
- *Mine Rehabilitation.* This handbook was published in October 2006 (DITR 2006a) within the Leading Practice Sustainable Development in Mining Series by the DITR. It outlines sustainable development and mine rehabilitation, planning, operations, and closure, and includes case studies addressing these aspects of mine rehabilitation.

3.2 Site-Specific Approval Obligations and Commitments

3.2.1 Ministerial Statements

The Minister for Environment has imposed site-specific conditions on the Christmas Creek Operations following environmental impact assessment. These conditions have become binding through incorporation into Ministerial Statements 707 and 871 (*Pilbara Iron Ore & Infrastructure Project: East-West Railway & Mines Sites (Stage B)* and *Christmas Creek Water Management Scheme*). These Ministerial Statements are likely to be supplemented or superseded by a new Ministerial Statement following EPA approval of the Christmas Creek Expansion Proposal PER (Fortescue 2014a) (expected late 2015).

Conditions and procedures included in these Ministerial Statements provide clear guidance on the environmental responsibilities of Fortescue in developing the Christmas Creek Operations. Application of Fortescue's EMS, and development of associated EMPs (Section 1.3), ensures that all environmental, including rehabilitation and closure, obligations and commitments specified in the Ministerial Statements are met with performance reporting to the Minister of Environment, on advice of the EPA, undertaken every five years after the start of the operations. A further suite of compliance reporting is undertaken every 12 months

Performance reviews must address:

- major environmental issues associated with implementing the project, the environmental objectives for these issues, the methodologies used to achieve these, and key indicators of environmental performance measured against these objectives
- level of progress in achieving sound environmental performance
- significant improvements gained in environmental management, including the use of external peer reviews
- stakeholder and community consultation about environmental performance and the outcomes of that consultation, including reporting of any on-going concerns that are expressed
- proposed environmental objectives for the next five years, including improvements in technology and management processes.

Compliance reports provided to the Minister of the Environment through the EPA address:

- the status of implementation of the operation as defined in schedule 1 of the Ministerial Statements
- evidence of compliance with the conditions and commitments set out in the Ministerial Statements
- performance of environmental management plans and programs developed to satisfy all requirements of the Ministerial Statements

3.3 Fortescue Standards and Guidelines

Fortescue governs rehabilitation and closure planning on a corporate level, through:

- introduction of progressive mine rehabilitation into project development and mine planning, enabling the reduction of LOM closure costs and overall environmental liabilities
- improving the accuracy of Fortescue's closure liabilities and annual provisioning estimates.

These objectives are achieved by requiring that:

- the collection of baseline information required for successful mine closure and rehabilitation is obtained as early as possible in the project design and approvals process
- environmental risks are acknowledged during project design and appropriate management strategies implemented prior to and during operations
- mine closure and rehabilitation liabilities and provisioning are recognised during project design and feasibility and updated annually reflecting the 5 year mine plan

- mine closure and rehabilitation plans are in alignment with relevant current guidelines and are regularly reviewed through an integrated, multi-disciplinary approach and these are recognised in the all mine plans and relevant approval documents.

Fortescue's EMS (Section 1.3) provides the environmental compliance framework to determine when environmental approvals are required, and then captures environmental compliance obligations as they are agreed by the business. Compliance against stakeholder agreed management and monitoring programs or the MCP are monitored through application of the *Self Verification of High Risk Environmental Legal Obligations Guideline* (100-GU-EN-0030). Where non-conformance issues or opportunities for improvement are identified these issues are documented and tracked via the Business Management System (BMS). Each compliance obligation is assessed for its relative risk, and the results are used to drive first and second party internal auditing functions. Results of risk assessments are also used to drive continual improvement processes.

Implementation of environmental compliance obligations is undertaken by site environmental teams, with oversight from the corporate environmental team. Regular review of Fortescue's environmental performance by senior management ensures that focus is applied to areas of concern and that environmental performance is linked to the strategic direction of the business.

All identified LOM closure strategies are subjected to a risk assessment in terms of the *Fortescue Risk Management Policy Standards* (100-ST-RK-0011 to 0016 inclusive). Adherence to these standards ensures that all environmental and corporate closure risks are identified early in the design and planning phase so that the most appropriate and acceptable closure option can be identified and required management controls established to minimise potential risk and associated impacts.

4. STAKEHOLDER CONSULTATION

Fortescue recognises the importance of stakeholder engagement throughout the mine closure planning process to ensure that rehabilitation and closure works, and overall objectives and criteria, are in accordance with stakeholder expectations. Initial stakeholder consultation for the Christmas Creek project began in 2003, with acquisition of the Cloudbreak and Christmas Creek tenements, and continued through to December 2005 when approval to develop Christmas Creek was granted (Ministerial Statement 707). On the 10 October 2005, a Land Access Agreement (LAA) was secured with the Nyiyaparli people, with rehabilitation and closure outcomes forming an important part of this Agreement.

All stakeholder engagement within Fortescue is governed by the *Pilbara Iron Ore Infrastructure Project Stakeholder Consultation Strategy* (100-PH-EN-0003). This document guides community consultation by:

- identifying and engaging key stakeholders
- identifying and verifying areas of stakeholder concern for social and environmental values
- establishing a robust consultation approach to ensure effective consultation is undertaken
- developing individual stakeholder consultation plans
- assessing and managing stakeholder issues/concerns that might arise during the engagement process so that proposed impacts are minimised to as low as reasonable practicable.

The Stakeholder Consultation Strategy was developed to meet the requirements of Ministerial Statement 707 (Proponent Commitment 11) and covers all aspects of community consultation at Christmas Creek.

4.1 Stakeholder Identification

A full list of relevant stakeholders for the Christmas Creek Operations is provided in the Preliminary Draft Christmas Creek Expansion Proposal PER (Fortescue 2014a), covering Traditional Owners (TOs), pastoralists and State and Commonwealth regulatory agencies.

4.2 Stakeholder Engagement Register

A Stakeholder Engagement Register for the Christmas Creek Operations is provided in the original 2005 PER (Table 25; Appendix Q; (ENVIRON, 2005)) and the Preliminary Draft Christmas Creek Expansion Proposal PER (Table 11 of Fortescue 2014a). These registers document specific consultations undertaken during the development of Christmas Creek since

early 2005. Stakeholder engagement will continue through the LOM to ensure that rehabilitation and closure activities are aligned with changing community and government expectations.

5. POST MINING LAND USE AND CLOSURE OBJECTIVES

5.1 Pre-Mining Land Use

The pre-mining land use for the Christmas Creek Operations was pastoral, with the project envelope located on the Hillside, Roy Hill and Bonney Downs Pastoral Leases (low stocking cattle grazing).

5.2 Heritage

5.2.1 Native Title and Aboriginal Heritage

The Christmas Creek Operations occur entirely within the Nyiyaparli Native Title Boundary (WC05/6). In October 2005, Fortescue secured a Land Access Agreements (LAA) covering all the claim area of the Nyiyaparli people. The LAA includes comprehensive provisions about cultural heritage protection, and how Fortescue and the Traditional Owners will deal with heritage matters, including rehabilitation and closure. The LAA sets out how heritage surveys are conducted as well as the consultation process in the event that Fortescue needs to make a section 18 application to disturb a heritage site.

Fortescue consults regularly with the Traditional Owners on all aspects relating to the identification, protection and management of their cultural heritage, consistent with the Cultural Heritage Principles agreed between Fortescue and the Traditional Owners as set out in the LAA. Issues of native title relevant to the Proposal are managed through this agreement. A Heritage Subcommittee has been established to address heritage matters and Fortescue will continue to consult with the Nyiyaparli people throughout the LOM.

5.3 Closure Objectives and Guiding Principles

As specified in the 2011 and 2014 MCP Guidelines, the overall objective of closure is to construct a safe (to humans and animals), stable (physically, geochemically and geotechnically), non-polluting landform that is capable of sustaining an agreed post-operational land use. Although these holistic goals may seem unassuming and straightforward at first glance, their achievement, particularly for operations covering large areas and having long LOM (such as for Christmas Creek), is a complex process and requires a 'whole of company' approach. To successfully achieve these closure goals, buy-in at a corporate, legal, social, planning, operations and environmental level must occur, and failure to consult with any one of these groups within a company, will likely result in closure and relinquishment of tenements not being realised.

Fortescue's EMS (Section 1.3) ensures that a 'whole of company' management approach is applied to closure. Key EMPs that have been specifically developed to implement the guiding principles of the EMS include:

- *Planning for Closure Standard* (100-ST-EN-0001)
- *Rehabilitation and Revegetation Management Plan* (100-PL-EN-0023)
- *Rehabilitation and Revegetation Monitoring Procedure* (45-PR-EN-0027)
- *Stakeholder Consultation Strategy* (100-PH-EN-0003)
- *Verification of High Risk Environmental Legal Obligations Guideline* (100-GU-EN-0030)
- *Risk Management Policy Standards* (100-ST-RK-0011 to 0116 inclusive).

Fortescue's key closure objectives include:

- Ensure the interests of all relevant stakeholders are considered during all stages of closure planning.
- Establish rehabilitation objectives and completion criteria, based on the findings of monitoring and research, which are appropriate to the agreed post-mine land use.
- Where practicable, progressively rehabilitate and revegetate disturbed areas in accordance with regulatory criteria, Ministerial conditions and commitments;
- Construct safe, stable, non-polluting landforms that are geomorphologically and functionally consistent with the surrounding landscape and capable of sustaining agreed post-operational land use, and do not impact on surrounding environmental values or uses.
- Revegetate disturbed areas to meet agreed post-operational land use objectives and completion criteria.
- Develop indicators to demonstrate when rehabilitation activities meet the established objectives and completion criteria.

Through the implementation of the above closure objectives:

- no significant long-term physical off-site impacts will occur as a result of operations
- no significant long-term impact on baseline surface or groundwater flow patterns and quality will occur as a result of operations
- no unsafe areas will remain after closure whereby members of the general public and animals could be harmed
- rehabilitated and closed operational areas will be aesthetically consistent with the surrounding landform and meet agreed stakeholder expectations.

5.4 Final Land Use

Following cessation of mining, and subsequent rehabilitation and closure of post-mine landforms, the land use of the area will be returned to pastoral (low intensity livestock grazing). The Department of Parks and Wildlife (DPaW) are proposing that portions of the Mulga Downs,

Hillside, Marillana and Roy Hill stations, including parts of Christmas Creek Operations, be excluded from the renewal of pastoral leases in 2015, and be added to the conservation estate or managed by conservation agreement (EPA, 2013b). This change in land use has not been ratified by the current Government, and consequently, Fortescue will continue closure planning to re-establish low intensity livestock grazing (pastoral) across the site, similar to the pre-mine land use. If however, there is a change in land use prior to completion of mining, then Fortescue will review the post-mine land use.

Although the post-mine land use within the development envelope is expected to be returned to pastoral (low intensity livestock grazing), the specific post-mine land use of the closure domains considered in this MCP are shown in Table 3.

The Mine Void closure domain has been split into three categories, which reflect the different options in contemplation for their rehabilitation. These options are included so that potential post-closure land uses can be discussed. However each option is at a different stage in the work required to prove feasibility. In particular the retention of an open mine void is included as a potential option for use in the future, pending further studies and stakeholder engagement.

Table 3: Expected Post-mine Land Use by Closure Domain

Closure Domain		Post Closure Land Use	Specific Strategies to Facilitation Land Use
Mine Voids	Open void	No specified land use due to safety/access restrictions	Abandonment bunds to prevent human / animal access
	Partially backfilled	No specified land use due to safety/access restrictions	Abandonment bunds to prevent human / animal access
	Completely backfilled – reinstatement of profile	Areas will support low intensity grazing (pastoral)	Physical and geotechnical stability will not compromise sustainability of re-established ecosystem or surface water objectives
Waste Rock landforms (WRLs)	Areas will support low intensity grazing (pastoral)	Physical and geotechnical stability will not compromise sustainability of re-established ecosystem or surface water objectives	
Tailings Storage Facilities (TSFs)	Areas will support low intensity grazing (pastoral)	Physical and geotechnical stability will not compromise sustainability of re-established ecosystem or surface water objectives	

6. PROVISIONAL COMPLETION CRITERIA

Completion criteria are measurable targets against which closure implementation, and subsequent performance, can be assessed. Fortescue applies an adaptive management approach (Section 9.4.1) to the development of completion criteria, with identification of provisional criteria commencing during early project approval stages, following stakeholder consultation and collection of baseline data. These provisional completion criteria are continually reviewed and updated throughout the entire LOM (i.e. iterative feedback loop) as expectations of relevant stakeholders change over time and in response to ongoing monitoring, research and trial rehabilitation information.

Fortescue believes that completion criteria should be achievable, realistic and be aligned with stakeholder expectations. They should not be developed in isolation (otherwise they will have no meaning), and should be intricately linked to:

- broad closure objectives (i.e. safe, stable, non-polluting and sustainable)
- stakeholder-agreed post-mine land use
- monitoring approach (i.e. to guide what parameters are monitored and ensure no redundancy in monitoring approach).

This relationship is depicted in Plate 2.

