PEABODY ENERGY

WILPINJONG REHABILITATION REVIEW

2013

Summary

The rehabilitation review aims to assess the current state of the rehabilitation program and recommend changes where necessary to improve the effectiveness of the rehabilitation program. A field assessment was undertaken in October 2013 across areas that were rehabilitated and seeded in March 2013, looking in particular at groundcover, tree density, erosion and weed occurrence; it complements the annual rehabilitation monitoring which occurred at thirteen fixed, permanent transects located in the rehabilitation areas in October 2013.

The field assessment of 2013 rehabilitation areas showed that there was an adequate establishment of vegetation, though groundcover and yield were below optimum, owing to the low level of fertilizer used and the below-average rainfall. Fixed monitoring transects show that the groundcover percentage is variable and groundcover yields are low; trees and shrubs have colonized the areas.

The broad assessment undertaken in October 2013 concentrated on areas where rehabilitation was completed in Pit 2 and Pit 5 areas in March 2013. Whilst there was adequate germination of trees and groundcover species, poor nutrition severely restricted cover and growth. Groundcover % (22-97%) and dry matter yield (31-1720 kg/ha) were highly variable and there was some erosion. The *Ripping, Seeding & Fertilising Inspection & Test Plan Final Land Form* records for March 2013 show that 70 kg/ha of the fertilizer Starter 15 was used in the rehabilitation works. Starter 15 has 14%N, 12.7%P and 11%S, which at a rate of 70kg/ha would only provide 10kg N/ha and 9kgP/ha, which is inadequate for establishing vigorous plant cover in rehabilitation areas. Well-below average rainfall in the winter/spring period) will have exacerbated the problem. Therefore the 2013 areas will require an additional fertiliser dressing of 230kg/ha in early 2014 just prior to summer rain.

The additional broad assessment of the rehabilitation areas in late 2012 showed that there were some areas of significant erosion often associated with contour banks that had failed. Groundcover was extremely variable, but generally adequate (60%) and there were significant areas showing signs of nutrient deficiency. Deficiency of nitrogen and phosphorus were observed and soil tests also show soil acidity and sodicity will be restricting plant growth in some areas. It is recommended that additional nitrogen and phosphorus fertilizer be applied ahead of the 2013/14 summer season and the use of lime across rehabilitation areas with soil pH (H_2O) less than 6.5.

A set of rehabilitation success criteria have been developed for the areas being rehabilitated to a grazing land use and success criteria for all forms of rehabilitation should be tested during the annual monitoring program timed for September 2013 to see which areas meet the success criteria.

The final landform development program is progressing well with separate rehabilitation areas being developed to support both wildlife and grazing. Additional tree seed sowing may be required in the wildlife corridor areas, although early indications from the monitoring program suggest that establishment of woody species is adequate.

The success criteria for rehabilitation success are adequate for the development of stable landform with safe levels of ground cover, high yields of perennial pasture species, and sufficient shrub/tree density to allow for long term development of open woodland.

Topsoil stripping should continue as previously with use of the surface one metre of material and, depending on soil test analyses, generous fertilization and amendment with lime to allow for healthy rehabilitation in the long term.

Due to the spatially variable nature of the mining program and subsequent rehabilitation, it is recommended that consideration of partial mining lease relinquishment be deferred until sufficient areas are available for the establishment of a grazing regime prior to partial mining lease relinquishment. At present the rehabilitation areas are too small and fragmented by mine roads and access roads to consider relinquishment.

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1.0 Introduction

Prior to mining activities in the Wilpinjong area the land in the valley had been cleared in the early part of the last century for grazing or cropping, which was only possible through the use of superphosphate fertilizer as the soils were inherently infertile. Pastures for cattle and sheep were based on the use of subterranean clover and superphosphate after the 1950s. Rabbit and kangaroo shelter in the bushland fringes adjacent to the minesite. Heavy grazing by these animals may impact on rehabilitation success though the mine and rehabilitation area have been netting fenced.

