GREEN COAST RESOURCES | Hey Point Bauxite Project | October 2014

Mine Rehabilitation Plan

METSERVE
Mining & Energy Technical Services Pty Ltd

Document History and Status

Issue	Revision	Issued to	Qty	Date	Reviewed by
1	1 (Draft)	Internal	1	27/10/2014	Megan McKinney
2	2 (Draft)	Internal	1	29/10/2014	Michael Correll
3	3 (Final draft)	Anthony Bianco	1	29/10/2014	Chris Wiley
4	4 (Final)				

MET Serve Project Delivery System

Printed: 30 October 2014
Last saved: 30 October 2014
File ID: Radix Document ID 222494
Project Manager: Chris Wiley
Name of Organisation: MET Serve Pty Ltd.
Name of Project: Hey Point Bauxite Project
Name of Document: Mine Rehabilitation Plan
Document Version: 002
Project Number: CL003

PO Box 306
Fortitude Valley Post Office
Fortitude Valley
QLD 4006

ABN 94 143 463 316

TABLE OF CONTENTS

FIGURES

TABLES

1 INTRODUCTION

1.1 PURPOSE OF THE PLAN

Green Coast Resources proposes to mine bauxite at Hey Point, Weipa (Mining Lease Application 20611). The Hey Point Bauxite Project (HPBP) will remove 111.5 ha of remnant Eucalyptus tetrodonta forest belonging to regional ecosystem 3.5.2. After mining has taken place, disturbed areas will be rehabilitated. The aim of this plan is to outline the rehabilitation techniques to be adopted by Green Coast Resources. The methodologies are informed by the successes and failures of other rehabilitation projects for bauxite mining in neighbouring areas and similar habitat. These other projects have experimented with a range of techniques over 40 years.

The purpose of the Mine Rehabilitation Plan is to:

- ensure that rehabilitation planning is integrated into day-to-day mining activities;
- provide technical and procedural information about the rehabilitation of mined land at Hey Point;
- inform mine management and operators about the requirements of mine rehabilitation at Hey Point;
- assist regulatory authorities to understand rehabilitation procedures to be adopted at Hey Point;
- assist Green Coast Resources to manage and minimise mine-related impacts to ensure future land and water uses are not negatively impacted; and
- increase the likelihood that rehabilitation at Hey Point meets regulatory requirements and community expectations.

1.2 DESCRIPTION OF THE MINE SITE

1.2.1 Location

The Hey Point Bauxite Project is located on Mining Lease Application 20611, 10 km south of Weipa, on Cape York Peninsula. The South of Embley Mine lies immediately south and west of the HPBP. The Embley River forms the northern and eastern boundaries of the HPBP. The majority of the mining lease comprises a low (5-10 m high), flat bauxite plateau. Low, vertical cliffs occur where this meets the Embley River except along the northern shoreline, where gentle slopes grade into sand dunes.

1.2.2 Climate

The Weipa region experiences a pronounced monsoonal climate. The mean rainfall is 1,784 mm, but 85% of this falls between December and March. In contrast, the driest four months of the year (June to September) receive <1% of the annual rainfall. The wet season is characterised by regular thunderstorms and heavy rain events. Cyclones occur relatively frequently; they passed within 200 km of Weipa during 74% of the last 50 wet seasons (data from the Bureau of Meteorology).

In contrast to highly seasonal rainfall, the temperature at Weipa remains relatively stable year-round. Mean monthly maxima vary between 30.4°C (July) and 35.5°C (October-November). Mean monthly minima vary between 18.7°C (August) and 24.2°C December and January) (data from the Bureau of Meteorology).

1.2.3 Vegetation

The vast majority (85%) of the HPBP mining lease comprises a single regional ecosystem: Eucalyptus tetrodonta open forest (RE 3.5.2). This is the only vegetation type growing on the bauxite plateau and the only one to be impacted by mining activities (MET Serve 2014a). The dominant tree is E. tetrodonta, but Corymbia nesophila, Alstonia actinophylla, Parinari nonda and Erythrophleum chlorostachys are common constituents of the sub-canopy. The midstorey is generally sparse, due to regular fires, and is dominated by a range of shrubs, including Acacia rothii, Ficus opposita, Grevillea glauca, Planchonia careya and Syzygium suborbiculare. The grassy understorey is dominated by Sarga plumosum, Heteropogon triticeus, Eriachne rara and Cymbopogon refractus, but also contains a high diversity of other grasses and herbs.

The canopy height is usually 25-36 m, and ranges between 35% and 69% cover (based on canopy perimeters). Species richness is relatively high, with 46-66 species of vascular plants present within a 10 m x 50 m quadrat. A total of 112 species of plant have been detected within regional ecosystem 3.5.2 in the HPBP.

No threatened plant species have been detected to date within E. tetrodonta forest in the HPBP area. The Biodiversity Planning Assessment for the Cape York Peninsula Heritage Area identified the following 11 plant species inhabiting the E. tetrodonta forest at HPBP as having regional or State significance:

- Acacia rothii
- Corymbia nesophila
- Eucalyptus brassiana
- Galactia sp. Andoom
- Helicteres sp. Heathlands
- Hibbertia candicans
- Morinda reticulata
- Polymeria sp. Aurukun
- Spermacoce sp. Andoom
- Tinospora esiangkara
- Typhonium weipanum.

While this listing does not afford additional levels of protection to the above species, rehabilitation efforts should endeavour to re-establish populations of these within rehabilitated areas.

A diversity of other vegetation types (mangroves, vine forests, paperbark swamps, sand dunes) occurs within the HPBP mining lease in small, isolated patches along the Embley River. These support numerous species not found in the E. tetrodonta forest on the bauxite plateau. As these species and habitats will not be disturbed by the HPBP, these are not considered a main target of rehabilitation. Nevertheless, there is a possibility that in some mined areas the water table may rise close to the new ground surface. If this occurs, the vegetation communities (e.g., paperbark swamps) that occur in analogous situations on the mining lease can be used as surrogate rehabilitation targets, in the event that E. tetrodonta forest is inappropriate.

2 OBJECTIVES

2.1 VISION

Following the removal of bauxite, Green Coast Resources aims to return the HPBP mining lease to a locally native ecological community that is progressing, credibly, towards a state resembling the vegetation that occurred on-site prior to mining.

The objectives of mine rehabilitation are to:

- create a landscape safe for humans and wildlife into the foreseeable future;
- create a stable landscape with natural rates of erosion;
- establish vegetation communities that resemble those originally found on-site, which blend visually with the surrounding landscape and vegetation;
- establish functional, self-sustaining vegetation communities;
- re-establish key fauna and flora culturally important to Traditional Owners;
- establish ecosystems that resemble neighbouring unmined forests in their ability to respond to fire, termites, droughts and cyclones; and
- ensure minimal post-mining impacts on surface catchments, water quality and volume.

2.2 STATUTORY REQUIREMENTS

In Queensland, there is a legal requirement under the Environmental Protection Act 1994 (EP Act) for land to be rehabilitated post-mining. Sections 125 (1) (l) (i) (E) of the EP Act state that applications for an environmental authority should include details about how land will be rehabilitated after the relevant activity ceases. The administering authority must be satisfied with the rehabilitation before it can accept the surrender of an environmental authority. This decision is based on an assessment of a final rehabilitation report, to be prepared by the holder of the environmental authority.

Rehabilitation requirements are specified in a guideline published by the Queensland Government Department of Environment and Heritage Protection (Rehabilitation Requirements for Mining Resource Activities EM112, version 2). This guideline dictates that the end result of rehabilitation should, to the maximum extent possible, be maintenance free and require no future management intervention beyond normal land management practices for the post-mining land use.

Landowners and land managers have a legal responsibility under the Land Protection (Pest and Stock Route Management) Act 2002 (LP Act) to keep their land free of Class 1 and Class 2 pests. It is an offence to introduce, keep or supply these plants and animals.

3 HISTORY OF REHABILITATING BAUXITE MINES IN NORTHERN AUSTRALIA

There are two large bauxite projects that have been operating in northern Australia for many decades (in Gove and Weipa). Despite the large distance between them, the natural environment at both locations is similar: open Eucalyptus tetrodonta forest with a diverse, grass-dominated understorey growing on shallow, lateritic soils. The climates are also similar, being located directly across the Gulf of Carpentaria from one another. Despite the similarities of the two locations, the two projects have had vastly different levels of rehabilitation success, and these provide valuable insight into the recommended practices at Hey Point.