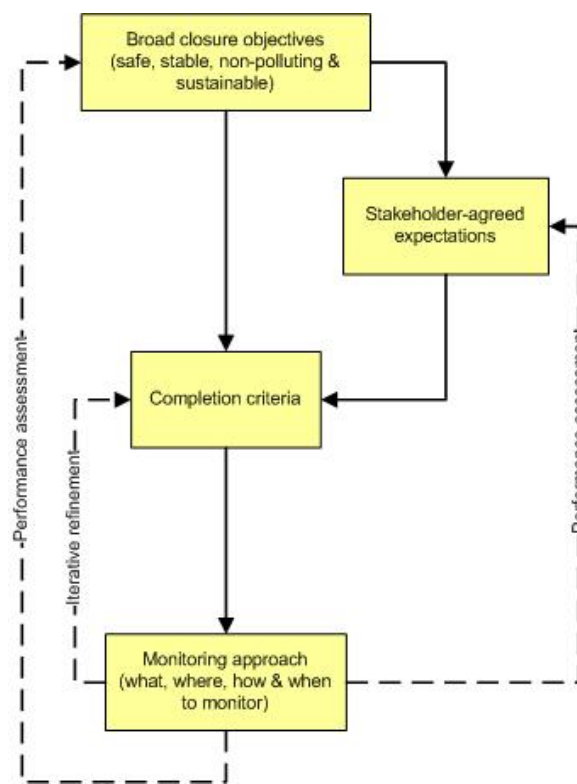


Plate 2: Relationship between Completion Criteria and Other Aspects of the Closure Process

6.1 Basis for Development

Provisional completion criteria for the Christmas Creek closure domains have been developed within the framework of Fortescue's overarching EMS and Fortescue's *Planning for Closure* (100-ST-EN-0001). Provisional completion criteria for the Christmas Creek Operations were developed in accordance with the following documents:

- *Guidelines for Preparing Mine Closure Plans* (EPA/DMP, 2011; 2014);
- *Strategic Framework for Mine Closure* (ANZMEC & MCA, 2000);
- *Rehabilitation of Terrestrial Ecosystems* (EPA, 2006);
- Leading Practice Sustainable Development Program for the Mining Industry Handbooks for *Mine Closure and Completion* (DITR, 2006), *Mine Rehabilitation* (DITR, 2006) and *Evaluation Performance: Monitoring and Auditing* (DITR, 2006)
- *Planning for Integrated Mine Closure Toolkit* (ICMM, 2008)
- *Good Practice Guidance for Mining and Biodiversity* (ICMM, 2006)
- *Enduring Value, the Australian Minerals Industry Framework for Sustainable Development* (MCA, 2005).

Completion criteria should:

- be specific enough to reflect unique environmental, social and economic circumstances
- be flexible enough to adapt to changing circumstances without compromising objectives
- include environmental indicators suitable for demonstrating that rehabilitation trends are heading in the right direction
- undergo periodic review in light of changed circumstances or improved knowledge resulting in modification if required
- be based on targeted research which results in increasingly informed decisions.

6.2 Development of Completion Criteria

Rehabilitation objectives for a mine feature (e.g. mine pit, waste rock landform) are primarily based on the closure objectives and agreed post mine land use. Fortescue's rehabilitation objectives for landforms is to ensure that they are safe, stable and non-polluting whilst being capable of sustaining agreed post operational land use.

The purpose of completion criteria is to allow demonstration that a given area or landform has achieved the rehabilitation objectives and provide confidence to regulators and post operational

land users that these areas or landforms are capable of sustaining over the long term the agreed post mine land use, utilising normal management practices.

The development of completion criteria will continue throughout the operational period of the mine to allow integration of data from ongoing rehabilitation trials, research and monitoring. The goals of this development are to progressively refine monitoring activities and rehabilitation to develop measurable metrics based on site specific data, providing confidence that completion criteria can fulfil the intended role within the mine closure planning framework.

Completion criteria developed for use by Fortescue are presented in Table 4.

Table 4: Christmas Creek Domains Completion Criteria

Subject	Objective	Domain	Criteria	Verification Tools	MCP Section
1. Safety					
1.1 Safety	Site is safe for use under the agreed post mine land use	All	Hazards which may endanger safety of humans or animals are identified and eliminated where possible. Residual safety hazards have been identified and appropriate management controls developed and implemented.	Relevant regulator guidelines have been met. Mine safety inspection audit).	Sections 8 and 10
1.2 Landform safety	Final landforms are safe	All	Landforms have been constructed as per management and operation guidelines for each domain: <ul style="list-style-type: none"> <i>Guideline for the Design of Mineral Waste Rock Landforms (WRL) (100-PR-EN-1017)</i> <i>Tailings Storage Facility Closure Management Guideline (CH-GU-OP-0001)</i> <i>Guideline for Re-Establishing Major Watercourses Across Backfilled Pits: Chichester Operations (GU-CH-EN-0002).</i> 	Rehabilitation monitoring confirms landforms constructed to management guidelines. Monitoring results display landform safety in relation to design criteria, geotechnical audits and relevant guidelines.	Sections 9 and 10
2. Stability					
2.1 Landform Stability	Final landforms are stable	All	Landforms have been constructed as per management and operation guidelines for each domain: <ul style="list-style-type: none"> <i>Guideline for the Design of Mineral Waste Rock Landforms (WRL) (100-PR-EN-1017)</i> <i>Tailings Storage Facility Closure Management Guideline (CH-GU-OP-0001)</i> <i>Guideline for Re-Establishing Major Watercourses Across Backfilled Pits: Chichester Operations (GU-CH-EN-0002).</i> 	Rehabilitation monitoring programs and geotechnical audits to confirm landforms constructed to management guidelines. Environmental reports available for review.	Sections 9 and 10
2.2 Surface Stability	Constructed surface is stable and does not display significant erosion	All (excluding mine voids)	Surface of landforms have been constructed in accordance with guideline specifications for each domain: <ul style="list-style-type: none"> <i>Guideline for the Design of Mineral Waste Rock Landforms (WRL) (100-PR-EN-1017)</i> <i>Tailings Storage Facility Closure Management Guideline (CH-GU-OP-0001)</i> 	Rehabilitation monitoring confirms landform surfaces constructed to management guidelines. Rehabilitation monitoring results indicate surface is stable.	Sections 9 and 10

Subject	Objective	Domain	Criteria	Verification Tools	MCP Section
			<ul style="list-style-type: none"> <i>Guideline for Re-Establishing Major Watercourses Across Backfilled Pits: Chichester Operations (GU-CH-EN-0002).</i> 		
3. Pollution					
3.1 Sedimentation	Landform surfaces not prone to sediment transport beyond natural geomorphic processes	All (excluding mine voids)	<p>Surface of landforms have been constructed in accordance with guideline specifications for each domain:</p> <ul style="list-style-type: none"> <i>Guideline for the Design of Mineral Waste Rock Landforms (WRL) (100-PR-EN-1017)</i> <i>Tailings Storage Facility Closure Management Guideline (CH-GU-OP-0001)</i> <i>Guideline for Re-Establishing Major Watercourses Across Backfilled Pits: Chichester Operations (GU-CH-EN-0002).</i> 	<p>Rehabilitation monitoring confirms landform surfaces constructed to management guidelines.</p> <p>Backfill monitoring confirms geomorphological stability of reconstructed channels is consistent with natural systems.</p> <p>Monitoring completed as per the <i>Fortescue Marsh Hydrology and Vegetation Monitoring and Management Plan (100-PL-EN-1013).</i></p>	Sections 9 and 10
3.2 Acid and/or Metalliferous Drainage	Acid and/or metalliferous drainage is appropriately managed	All	Waste material used in landform construction is characterised through Fortescue's <i>Guideline Planning for Closure – Characterisation of Mineral Waste Rock and Soils (100-GU-EN-0018).</i>	Monitoring reports generated through Fortescue's <i>Acid and/or Metalliferous Drainage Plan (100-PL-EN-1016)</i> indicate material is appropriately managed.	Sections 8 and 10
4. Sustainability					
4.1 Sustainability	Rehabilitation is sustainable and suitable for the agreed post mine land use	All where relevant	Rehabilitation activities are carried out in accordance with Fortescue's <i>Rehabilitation and Revegetation Management Plan (100-PL-EN-0023).</i>	Monitoring reports generated through Fortescue's <i>Rehabilitation and Revegetation Monitoring Procedure (45-PR-EN-0027).</i>	Sections 8 and 10
4.2 Growth medium	Suitable growth medium is in place to facilitate rehabilitation and agreed post mine land use	All (except voids)	<p>Surface of landforms have been constructed in accordance with guideline specifications for each domain:</p> <ul style="list-style-type: none"> <i>Guideline for the Design of Mineral Waste Rock Landforms (WRL) (100-PR-EN-1017)</i> <i>Tailings Storage Facility Closure Management Guideline (CH-GU-OP-0001)</i> <i>Guideline for Re-Establishing Major Watercourses Across Backfilled Pits: Chichester Operations (GU-CH-EN-0002).</i> 	Rehabilitation monitoring confirms landform surfaces constructed to management guidelines.	Sections 9 and 10

Subject	Objective	Domain	Criteria	Verification Tools	MCP Section
4.3 Vegetation development	Vegetation is suited to the agreed post mine land use	All (except voids)	Rehabilitation activities are carried out in accordance with Fortescue's <i>Rehabilitation and Revegetation Management Plan</i> (100-PL-EN-0023).	Monitoring reports generated through Fortescue's <i>Rehabilitation and Revegetation Monitoring Procedure</i> (45-PR-EN-0027).	Sections 8 and 10
4.4 Provenance	Vegetation is of local provenance	All	Rehabilitation activities are carried out in accordance with Fortescue's <i>Rehabilitation and Revegetation Management Plan</i> (100-PL-EN-0023) and supporting documentation <i>Seed Collection and Management Guidelines</i> (45-GU-EN-0007).	Monitoring reports generated through Fortescue's <i>Rehabilitation and Revegetation Monitoring Procedure</i> (45-PR-EN-0027).	Sections 8 and 10
4.5 Weeds	Presence of weeds does not limit the sustainability of rehabilitation or its potential to sustain agreed post mine land use	All	Rehabilitation activities are carried out in accordance with Fortescue's <i>Rehabilitation and Revegetation Management Plan</i> (100-PL-EN-0023). Weed management is carried out in accordance with Fortescue's <i>Weed Management Plan</i> (45-PL-EN-0013).	Monitoring reports generated through Fortescue's <i>Rehabilitation and Revegetation Monitoring Procedure</i> (45-PR-EN-0027).	Sections 8 and 10
5. Hydrology					
5.1 Surface Hydrology	Mining related impacts on natural surface water flows is minimised	All	Landforms have been constructed as per management and operation guidelines for each domain: <ul style="list-style-type: none"> <i>Guideline for the Design of Mineral Waste Rock Landforms (WRL)</i> (100-PR-EN-1017) <i>Tailings Storage Facility Closure Management Guideline</i> (CH-GU-OP-0001) <i>Guideline for Re-Establishing Major Watercourses Across Backfilled Pits: Chichester Operations</i> (GU-CH-EN-0002). 	Rehabilitation monitoring confirms landforms constructed to management guidelines. Backfill monitoring confirms geomorphological stability of reconstructed channels is consistent with natural systems Surface water monitoring confirms that pit lake water quality does not negatively impact on downstream surface water quality.	Sections 9 and 10
5.2 Groundwater Hydrology	Mining related impacts on groundwater quality have been minimised	All	Landforms have been constructed as per management and operation guidelines for each domain: <ul style="list-style-type: none"> <i>Guideline for the Design of Mineral Waste Rock Landforms (WRL)</i> (100-PR-EN-1017) <i>Tailings Storage Facility Closure Management</i> 	Rehabilitation monitoring confirms landforms constructed to management guidelines. Groundwater monitoring confirms that pit lakes and backfilled pits do not negatively impact on downstream groundwater quality.	Sections 9 and 10

Subject	Objective	Domain	Criteria	Verification Tools	MCP Section
			<i>Guideline (CH-GU-OP-0001)</i> <ul style="list-style-type: none"> <i>Guideline for Re-Establishing Major Watercourses Across Backfilled Pits: Chichester Operations (GU-CH-EN-0002).</i> 		
6. Miscellaneous					
6.1 Visual Amenity	Visual amenity of constructed landforms is compatible with local landforms	All (except voids)	<p>Landforms have been constructed as per management and operation guidelines for each domain:</p> <ul style="list-style-type: none"> <i>Guideline for the Design of Mineral Waste Rock Landforms (WRL) (100-PR-EN-1017)</i> <i>Tailings Storage Facility Closure Management Guideline (CH-GU-OP-0001)</i> <i>Guideline for Re-Establishing Major Watercourses Across Backfilled Pits: Chichester Operations (GU-CH-EN-0002).</i> 	<p>Rehabilitation monitoring confirms landforms constructed to management guidelines.</p> <p>Environmental reports available for review.</p>	Sections 9 and 10
6.2 Heritage	No disturbance of heritage sites during rehabilitation and access to sites of significance preserved	All	<p>Landforms have been constructed as per management and operation guidelines for each domain:</p> <ul style="list-style-type: none"> <i>Guideline for the Design of Mineral Waste Rock Landforms (WRL) (100-PR-EN-1017)</i> <i>Tailings Storage Facility Closure Management Guideline (CH-GU-OP-0001)</i> <p><i>Guideline for Re-Establishing Major Watercourses Across Backfilled Pits: Chichester Operations (GU-CH-EN-0002).</i>Rehabilitation activities are carried out in accordance with Fortescue's <i>Rehabilitation and Revegetation Management Plan (100-PL-EN-0023)</i>.</p> <p>Fortescue's <i>Stakeholder Consultation Strategy (100-PH-EN-0003)</i> has been adhered to.</p> <p>Fortescue's Ground Disturbance Permits Procedure (100-PR-EN-0004) has been adhered to.</p>	<p>Rehabilitation monitoring confirms landforms constructed to management guidelines.</p> <p>Stakeholder register has been completed</p> <p>Site heritage register has been maintained.</p> <p>Compliance audits of Ground Disturbance Permit Procedure</p>	Sections 9 and 10

7. COLLECTION AND ANALYSIS OF CLOSURE DATA

This section provides a summary of details on the physical and biological environment at Christmas Creek including:

- local climatic conditions
- local environmental conditions – topography, geology and hydrogeology
- local and regional information on flora, fauna and subterranean fauna
- local water resources details – type, location, extent, quality, quantity and environmental values (ecological and beneficial uses)
- soil and waste materials characterisation.