Wilpinjong Coal Mine (WCPL) has an active rehabilitation program which ensures that rehabilitation is undertaken within twelve months of spoil becoming available. By 2013 rehabilitation has been undertaken in sections of Pit 1, Pit 2 and Pit 5 spoil.

The scope of the rehabilitation review is as follows:

- Assess rehabilitation to identify areas that are unstable or have poor vegetation establishment and provide recommendations on how these issues can be resolved. These areas may be excessively scoured, have excessive weed infestation or where poor quality control with ripping, seeding or fertilizing has led to a poor rehabilitation result.
- Provide recommendations on how to implement and manage the final landform land use as set out in the WCPL EIS (i.e. the practical implementation and management of the mixed post-mining land uses of grazing and wildlife corridors)
- Refine the current success criteria to assist with the ML surrender process and make recommendations for improvement
- Develop a topsoil stripping, stockpile and management plan for the next five-year mine plan
- Develop a mining lease relinquishment strategy
- Update the WCPL MapInfo GIS records as required to record rehabilitation information.

In order to review rehabilitation at the site Landline Consulting staff carried out a field assessment of all rehabilitation areas in Pits 1, 2 and 5 in October 2013. This report discusses rehabilitation status across the project area.

2.0 Methods

Two biologists traversed the rehabilitation areas on foot to record details of location, poor seedling establishment and cover, erosion and weed infestation on areas where rehabilitation was completed in March 2013, rather than revisiting those areas assessed in 2012.

3.0 Final Landform design and land use

The final landform for rehabilitation land including location and site drainage has been designed to complement the natural landforms in and around the site (Map 4). Catchment surface flow will be reinstated from the base of the Munghorn Gap Nature Reserve area north to Wilpinjong Creek and on to the Goulburn River. Drainage lines with greater than 3% fall will be armoured to reduce scouring and erosion.

Sediment control dams will be constructed along major drainage lines and immediately before the junction with Wilpinjong creek to reduce suspended solids in surface flow from the site.

The WCPL Rehabilitation Management Plan September 2011(RMP) states “On completion of landform contouring, topsoiling and erosion and sediment control works, a vegetative cover will be established as soon as practicable. Depending on the proposed

post-mining land use proposed for areas of rehabilitation land, a decision will be made, based on vegetation monitoring results, to boost rehabilitation performance. Remedial action will involve direct seeding or planting of appropriate woody species.

Topsoil conditioning involving the addition of lime, gypsum or fertiliser will be used where required, based on an assessment of soil fertility. Seeding and planting activities will take into account seasonal factors and will be scheduled, where possible, prior to the expected onset of seasonal rains in September/October. Revegetation of rehabilitation areas will result in a combination of woodland areas, pasture areas and mixed woodland/pasture areas.

The aim of revegetation in woodland areas is to establish floristic diversity, and will include the use of endemic plant species characteristic of the vegetation communities present prior to mining disturbance. Revegetation of the woodland areas would include seeding or planting of species characteristic of the WBYBBRG EEC (e.g. White Box [*Eucalyptus albens*], Yellow Box [*E. melliodora*] and Blakely's Red Gum [*E. blakelyi*]). Pasture areas would be revegetated using either native and/or improved pasture species.

4.0 Rehabilitation criteria

A set of tentative completion criteria for assessing vegetation development in ECA sites and mine spoil rehabilitation are set out in the Rehabilitation Management Plan are presented here (Table 1). These may be modified as revegetation proceeds.

There are currently no completion criteria proposed for rehabilitated areas with a grazing post mining land use. Table 5 sets out suggested completion criteria for grazing areas and also proposes a milestone-based completion criteria assessment process rather than the currently proposed time-based process. A milestone-based process allows

rehabilitation to be assessed on performance rather than time which can allow for the relinquishment of a mining lease in a much shorter timeframe.