3.1 WEIPA

Rehabilitation at Weipa has aimed to achieve a variety of final land uses (cattle grazing, native forest, timber plantations and horticulture). Rehabilitation of native forest has been based on the facilitation model of vegetation succession. This assumes that fast-growing, short-lived pioneer species facilitate colonisation by late successional species. To this end, a wide diversity of pioneer species of Acacia, Grevillea and Dodonaea, the majority of which are not locally native, were traditionally included in seed mixes sown on rehabilitation sites. These non-local pioneer species dominate rehabilitation sites to the extent that they block the growth and establishment of Eucalyptus tetrodonta and other local canopy species (Gould 2012). E. tetrodonta is included in seed mixes, but generally has low establishment rates. A number of non-local eucalypt species have also been included in seed mixes, but unlike non-local pioneer species these gradually die-out, as they fail to naturally recruit (Pasco 2008).

Another factor limiting rehabilitation success at Weipa is the invasion of weeds. Two weeds in particular, Leucaena (Leucaena leucocephala) and Gamba Grass (Andropogon gayanus), reach high densities in some rehabilitated areas, blocking the growth of native species (Pasco 2008).

The practice of using non-local species in rehabilitation only ceased in 2007 (Pasco 2008), so there has been insufficient time to assess whether indigenous seed mixes are more successful.

Despite the poor success of Weipa rehabilitation on the basis of vegetation development, faunal recolonisation of rehabilitated sites is high. All frogs, and most lizards and snakes, found in the Weipa region are known to recolonise rehabilitated sites (Cameron and Cogger 1992).

3.2 GOVE

Rio Tinto Alcan operates a bauxite mine on a 20,000 ha mining lease at Gove, in north-eastern Arnhem Land, Northern Territory. Rehabilitation of mined land has been undertaken using consistent methodologies for 40 years, providing a valuable insight into the long-term success of these efforts. The goal of rehabilitation efforts at Gove is exclusively to establish a similar ecological community to that previously existing on-site (Eucalyptus tetrodonta dominated open forest, with a diversity of species used by the Traditional Owners). Unlike Weipa, Gove has only used locally native species in its rehabilitation, with the exception of short-lived pioneer grasses used to stabilise the soil over the first year. At Gove, exotic perennial grasses are generally scarce in rehabilitation, and Leucaena is mostly absent and strictly controlled. No other weeds occur in such densities that they block the regeneration of native plants.

Like Weipa, young rehabilitation sites at Gove are dominated by pioneer species of Acacia and Grevillea. However, the native pioneer species used are gradually overshadowed after about 10 years by Eucalyptus tetrodonta and other locally dominant canopy species (Figure 3-1). After 20-30 years' development, rehabilitated forest has a similar canopy cover, canopy height, eucalypt stem density and species richness to unmined reference sites (MET Serve 2014b). The species communities present in old rehabilitation sites do diverge somewhat from the reference state, but this is caused by exclusion of fire rather than a failure of key species to establish (MET Serve 2014b). The successful development of the vegetation community at Gove has allowed recolonisation by local fauna; bird species richness in old rehabilitation sites is comparable to reference sites (Brady and Noske 2009).

The highly successful rehabilitation at Gove contrasts strongly with the mixed, mostly negative, results at Weipa. Much of its success can be attributed to the locally native seed mixes used. However, other key differences include more intense weed management and the exclusive use of fresh topsoil (no stockpiling). The latter, in particular, underlies successful recolonisation by the multitude of understorey species not actively planted in seed mixes.

The Hey Point Bauxite Project Mine Rehabilitation Plan is heavily based on the successful rehabilitation methodology employed at Gove. Any limitations to the Gove model (namely, divergence in vegetation community due to fire exclusion) have been corrected in the Hey Point plan.

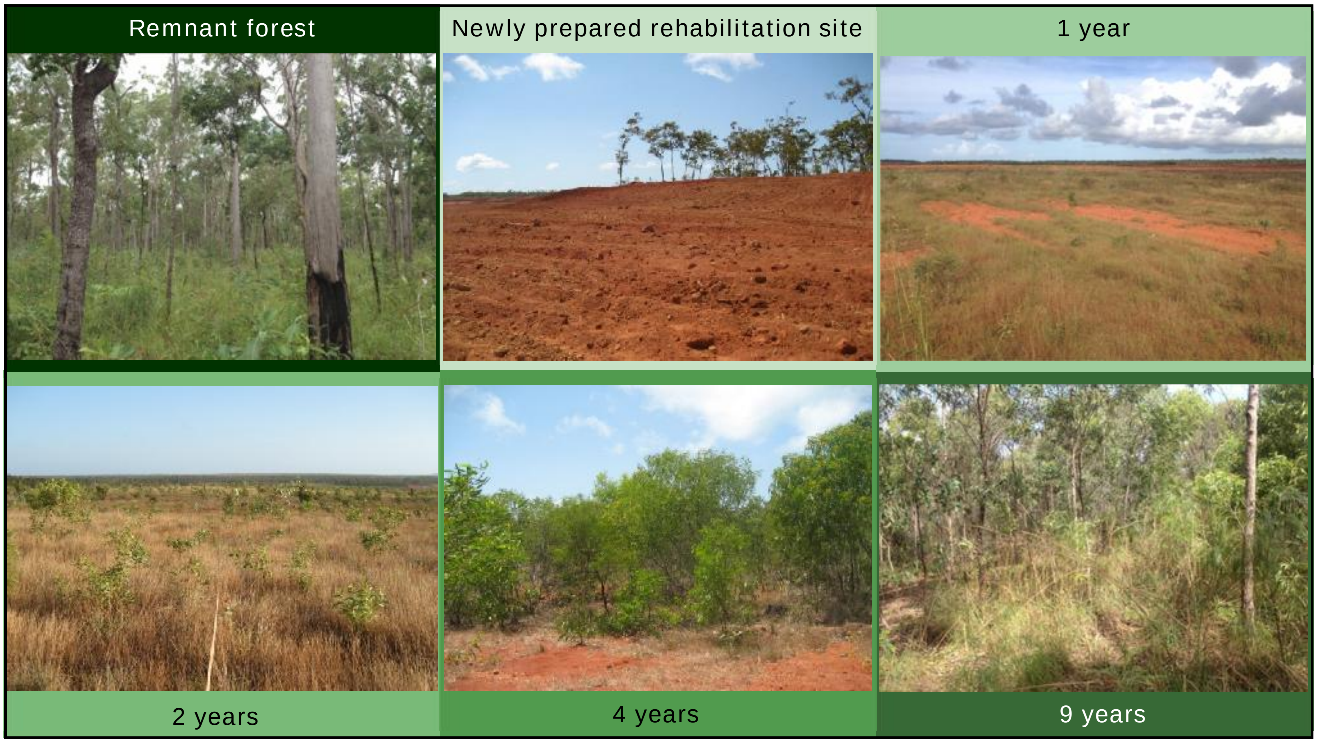


Figure 3-1 Progression of rehabilitation of Eucalyptus tetrodonta forests at Gove. This serves as a guide to the expected developmental trajectory at HPBP.

4 REHABILITATION PLANNING

4.1 PROJECTED FINAL LAND USE

The projected final land state of the HPBP is native vegetation resembling the community present on-site prior to mining, consistent with traditional land uses. This is the optimal goal of rehabilitation recommended by Queensland Government rehabilitation guidelines (EHP 2014).

4.2 OPERATIONS PLAN

An Operations Plan will be prepared, which will document the mining process and provide an action plan for each activity performed on-site.

The Operations Plan will include information about annual schedule of physical works, including the locations of mining, geology of the deposit, movement of topsoil and rehabilitation works to be undertaken. This information will be utilised to plan soil handling (partitioning of overburden into topsoil and subsoil) and patterns of soil replacement to minimise stockpiling and preserve soil seed banks.

4.3 COMPLETION CRITERIA

The Environmental Authority holder is responsible for nominating indicators for assessing the success of the rehabilitation efforts. Properties of a good indicator, as defined under State rehabilitation guidelines (EHP 2014), are that it:

- has an agreed, scientifically sound meaning;
- represents an environmental aspect of importance to society;
- tells us something important and its meaning is readily understood;
- has a practical measurement process;
- helps focus information to answer important questions; and
- assists decision-making by being effective and cost-efficient.