This information provides a basis for the development of completion criteria and performance indicators for closure monitoring.

The closure management of the mining operations is based on understanding the surrounding environment and the outcomes of monitoring and research programs.

7.1 Interim Biogeographic Regionalisation of Australia

The Australian Natural Resources Atlas identifies 85 bioregions and 403 subregions across Australia. The operations are located within the Pilbara bioregion of WA in the Interim Biogeographic Regionalisation of Australia (IBRA).

The Pilbara bioregion, which actively drains into the Fortescue, De Grey and Ashburton River systems, is divided into four subregions;

- Chichester (PIL1)
- Fortescue Plains (PIL2)
- Hamersley (PIL3)
- Roebourne (PIL4).

Christmas Creek mining operations lie within the Chichester subregion, which is described by Kendrick and McKenzie (2001) as:

“The Chichester subregion (PIL1) comprises the northern section of the Pilbara Craton. Undulating Archaean granite and basalt plains include significant areas of basaltic ranges. Plains support a shrub steppe characterised by *Acacia inaequilatera* over *Triodia wiseana* hummock grasslands, while *Eucalyptus leucophloia* tree steppes occur on ranges. The climate is semi-desert-tropical and receives 300 mm rainfall annually. Drainage occurs to the north via numerous rivers. Subregional area is 9,044,560 ha.”

7.2 Climate

Christmas Creek is located in the Pilbara region of Western Australia, which is characterised as arid-tropical with two distinct seasons; a hot summer (October to April) and mild winter (May to September). The Pilbara is one of the hotter areas in Australia, with an extreme temperature range, rising up to 50°C during the summer and dropping to around 0°C in winter (BOM, 2014).

The Pilbara region has high variable rainfall dominated by the occurrence of tropical cyclones mainly from January to March. Tropical cyclones bring sporadic and drenching rainfall events. With the exception of these large events, rainfall can be erratic and localised due to thunderstorm activity.

Mean monthly maximum temperatures at Newman range from 39°C in January to 23°C in July, and mean monthly minimum temperatures range from 25°C in January to 6°C in July (BOM, 2014). Average annual (pan) evaporation in the area is approximately 2,600 mm per year (BOM, 2014), which greatly exceeds annual rainfall and consequently contributes to the arid environment.

7.3 Overburden Characteristics

Overburden materials are characterised through Fortescue's *Characterisation of Mineral Waste Rock and Soils* (100-GU-EN-0018) and the *Acid and/or Metalliferous Drainage Management Plan* (100-PL-EN-1016). These guidelines classify waste material types based on their geochemical and physical characteristics, allowing assignment of each material type to a management class. This allows Fortescue to manage storage and disposal of waste material appropriately, including segregation and designed storage of potentially acid forming (PAF) materials. These guidelines have been developed in line with the Managing Acid and Metalliferous Drainage (AMD) handbook (DITR, 2007) and the Global Acid Rock Drainage (ARD) Guide (INAP, 2011).

7.3.1 Geological Setting

The Christmas Creek area lies within the Hamersley Basin, where Archaean granitoid rocks of the Pilbara Craton are overlain by meta-sedimentary and volcanogenic lithotypes. The Archaean basement granitoids are overlain by the Archaean Fortescue Group, which is itself overlain by the Archaean-Proterozoic Hamersley Group, which are both members of the Mount Bruce Supergroup (Thorne and Hagemann *et al.*, 2008).

The mineralisation at Christmas Creek is hosted by the Nammuldi Member of the Marra Mamba Formation (MMF), which is the lowermost formation of the Hamersley Group. The Nammuldi Member is the lowermost unit of the MMF, and overlies the Jeerinah Formation (the uppermost formation of the Fortescue Group) which marks the base of the main orebody. The Jeerinah Formation is sub-divided into a number of members, of which the Roy Hill Shale Member is the

uppermost. The regional geological sequence and stratigraphic descriptions are summarised in Table 5.

Table 5: Regional Stratigraphy

Formation	Member	Stratigraphy
Wittenoom Formation	Paraburdoo	Thin to thick bedded dolomite with minor chert
	West Angela	Dolomite with minor chert (largely absent locally)
Marra Mamba Formation	Mount Newman	Interbedded BIF with carbonate and shale
	MacLeod	Interbedded BIF, thin shale, chert and carbonate beds
	Nammuldi	Thick & podded mineralised BIF, separated by thin beds of siliceous and carbonate rich chert, and shale
Jeerinah Formation	Roy Hill Shale	Grey to black graphitic shale and Interbedded chert
	Warrie Member	Dolomite with interbedded chert, shale and mudstone

The Nammuldi Member forms low, flat topped ridges and a deep weathering profile, with no fresh rock evident at surface. The weathering profile comprises Tertiary colluvium containing generally loose detrital material derived from BIF, chert and shale, with a matrix of fine sediments, which promotes the precipitation of both calcrete and ferricrete forming local hard caps.

The MMF is overlain by the Wittenoom Formation, however in the area of mineralisation the Wittenoom Formation is largely absent and the MMF is mostly overlain by tertiary deposits. The thickness of these tertiary deposits generally decreases with distance from the Fortescue Marsh and in some areas, particularly in the northern Project area, the MMF outcrops.

Between the orebody locations (mine site) and the Fortescue Marsh, the alluvial sediments (referred to as Tertiary Detritals) are in the form of a palaeovalley infill comprising Quaternary and Tertiary alluvial, colluvial and lacustrine sediments. The palaeovalley cuts through the Hamersley Group formations, predominately within the Wittenoom Formation.

7.3.2 Geochemical Studies

Fortescue has developed standard procedures for the investigation and identification of PAF material that has the potential to become a source of AMD. These procedures are detailed in Fortescue's guidelines *Characterisation of Mineral Waste Rock and Soils* (100-GU-EN-0018) and the *Acid and/or Metalliferous Drainage Management Plan* (100-PL-EN-1016).

In accordance with this guideline, five separate baseline studies have been conducted by four separate consultants (Graeme Campbell and Associates, URS, Tetra Tech and Golders) to investigate geochemical characteristics of the material at Christmas Creek. A report written by Tetra Tech (2014) summarised the results of these baseline studies and presented recommendations for sampling procedures for ongoing operations.

These assessments included chemical analyses, geological information and mine planning input along with groundwater, surface water and ecological study data. The results of the

investigations indicate that the waste materials scheduled to be disturbed have a very low potential for acid generation and a low potential for metal leaching. Table 6 lists the stratigraphic units at Christmas Creek, some of which will form the waste material during LOM.

Table 6: Stratigraphic Units at Christmas Creek

Stratigraphy	Fortescue Ore Code
Tertiary Detritals	Overburden
Hardcap or hydro-hematite-brown goethite	U8
Mt Newman Member – Bedded Iron Mineralisation	U7u
Mt Newman Member – Shale unmineralised	US12
Mt Newman Member – Transition Zone	U7l
Mt Newman Member – BIF	US11
Macleod Member – Bedded Iron Mineralisation	U6
Macleod Member – Shale unmineralised	US10
Macleod Member – Transition Zone	U6l
Macleod Member – BIF	US9
Nammuldi Member – Bedded Iron Mineralisation	U5
Nammuldi Member – Shale unmineralised	US8
Nammuldi Member – Transition Zone	U5l
Nammuldi Member – BIF	Not scheduled to be intersected during LOM
Roy Hill Shale (commonly leached kaolinitic or black shale when fresh)	
Jeerinah Formation (dolomites, volcanics, sandstones)	

7.3.3 Acid and/or Metalliferous Drainage Characteristics

The only geological unit where acid generation potential was identified (through the presence of mineralogical pyrite) was the Roy Hill Shale unit. The current mine plan has been developed to prevent intersection of the Roy Hill Shale unit during mining activities. The majority of samples tested from the remainder of the geological units at Christmas Creek for geochemical characterisation had total sulphur values below 0.1%, and were therefore classified as barren. The waste rock materials represented by the samples analysed are therefore considered unlikely to generate acid drainage resulting in significant environmental impact.

7.3.4 Neutral Metalliferous Drainage Characteristics

Short term leaching tests on waste rock material conducted during the various geochemical studies described have reported elevated levels of leachate above the ANZECC (2000) trigger values for the protection of freshwater species in slightly to moderately disturbed ecosystems in upland rivers for the elements Al, As, B, Cd, Cr, Cu, Pb, Mn, Hg, Ni and Zn. Following recent studies, site specific assessment criteria have been developed for the mine; and these will be adopted following review by the EPA in 2015.

Management for AMD and Neutral Metalliferous Drainage at the Christmas Creek Site is detailed in Fortescue's *Acid and/or Metalliferous Drainage Plan* (100-PL-EN-1016) and at a high level in Section 8.

7.4 Soil and Landform Characteristics

7.4.1 Landforms and Land Systems

The regional topography of the eastern Pilbara is dominated by the Hamersley Plateau in the south and the Chichester Ranges in the north, with the two features divided by the Fortescue Valley. The main drainage is the Fortescue River, which flows north-west on Roy Hill Station into the Fortescue Marsh. The pre-mining topography within the Christmas Creek area has been described as hilly to undulating terrain, sloping south - south-west towards the Fortescue River Valley, with elevations ranging between RL 400 m AHD and RL 500 m AHD.

The dominant land systems within the Christmas Creek area are the Newman, Jamindie, and Turee land systems as classified by van Vreeswyk and Payne *et al.* (2004):

- Newman Land System – rugged jaspilite plateaux, ridges and mountains supporting hard Spinifex grasslands
- Jamindie Land System – stony hardpan plains and rises supporting groved Mulga shrublands, occasionally with Spinifex understory
- Turee Land System – stony alluvial plains in the vicinity of the Fortescue Marsh supporting tussock grasslands

The spatial distribution of these land systems relative to the Christmas Creek Operations is depicted in Figure 7 of the Preliminary Draft Christmas Creek Expansion Proposal PER (Fortescue 2014a). In general, the land systems define a topo-sequence, in which the rugged ridges and plateaux of the Newman Land System make up the higher elevation areas across the northern extent of the operations, the gently sloping plains and rises of the Jamindie Land System extend down from the ridges across the central portion of the site, and the relatively flat alluvial plains of the Turee Land System extend to the south, between the operational mine areas and the Fortescue Marsh.

7.4.2 Soil Types

The predominant soils of the region are Tertiary aged colluvium, characterised by angular fragments of Banded Iron Formation (BIF), chert and shale. As the soil types are generally homogeneous within each Land System, soil types are consistently controlled by the local topographic-sequence, with the ridges and hill flanks consisting of ferruginous gravelly soils that form extensive sheets of scree, and the lower-lying floodplains consisting of sheets of silty and sandy soils with clay contents increasing down-gradient toward the Fortescue Marsh.

The management of soils is controlled through Fortescue's Guidelines and Procedures; *Vegetation Clearing and Topsoil Management* (45-PR-EN-0013), *Overburden Management Re-Growth and Waste* (45-PR-EN-0012) and *Planning for Closure – Characterisation of Mineral Waste Rock and Soils* (100-GU-EN-0018).

7.5 Surface Water

7.5.1 Fortescue Surface Water Assessment Protocols

Fortescue have developed a *Surface Water Management Plan* (SWMP) (45-PL-EN-0024) and *Fortescue Marshes Management Plan* (45-PL-EN-0009) as part of the environmental approval under Ministerial Statement 707. These plans describe all aspects related to surface water management relevant to Christmas Creek, including an assessment of potential risks and impacts, a description of management protocols, monitoring guidelines, stakeholder consultation, and key roles and responsibilities.

A number of background studies have been completed in order to adequately characterise the local and regional surface water environment, and to aid in the preparation of monitoring and management plans:

- *Surface Water Investigation and Impact Assessment* (WorleyParsons, 2014a)
- *The Fortescue Marsh Catchment Water Balance Study* (WorleyParsons, 2014b)
- *Fortescue Marsh: Synthesis of Eco-hydrological Knowledge* (Equinox, 2013).

7.5.2 Regional Surface Water Environment

The regional surface water environment is described in detail in Appendix D of the SWMP (45-PL-EN-0024), and in the reports listed in Section 7.5.1. In summary, the Christmas Creek site is located in the upper Fortescue River catchment. In common with other areas in the Pilbara Region, the Fortescue Valley is subjected to localised thunderstorm and cyclonic rainfall events which can produce very large runoff events. The period between July to November typically has relatively low rainfall, although significant runoff events during this time can occur.

Surface flows in the vicinity of the Christmas Creek mine development generally flow towards the south, down from the Chichester Plateau, and eventually into the Fortescue Marsh.

7.5.3 Local Surface Water Environment

The local surface water environment is described in detail in Appendix D of the SWMP (45-PL-EN-0024), and in the reports listed in Section 7.5.1. In summary, the Christmas Creek mine development comprises a series of pits located along the southern flank of the east-west running Chichester Ranges. The Chichester Range is located along the northern extent of the

Fortescue Marsh, and the majority of the surface water runoff onsite thus flows southwards toward the marsh

The mine pits are predominantly located on the western side of Christmas Creek, which has a catchment area of around 225 km² above the mine development area. During peak flood events, Christmas Creek carries a significant discharge and over the lower slopes of the plateau, spreads out over the relatively wide shallow floodplain. One of the pits abuts the western floodplain of Christmas Creek, whereas the other pits are away from the floodplain. In common with the other proposed pit areas, numerous small creeks discharge southwards through the proposed pit development area. These creeks have relatively steep slopes in the higher rocky ridge areas and relatively flat slopes away from the ridge.