Table 1. Current Tentative WCPL RMP Completion Criteria (from RMP)

Mine Component	Quantitative Completion Criteria		
	Year 1	**Year 5**	**Year 15**
Rehabilitation Areas - Woodland	• Ground > 60% • Groundcover species > 3 • Stem density of woody plants > 300 stems /ha • Woody plant diversity >3 upper storey species and > 3 under storey species	• Groundcover > 60% • Groundcover species > 3 • Stem density of woody plants > 100 stems/ha • Woody plant diversity > 3 upper storey species and > 3 under storey species • Erosion score less than 3	• Groundcover > 60% • Groundcover species > 3 • Stem density of woody plants > 800 stems/ha or similar to that in analogue site • Woody plant diversity > 3 upper storey species and > 3 under storey species • Natural regeneration woody species > 10 stem/ha • Erosion score less than 3 • Soil chemistry parameters similar to those on analogue sites
Regeneration Areas	• Groundcover > 60% • Groundcover species > 3 • Stem density of woody plants > 100 stems/ha • Woody plant diversity > 3 upper storey species and > 3 under storey species	• Groundcover > 60% • Groundcover species > 3 • Stem density of woody plants > 100 stems/ha • Woody plant diversity > 3 upper storey species	• Groundcover > 60% • Groundcover species > 3 • Stem density of woody plants > 800 stems/ha or similar to that in analogue site • Woody plant diversity > 3 upper storey species and > 3 under storey species • Natural regeneration woody species > 10 stem/ha • Similar species occurrence to adjacent reference sites
Enhancement and Conservation Areas – Enhancement of existing remnant vegetation (including WBYBBRG EEC)	• Groundcover > 60% • Groundcover species > 4 • Stem density of woody plants > 500 stems/ha • Woody plant diversity > 3 under storey species	• Groundcover > 60% • Groundcover species > 4 • Stem density of woody plants > 500 stems/ha • Woody plant diversity > 3 upper storey species and > 3 under storey species	• Cover > 60% • Groundcover species > 3 • Stem density of woody plants > 800 stems/ha • Woody plant diversity > 3 upper storey species and > 3 under storey species • Natural regeneration