Each objective of rehabilitation must have at least one indicator relating to it. These indicators will form completion criteria, which should be developed in consultation with stakeholders (landowner, local government, indigenous groups, community groups, State government). Completion criteria should be proposed during the application process, and must be met in order to obtain approval of a surrender application.

The completion criteria proposed for HPBP are described and justified in the following subsections. These have been adapted from the Queensland Government rehabilitation guidelines, and tailored to the specific environments and objectives of the HPBP.

4.3.1 Objective A: Safe Landscape

Objective A states that the HPBP will create a landscape safe for humans and wildlife into the foreseeable future. No chemical wastes will be generated on-site from the HPBP and the soils and geology of the area are not prone to acid or metalliferous drainage when disturbed. All herbicides to be used on-site for weed control have a short half-life, and pose a low risk to wildlife.

The main way in which rehabilitated sites of the HPBP may not be safe to humans or wildlife is through unsafe re-sculpturing of the slopes forming the pit walls. This will be assessed through Completion Criterion A1.

	Completion criteria	Earliest possible assessment
A1	All artificial slopes within the HPBP rehabilitation area will have a slope that is <5 m tall and <30°.	At the completion of rehabilitation earthworks.

4.3.2 Objective B: Stable Landscape

Objective B states that the HPBP will create a stable landscape with natural rates of erosion. The HPBP will only lower the ground level by 2-3 m, and the resulting post-mining slopes are not expected to be susceptible to landslips or rock falls. The main reason for rehabilitation sites having potentially elevated levels of erosion is due to increased run-off caused by compacted soil and insufficient plant cover. A limited amount of erosion may occur within the first wet season, due to the lack of ground vegetation at this time. However, active erosion should not persist once vegetation has established on rehabilitation sites (after ~ 3 years).

	Completion criteria	Earliest possible assessment
B1	No active rill, gully or sheet erosion is to be visible within the HPBP rehabilitation area.	Three years old.
B2	No patches of exposed, bare soil (<5% cover of vegetation or organic litter) should exceed 25 m^2 in area.	Three years old.

4.3.3 Objective C: Visual Amenity

Objective C states that the HPBP will create a community similar to that which occurred on-site previously, and which blends visually with the surrounding landscape. This will be achieved by ensuring that the rehabilitated vegetation community develops a structure and composition similar to that of unmined areas.

Of the completion criteria assessing Objective C, C1 is most informative of the overall success of rehabilitation. This is because both successful (Gove) and unsuccessful (Weipa) rehabilitation achieve rapid growth and cover of pioneer species, but only successful rehabilitation achieves a transition to Eucalyptus tetrodonta dominated forest after approximately 10 years.

Appropriate benchmarks for various forest structural attributes will be based on measurements in neighbouring forest. It is unreasonable to use the mean/median values of reference sites as a benchmark for rehabilitation sites, as by definition half of undisturbed forests fail to meet this benchmark. Equally, using the lowest recorded values in reference sites as a benchmark for rehabilitation sites is also unreasonable, as this is heavily skewed by individual extreme values. The HPBP completion criteria are based on the 10th percentile among analogue sites. This ensures that the characteristics of rehabilitation sites fall within the natural range observed in analogue sites.

	Completion criteria	Earliest possible assessment
C1	Greater than 50% of the woody biomass of rehabilitation sites (as assessed by basal area*) should comprise the dominant trees Eucalyptus tetrodonta, Corymbia nesophila and/or Erythrophleum chlorostachys.	Dominant canopy species are expected to surpass pioneer species after 10 years.
C2	Canopy cover within rehabilitation sites should exceed the 10th percentile among reference sites.	Five years old.
C3	Stem densities within rehabilitation sites should exceed the 10th percentile among reference sites.	Five years old.

* Basal area is assessed by measuring the diameter at breast height of all woody vegetation >2 m tall within a 100 m x 10 m belt transect.

4.3.4 Objective D: Functional, Self-sustaining Vegetation Community

Objective D states that the HPBP will create functional native vegetation communities with the ability to be self-sustaining. A key indicator of sustainability is whether there is natural recruitment (seedlings or suckers) occurring in rehabilitation areas beyond the initial establishment period.

	Completion criteria	Earliest possible assessment
D1	Within a 100 m x 10 m belt transect, there should be seedlings or suckers (<2 m in height) of Eucalyptus tetrodonta, Corymbia nesophila and/or Erythrophleum chlorostachys.	Ten years old, or after dominant canopy species have begun to reproduce.
D2	The organic litter cover and depth in rehabilitation sites should exceed the 10th percentile among reference sites.	Five years.
D3	Native species richness within a 10 m x 50 m area within each rehabilitation site should exceed the 10th percentile among reference sites.	Three years, but is expected to continue to increase after this time.
D4	The site should be free of Class 1 and 2 declared weeds defined under the LP Act.	18 months, but new infestations may appear at later times and ongoing monitoring is required.

4.3.5 Objective E: Recolonisation by Culturally Significant Wildlife

Objective E states that the HPBP will create habitats that support recolonisation by flora and fauna culturally important to Traditional Owners. The two key wildlife inhabiting the Eucalyptus tetrodonta forests that will be disturbed by the HPBP are the Agile Wallaby (Macropus agilis) and yams (Dioscorea spp.).

	Completion criteria	Earliest possible assessment
E1	The understorey of rehabilitation sites should be dominated (as assessed by percentage cover) by native grasses, which are the primary food source of Agile Wallabies.	Three years.
E2	Dioscorea spp. should be present in rehabilitation sites	Five years, but recolonisation is likely to continue after this time.

4.3.6 Objective F: Resistance to Natural Stresses

Objective F states that the HPBP will create ecosystems that resemble neighbouring unmined forests in their ability to respond to fire, droughts and cyclones. Of these, fire and the annual prolonged dry season are the most regular natural stressors and are therefore most readily assessed. It is assumed that recovery from cyclones is likely to be high for ecosystems that are able to recover from other stresses. The vegetation community must withstand stress; perennial species must survive through stress and annual species must regenerate following stress. The optimal way to assess stress resistance is to examine whether all other completion criteria are met despite a recent stress being experienced.

	Completion criteria	Earliest possible assessment
F1	The vegetation community at rehabilitation sites must persist over multiple wet seasons.	18 months.
F2	The vegetation community must fulfil all other completion criteria after having experienced a fire within the previous five years.	Seven years, or possibly earlier in the event of accidental fires.

4.3.7 Objective G: No Impacts to Water Quality

Objective G states that the HPBP will cause minimal post-mining impacts to surface catchments, water quality and volume. Regular sampling of water quality in the spring-fed streams and wetlands on-site will commence prior to mining, and will continue throughout the period of operations. Sampling of nearby spring-fed wetlands outside the mining lease (to act as control sites) will occur concurrently, and will provide several years of baseline data by the time rehabilitation is complete.

	Completion criteria	Earliest possible assessment
G1	Salinity of the spring-fed streams and wetlands should not exceed the 80th percentile of baseline levels.	18 months, but sampling should commence before this time to monitor potential changes during and just after mining.
G2	Turbidity of streams and wetlands should not exceed the 80th percentile of baseline levels.	18 months, but sampling should commence before this time to monitor potential changes during and just after mining.
G3	Concentrations of aluminium, iron and manganese in spring-fed streams and wetlands should not exceed the 80th percentile of baseline levels.	18 months, but sampling should commence before this time to monitor potential changes during and just after mining.
G4	pH of streams and wetlands should not be lower than the 20th percentile of baseline levels.	18 months, but sampling should commence before this time to monitor potential changes during and just after mining.

5 REHABILITATION PROCESS

The rehabilitation process to be adopted at HPBP is based closely on the successful rehabilitation program at Gove, Northern Territory.

Rehabilitation will occur annually, from the middle to late dry season. No rehabilitation will be conducted during the wet season, to avoid soil compaction and damage. The rehabilitation process will commence at timber clearing, and be completed once closure criteria have been fulfilled and the environmental authority has been surrendered.