7.6 Groundwater

7.6.1 Fortescue Groundwater Assessment Protocols

Fortescue have developed a *Groundwater Management Plan* (100-PL-EN-1009) and *Christmas Creek Groundwater Operating Strategy* (CC-PH-HY-0002) as part of the environmental approvals under Ministerial Statements 871 and 707. These plans describe all aspects related to groundwater management relevant to Christmas Creek, including an assessment of potential risks and impacts, a description of management protocols, monitoring guidelines, stakeholder consultation, and key roles and responsibilities.

A number of background studies have been completed in order to adequately characterise the local and regional groundwater environment, and to aid in the preparation of monitoring and management plans:

- *Hydrogeological Assessment of the Christmas Creek Life of Mine Water Management Scheme* (Fortescue, 2013a)
- *Modelling Analysis of Mining Dewatering Impact on Soil Water Availability to the Samphire Vegetation on the Fringe of Fortescue Marsh* (Fortescue, 2014c)
- *Fortescue Marsh: Synthesis of Eco-hydrological Knowledge* (Equinox, 2013).

7.6.2 Regional Environment

The regional groundwater environment is described in detail in Preliminary Draft Christmas Creek Expansion Proposal PER (Fortescue 2014a), and in the reports listed in Section 7.6.1. In summary, groundwater movement within the Christmas Creek area is driven by rainfall-recharge on the elevated flanks of the Fortescue Valley and surrounding plateau. Fresh groundwater movement is thus generally southwards towards the valley, however this is opposed by a northward pressure gradient associated with density-driven saline groundwater. As a result, an

interface has developed with fresh/brackish water overlying saline/hypersaline groundwater in the transition zone between the Chichester ranges and the Fortescue Marsh Basin.

7.6.3 Local Environment

The local groundwater environment is described in detail in the Preliminary Draft Christmas Creek Expansion Proposal PER (Fortescue 2014a), and in the reports listed in Section 7.6.1. Table 12 of the PER summarises all known geological units and their associated hydrological properties.

7.7 Vegetation

The Christmas Creek Operations occur within the Fortescue Botanical District of the Eremaean Botanical Province as defined by Beard (1975). The vegetation of this province is typically open, and frequently dominated by Spinifex, Wattles and occasional Eucalypts.

7.7.1 Fortescue Flora and Vegetation Assessment Protocols

Fortescue uses a standard vegetation mapping approach consistent with EPA's Guidance Statement 51 '*Assessment of Environmental Factors for Terrestrial Flora and Vegetation Surveys*'. Vegetation surveys are normally completed as a component of pre-development approvals.

Fortescue vegetation mapping uses the vegetation classification methods described in the National Vegetation Information System (NVIS) Vegetation Manual. The NVIS classifies vegetation types using a hierarchy based on six levels as described in Table 1 of Fortescue's *Significant Flora and Vegetation Monitoring Guidelines* (45-GU-EN-0001).

In the case of Mulga vegetation, Mulga associations are classified based on recognisable taxa within the Mulga species complex, Fortescue mapping of Mulga vegetation is adopted from NVIS information and is described in Table 2 of document 45-GU-EN-0001.

In accordance to Fortescue's significant flora monitoring guidelines, subsets of vegetation associations are aggregated into larger vegetation monitoring units (VMUs), based on:

- landscape position,
- soil types
- eco-hydrology
- other environmental gradients

Appropriately defined VMUs can be expected to respond similarly to particular types of impacts e.g. groundwater drawdown or sheet-flow disruption. This provides the basis for identifying and evaluating factors causing vegetation change, allowing for selective adaptive management

responses to occur under Fortescue's *Vegetation Health Monitoring and Management Plan* (CC-PL-EN-0004), which uses the monitoring and evaluation framework developed by the International Union for Conservation of Nature (IUCN).

7.7.2 Local Flora and Vegetation

Numerous flora and vegetation surveys have been conducted to support environmental approvals and conditions. The southern reinjection part of the project area is located in the Priority 1 Ecological Community 'Fortescue Marsh' under zone 1a "Northern Flank" and zone 1b "Marsh" of the Fortescue Marsh management zones, represented by mulga woodlands and samphire vegetation. The remainder is located in the buffer zone of the Priority Ecological Community. The Mulga woodlands of Christmas Creek are considered significant, as they represent the northern limit of the distribution of this vegetation type (ENV, 2013). Surveys have recorded 541 taxa including 14 priority species and 20 introduced flora within the project area (ENV, 2013; Fortescue, 2014a). The 14 priority species comprised:

- five species of priority 1 (P1)
- one P2
- six P3
- two P4 species.

Several of these (particularly the *Tecicornia* spp.) are restricted to the Fortescue Marsh area. Others, such as *Rhagodia* sp Hamersley (P3) and *Goodenia nuda* (P4) are more widely distributed across the project area and are associated with mulga communities.

ENV (2013) described and mapped a total of 13 broad vegetation types, two mosaics and 11 vegetation associations. A detailed description of these vegetation types and associations can be found in Table 30 of the Preliminary Draft Christmas Creek Expansion Proposal PER (Fortescue 2014a). A comprehensive bioregional floristic analysis was undertaken combining previous survey data (Trudgen and Griffin, 2011) with data from the ENV survey (ENV 2013). This confirmed that Mulga north of Fortescue Marsh is floristically different to other Mulga vegetation in the bioregions, as it supports a Mulga taxon that is poorly represented south and west of the project area.

From the bioregional floristic analysis undertaken (Trudgen and Griffin, 2011), 17 floristic groups were identified which are equivalent to the 14 vegetation types of the creeks, plains and slopes and one floristic group which is associated to vegetation associations 1 – 9 of the samphire flats of Fortescue Marsh.

7.7.3 Weeds and Declared Plants

In accordance with Fortescue's *Weed Management Plan* (45-PL-EN-0013), in total twenty taxa of introduced flora have been recorded (ENV, 2013), with the majority of these weeds common

throughout the Pilbara as a result of pastoralism and other anthropogenic activities. *Argemone ochroleuca* (Mexican Poppy) is declared under Section 22 of the *Biosecurity and Agriculture Management Act 2007* and *A. mexicana* is prohibited under Section 12 of the same Act.

7.7.4 Potential Groundwater-Dependent Ecosystems

Fortescue have developed a series of environmental management objectives to mitigate environmental impacts on Groundwater Dependent Ecosystems (GDE) found in the project area, as detailed in Fortescue's *Groundwater Management Plan* (100-PL-EN-1009).

Creeks and rivers comprised of *Eucalyptus camaldulensis* (River Red Gum) and *E. victrix* (Coolibah) as dominant species are mapped as vegetation type 1 (ENV, 2013) and represent potential GDE. This vegetation is restricted to river, creek and drainage lines and may be sensitive to changes in groundwater tables that exceed the natural fluctuations. The potential GDE represent one of the 45 vegetation associations at the bioregional level and one of 11 associations at the subregional level that have a high priority for preservation (Kendrick, 2001; McKenzie and J.E. *et al.*, 2002; ENV, 2013).

7.7.5 Threatened and Priority Ecological Communities

No vegetation types described in current and previous flora and vegetation assessments of the survey area resemble Threatened Ecological Communities (TECs).

The Fortescue Marsh Priority Ecological Community (PEC) is classified as a Priority 1 PEC and comprises an area from east of Mulga Downs to Marillana and Roy Hill stations. The Marsh land system, classified as the PEC, represents 18.66% of the survey area (ENV, 2013). No direct clearing of the vegetation associations with the Fortescue Marsh PEC has been anticipated and therefore there will be no direct impacts to the Fortescue Marsh Priority 1 PEC (CC-RP-EN-0071; Fortescue, 2014a).

7.7.6 Fortescue Fauna Assessment Protocols

Fortescue have developed fauna management plans to adhere to the requirements of condition 14 of the *Environment Protection and Biodiversity Conservation Act 1999* approval 2010/5706. The monitoring guidelines and management plans assist in the management and monitoring of the potential impacts on fauna species resulting from implementation of mining within the project area.

Fortescue's management plans and monitoring guidelines comply with all relevant environmental Commonwealth and State legislation relevant to the management of Fauna in Western Australia. Details of this compliance can be found in Table 2 of Fortescue's *Fauna Management Plan* (CC-PL-EN-0003).

The overall objective of Fortescue's fauna monitoring and management programs is to monitor and measure the success of management actions to protect conservation significant fauna species and ensure compliance with applicable State and Commonwealth approval conditions.

7.7.7 Existing Environment

Surveys and monitoring of terrestrial fauna have been conducted in the Christmas Creek area since 2004. Systematic sampling undertaken in the Christmas Creek area in 2011 (ENV, 2012) supports 120 vertebrate fauna species, four amphibian species, 45 reptile species, 11 mammal species and 60 bird species.

Four main fauna habitat types were identified within the project area (Ecologia, 2011; ENV, 2012):

- Drainage Line and Alluvial Plain
- Marsh
- Low Hill and
- Stony Plain.

The Marsh habitat has been identified to be of high value for fauna species as after periods of heavy rainfall, as the Fortescue Marsh becomes inundated providing a suitable nesting habitat for thousands of waterbirds. As a result, the Fortescue Marsh is recognised as an important ecological area in the Pilbara, being classed as an Environmentally Sensitive Area (ESA) and a Priority Ecological Community (PEC) (Ecologia, 2010). As mentioned in Section 7.7.5, no clearing of the Fortescue Marsh PEC has been anticipated and therefore no direct impacts to the Marsh habitat will occur. The majority of disturbance in the project area occurs in the Stony Plain Habitat (9,405 ha), followed by the Low Hill habitat type (5,763 ha) and the Drainage Line and Alluvial Plain habitat type (2,572 ha). These three habitat types occur extensively throughout the Pilbara region. Table 50 in the Preliminary Draft Christmas Creek Expansion Proposal PER (Fortescue 2014a) outlines the fauna habitats affected by clearing.

7.7.8 Conservation Significant Fauna

Fortescue's *Conservation Significant Fauna Management Plan* (100-PL-EN-0022) describes the key management actions, performance indicators, evidence, timing and responsibilities for conservation significant fauna management. Based on searches of databases and literature from within 50 km of the project area, results from previous surveys and findings of current surveys have indicated there is a potential for 23 species of conservation significant vertebrate fauna to occur. Of these species a total of eight species of conservation significance have been recorded within the project area (Fortescue, 2014a) including:

- *Liasis olivaceus barroni* (Pilbara Olive Python)

- *Ardeotis australis* (Australian Bustard)
- *Merops ornatus* (Rainbow Bee-eater)
- *Neochmia ruficauda subclaescens* (Western Star-Finch)
- *Burhinus grallarius* (Bush Stone-curlew)
- *Leggadina lakedownensis* (Short-tailed Mouse)
- *Falco hypoleucos* (Grey Falcon)
- *Haliaeetus leucogaster* (White-bellied Sea-Eagle).

None of these species are considered likely to be significantly affected by mining activities and no change to conservation status or regional distribution is expected to occur to any conservation significant vertebrate taxa as a result of mining (Fortescue, 2014a).

7.7.9 Short Range Endemic Invertebrate Species

Short Range Endemic (SRE) species are invertebrate species with highly restricted distribution ranges and are consequently endemic to relatively small or localised areas.

A total of 26 species from six taxonomic groups occur at Christmas Creek (Subterranean-Ecology, 2012):

- Spiders
- Pseudoscorpions
- Scorpions
- Myriapods
- Isopods
- Snails.

DNA sequencing revealed the occurrence of two potential SRE species, the millipede *Anthichiropus* sp. and the spider *Karaops* sp. The remaining taxa were not considered to be SRE species (Subterranean-Ecology, 2012; Fortescue, 2014a)

No SRE species of conservation significance have been recorded with the project area.

Desktop research of the DPaW Threatened Fauna list found no listed terrestrial invertebrate species from within the project area (Fortescue, 2014a).

7.7.10 Subterranean Fauna

Fortescue have developed a *Subterranean Fauna Survey Plan* (SFSP) (45-PL-EN-0010) to provide guidance for subterranean fauna surveys to determine the abundance, diversity and distribution of subterranean fauna within Fortescue Operations Area. Habitat connectivity is important for subterranean fauna in terms of their geographic range. Potential boundaries such as geological intrusions and impermeable formations can prevent the movement of subterranean fauna. The geology of the northern flank of the Fortescue Marsh within the 120 km between Nullagine-Newman Road and the BHP Billiton Railway Line is considered broadly similar and therefore mining at Christmas Creek is considered unlikely to affect the distribution of subterranean fauna.

Stygofauna

Stygofauna recorded in the project area contain both widespread species that consist mostly of stygophiles (inhabit both surface and subterranean aquatic environments) and more restricted species that may be considered stygobitic (strictly groundwater-adapted species). Hydrological information for the northern Fortescue Valley suggests that these stygofauna habitats should be well connected, however, survey results are variable and do not always reflect this connectivity (Fortescue, 2014a).

Bennelongia (2014) conducted the most recent baseline survey recording a total of 69 stygofauna species belonging to 13 higher taxonomic groups, representing a rich stygofauna community for the Pilbara region.