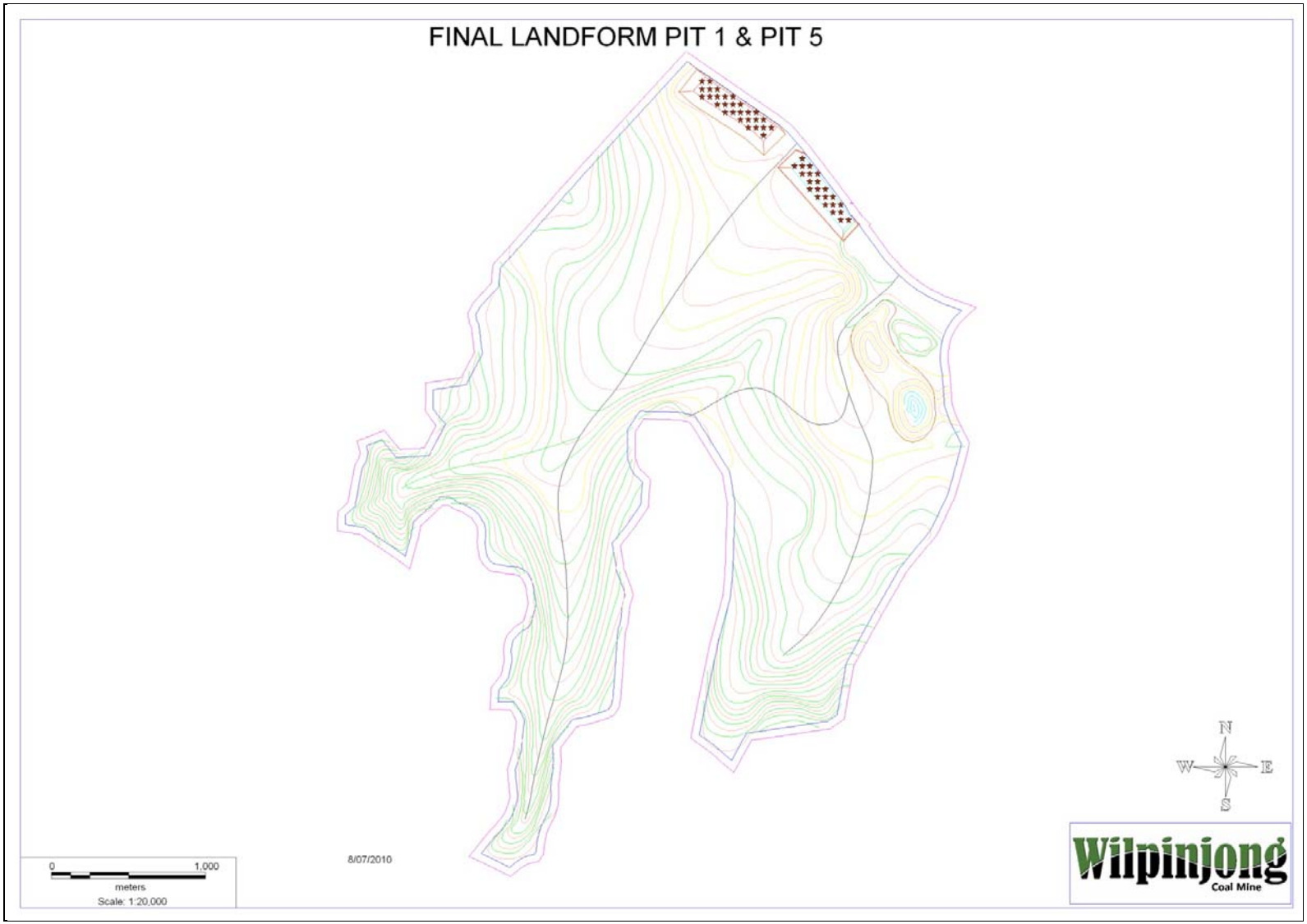
Mine Component	Quantitative Completion Criteria		
	Year 1	**Year 5**	**Year 15**
			woody species > 10 stem/ha • Similar species occurrence to adjacent reference sites
Enhancement and Conservation Areas – Enhancement of existing remnant vegetation (including WBYBBRG EEC)	• Groundcover > 60% • Groundcover species > 3 • Stem density of woody plants> 500 stems/ha • Woody plant diversity > 3 upper storey species and > 3 under storey species	• Groundcover > 60% • Groundcover species > 3 • Stem density of woody plants > 500 stems/ha • Woody plant diversity > 3 upper storey species	• Groundcover > 60% • Groundcover species > 3 • Stem density > 3 upper storey species and > 3 under storey species • Natural regeneration woody species > 10 stem/ha • Similar species occurrence to adjacent reference sites

Map 1. Location of 2013 rehabilitation assessment sites at Pits 1, 2 and 5

Map 2. Location of 2102 rehabilitation assessment sites at Pit 1

Map 3. Location of additional rehabilitation assessment sites at Pit 1 in 2012

Map 4. Location of additional rehabilitation sites at Pit 5 in 2012



Map 5. Final landform design for Pits 1 and 5

5.0 Rehabilitation Assessment Findings

The field assessment of rehabilitation in late 2013 is based on conventional quadrat/transect and soil analysis carried out at 13 rehabilitation monitoring sites (R1 – R13) (Map 1) associated with Pits 1, 2, and 5, together with additional observations of the 2013 rehabilitation areas. Performance of the 2013 rehabilitation was quite uniform in terms of groundcover growth and there was little soil erosion; therefore the detailed observations were not undertaken. Measurements and photos from the 13 regular monitoring sites are set out in Appendix 2.

The four key parameters for assessing performance of the WCPL rehabilitation were:

- Erosion and scouring
- Weeds
- Groundcover
- Soil fertility

These parameters are discussed in detail in sections 5.2 – 5.5.

5.1 Rainfall

Rainfall at the Wilpinjong mine site is shown in Table 2 for the period 2006-13. Following the seeding and fertilizer application in March 2013 there was below average rainfall in April, May, July, August and October.