5.1 TIMBER CLEARING

Timber clearing will only be conducted during the dry season when soil moisture levels are low to prevent damage to plant propagules and soil organisms through compaction. Clearing will occur through the use of a chain linking two dozers. Once timber is felled, it will be raked and piled. Large logs are to be separated from others and deposited directly onto rehabilitation sites. Half of the remaining logs will be mulched and the other half burnt.

5.2 SOIL MANAGEMENT

Correct soil handling is paramount to the success of rehabilitation projects. Topsoil is a valuable and limited commodity, which can be irreversibly lost through poor management. Movement of top soil during the wet season will be avoided, as this destroys the soil structure and leads to the decomposition of buried plant propagules.

5.2.1 Soil Fungi Spore Bank

Most Australian plants depend upon associations with mycorrhizal fungi to absorb water and nutrients from infertile soils. Direct placement of freshly removed soil onto rehabilitation sites preserves the viability of fungal spores. Biologically active soils are crucial for the healthy growth of regenerating vegetation. Stockpiling topsoil beyond a single dry season is known to destroy fungal communities in the Australian monsoonal tropics (unpublished data from Rio Tinto Alcan Gove).

5.2.2 Soil Classifications

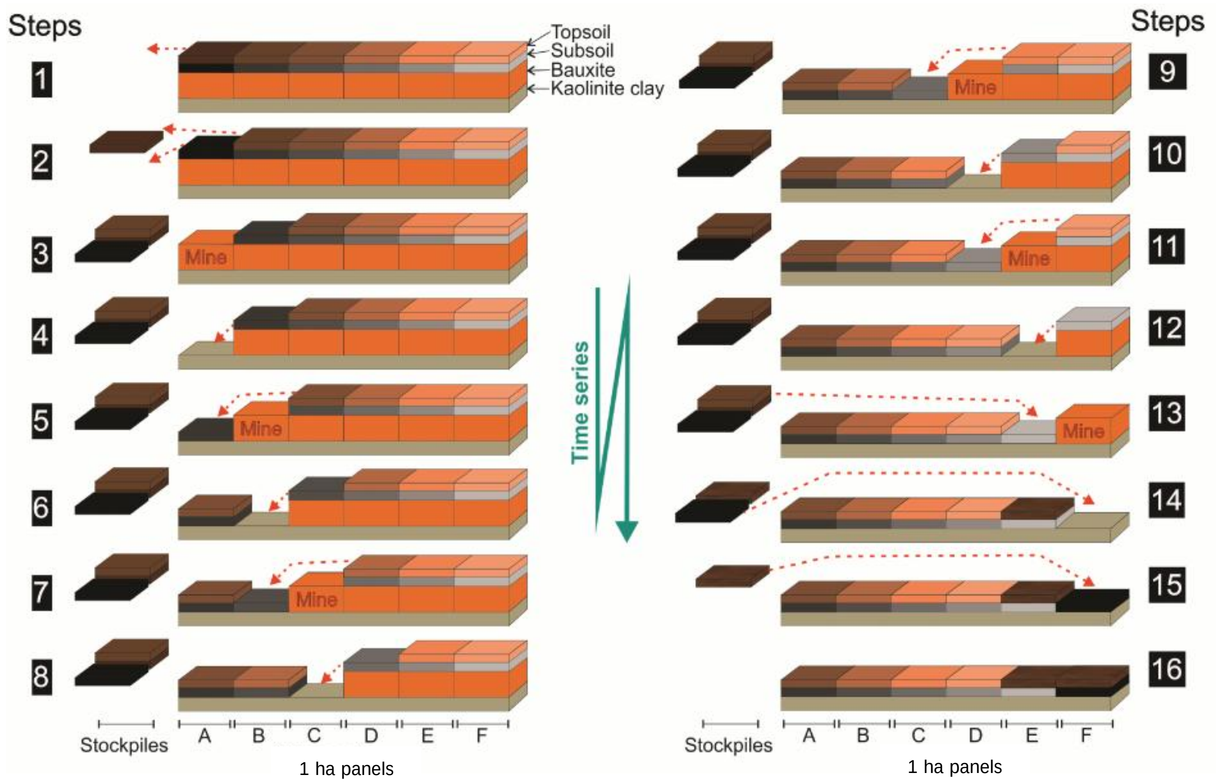
For the purposes of rehabilitation at Hey Point, four soil types are recognised:

1) Topsoil: the top 30 cm of the soil profile is rich in organic matter, micro-organisms and plant seeds. It is the principal growing medium for regenerating plants.
2) Subsoil: the layer between the topsoil and the bauxite, which varies in thickness from 10 to 210 cm (mean = 60 cm). It is a poor medium for plant growth and should be moved and stored separately from top soil. It is also referred to as ‘earthy bauxite’.
3) Bauxite: a layer of pisolitic or semi-pisolitic bauxite an average of 2.5 m thick (range = 1 m - 3.6 m). This constitutes the ore to be extracted for export.
4) Kaolinite clay: a finely textured, non-cracking clay located beneath the bauxite layer.

5.2.3 Soil Handling and Placement

Overburden (top soil and subsoil) removal must be well planned. Understanding the volumes and soil types that require movement is important for efficient use of machinery and prevention of double-handling. Wherever possible, overburden removed from one block will be placed directly into areas requiring rehabilitation, rather than stockpiling (Figure 5-1). If stockpiling is unavoidable, soil will not be stored for longer than a single dry season. If stockpiled soil becomes wet, plant seeds and micro-organisms will decompose and lose viability. All topsoil handling and placement will occur only during the dry season, when there is limited possibility of soil damage or compaction. It is essential that no water-based dust control methods be employed during overburden removal or in the vicinity of topsoil stockpiles.

Overburden from the first panels mined each dry season will require stockpiling (Figure 5-1). With this in mind, priority for the first panels mined each year will go to panels with the thinnest overburden, to minimise space required for stockpiles and amount of double-handling required.



Step	Description	Step	Description
1	Topsoil moved from panel A to stockpile	9	Topsoil from panel E moved to panel C; panel D mined
2	Subsoil from panel A and topsoil from panel B moved to stockpile	10	Subsoil from panel E moved to panel D
3	Panel A mined	11	Topsoil from panel F moved to panel D; panel E mined
4	Subsoil from panel B moved to panel A	12	Subsoil from panel F moved to panel E
5	Topsoil from panel C moved to panel A; panel B mined	13	Topsoil from stockpile moved to panel E; panel F mined
6	Subsoil from panel C moved to panel B	14	Soil from stockpile moved to panel F
7	Topsoil from panel D moved to panel B; panel C mined	15	Topsoil from stockpile moved to panel F
8	Subsoil from panel D moved to panel C	16	Ready for rehabilitation prior to start of wet season

Figure 5-1 Schematic diagram of soil movements between six theoretical mining panels. Soil handling is minimised by direct placement of most topsoil and subsoil panels. Soil stockpiling is restricted to the first two panels mined each dry season. For illustrative purposes, only six panels are depicted, although up to 40 panels are expected to be mined per dry season. Stockpiled soil will be used on the final panels to be mined each dry season, and never stored over a wet season.

Soil will be removed using a scraper, to minimise mixing of soil types/depths. The removal of the topsoil profile will be performed with two to three cuts of the scraper, and the complete profile will be collected in the same bowl. The third cut will be deep enough that a small quantity of redder subsoil layer is removed. Exposure of the redder subsoil is an indication that sufficient topsoil has been removed. Subsoil will be removed using a loader and truck. Likewise, any stockpiled soil will be moved using a loader and truck. The appropriate placement of soil types onto the mined floor is crucial for successful rehabilitation. Direct placement of subsoil will be undertaken prior to the deposition of topsoil.

5.2.4 Surface Preparation

Correct placement of soil has long-lasting implications for rehabilitation. Subsoil will be placed directly from pre-mined panels onto mined panels by trucks and spread by a dozer. Then, topsoil will be deposited directly in piles (one scraper load = one pile), with a gap of 1 m between piles. Piles will then be smoothed out using a dozer to produce a topsoil profile that is approximately 30 cm thick. It is important that the topsoil is placed at a thickness similar to that from where it was removed. Excessive topsoil placement will lead to future shortages.

Soils will be spread in such a manner that mimics the natural topography of gently undulating slopes, creating a landscape of minor troughs and depressions, but lacking unnatural-looking bunds or piles. In low-lying areas where substantial run-off may occur, drainage sumps will be created to promote water infiltration and prevent excessive ponding.