Thirty-nine of the 69 species collected within the project area are known from beyond the upper Fortescue Catchment. Thirty-one of these species are very widespread, either known from throughout the Pilbara or beyond. Eight species are known to have relatively extensive ranges in the central and eastern Pilbara/Fortescue catchment.

Twenty-six species of the 69 species collected are currently known only from within the upper Fortescue catchment. Four species have uncertain distribution because they could not be identified to species level.

An assessment of stygofauna occurrence in accordance to the *Subterranean Fauna Survey Plan* (45-PL-EN-0010) concluded that the risk to long-term survival of stygofauna species as a result of mine development was acceptable (Bennelongia, 2014)

Troglofauna

Troglofauna were collected from all three of the major troglofauna habitats within the survey area:

- Hardcap Zone
- Mineralised MMF

- Colluviums or alluvium

Based on the scale at which geological information is available, all troglofauna habitats within the project area are likely to be well connected with the surrounding habitats (Fortescue, 2014a).

Bennelongia (2014) conducted the most recent baseline survey collecting a total of 29 troglofauna species of 13 orders representing a moderately rich troglofauna community for the Pilbara region.

Three of the 29 species collected in Christmas Creek are known to occur throughout the Pilbara (Bennelongia, 2014), while the remaining 26 species are known only from the northern Fortescue Valley. Four of these species are known from Christmas Creek and Cloudbreak, two species are of uncertain range owing to low taxonomic resolution and 20 species are currently known only from the project area (Bennelongia, 2014).

The primary risk to troglofauna from the Christmas Creek operations is that groundwater injection will cause loss of up to 19% of troglofauna habitat within the injection areas, via groundwater mounding. The extensive geological continuity along the Fortescue valley and footslopes of the Chichester Range make it unlikely that any species will be restricted to the area of the groundwater injection and therefore there is no risk to the long-term survival of Troglofauna species as a result of mining operations (Bennelongia, 2014).

7.8 Visual Amenity

Christmas Creek is located within the Chichester Range and is set amongst rolling hills, escarpments and winding tree-lined watercourses. The operating mining developments are visible from the pastoral stations within the immediate vicinity of the project area and may be visible from roads and pastoral tracks. On completion of rehabilitation, the mining area is not expected to create an unacceptable visual impact on the landscape when viewed from areas proposed for future conservation.

7.9 Cultural Heritage

Christmas Creek is located entirely within the Nyiyaparli Native Title boundary (WCO5/6). Fortescue's adheres to its policy of minimising the impact to cultural heritage and secured Land Access Agreements (LAAs) in October 2005. In recognition of the Nyiyaparli people and their heritage and cultural concerns within the area, Fortescue remains committed to consulting with the Nyiyaparli people regarding proposed mining developments within this area and have developed an internal system; *Guideline for the Management of Aboriginal Cultural Heritage on Fortescue Project Areas* (45-PL-HE-0002). More information can be obtained from Fortescue's Preliminary Draft Christmas Creek Expansion Proposal PER (Fortescue 2014a).

7.9.1 Aboriginal heritage

Heritage surveys have been undertaken across the wider Chichester area (Cloudbreak and Christmas Creek) since 2003. Approximately 433 archaeological Aboriginal Heritage sites have been recorded throughout the Christmas Creek area, with an additional 671 salvaged sites and two ethnographic places (Fortescue, 2014a).

7.9.2 Non-Indigenous heritage

A search of the State Register of Heritage Places was most recently conducted in May 2014 (Fortescue, 2014a). No non-indigenous heritage sites were identified as occurring or expected to occur within the Christmas Creek area.

7.10 Rehabilitation Monitoring, Research and Trials

Rehabilitation at Fortescue's controlled sites is managed under Fortescue's *Rehabilitation and Revegetation Management Plan* (100-PL-EN-0023) and a *Rehabilitation and Revegetation Monitoring Procedure* (45-PR-EN-0027), which has been developed to satisfy the requirements of Ministerial Statement 707.

Fortescue has undertaken a desktop assessment of rehabilitation strategies in the Pilbara (Fortescue, 2014d). This assessment provides a summary of rehabilitation practices at Fortescue, along with providing strategies and case studies of rehabilitation covering:

- characterisation of soil profiles and waste material
- vegetation, topsoil and growth medium measurement
- reconstruction of soil profile
- selecting appropriate species and seed management
- vegetation establishment
- completion criteria
- rehabilitation and revegetation monitoring
- potential rehabilitation strategies for Christmas Creek closure domains.

A detailed description of these rehabilitation practices is provided in Fortescue's desktop assessment of rehabilitation strategies (2014d).

Fortescue's rehabilitation at Christmas Creek to date consists of borrow pits, laydown areas and access track rehabilitation.

Borrow pits are rehabilitated as per Fortescue's *Borrow Pit Management Plan* (45-PL-EN-0018). Following contouring, borrow pits are deep ripped and where applicable, topsoil spreading and seeding is also undertaken. Borrow pit monitoring commenced in 2014 as part of Fortescue's rehabilitation monitoring program in accordance with Fortescue's *Rehabilitation and Revegetation Monitoring Procedure* (45-PR-EN-0027), with parameters recorded for:

- vegetation
 - species richness
 - diversity
 - composition
 - perennial species percentage cover
 - density
- landscape function analysis
 - stability
 - nutrient cycling
 - infiltration.

Monitoring results show that the rehabilitation is performing well when compared to analogue sites. Species richness, diversity and composition are all similar to the analogue sites. The overall cover of native perennials is lower than the analogue sites; due mostly to a lack of spinifex in the ground cover, but the cover of middle-storey and the density of upper storey species is comparable to remnant vegetation. The landscape function analysis data shows both the infiltration and nutrient cycling indices of the rehabilitation site are comparable with the analogues, but that the stability index is below that of remnant vegetation.

A schedule of rehabilitation, research and trials is included in the Rehabilitation and Revegetation Guidelines (45-GU-EN-0008). Future rehabilitation earthworks are planned for 2015/2016, including Flinders Waste Rock Dump. A revegetation trial to investigate optimum seeding rates is planned for this area, with a seed mix selected as per Fortescue's *Seed Collection and Management Guidelines* (45-GU-EN-0007). Earthworks for the area to be used for the revegetation trial were completed in December 2014.

7.11 Contaminated Sites

One registered contaminated site occurs at the Christmas Creek Operations. A spill of diesel fuel occurred in 2014 which extended beneath some permanent infrastructure. This site is classified as 'possibly contaminated – investigation required'. Potentially contaminated soil which is located beneath existing infrastructure will be subject to remediation following the closure/decommissioning of that infrastructure and as such, the site is not anticipated to be contradictory to the proposed final land use at Christmas Creek.

8. IDENTIFICATION AND MANAGEMENT OF CLOSURE ISSUES

8.1 Identification of Closure Issues

The identification of closure issues was conducted with reference to the Leading Practice Sustainable Development in Mining handbooks published by DITR, as related to mine closure (DITR, 2006b) and mine rehabilitation (DITR, 2006a). Closure strategies were subjected to a risk assessment following the Fortescue *Risk Management Policy Standards* (100-ST-RK-0011 to 116 inclusive). Each closure domain was analysed in respect to the closure data as outlined in Section 7, with the management strategies for each issue being a direct outcome of the domain specific constraints (data-based) and leading practice in the industry (concept-based). The closure issues identified through this process are listed in Table 7.

The issues identified have been grouped into three overarching closure principles which together form the design goals of landform rehabilitation; stability, non-pollution and ecological sustainability. The closure issues and management procedures which fall within each design goal are presented for each of the three major closure domains identified in Section 2.4; Mine Pits, WRLs and TSFs.

8.2 Management of Closure Issues

Management of the identified mine closure issues are administered through Fortescue's Governance and Sustainability team with Executive oversight provided by Fortescue's Mine Closure Steering Committee. This structure provides a procedural, iterative approach to the decision making process involved in management of closure issues. The individual management plans and procedures which govern the closure issues identified in Table 7 and which together form the basis for the management of closure issues, which are shown in Table 8.

8.3 Gap Analysis

The review and analysis of the closure data and subsequent identification of closure issues through Fortescue's *Risk Management Policy Standards* (100-ST-RK-0011 to 0016 inclusive) produced a list of principle knowledge gaps which are shown in Table 9.

Appropriate investigations will be undertaken to fill these gaps consistent with Fortescue's *Planning for Closure Standard* (100-ST-EN-0001). The results of these investigations will be used to inform Fortescue's ongoing, iterative management approach to closure and rehabilitation planning.

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Table 7: Identification of Closure Issues

Overarching Closure Principles			Stability			Non-Polluting		Sustainability
Closure Issue			Geotechnical Stability	Erosion	Geochemistry	Hydrology	Hydrogeology	Rehabilitation
Domains	Mine Pits	Voids	Pit wall slumping – encroaching into Zone of Instability. Abandonment Bund within Zone of Instability.	Excessive erosion of pit wall crests leading to and exacerbating slumping. Abandonment Bund within Zone of Instability.	Possible development of neutral metalliferous drainage.	Mine pit voids may modify channel flow patterns and cause shadowing and changes to surface flow volumes. Creation of temporary or permanent pit lakes may result in decreased surface water quality through evaporative concentration leading to hypersalinity.	Creation of temporary or permanent pit lakes may result in decreased groundwater quality through evaporative concentration leading to hypersalinity. Creation of temporary or permanent pit lakes may result in permanent changes to groundwater levels down-gradient from the pit.	No rehabilitation of the mine voids will occur.
		Backfilled Pits	Unconsolidated backfill slumps resulting in unstable and undulating land surface	Variability in permeability of backfill leads to tunnel erosion and preferential bypass. Reconstructed land surface experiences increased erosion.	Possible development of neutral metalliferous drainage.	Backfilled pit voids may affect water quality through erosion of backfill material and sedimentation of surrounding environment. Backfilling of voids may modify channel flow patterns and cause erosion and changes to surface flow volumes.	Not applicable as no AMD present in backfill material.	Re-establishment of vegetation and ecosystem function not meeting closure goals. Spread of weed species inhibiting local species re-establishment.
	Waste Rock Landforms (WRL)		Slumping or mass failure of the WRL or batter slopes. Potential release or dispersion of material into the surrounding environment.	Excessive erosion of the WRL surface resulting in an unstable surface and poor rehabilitation performance. Potential release or dispersion of material into the surrounding environment.	Possible development of neutral metalliferous drainage.	The WRL may affect water quality through erosion of the batter slopes and sedimentation of the surrounding environment. The WRL may modify channel flow patterns and cause shadowing and changes to surface flow volumes.	Not applicable as no AMD present in waste rock.	Re-establishment of vegetation and ecosystem function not meeting closure goals. Spread of weed species inhibiting local species re-establishment.
	Tailings Storage Facility (TSF)		Embankment wall failure, either through pore pressures (phreatic surface in TSF) or overtopping and incision of freeboard.	Excessive erosion of embankment walls weakens the stability of the TSF and impact on rehabilitation performance.	Possible development of neutral metalliferous drainage.	The TSF may affect water quality through erosion of the embankment walls and sedimentation of the surrounding environment. The TSF may modify channel flow patterns and cause shadowing and changes to surface flow volumes.	Not applicable as no AMD present in tailings.	Re-establishment of vegetation and ecosystem function not meeting closure goals. Spread of weed species inhibiting local species re-establishment.

Table 8: Management of Closure Issues

Overarching Closure Principles			Stability			Non-Polluting		Sustainability
Closure Issue			Geotechnical Stability	Erosion	Geochemistry	Hydrology	Hydrogeology	Rehabilitation
Domains	Mine Pits	Voids	Abandonment Bunds located away from pit crest as determined by geotechnical modelling.	Refer to Safety Bund Walls Around Abandoned Open Pit Mines Guideline (DoIR, 1997)	Sampling of wall rock material and monitoring of surface and groundwater. Refer to Fortescue's <i>Acid and/or Metalliferous Drainage Plan</i> (100-PL-EN-1016).	Refer to Table 6 in the <i>Surface Water Management Plan</i> (45-PL-EN-0024) and <i>Surface Water Investigation and Impact Assessment</i> (WorleyParsons, 2014a).	Ongoing groundwater monitoring according to the Groundwater Operating Strategy (CC-PH-HY-0003) is designed to detect potential groundwater quality issues throughout LOM.	No rehabilitation of the mine voids will occur.
		Backfilled Pits	Backfilled pit is constructed to stable design as determined by geotechnical modelling. Refer to Fortescue's <i>Guideline for Re-Establishing Major Watercourses Across Backfilled Pits: Chichester Operations</i> (GU-CH-EN-0002)..	Backfilled pit surface is stable and self-sustaining under drainage patterns. Refer to <i>Guideline for Re-Establishing Major Watercourses Across Backfilled Pits: Chichester Operations</i> (GU-CH-EN-0002).	Sampling of waste rock material and monitoring of surface and groundwater. Refer to Fortescue's <i>Acid and/or Metalliferous Drainage Plan</i> (100-PL-EN-1016).	Refer to Fortescue's <i>Guideline for Re-Establishing Major Watercourses Across Backfilled Pits: Chichester Operations</i> (GU-CH-EN-0002).	Ongoing groundwater monitoring according to the <i>Groundwater Operating Strategy</i> (CC-PH-HY-0003) is designed to detect potential groundwater quality issues throughout LOM.	Refer to Fortescue's <i>Rehabilitation and Revegetation Management Plan</i> (100-PL-EN-0023), <i>Guideline for Re-Establishing Major Watercourses Across Backfilled Pits: Chichester Operations</i> (GU-CH-EN-0002).and <i>Weed Management Plan</i> (45-PL-EN-0013).
	Waste Rock Landforms (WRL)		Slumping or mass failure of the WRL or batter slopes. Potential release or dispersion of material into the surrounding environment.	WRL slopes battered to required angle to achieve stable slope as determined by geotechnical modelling. Refer to Fortescue's <i>Guideline for the Design of Mineral Waste Rock Landforms (WRL)</i> (100-PR-EN-1017).	Refer to Fortescue's <i>Guideline for the Integrated Planning and Design of Waste Rock Landforms</i> (CH-GU-EN-0002), <i>Overburden Management Re-Growth and Waste Procedure</i> (45-PR-EN-0012) and <i>Vegetation Clearing and Topsoil Management Procedure</i> (45-PR-EN-0013).	Sampling of waste rock material and monitoring of surface and groundwater. Refer to Fortescue's <i>Acid and/or Metalliferous Drainage Plan</i> (100-PL-EN-1016).	Refer to Table 6 in the <i>Surface Water Management Plan</i> (45-PL-EN-0024) and <i>Surface Water Investigation and Impact Assessment</i> (WorleyParsons, 2014a).	Ongoing groundwater monitoring according to the <i>Groundwater Operating Strategy</i> (CC-PH-HY-0003) is designed to detect potential groundwater quality issues throughout LOM.
	Tailings Storage Facility (TSF)		Embankment wall failure, either through pore pressures (phreatic surface in TSF) or overtopping and incision of freeboard.	Tailings facilities decommissioned and rehabilitated in accordance with Fortescue's <i>Tailings Storage Facility Closure Management Guideline</i> (CH-GU-OP-0001).	Tailings facilities constructed using Fortescue's <i>Tailings Storage Facility Closure Management Guideline</i> (CH-GU-OP-0001).	Sampling of tailings material and monitoring of surface and groundwater. Refer to Fortescue's <i>Acid and/or Metalliferous Drainage Plan</i> (100-PL-EN-1016).	Refer to Table 6 in the <i>Surface Water Management Plan</i> (45-PL-EN-0024) and <i>Surface Water Investigation and Impact Assessment</i> (WorleyParsons, 2014a).	Ongoing groundwater monitoring according to the <i>Groundwater Operating Strategy</i> (CC-PH-HY-0003) is designed to detect potential groundwater quality issues throughout LOM.