Table 2. Monthly rainfall at Wilpinjong Coal Mine and long term rainfall at nearby Gulgong Post Office (1881 – 2007)

Monthly	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2006	67	77	9	21	1	37	51	7	16	2	70	na	357
2007	26	35	57	39	49	187	15	29	0	39	149	171	797
2008	76	115	16	12	10	61	28	69	28	70	91	117	694
2009	11	68	42	25	7	45	48	8	36	43	24	103	461
2010	61	140	67	41	56	34	81	71	62	60	150	231	1054
2011	11	34	43	32	38	17	6	42	93	38	145	58	557
2012	67	106	150	24	49	34	61	13	35	4	21	66	629
2013	74	54	61	12	0	78	21	7	33	9			(349)
Site mean	**49**	**79**	**56**	**26**	**26**	**62**	**39**	**31**	**38**	**33**	**93**	**124**	**650**
Long term mean	70	61	55	45	46	51	49	46	46	56	59	65	649

5.2 Erosion and scouring

Erosion and scouring can occur on newly established rehabilitation due to sub-optimal groundcover establishment particularly on sloping areas and this often occurs early in the revegetation process. Good groundcover is vital for stabilising rehab as it reduces the volume and velocity of surface runoff and the plant root mass stabilizes the soil. The volume and intensity of rainfall also affects the degree of erosion and scouring that occurs. High intensity rainfall events can result in excessive erosion and scouring in newly established rehabilitation where sub-optimal groundcover has occurred and where landform drainage structures such as contour banks, rock water ways and contour ripping have been installed incorrectly. However, an appropriately designed and implemented maintenance program can be used to repair excessive erosion as it occurs.

There was little erosion on the new sites rehabilitated in 2013. Some areas had minor sheet erosion but there were no gullies greater than 300mm, despite low levels of groundcover. This situation compared with the 2012 observations of erosion and scouring at 46 of the 100 spot sites across the rehabilitation areas (Photographs 1 – 3). Soil disturbance varied from minor sheet erosion that would be expected to self-repair with the ongoing establishment of groundcover, to gullying that can only be resolved with maintenance works. The largest erosion gullies that require maintenance intervention are located in the Pit 1 rehabilitation area associated with the longest and steepest slopes. This rehabilitation was completed in spring 2010 when a series of high intensity rainfall events (Table 2) occurred prior to the establishment of a stabilising groundcover regime. These erosion affected areas are shown in Figure 1.

This area will require maintenance intervention using imported benign fill, topsoil, re-establishment of drainage structures, seeding and fertilising. Incremental failure of this section of the rehabilitation is likely if maintenance work is not undertaken.