After soils have been landscaped, a dozer with a tine attached will be used to deep-rip the profile to fracture the compacted mine floor. This is achieved using the ‘track-on-track’ technique (ensuring the tractor sits on the previous track mark). The tine should penetrate through the profile at least 50 cm into the mined-out floor. This assists in tree root penetration and water infiltration. On steeper rehabilitated slopes, it is advised to rip down the slope to reduce erosion potential. A steep, flat surface is prone to sheet erosion, whereas ripping across the slope stops erosion up to a point, but when water eventually spills over the trough at the weakest point, erosion has the potential to be severe.

Where the replaced soil depth is less than 40 cm, deep-ripping may be done after both top soil and subsoil have been deposited. Where there are excessive amounts of subsoil to be placed in the mined void, the dozer tine may not be able to penetrate the soil to reach the mine floor. Where this is anticipated, deep-ripping must be carried out prior to the deposition of more than 40 cm of soil. However, some subsoil should be present at the time of deep-ripping; otherwise, the ripped surface will be too jagged for vehicles to access the site for spreading topsoil, seed etc.

5.2.5 Mulching and Timber Placement

After ripping and once topsoil has been spread, mulch produced from timber within cleared areas will be spread onto rehabilitation sites. Mulch will be spread in 1 m wide bands, with gaps of 3-4 m (width of the grader) in between bands. These bands of mulch will protect the topsoil from erosion, while the gaps will allow maximal germination of native plants. Large logs collected from cleared areas will be deposited onto rehabilitation sites at the time of mulching. These will be positioned atop the bands of mulch, to permit access for the grader to non-mulched strips.

5.2.6 Topsoil Scarification

Once rehabilitation areas have had topsoil deposited, been deep-ripped and had mulch/timber spread, scarification will be carried out. All non-mulched strips will be scarified with a grader and tine implement. The direction of travel should follow any existing dozer or tractor tracks. This breaks any soil compaction that may have occurred as a result of previous machinery movements, and provides a loose soil surface that allows seeds to penetrate into the soil structure. If rain occurs between scarification and sowing, and surface crusting is evident, scarification will be repeated. Otherwise, any subsequently sown seed will rest exposed on the crusted soil surface.

5.3 Revegetation

The revegetation program relies on a combination of direct seeding and passive regeneration through the soil seed bank. Most understorey species are annuals or perennials that seed annually. They are thus well represented in the soil seed bank, and generally do not require direct seeding. In contrast, woody species such as Eucalyptus tetrodonta do not seed every year, and rely heavily on root suckers and re-sprouting from lignotubers for propagation. Soil seed banks generally contain unsufficient quantities of this key canopy species, and these should be supplemented by direct seeding before the onset of the wet season.

5.3.1 Species Selection

Vegetation selection is based on the ultimate goal of restoring mined land to Eucalyptus tetrodonta forest. Understorey grasses and herbs will recolonise rehabilitated sites passively, provided top soil has been managed according to the guidelines specified in this Mine Rehabilitation Plan. Certain woody species may require additional direct seeding to achieve optimal densities. The following species should be added to rehabilitation sites:

- Acacia rothii
- Corymbia nesophila
- Erythrophleum chlorostachys
- Eucalyptus tetrodonta
- Grevillea glauca.

The species to be added to rehabilitation are locally native. The only exception to this is the pioneer grass, Silk Sorghum. This is a short-lived hybrid pasture grass that acts as a soil-stabiliser over the first wet season, but which is rapidly outcompeted by native species after 1-2 years. Only certified weed-free sorghum seed must be used.

5.3.2 Seed Management

Only seeds of local provenance (the Weipa region) should be used for rehabilitation. This can be achieved either through annual seed collection, or by the purchase of seed from nearby sources (e.g., neighbouring mines).

5.3.3 Seed Collecting

Seed collection will occur annually, dependent on the ripening and quality of seeds and fruits. Individual species mature at different times of the year, and several species may not seed every year. In years when seed becomes available, it is important to collect enough to supply the needs of the HPBP for its duration. Seed that is dried, cleaned and fumigated can be stored for the three-year duration of the HPBP without loss of viability.

Table 5-1 Seed collection schedule for key woody plants of the HPBP

Species	Flowers	Seed collected
Acacia rothii	April-May	July-August
Corymbia nesophila	June-July	September-October
Erythrophleum chlorostachys	September-October	February-April
Eucalyptus tetrodonta	July-August	November-December
Grevillea glauca	May-June	September-November

Seed will be collected from within the forecast disturbance footprint of the HPBP. Some species (E. tetrodonta, C. nesophila and E. chlorostachys) hold their seeds beyond reach within the canopy, and therefore require felling in order to collect sufficient quantities of seed. It is important that seed is collected from multiple individual trees. Trees that show the greatest vigour, maturation and heaviest seed set will be favoured as seed sources.

The following guidelines apply to the collection of E. tetrodonta and C. nesophila:

1) Selected trees are felled with a chainsaw;
2) Seed capsules are collected by cutting small terminal branches with secateurs or snapping by hand. Leaf material and larger branches are discarded;
3) Terminal branches bearing seed capsules are placed into plastic bins for transport back to the seed storage area;
4) Seed-bearing branches are spread (capsules down) on sheets of plastic;
5) If the seed-drying area is exposed to the weather, the plastic must be weighed down with rocks to secure it against wind;
6) seed is to be protected from birds and ants; and
7) the fine seed is sieved from the capsules once the capsules have opened.

The other three species can be collected by placing a bin underneath fruiting branches, and stripping off fruits by pulling downwards along the branch. Seeds will be transported back to the seed-storage area and dried on racks.

After drying, most seed is shed naturally from its pod or capsule. To ensure maximum procurement of seed, pods and capsules should be agitated by hand or using a modified electric mulcher (in which the metal blades have been replaced with pieces of stiff rubber). The seed and capsules are then passed through a sieve to remove twigs, capsules and other debris.

5.3.4 Seed Storage

To minimise loss of seed through fungal infections, fruits and seeds will be spread and dried immediately upon collection. Once seed is extracted from the capsules and pods, cleaned seed will be placed in an air-conditioned room (18°C) for a final drying period of 24-48 hours.

Dried seed will be weighed and labelled with the species, source and collection date. Seed will then be fumigated using phostoxin grain fumigation tablets at a rate of one tablet per 15 kg. To fumigate, remove one phostoxin tablet from the sealed storage container and place it into a vial. Cover the container with a dust mask and wrap the elastic tightly around the vial to seal. Covering the vial with a dust mask will make the vial breathable. Place the breathable vial into the sealable container with seed. Seal the container. Always wear gloves and a dust mask when handling phostoxin tablets.

Seed viability testing is not required; studies at Gove with very similar species show that no loss of viability occurs over the first three years of storage. The oldest seed stocks will be used first when selecting seed for rehabilitation.

5.3.5 Seed Purchasing

Large-scale mines, which undertake their own rehabilitation programs, occur in close proximity to the HPBP. Purchasing seed from these operators may provide an alternative source of seed for species with unreliable seeding rates.

Silk Sorghum can be purchased through Heritage Seeds Pty Ltd, and may be purchased annually as required.

5.3.6 Seed Mixes and Sowing Rates

A sowing rate of 3.5 kg/ha will be used for the seed mix shown in Table 5-2. Single superphosphate will be added at the time of sowing at a rate of 200kg/ha. Superphosphate granule size varies; small granules can be combined with seeds for a single application. If larger granules are used, seeds tend to fall between the gaps, leading to an uneven distribution of seed. Superphosphate added to the seed mix is preferred, as it acts as a marker for areas that have been seeded, to enable a more even spread.

Seed/fertiliser will be spread by hand or using a fertiliser spreader (a single-compartment hopper) combined with an agricultural tractor.

Table 5-2 Seed mix to be added to rehabilitation sites

Species	Weight
Silk Sorghum	40 kg
Acacia rothii	3 kg
Corymbia nesophila	2 kg
Erythrophleum chlorostachys	1 kg
Eucalyptus tetrodonta	6 kg
Grevillea glauca	1 kg
Total	53 kg

5.3.7 Sowing Time

Sowing is best undertaken just prior to the onset of the wet season (September-October). Seed may be sown earlier, but there is an increased risk that a large proportion of this may be consumed by birds prior to germination.