Table 9: Gap Analysis

Overarching Closure Principles			Stability			Non-Polluting		Sustainability
Closure Issue			Geotechnical Stability	Erosion	Geochemistry	Hydrology	Hydrogeology	Rehabilitation
Domains	Mine Pits	Voids				No management system in place for pit lake water quality management, although some basic pit lake modelling has been conducted (SRK, 2014) No management system in place for partial backfilling of mine pit voids.	No management system in place for pit lake water quality management, although some basic pit lake modelling has been conducted (SRK, 2014) No management system in place for partial backfilling of mine pit voids.	
		Backfilled Pits						
	Waste Rock Landforms (WRL)							
	Tailings Storage Facility (TSF)							

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9. CLOSURE IMPLEMENTATION

Fortescue applies a whole of mine life approach to closure implementation, commencing from preliminary stakeholder consultation and culminating in relinquishment of the rehabilitated site back to the State. All aspects of rehabilitation and closure planning, scheduling, implementation and monitoring are considered under Fortescue's closure governance ensure that

- stakeholder interests are considered during all stages of closure planning
- rehabilitation objectives and completion criteria that are developed are appropriate to agreed post-operational land use
- progressively rehabilitated and revegetated disturbed areas are not required for ongoing operations in accordance with regulatory criteria, ministerial conditions and commitments
- surfaces of constructed safe, stable, non-polluting landforms are not prone to sediment transport beyond natural geomorphic processes and are capable of sustaining agreed post-operational land use
- surface and groundwater flow patterns and quality do not significantly impact downstream environmental values or uses
- revegetated disturbed areas meet agreed post-operational land use objectives and completion criteria
- indicators are developed that demonstrate when rehabilitation activities meet the established objectives and completion criteria

For each of the above objectives, specific Management Plans (MP) or Management Actions (MA) have been developed to ensure rehabilitation and closure activities are managed, and that appropriate monitoring, reporting and corrective action functions are developed to support the successful implementation, and continual improvement of closure. A full description of the Environmental Management Process that has been developed to achieve the objectives is provided in the *Rehabilitation and Revegetation Management Plan* (100-PL-EN-0023).

For the closure domains covered by this MCP (Mine Pits, WRLs and TSFs), EMPs have been developed that cover all aspects of:

- baseline data collection (i.e. identifying resources available for closure and potential closure risks)
- material handling and utilisation (i.e. ensuring that rehabilitation resources are appropriately captured and handled during the mining process)
- construction of the post-mine landforms (i.e. providing specific guidance on 'how' to construct the landforms)

- rehabilitation and revegetation of the post-landforms (i.e. providing specific guidance on 'how' to rehabilitate the landforms)
- monitoring of rehabilitation performance (i.e. assessing rehabilitation performance against stakeholder agreed completion criteria)
- adaptive management (i.e. to ensure lessons learned from rehabilitation performance monitoring are integrated into future closure plans)

A description of the relevant EMPs governing the above aspects for each closure domain considered in this MCP is provided in the following sections.

9.1 Mine Pits

Fortescue applies a whole of mine life approach to closure of mine pits, commencing from preliminary stakeholder consultation, background data collection, material movement, rehabilitation and culminating in relinquishment of the rehabilitated site back to the state. Three options are currently being considered for closure of former mine pit voids:

- Option 1: complete backfill of mine pit void, and reinstatement of pre-mine surface flow regime
- Option 2: partial backfill of mine pit void to above the pre-mine water table
- Option 3: no backfill, resulting in pit lake development.

Fortescue's *Guideline for Re-Establishing Major Watercourses Across Backfilled Pits* (CH-GU-EN-0002) specifies that Option 1 is considered to be the most appropriate option for closure of mine pits that will intersect significant surface water flow channels, while Options 2 and 3 will also be considered for mine pit voids located in other positions in the landscape.

Regardless of the option chosen, implementation of mine pit closure will be governed by Fortescue's overarching EMS. Table 10 summarises each stage of the closure process, and identifies the relevant Management Plan(s) that will govern closure implementation of the mine voids, and ensure that all closure risks, issues and their management are addressed.

Table 10: Closure Implementation for Mine Pits

Rehabilitation/ Closure Aspect	Management Plan(s)
Baseline data collection	<i>Groundwater Management Plan (100-PL-EN-1009)</i> <i>Surface Water Management Plan (45-PL-EN-0024)</i> <i>Significant Flora and Vegetation Monitoring Guidelines (45-GU-EN-0001)</i> <i>Overburden Management Re-Growth and Waste (45-PR-EN-0012)</i> <i>Acid and/or Metalliferous Drainage Plan (CB-PL-EN-0028)</i>
Material handling and utilisation	<i>Vegetation Clearing and Topsoil Management (45-PR-EN-0013)</i> <i>Guideline for Re-Establishing Major Watercourses Across Backfilled Pits (CH-GU-EN-0002)</i> <i>Overburden Management Re-Growth and Waste (45-PR-EN-0012)</i>
Design and construction of landforms	<i>Guideline for Re-Establishing Major Watercourses Across Backfilled Pits (CH-GU-EN-0002)</i> <i>Design Specification for Mine Pit Backfill and Associated Surface Water Management Structures (100-SW-EN-0046)</i> <i>Standard Engineering Specifications for Drainage and Flood Protection (100-SP-CL-0004)</i> <i>Ground Control Management Plan (CC-PL-OP-0005)</i>
Rehabilitation of landforms	<i>Guideline for Re-Establishing Major Watercourses Across Backfilled Pits (CH-GU-EN-0002)</i> <i>Rehabilitation and Revegetation Management Plan (100-PL-EN-0023)</i>
Monitoring of rehabilitation performance	<i>Rehabilitation and Revegetation Management Plan (100-PL-EN-0023)</i> <i>Rehabilitation and Revegetation Monitoring Procedure (45-PR-EN-0027)</i> <i>Acid and/or Metalliferous Drainage Plan (100-PL-EN-1016)</i> <i>Groundwater Management Plan (100-PL-EN-1009)</i> <i>Surface Water Management Plan (45-PL-EN-0024)</i> <i>Fortescue Marsh Hydrology, Vegetation Monitoring and Management Plan (100-PL-EN-1013)</i>

9.2 Waste Rock Landforms

The key rehabilitation and closure aspects which require consideration during the closure implementation procedure developed by Fortescue for WRLs are shown in Table 11, along with the relevant management plans which govern each aspect.

Table 11: Closure Implementation for Waste Rock Landforms

Rehabilitation/Closure Aspect	Management Plan(s)
Baseline data collection	<i>Vegetation Clearing and Topsoil Management (45-PR-EN-0013)</i> <i>Planning for Closure – Characterisation of Mineral Waste Rock and Soils (100-GU-EN-0018)</i> <i>Acid and/or Metalliferous Drainage Plan (100-PL-EN-0016)</i>
Material handling and utilisation	<i>Overburden Management Re-Growth and Waste (45-PR-EN-0012)</i> <i>Rehabilitation and Revegetation Management Plan (100-PL-EN-0023)</i> <i>Vegetation Clearing and Topsoil Management (45-PR-EN-0013)</i>
Design and construction of landforms	<i>Guideline for the Design of Mineral Waste Rock Landforms (WRL) (100-PR-EN-1017)</i> <i>Surface Water Management Plan (45-PL-EN-0024)</i> <i>Standard Engineering specifications for Drainage and Flood Protection (100-SP-CL-0004)</i> <i>Ground Control Management Plan (CC-PL-OP-0005)</i> <i>Cultural Heritage Management Plan (CB-PL-HE-0001)</i>
Rehabilitation of landforms	<i>Guideline for the Design of Mineral Waste Rock Landforms (WRL) (100-PR-EN-1017)</i> <i>Rehabilitation and Revegetation Management Plan (100-PL-EN-0023)</i> <i>Weed Management Plan (45-PL-EN-0013)</i>
Monitoring of rehabilitation performance	<i>Rehabilitation and Revegetation Monitoring Procedure (45-PR-EN-0027)</i> <i>Acid and/or Metalliferous Drainage Plan (100-PL-EN-0016)</i> <i>Groundwater Management Plan (100-PL-EN-1009)</i> <i>Surface Water Management Plan (45-PL-EN-0024)</i> <i>Fortescue Marsh Hydrology and Vegetation Monitoring and Management Plan (100-PL-EN-1013)</i>

9.3 Tailings Storage Facilities

Specific guidance and direction on closure implementation of the various TSFs proposed for the Christmas Creek Operations are provided in Table 12. These documents cover all required work to closure of both above-ground and in-pit TSFs.

Table 12: Closure Implementation for Tailings Storage Facilities

Rehabilitation/Closure Aspect	Management Plan(s)
Baseline data collection	<i>Vegetation Clearing and Topsoil Management (45-PR-EN-0013)</i> <i>Planning for Closure – Characterisation of Mineral Waste Rock and Soils (100-GU-EN-0018)</i> <i>Groundwater Management Plan (100-PL-EN-1009)</i> <i>Surface Water Management Plan (45-PL-EN-0024)</i> <i>Significant Flora and Vegetation Monitoring Guidelines (45-GU-EN-0001)</i> <i>Acid and/or Metalliferous Drainage Plan (100-PL-EN-0016)</i> <i>Tailings Storage Facility Closure Management Guideline (CH-GU-OP-0001)</i>
Material handling and utilisation	<i>Rehabilitation and Revegetation Management Plan (100-PL-EN-0023)</i> <i>Vegetation clearing and topsoil management (45-PR-EN-0013)</i> <i>Acid and/or Metalliferous Drainage Plan (100-PL-EN-0016)</i>
Design and construction of landforms	<i>Rehabilitation and Revegetation Management Plan (100-PL-EN-0023)</i> <i>Tailings Storage Facility Closure Management Guideline (CH-GU-OP-0001)</i>
Rehabilitation of landforms	<i>Rehabilitation and Revegetation Management Plan (100-PL-EN-0023)</i> <i>Tailings Storage Facility Closure Management Guideline (CH-GU-OP-0001)</i>
Monitoring of rehabilitation performance	<i>Rehabilitation and Revegetation Monitoring Procedure (45-PR-EN-0027)</i> <i>Acid and/or Metalliferous Drainage Plan (100-PL-EN-0023)</i> <i>Groundwater Management Plan (100-PL-EN-1009)</i> <i>Surface Water Management Plan (45-PL-EN-0024)</i> <i>Fortescue Marsh Hydrology and Vegetation Monitoring and Management Plan (100-PL-EN-1013)</i>

9.4 Progressive Rehabilitation and Revegetation

Fortescue understands the importance and need for progressive rehabilitation and revegetation given the long LOM (i.e. up to 40 years) and large spatial footprint (i.e. proposed clearing footprint up to 17,956 ha and final development envelope of 33,000 ha) of the operation. It would not be economically or environmentally feasible to rehabilitate this area of land in its entirety at the end of mining, and consequently progressive rehabilitation is considered throughout LOM planning to ensure that it is practically and progressively implemented across the Christmas Creek Operations.

Implementation of progressive rehabilitation is seen by Fortescue as a beneficial and favourable process as it enables continuous and iterative learning and refinement of rehabilitation processes, through an 'action – response' approach. The extended LOM of the operation allows for the long-term performance of implemented rehabilitation activities and processes to be monitored to accurately assess both their ecosystem function (e.g. response to fire, dispersal mechanisms of vegetation and/or colonisation of fauna) and environmental impacts. The anticipated length of operation at Christmas Creek provides unique opportunities to assess long-term development of rehabilitation and its overall stability and sustainability, particularly in respect to adverse climatic (e.g. drought, cyclones) and natural (e.g. fire, weeds, pests) events.