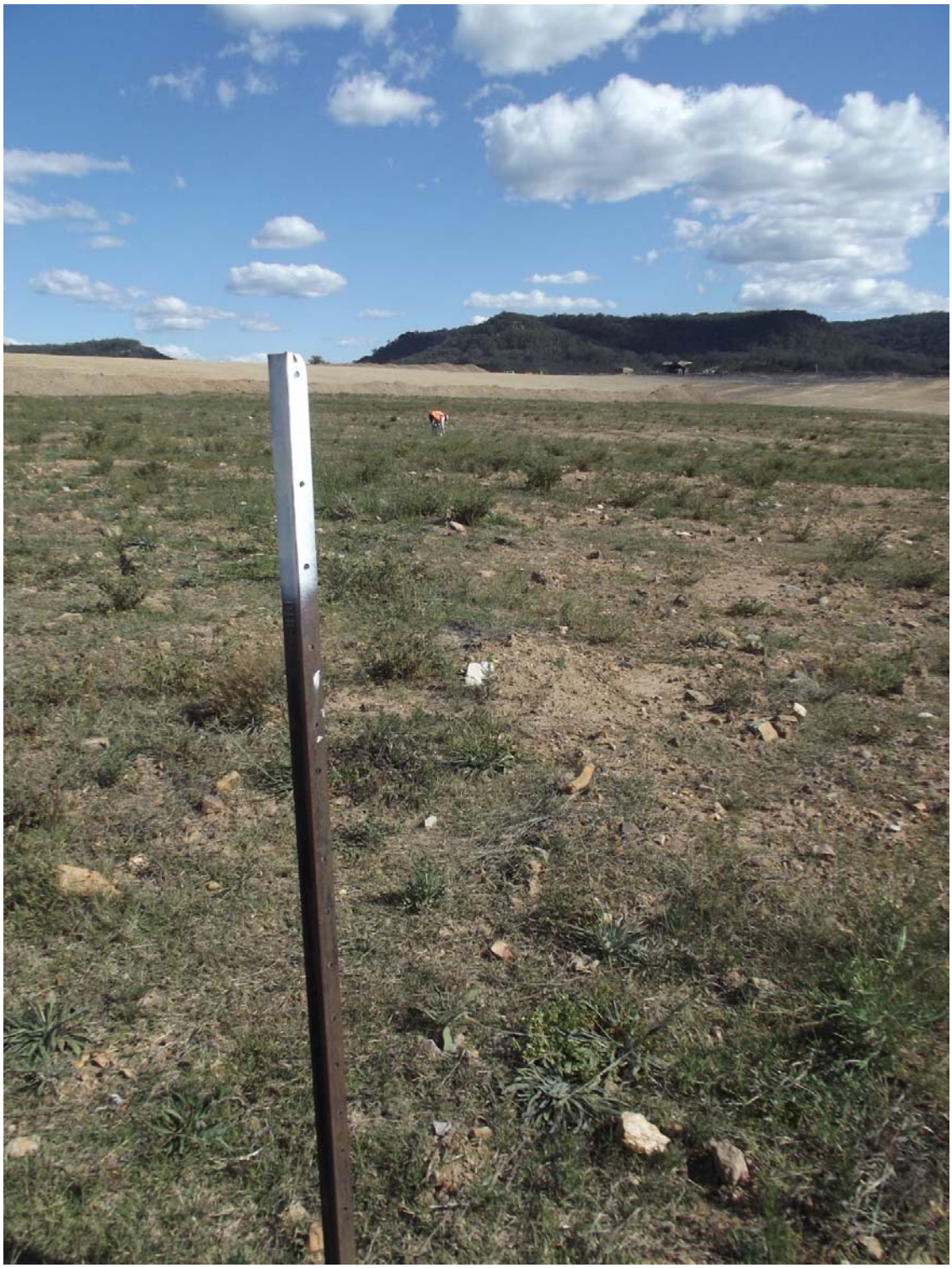
A good example of how these areas can be successfully repaired can be seen at site P1 13 in Pit 1 where a large gully was successfully repaired using imported benign fill in

combination with topsoil placement, drainage control, seeding and fertilising. Further erosion and scouring repairs are suggested above the high water margins of Lake Ed in Pit 1, though these areas will stabilize with reeds.