5.3.8 Field Germination

Silk Sorghum takes 2-4 weeks to germinate, following rain. Germination of E. tetrodonta and other woody species occurs within 3-18 months, following rain. Native grasses and herbs should replace Silk Sorghum in dominance after 18 months.

5.4 Erosion Control

The susceptibility of rehabilitated areas to erosion depends on the amount of heavy rain, slope profile, soil characteristics and vegetation cover. The concave topography of the HPBP mine floor will limit the potential runoff into neighbouring areas (e.g., the Embley River). Nevertheless, erosion prevention measures should be adopted to minimise unwanted soil movements within the rehabilitation areas. Measures include the following:

- scarification into troughs and ridges to reduce surface water runoff and encourage infiltration;
- incorporation of drainage sumps into the landform design, which are deep-ripped by the dozer for increased infiltration;
- construction of silt traps at points along access tracks where storm water is likely to run onto rehabilitation areas;
- inclusion of Silk Sorghum in seed mixes, to protect the soil from rain impacts, slow surface water flow, and protect and cool native seedlings during the first year.

6 REHABILITATION MAINTENANCE

6.1 REHABILITATION UPGRADE GUIDELINES

Any rehabilitated areas that are unlikely to meet completion criteria must be upgraded. The most likely cause of poor success is where topsoil has been stored for excessive periods, and/or while wet, prior to its use.

Early detection of failure is important to minimise costs of rehabilitation maintenance and improve the probability of long-term success. Densities of seedlings can be assessed at 6-18 months to determine whether appropriate stem densities will be achieved. Low seedling densities can be caused by the following reasons:

- Seed may have been consumed by birds prior to germination. A number of seed-eating species (e.g., Peaceful Dove, Bar-shouldered Dove, Sulphur-crested Cockatoo, Pale-headed Rosella, Red-winged Parrot and Torresian Crow) inhabit the HPBP area and these may contribute to the loss of seed. Areas sown in the early dry season are at greatest risk of seed loss through birds, as these have the longest wait until likely germination.
- Insufficient amounts of seed, or seed of poor viability, may have been used.
- Soil condition may have been inappropriate for seedling establishment. This may occur if soil micro-organisms have been killed by stockpiling wet soil, if inappropriate soil types (e.g., subsoil) have been placed atop the soil surface, or if soil crusting occurred prior to sowing.

The cause of poor seedling establishment is important to establish in order to prescribe appropriate remedial actions. If seed quality or quantity is the reason, failed sites will be re-scarified and re-sown with a higher density seed mix and fertiliser. This should preferably be undertaken immediately prior to the wet season, to limit risk of consumption by birds. If tree establishment is poor, but native grass recolonisation is high, some grass removal may be required to allow tree seedlings to establish. This can be achieved by skimming off the vegetation with the blade of a grader. Following this, the ground will be chisel ploughed. The chisel plough cuts furrows (15 cm deep) into the soil, protecting seeds from birds and providing a microclimate with lower wind, greater water infiltration, less direct sun and high litter accumulation.

If soil condition is the reason, the rehabilitation areas will be covered by 5 m wide strips of fresh topsoil, with a gap of 9 m between strips. These should be 20 cm thick and re-sown with the original seed mix and fertiliser.

The exact management interventions required should be assessed independently for each failed rehabilitation site. The following should be considered when assessing failed sites:

- plant diversity and density;
- the need to reduce grass cover with the use of the blade of a grader, to benefit establishment of woody plants;
- the need to re-scarify the surface soil;
- the need to apply additional topsoil;
- the need to re-sow, with or without fertiliser; and/or
- the need to re-apply both native species and Silk Sorghum, or native seed only.

6.2 EROSION

Some minor rill erosion is expected to occur in the first wet season after topsoil placement and rehabilitation, due to the exposed soil not yet having sufficient protection. However, this should not persist beyond the first year. If it does, remedial action is required. This may include the construction of new silt traps or drainage sumps, or the re-sowing of Silk Sorghum. Once native vegetation has established on rehabilitation sites, erosion is likely to be negligible, and measures that promote the establishment of native trees and grasses will serve to eliminate further erosion controls.

6.3 Lacustrine Areas

In the unlikely event that the lowest-lying areas of the mine floor fill with ground water during the late wet season, when the aquifer is closest to ground level, a different target vegetation community (other than Eucalyptus tetrodonta forest) is warranted. Analogous swampy areas at the edge of the plateau within the HPBP mining lease support communities of Melaleuca quinquenervia, Melaleuca saligna, Melaleuca viridiflora and Melaleuca leucadendra. These species should be sown in seasonally flooded areas during the early dry season (when the water levels have receded, exposing wet soil). No scarification of these wet soils is required prior to sowing.

6.4 Fire

Most plant species indigenous to the E. tetrodonta forests of Cape York are fire-resistant, and regular fire is necessary to maintain the structure and diversity of the forest (Bowman et al. 1988; Woinarski et al. 2004). However, young seedlings may be killed by fire, and excessive fires during the early phases of rehabilitation may prevent trees from reaching the ‘escape height’ (height above which the tree is rarely killed by fire) (Bond et al. 2012).

It is recommended that fire is excluded from rehabilitation areas for the first five years of their development. This will be achieved by maintaining a firebreak along the landward edge of the mining lease, and back-burning along this edge in the early dry season (May-June) each year. Fire management will occur in consultation with Traditional Owners and RTA Weipa, as the South of Embley Project that adjoins the HPBP will also be subject to a managed fire regime.

After five years, fire will be introduced to rehabilitation with caution, as the fuel loads present (grass and shrubs) may be large, and high scorch heights may kill the trees present. Low-intensity, ‘cool’ fires, lit in April-May will be required at this time to reduce fuel loads without killing trees.

6.5 Weeds

Weeds such as Leucaena and Gamba Grass are a major reason for the failure of large areas of rehabilitation at the Weipa Mine. These species are currently absent from the HPBP, and due to the high costs of their control, prevention of their entry into the site is a priority. It is important to prevent infestations of new weeds, and to detect and control any such infestations early.

Eleven species of exotic plants have been recorded at the HPBP (Table 6-1). Most of these are relatively benign, with respect to their potential for inhibiting rehabilitation. None are declared weeds under the Land Protection (Pest and Stock Route Management) Act 2002. None are Weeds of National Significance. One weed present on-site at the HPBP that may disrupt successful rehabilitation is Hyptis suaveolens. This is an annual herb, 1-2 m tall, with small purple flowers and tubular, spikey cup-shaped fruits. It can be recognised even when dead in the dry season by the square-shaped stems and dried aromatic leaves. It has the potential to form dense thickets in disturbed areas, which can prevent the establishment of native species. It is crucial that H. suaveolens is controlled in the early wet season, prior to flowering and seeding.

Weed control and management is an important component of successful rehabilitation at HPBP. The HPBP is obliged under the Land Protection (Pest and Stock Route Management) Act 2002 to prevent the spread of declared weeds, and some non-declared weeds can also severely impair the successful development of rehabilitation. It is therefore important to prioritise weed species of concern, and identify their management requirements (Table 6-1). Priority is awarded to species that have the highest risk of severely impairing the success of rehabilitation, and for which eradication is a possibility. Priorities should be reviewed annually, by monitoring the spread of low and medium-priority species.

Table 6-1 Weed prioritisation at the HPBP

Common Name	Scientific Name	Class	Priority*
Weeds occurring on-site			
Coconut	Cocos nucifera	Not declared	Low
Beggar's Tick	Bidens bipinnata	Not declared	Low
Elephant's Foot	Elephantopus scaber	Not declared	Low
Pigeon Pea	Cajanus cajan	Not declared	Low
Sticky Stylo	Stylosanthes viscosa	Not declared	Medium
Mint Weed	Hyptis suaveolens	Not declared	High
Spinyhead	Sida acuta	Not declared	Medium
Stinky Passionfruit	Passiflora foetida	Not declared	Medium
Finger Grass	Digitaria eriantha	Not declared	Low
Stinking Love Grass	Eragrostis cilianensis	Not declared	Low
Itchgrass	Rottboellia cochinchinensis	Not declared	Medium
Declared weeds in nearby areas			
Gamba Grass	Andropogon gayanus	Class 2	Very high
Neem Tree	Azadirachta indica	Class 3	Very high
Leucaena	Leucaena leucocephala	Class 3	Very high
Sicklepod	Senna sp.	Class 3	Very high
Grader Grass	Themeda quadrivalvis	Class 3	Very high

* Very high = to be eradicated if found on-site; high = to be controlled in rehabilitation and stockpile areas, and contaminated sites avoided as a source of topsoil for rehabilitation; Medium = to be monitored, and controlled if deemed to be impeding rehabilitation; Low = not subject to control.