The EMPs that govern the implementation of rehabilitation and closure to achieve the stakeholder agreed objectives have been developed following review of rehabilitation monitoring data obtained at other Fortescue and Pilbara mining operations, and industry-wide guidelines. Rehabilitation and closure tasks or activities to be implemented at Christmas Creek are therefore considered best-practice and their evolution and monitoring over time will assist in improving industry standards across the board.

9.4.1 Adaptive Management

Adaptive management or the iterative development of rehabilitation and closure is governed by Fortescue's *Rehabilitation and Revegetation Management Plan* (100-PL-EN-0023). This Plan outlines Contingency Actions to be implemented when monitoring shows that the management objectives and closure criteria are not being achieved. Initial qualitative Management Triggers are to be revised after the first and subsequent monitoring programs and refined with quantitative values to ensure objectivity in assessing monitoring data.

Expert opinion will be sought if and when required, to guide contingency measures which will include further monitoring work to better understand influences causing those changes in the environment. By understanding why certain management strategies or monitoring does not work, specialist advice can be used to modify and improve these programs, so that Fortescue is continually moving forward with respect to environmental stewardship.

9.5 Implementation Schedule

Closure implementation for the various mine pits, WRLs and TSFs to be created at the Christmas Creek Operations will occur throughout the LOM. Given the appreciable length of the operation (i.e. up to 40 years), it is not considered practicable or realistic, to define a specific implementation schedule for individual pits and landforms at this time. As discussed in Section 9.4, progressive rehabilitation is favoured by Fortescue, and wherever practicable, timely rehabilitation of post-mine landforms will occur following the cessation of mining, so as to minimise the area that is open and not rehabilitated; this is considered an important economic-driver as such areas represent a liability to the operation.

9.6 Unplanned or Unexpected Closure

Fortescue understands that given the long LOM of the project, future changes in, economic environment may result in unplanned or unexpected permanent closure or suspension of operations under care and maintenance. As these events may represent an appreciable environmental risk, the DOE, DMP and EPA require that consideration is given in the MCP to addressing and mitigating any potential impacts to the environment, and which may result in an unacceptable liability to the State.

Progressive rehabilitation is the best mechanism to protect against unplanned or unexpected closure or suspension of operations. Through progressive rehabilitation, the area of land left open and not rehabilitated to an acceptable agreed standard is kept to a practicable minimum, reducing the potential liability of the site. As described in Section 9.4, Fortescue is committed to progressive rehabilitation throughout the life of the operation.

In addition to progressive rehabilitation during operations, planning for unexpected closure or suspension of operations at Christmas Creek will involve the following:

- making safe closure domains so that they do not represent a risk to humans and animals
- preventing potential physical (e.g. erosion, subsidence) and chemical (e.g. acid and/or metalliferous drainage) pollution pathways from either establishing or exacerbating over time
- secure and signpost the site to prevent inadvertent entry.

Implementation of the Fortescue EMS through the various EMPs, Procedures and Standard Work Instructions (SWIs), and the overarching adaptive management framework (Section 9.4.1), ensures that all environmental, and more specifically rehabilitation and closure strategies, are continually revised and updated as new information comes to light. A critical aspect of this process is the integration of mine closure into the LOM planning at all stages of the operations. This ensures that resources required to undertake and complete rehabilitation works, in both the short and long-term, are factored into budget planning during the operational phase; thus there is an up-to-date register of required rehabilitation and closure provisions. The strength of this process is enhanced through the application of annual cost provisioning for closure, congruent with the closure cost estimating methodology outlined in Section 11. This allows for the current closure cost liability to be readily established, and the present closure obligation costs to be defined in the case of unplanned or unexpected closure or suspension of operations.

10. CLOSURE MONITORING AND MAINTENANCE

10.1 Monitoring Programme Overview

Fortescue has implemented monitoring programmes at all its mining operations, to evaluate the performance of rehabilitated mine landforms and to assess whether they have either met the site completion criteria or are showing satisfactory progress towards meeting these criteria. These programmes will be expanded as new areas of the mine are rehabilitated and will be refined based on monitoring results and rehabilitation success.

Ecological monitoring post closure to measure the performance of rehabilitation and revegetation works against site specific completion criteria will be in accordance with Fortescue's *Rehabilitation and Revegetation Monitoring Procedure* (45-PR-EN-0027). An important component of leading practice rehabilitation is the use of monitoring and trials to track the progress of rehabilitation and ensure continuous improvement through adaptive management, such that:

- monitoring procedures will be used to assess whether initial establishment has been successful, rehabilitation is developing satisfactorily and is ready for signoff; and
- trial activities will be undertaken where knowledge gaps or deficiencies in rehabilitation progress occur.

Fortescue's adaptive management approach to rehabilitation involves regularly assessing performance by taking into consideration results of rehabilitation and trials from Fortescue's operations in the region and refining its management practices to facilitate continuous improvement. Rehabilitation areas and trials will be monitored on a regular basis to assess the success or otherwise of a particular rehabilitation technique, with the results used to further refine the operations rehabilitation programme.

Monitoring events will be undertaken in line with the process outlined within this section, with the outcomes informing rehabilitation strategies, facilitating refinement in completion criteria and directing maintenance and remedial action plans.

10.1.1 Rehabilitation Monitoring Methodology

Progressive rehabilitation and ongoing performance assessment will be carried out in areas where mining and related operations have been completed and further disturbance is unlikely. Monitoring procedures will be used to assess whether initial establishment has been successful, rehabilitation is developing satisfactorily and is ready for signoff.

In accordance with Fortescue's *Rehabilitation and Revegetation Monitoring Procedure* (45-PR-EN-0027) monitoring of all rehabilitated areas is to be conducted on an annual basis for the first three years to determine initial establishment, then on a biennial basis to determine trajectory towards reference sites and established completion criteria. Areas should be monitored as soon

as possible, in the appropriate season, following completion of earthworks, spreading of topsoil and any seeding/planting. Ideally, monitoring should be conducted between April-June each year to capture vegetation growth and establishment following the summer rainfall in the first months of the year.

In accordance with Fortescue's *Conservation Significant Fauna Management Plan* (100-PL-EN-0022) where baseline survey results are available, monitoring sites will be established at locations where species have been previously recorded in suitable habitat and denning/shelter zones outside of direct impacts areas within impact areas and rehabilitated areas.

Fauna monitoring will be completed as per the *Christmas Creek Mine Site Fauna Management Plan* (CC-PL-EN-0003) and the *Significant Fauna Management Plan* (100-PL-EN-0022) during both operations and post-closure.

Vegetation parameters including species richness, diversity, composition, perennial percentage cover, density and vegetation condition are monitored along linear transects and quadrats as per the *Rehabilitation and Revegetation Monitoring Procedure* (45-PR-EN-0027).

The frequency of monitoring may to be increased or decreased depending on the outcomes of specific areas. A more detailed description of Fortescue's rehabilitation monitoring methodology is contained in the *Rehabilitation and Revegetation Monitoring Procedure* (45-PR-EN-0027).

10.1.2 Weed Monitoring

Fortescue's *Weed Management Plan* (45-PL-EN-0013) describes the weed monitoring to be conducted, and measures used to prevent the introduction and spread of weeds and the ongoing effectiveness of weed control measures. A detailed overview of Fortescue's key management actions for management of weeds at Christmas Creek is given in Table 4 of the *Weed Management Plan* (45-PL-EN-0013).

10.1.3 Surface Water Monitoring

Surface water monitoring at Christmas Creek consists of opportunistic surface water monitoring, as per Fortescue's *Surface Water Management Plan* (45-PL-EN-0024). In addition, monthly monitoring is conducted at permanent pools within the Fortescue Marsh as per the *Fortescue Marshes Management Plan* (100-PL-EN-0009).

10.1.4 Groundwater Monitoring

Groundwater monitoring activities are governed by the *Christmas Creek Groundwater Operating Strategy* (CC-PH-HY-0002). Monitoring activities consisted of undertaking monthly field measurements from both active production bores and groundwater monitoring wells.

Recent monitoring data are summarised in the *Christmas Creek Triennial Aquifer Review: August 2010 - July 2013* (Fortescue, 2013b).

10.1.5 Vegetation Monitoring

Fortescue conducts its monitoring of significant flora and vegetation (excluding mangroves) under the *Significant Flora and Vegetation Management Plan* (45-PL-EN-0017), which covers all of Fortescue's Operations, which was developed to support the requirements of Condition 6 (Mulga and Other Flora and Communities) of Ministerial Statement 707. The objective of the plan is to minimise the direct and indirect impacts of Fortescue's operations on significant flora and vegetation in the Pilbara region.

Where significant flora and vegetation are known or likely to occur, monitoring programs are implemented, and currently exist, as outlined in the *Significant Flora and Vegetation Monitoring Guidelines* (45-GU-EN-0001). Significant flora and vegetation is defined as Mulga, Declared Rare Flora, Threatened Species, Priority Flora, Threatened Ecological Communities, Riparian Vegetation and Samphire Communities.

In addition, the *Vegetation Health Monitoring and Management Plan* (CC-PL-EN-0004) addresses the requirements of Ministerial Statement 871 and EPBC approval 2010/5706 for the Christmas Creek Water Management Scheme. The plan addresses the scientific rationale, vegetation health and community monitoring and monitoring schedules for the following groundwater dewatering and injection management areas:

- Dewatering impact area as defined in EPA (2011)
- Mounding impact areas 1 and 2 (EPA 2011)

Monitoring is conducted to ensure existing management strategies are effective at preventing significant impacts to keystone species and to determine whether additional management strategies, or alterations to existing strategies, are required where pre-determined trigger levels are exceeded.

10.1.6 Reporting

The progress and performance of rehabilitation monitoring sites and any new rehabilitation activities conducted at Christmas Creek will continue to be reported in accordance with condition 5 of Ministerial Statement 707. Rehabilitation reporting shall demonstrate that outcome has been evaluated through the application of relevant actions. Rehabilitation details reported in the Compliance Reports will include a summary of the rehabilitation monitoring results for the reporting period, maintenance / remedial actions completed or planned and the area and nature of any new rehabilitation that has been undertaken on-site. Any rehabilitation activities planned for the future reporting period will continue to be reported as environmental initiatives as per the Ministerial Statement.

The results of monitoring will be used internally on an annual basis to assess rehabilitation performance and identify whether alternative management strategies are required or if completion criteria require review. This is a critical component of the adaptive management system (Section 9.4.1) employed by Fortescue and the iterative feedback loop in setting closure criteria (Plate 2).

11. FINANCIAL PROVISIONING FOR CLOSURE

Fortescue acknowledge that mining operations create environmental change and cause environmental disturbance, and that rehabilitation and revegetation of these operations is required to close and relinquish the site. The costs associated with these rehabilitation and closure works are significant, and Fortescue undertakes annual provisioning of closure to ensure adequate funds are available to progressively rehabilitate the site, conduct post closure monitoring and fund remediation activities.

Financial provisioning for closure within Fortescue is governed by the *Planning for Closure – Mine Closure Provision Estimate Calculations* (100-PR-EN-1037) document that outlines the methodology to be applied to obtain order of magnitude closure cost estimates. Closure cost estimates are developed and reviewed using the best available financial and mine information. Estimates that support the Mine Closure Strategy are conceptual (+/- 30%), while the Mine Closure Plan estimates have an accuracy of +/-20%.

It is expected that cost estimates will increase in accuracy with each year, to a point 5 years from the end of mine life. These closure cost estimates have an accuracy of +/-10% as these figures will be utilised in the development of progressive rehabilitation capital budgets that are supported by the 5 year mine plans.

The financial provisioning methodology outlined in *Planning for Closure – Mine Closure Provision Estimate Calculations* (100-PR-EN-1037) has been externally peer reviewed to confirm that the approach adopted and assumptions made are sound and that the mine closure provision estimates reflect those used in similar operations elsewhere in Australia.

Closure cost estimates are determined using internal systems which calculate the rehabilitation and closure costs on a per hectare basis for each closure domain. Input data includes (data updated quarterly):

- ground disturbance, including areas of each domain requiring rehabilitation
- material volumes
- machinery
- financial information, including salaries, fuel costs, fuel burn rate (br), and maintenance costs.

The closure cost estimate captures the following required information (EPA/DMP, 2014):

- earthmoving and landscape forming
- management of problematic materials where relevant
- post-closure management of surface water drainage
- closure research and trials

- decommissioning and removal of infrastructure
- remediation of contamination
- progressive and final rehabilitation
- maintenance, and monitoring and auditing programs including post-closure phase
- ongoing stakeholder engagement process
- closure project management costs
- project management
- specialist and consultant fees
- legal requirements
- provision for premature closure (permanent closure or suspended operations under care and maintenance)
- provision for installing additional infrastructure if required for the agreed land uses
- provision for potential delays, extreme events or other external factors relevant to closure.

12. MANAGEMENT OF INFORMATION AND DATA

Management and storage of all rehabilitation and closure information and data will be undertaken in accordance with the Fortescue EMS (and corresponding company-wide Business Management System (BMS). In the BMS all document control is governed by the *Document Control Procedure* (100-PR-DC-0002).

Throughout the LOM of the Christmas Creek Operations, this MCP document will be progressively updated to capture and summarise current closure planning information associated with:

- closure planning prior to cessation of operations;
- implementation of the closure program of works; and
- post-closure monitoring and reporting period

Compliance reporting of the MCP will be undertaken in accordance with the requirements of Ministerial Statement 707 (along with the requirements of any future Ministerial Statements), with the MCP document regularly updated to fill identified gaps, revise completion criteria, append with new performance monitoring results and document recent stakeholder consultation.