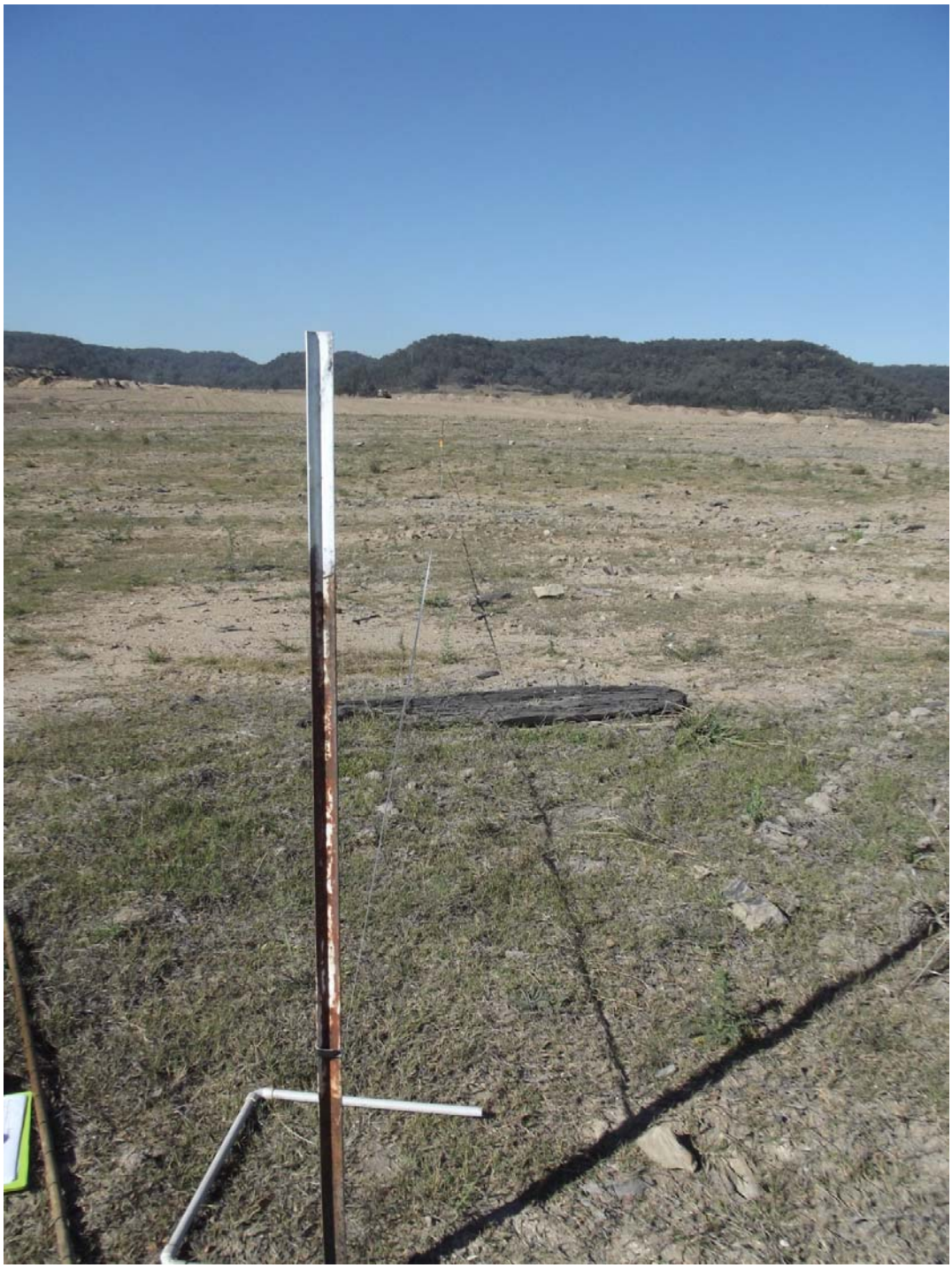
Poor soil fertility and/or low plant numbers occur in patches across the P1 and P2 areas, but are particularly obvious in parts of the P5 area (Photographs 5 – 7).

Apart from the above mentioned areas in Pit 1, the remainder of the rehabilitated areas across the WCPL site have minor to moderate examples of erosion and scouring. It is expected that these areas will stabilise naturally with increasing groundcover development. Maintenance fertilization will improve groundcover levels particularly in the 2013 rehabilitation areas. Annual monitoring should be carried out to determine whether these areas self-repair or require some level of maintenance.