6.5.1 Preventative Measures

All machinery brought to the mine will be cleaned thoroughly using high-pressure hoses, to remove all soil that may contain weed propagules. Vehicle wash-down will occur in Weipa before machinery is brought to site. Contractors (and persons bringing in hired equipment) must complete a Mine Site Environmental Clearance Form before any equipment enters the mine site. The cleaning and inspection of off-road vehicles and machinery on-site after visiting weed-infested areas will be the responsibility of all inducted mine staff and contractors.

Soil required for earthworks or topsoil will be sourced from weed-free areas on-site wherever possible, or if not possible, treated before use.

In the event that a new infestation of a very high priority weed is detected on-site, it is important to contain the infestation to its current location by ceasing grader work, isolating the affected area and limiting access. The infested site will maintain its controlled status until eradication has been deemed successful by the Mine Supervisor (no individual seedlings have regrown after at least one wet season).

Education and weed awareness are important components of a successful weed management program. For this reason, the mine site induction will include basic weed identification and clear directions about each individual's responsibilities in order to minimise weed spread. Mine site employees and contractors will be required to notify the Mine Supervisor should they suspect a weed growing in their work area. Inspection and confirmation of the possible weed infestation is then to be undertaken by qualified persons, and planning and control actions taken as necessary.

6.5.2 Controls

Prior to the commencement of each operating season (March-April), it is important to devise an annual plan of action. Infestations will be mapped onto the site plan, and the desired goals will be established. This ensures that resources are utilised most efficiently and at optimal times (prior to seeding). It is also important to review the success of weed control undertaken during the previous year, and make the necessary adjustments to improve success, if necessary.

Fires frequently burn through the HPBP area. The frequency of fires will be greatly reduced, in the short-term, by management actions outlined in Section 6.4. Nevertheless, incidental fires have the potential to stimulate germination of weed seeds, leading the exhaustion of soil seed stores. Consequently, the judicious control of weed seedlings after fire but before seeding can be highly successful in controlling weed spread. For this reason, sites of known weed infestations should be intensely targeted for control approximately two months after fire.

Control of weeds can be achieved through mechanical or chemical methods. In general, chemical methods are preferred as they achieve greatest success per unit effort. Mechanical methods are only preferred when infestations are small, located in waterways and/or located among sensitive native species for which collateral impacts of sprays are unacceptable. Recommended herbicide applications for weed species are listed in Table 6-2.

Table 6-2 Recommended herbicides for weed control at HPBP

Weed	Active Constituent	Herbicide (example)	Carrier	Rate	Application
Mint Weed Hyptis suaveolens	2,4-D	Amicide 625	Water	250ml/100L	Foliar
Stinky Passionfruit Passiflora foetida	2,4-D	Amicide 625	Water	250ml/100L	Foliar
Spikyhead Sida acuta	2,4-D	Amicide 625	Water	250ml/100L	Foliar
Sticky Stylo Stylosanthes viscosa	Fluroxypyr	Starane	Water	300ml/100L	Foliar
Gamba Grass Andropogon gayanus	Glyphosate	Weedmaster	Water	10 ml/L	Foliar
Neem Tree Azadirachta indica	Fluroxypyr	Starane	Diesel	17ml/L	Cut stump/basal bark
Leucaena Leucaena leucocephala	Fluroxypyr	Starane	Diesel	17 ml/L	Cut stump/basal bark
Sicklepod Senna sp.	2,4-D	Amicide	Water		Foliar
Grader Grass Themeda quadrivalvis	Glyphosate	Weedmaster	Water	10 ml/L	Foliar

Glyphosate is a non-selective herbicide that is ideal for killing grasses, but may also be used to kill other weeds in places where collateral damage to neighbouring native grasses is not a risk (e.g., soil stockpiles). Fluroxypur and 2,4-D are broadleaf herbicides that generally do not kill monocots (grasses, sedges etc), and may be used in areas where weeds are growing amongst native grasses. All herbicides listed in Table 6-2 will kill native broad-leaved herbs and shrubs that they come into accidental contact with. Accidental contact with neighbouring plants should be avoided wherever possible, and usage should always follow the safety directions accompanying each product.

Weed control must be carried out before the flower/seeding of weeds. The ideal time is shortly after the first wet season rains in October-November. Control may continue to take place until February-March (depending on the species), after which time most weeds have begun to seed.

7 REHABILITATION MONITORING

7.1 Annual Assessment

Monitoring of rehabilitation sites will be undertaken in June-July, the year following site establishment. Plant density will be calculated for all woody plant species (including those added as seed). Densities should be such that seedlings should not be further than 20 m apart, and ideally 7-11 m. Densities can be inferred from 100 m x 10 m transects.

Percentage ground cover and diversity of understorey species will also be recorded, to assess the rate of recolonisation by species from the soil seed bank. This will be assessed through ten 1 m x 1 m quadrats along the 100 m transect used to assess stem densities.

An inventory of all species observed to recolonise rehabilitation sites will be kept.

It is not necessary for all 1 ha panels to be individually assessed, as many panels rehabilitated within a single year are likely to have similar levels of success. It is recommended that every third panel is assessed using the methods described above. It is important that the last two panels mined in any one dry season are also assessed, as these utilise stockpiled topsoil and therefore have the highest potential risk of failure.

Annual assessments allow the early detection of rehabilitation failure, reducing costs of remediation.

7.2 Photo Monitoring

Photos will be taken of every 1 ha mining panel in every year during the June-July assessments. The photographer should stand at the midpoint of each panel and take four photos, one towards each cardinal direction (north, south, east and west). The panel and direction will be recorded with each photo. This will serve as a record of rehabilitation development over time.

7.3 Water Monitoring

Water samples will be collected monthly (when surface water is present), commencing in January 2015, and continuing throughout the duration of the project. For the locations of monitoring sites, the sampling techniques to be adopted and the attributes to be measured, refer to the HPBP Water Monitoring Plan.

7.4 Completion Criteria Assessment

The certification or final sign-off of rehabilitation requires adequate information to be provided by the applicant (Green Coast Resources) in a rehabilitation report. This includes evidence that the rehabilitation meets the completion criteria and a risk assessment. Necessary evidence includes clear and comprehensive information about the performance of rehabilitation from when it was undertaken until when the application for surrender is made. One component of this sign-off is an assessment of the residual risk of failure at the time of application. This is because even if all criteria are met for several years, there is no guarantee that the rehabilitation will not fail in the future. Robust data that demonstrate a low risk of future failure is therefore required for sign-off. Such data may include growth trajectories that demonstrate that the vegetation at HPBP is developing in a similar way to that at Gove, where 40 years of additional development demonstrate that future success is likely.

Eleven of the eighteen proposed rehabilitation completion criteria may be assessed within the first three years, and fifteen of the criteria may be assessed within the first five years. One of the criteria for which more time is required is C1 (the dominance of key canopy species). This is the primary criterion for which the Weipa Mine tends to fail, and is possibly the most important of all proposed criteria for predicting the future risk of failure. The transition from pioneer species to eucalypt forest only occurs after 10 years, and cannot be assessed prior to this time.

Regular assessment of rehabilitation against the completion criteria is important for two reasons. First, it allows an early detection of failure, reducing the costs of remediation. Second, it allows for growth trajectories to be calculated, providing a robust argument for low likelihood of future failure and evidence for mining lease relinquishment.

It is recommended that completion criteria are first assessed across the HPBP when the oldest panels are three years old. At this time, panels ranging in age from 1-3 years will be present on-site, providing data on growth trajectories over the first three years. Thenceforth, the HPBP should be re-assessed every 2 years until the oldest sites are ten years old (the age at which all criteria may be assessed).