13. REFERENCES

13.1 Fortescue Standards and Management Plans

- Rehabilitation and Revegetation Monitoring Procedure. 45-PR-EN-0027, (April 2014)
- Fortescue Marsh Hydrology and Vegetation Monitoring and Management Plan. 100-PL-EN-1013, (July 2014)
- Ground Disturbance Permits Procedure. 100-PR-EN-0004
- Ground Control Management Plan. CC-PL-OP-0005, (August 2014)
- Groundwater Management Plan. 100-PL-EN-1009, (July 2014)
- Conservation Significant Fauna Management Plan. 100-PL-EN-0022, (October 2014)
- Conservation Significant Fauna Monitoring Guidelines. 100-GU-EN-0034, (October 2014)
- Acid and/or Metalliferous Drainage Plan. 100-PL-EN-1016 (December 2014)
- Guideline for the Design of Mineral Waste Rock Landforms (WRL) (100-PR-EN-1017) (August 2012)
- Guideline for Re-Establishing Major Watercourses Across Backfilled Pits. CH-GU-EN-0002, (June 2014)
- Rehabilitation and Revegetation Management Plan. 100-PL-EN-0023, (September 2013)
- Christmas Creek Groundwater Operating Strategy. CC-PH-HY-0003, (June 2013)
- Guideline for the Management of Aboriginal Cultural Heritage on Fortescue Project Areas. 45-PL-HE-0002, (2012)
- Surface Water Management Plan. 45-PL-EN-0024, (November 2012)
- Significant Flora and Vegetation Monitoring Guidelines. 45-GU-EN-0001, (August 2012)
- Planning for Closure Standard. 100-ST-EN-0001, (July 2012)
- Vegetation Health Monitoring and Management Plan. CC-PL-EN-0004, (February 2012)
- Planning for Closure - Characterisation of Mineral Waste Rock and Soils. 100-GU-EN-0018, (November 2013)
- Vegetation Clearing and Topsoil Management. 45-PR-EN-0013, (November 2011)
- Weed Management Plan. 45-PL-EN-0013, (August 2011)

Subterranean Fauna Survey Plan. 45-PL-EN-0010, (September 2011)

Fauna Management Plan. CC-PL-EN-0003, (December 2011)

Overburden Management Re-Growth and Waste. 45-PR-EN-0012, (October 2009)

Pilbara Iron Ore and Infrastructure Project Stakeholder Consultation Strategy. 100-PH-EN-0003, (July 2006)

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ANZMEC and MCA (2000) *Strategic Framework for Mine Closure*. Australian and New Zealand Minerals and Energy Council and Minerals Council of Australia. Canberra, ACT.

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BOM (2014) *Australian Government Bureau of Meteorology Website: Climate Data Online*. Available (accessed from <http://bom.gov.au/climate/data> December 2014).

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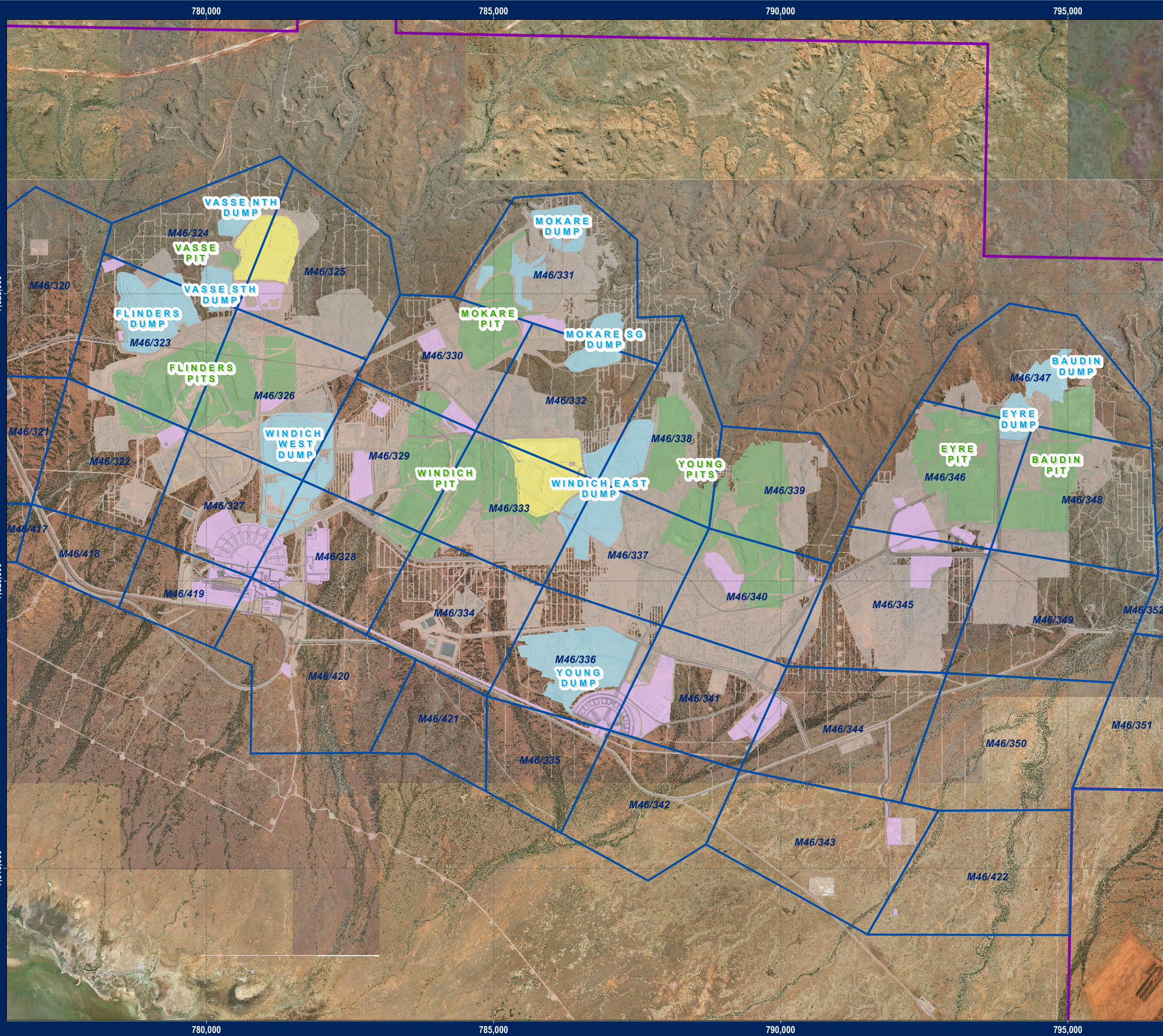
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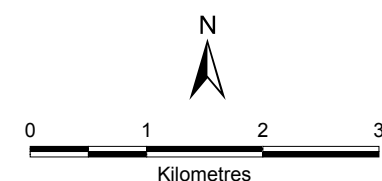
Figure 1: Christmas Creek Operations Site Plan

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- LEGEND**
- Mine Pits
 - Tailings Storage
 - Waste Dumps
 - Mine Infrastructure
 - Other Disturbance
 - FMG Tenements
 - GOV State Agreements - FMG
 - FMG Chichester Infrastructure

Data Source(s):
FMG Tenure, Derived from DMP WA Tenements, Dec 2014
GOV State Agreements, DMP, 2013



Christmas Creek Operations

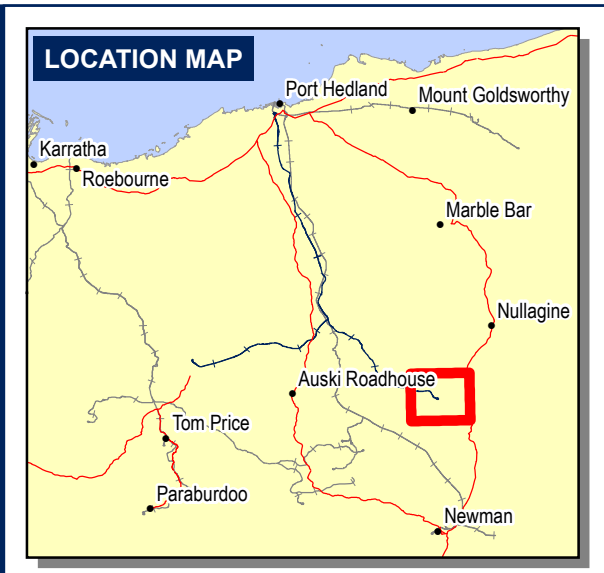
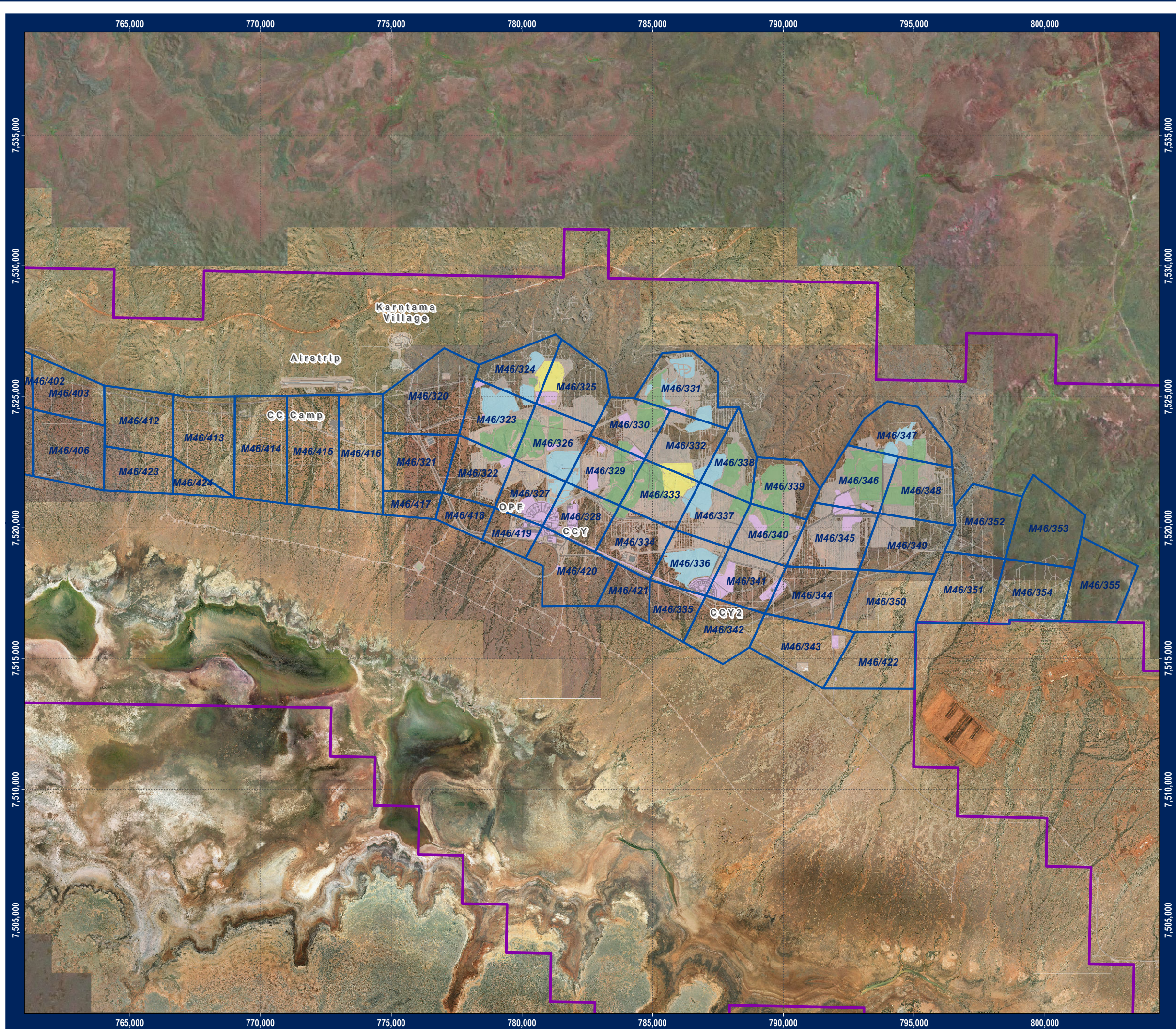
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Drawn By: S. Roestenburg	Size: A3L
Revised By: pmastalir	Revision: 1
Approved By: P. Mastalir	Confidentiality: 1
Scale: 1:65,000	
Coordinate System: GDA 1994 MGA Zone 50	
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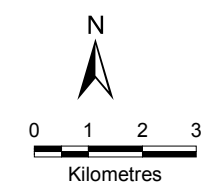
Figure 2: Christmas Creek Operations Tenements

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- LEGEND**
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 - Tailings Storage
 - Waste Dumps
 - Mine Infrastructure
 - Other Disturbance
 - FMG Tenements
 - GOV State Agreements - FMG
 - FMG Chichester Infrastructure

Data Source(s):
FMG Tenure, Derived from DMP WA Tenements, Dec 2014
GOV State Agreements, DMP, 2013



Christmas Creek Tenements

Requested By: A. Bartleet	Date: 2/01/2015
Drawn By: S. Roestenburg	Size: A3L
Revised By: pmastalir	Revision: 1
Approved By: P. Mastalir	Confidentiality: 1
Scale: 1:140,000	
Coordinate System: GDA 1994 MGA Zone 50	
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