Data from the oldest sites may be used to infer with confidence the projected growth trajectories of younger sites under the following conditions:

- similar rehabilitation techniques were applied to all ages; and
- the growth trajectories of youngest sites were similar to the trajectories of older sites when the latter were assessed at a comparable age.

For this reason, sign-off of rehabilitation is anticipated to be likely, pending successful rehabilitation, eleven years after the commencement of mining, and eight years after the cessation of mining.

8 COMMON REHABILITATION PROBLEMS

8.1 SOIL MANAGEMENT

Soil management preceding and during the rehabilitation process is fundamental to its success. Soils that are moved while too moist, placed incorrectly, left stockpiled over a wet season, or not scarified or sown at the correct time of year generally result in suboptimal rehabilitation outcomes.

8.2 FIRE

Fire is likely to have a detrimental effect on rehabilitation development if it occurs within the first five years. For this reason, careful exclusion of fire from young rehabilitation sites should be an important goal, and reintroduction of fire into older rehabilitation sites should be undertaken with great care.

8.3 SOIL COMPACTION

Soil compaction caused by heavy mine and earth-moving equipment can block seedling establishment and water infiltration, and must be rectified by deep-ripping into the mine floor with dozers and scarifying the soil surface with a grader with modified tines.

It is important to maintain separation between subsoil and topsoil; otherwise, soil seed banks and organic matter in top soil will be too diluted. Use of fresh topsoil will help maintain its structure and micro-organism communities.

8.4 DIEBACK

Dieback has been observed in scattered locations within rehabilitation in other bauxite mines in northern Australia. This can be caused by storm damage, drought stress, fungal infections and/or chemical toxicity. Dieback is not foreseen to be a major issue at Hey Point, but the cause of any sudden tree deaths should be investigated to manage the situation to prevent further losses.

8.5 VEGETATION FAILURE

Unsatisfactory seedling establishment may occasionally occur through poorly prepared soil, loss of seed to wildlife, or low seed viability. The remediation required to rectify the low seedling densities depends on the cause of the problem (see Section 6.1).

8.6 EXCESSIVE GRASS COVER

Excessive grass cover can inhibit the establishment of trees and shrubs. Generally, it takes several years for native grass densities to reach maximal levels, by which time trees and shrubs have normally outgrown the understorey. The only circumstance where this does not occur is when the initial germination rates of trees and shrubs were poor.

Exotic weed grass, on the other hand, poses a greater threat to the success of rehabilitation. Weeds such as Grader Grass, Gamba Grass and Mission Grass are currently absent from the HPBP, but if introduced have the potential to outcompete native species. In the event these species become established, their control and eradication should be a priority.

8.7 EXCESSIVE TREE COVER

Excessive densities of trees and shrubs can lead to heavy loads of leaf litter and the shading out of the understorey. This can inhibit the growth of understorey grasses and herbs. High densities of pioneer shrubs (non-local species of Acacia and Grevillea) are a primary cause of failure of rehabilitation at the Weipa Mine, due to the suppressive effect of these shrubs on local Eucalyptus and Corymbia species.

This is unlikely to be a significant problem if the guidelines specified in this plan are followed, and fires are reintroduced into rehabilitation areas after five years.

8.8 EROSION

Erosion is a potential problem on steep slopes or where vegetation establishment has been poor. By ensuring concave slope profiles, sediment troughs and good vegetation cover, this is not likely to be an important limitation at the HPBP. The site has a gentle topography that mine rehabilitation areas will mimic once topsoil and subsoil has been replaced onto the mined out floor.

8.9 WEEDS

Weeds are a major source of failure of rehabilitation efforts. The low density of weeds in the HPBP area affords an ideal opportunity for managing weed infestations into the future. It is imperative that new weed infestations are prevented and/or controlled at the earliest possible opportunity. This reduces the long-term cost of weed control and the likelihood of successful eradication.

9 GLOSSARY

Acid and metalliferous drainage: highly acidic liquids that form when certain rocks, especially those containing sulphide minerals, weather in response to being exposed to air, due to the removal of overlying soil/rock.

Dieback: the phenomenon whereby whole trees or peripheral parts are killed without an obvious culprit.

Drainage sump: a channel constructed to divert surface run-off.

Facilitation model: a model of forest regeneration whereby recolonisation by primary forest species is dependent on the microclimate created by the early establishment of fast-growing, short-lived pioneer species.

Gully erosion: a form of soil erosion consisting of an open, incised and unstable channel generally more than 30 cm deep.

Indigenous plant: a plant species that occurs naturally (not caused by human colonisation) at the site.

Lacustrine: pertaining to a lake.

Local plant: see 'indigenous plant'.

Midstorey: the stratum of vegetation beneath the canopy, which around Weipa comprises short-lived shrubs, 2-5 m tall, which are regularly removed by fire.

Overburden: material overlying the resource to be extracted; at the HPBP, this comprises topsoil and subsoil.

Pioneer species: short-lived, fast-growing shrubs and small trees that dominate disturbed environments, but which are replaced by larger, slower-growing trees after time.

Pisolitic: composed of spherical, concretionary grains.

Rehabilitation: the process of regaining some of the original values of disturbed environments.

Rehabilitation completion criteria: agreed standards that rehabilitated sites must meet before rehabilitation can be considered to have a low risk of future failure.

Rehabilitation indicator: a measure of the success of rehabilitation efforts against the pre-defined rehabilitation objectives.

Rehabilitation objective: a pre-defined goal of rehabilitation efforts.

Rill erosion: a form of soil erosion consisting of narrow, shallow, incised channels, 5-30 cm deep.

Scarification: ploughing the soil surface to break any crusts, repair soil compaction, and produce a loose seed bed for optimal seedling establishment.

Sheet erosion: a form of soil erosion, whereby loose soil particles are moved downhill by broad sheets of rapidly flowing water. On relatively rough surfaces, sheet erosion usually gives way to rill or gully erosion.

Sub-canopy: the tree layer just below the canopy, which consists of smaller mature trees.

Subsoil: the soil layer that is deeper than the root zone of most plants (>30 cm), but above the bedrock or resource to be mined.

Topsoil: the top 30 cm of the soil profile, which contains most plant roots and soil micro-organisms.

Understorey: the community of grasses, herbs and small woody shrubs (<2 m) that grow beneath the canopy, sub-canopy and midstorey.

Weed: a plant not indigenous to the local area.

10 REFERENCES

Bond, W.J., G.D. Cook and R.J. Williams (2012). Which trees dominate in savannas? The escape hypothesis and eucalypts in northern Australia. Australia Ecology 37, 678-685.

Bowman, D.M.J.S., B.A. Wilson and R.J. Hooper (1988). Response of Eucalyptus forest and woodland to four fire regimes at Munmarlary, Northern Territory, Australia. Journal of Ecology 76, 215-232.

Brady, C.J. and R.A. Noske (2009). Succession in bird and plant communities over a 24-year chronosequence of mine rehabilitation in the Australian monsoon tropics. Restoration Ecology 18, 855-864.

Cameron, E.E. and H.G. Cogger (1992). The herpetofauna of the Weipa region, Cape York Peninsula. Technical Papers of the Australian Museum 7, 1-200. ISSN 1031-8062.

EHP (2014). Rehabilitation Requirements for Mining Resource Activities EM112, version 2. Guideline for Resource Activities published by the Department of Environment and Heritage Protection of the Queensland Government. May 2014.

Gould, S.F. (2012). Comparison of post-mining rehabilitation with reference ecosystems in monsoonal eucalypt woodlands, northern Australia. Restoration Ecology 20, 250-259.

MET Serve (2014a). Terrestrial Ecology Report, Hey Point Bauxite Project. Report prepared by MET Serve Pty Ltd for Green Coast Resources Pty Ltd. October 2014.

MET Serve (2014b). Long-term monitoring of flora development in mine rehabilitation. Report by MET Serve Pty Ltd for Rio Tinto Alcan Gove Operations.

Pasco, A. (2008). Assessing the success of vegetation development on tropical rehabilitated landscapes following mining. Masters thesis submitted at Faculté des Sciences, Université Montpellier.

Woinarski, J.C.Z., J. Risler and L. Kean (2004). Response of vegetation and vertebrate fauna to 23 years of fire exclusion in a tropical Eucalyptus open forest, Northern Territory, Australia. Austral Ecology 29, 156-176.