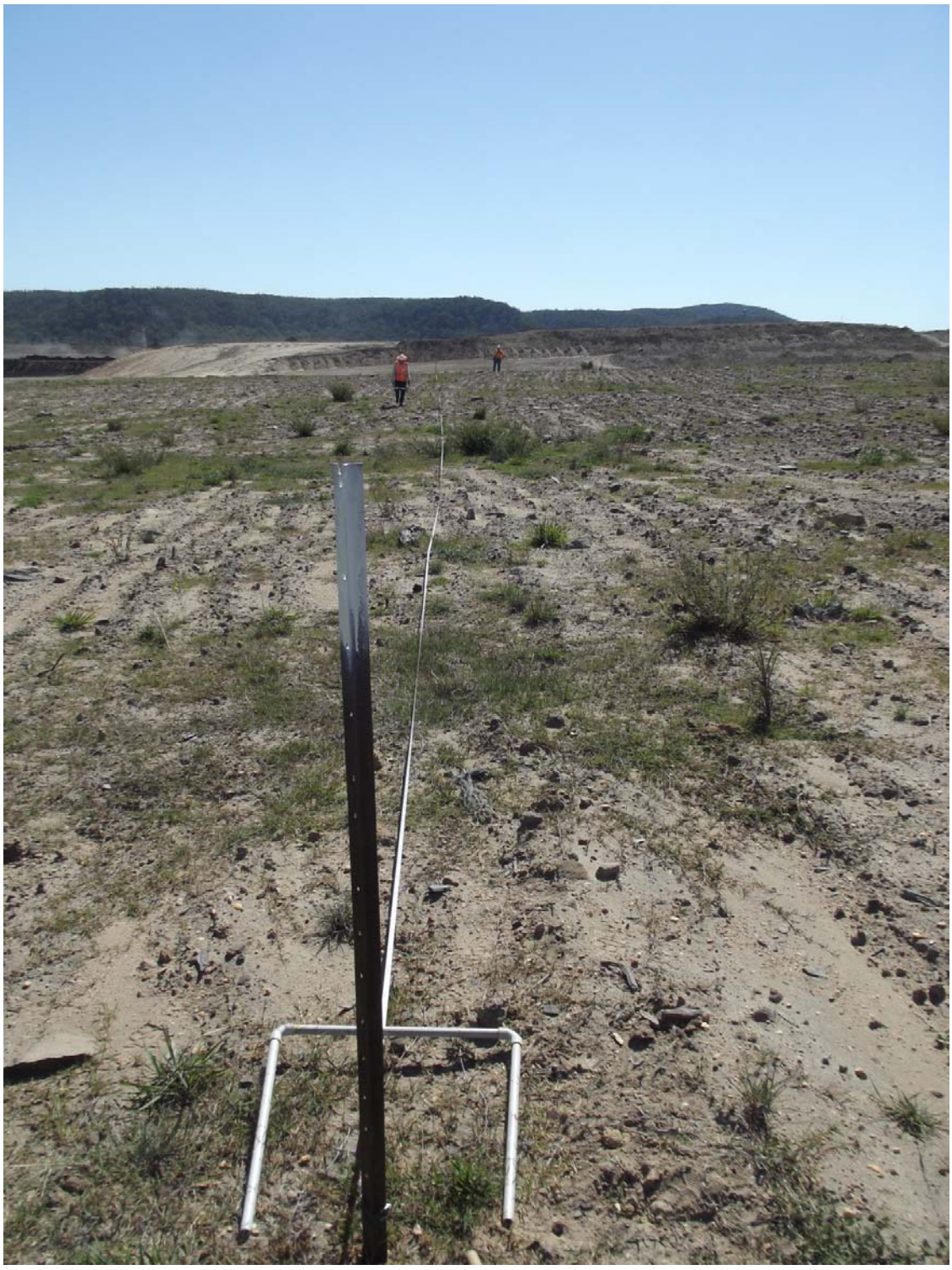
Photographs of poorly vegetated areas in late 2013



Photograph 1. Poor growth, but stable soil surface in the Pit 1/5 rehabilitation area



Photograph 2. Poor growth in the Pit 5 rehabilitation area



Photograph 3. Poorly vegetated area in the Pit 5 rehabilitation area

Photograph 4. Poor growth, but stable soil surface conditions area in the Pit 2 rehabilitation area assessed in 2012

5.3 Weeds

Weeds were observed across all areas of the WCPL rehabilitation areas in 2013, but there are few weeds present in the 2013 rehabilitation areas. The five weeds were:

- Saffron Thistle
- Scotch Thistle
- Bathurst Burr
- Paterson's Curse
- Blackberry

Saffron Thistle is the most pervasive across the site and was very common on the background grazing property prior to mining disturbance. It is a common weed throughout the Mid-Western Regional Council (MWRC) area in disturbed and heavily grazed areas. Seed can remain viable in the soil for more than a decade. Herbicides such as Grazon can be used for short term control of this weed but lenient grazing management practices during the summer growing season offer a more sustainable, cost-effective solution by encouraging desirable groundcover species to compete effectively to suppress the weed.

Saffron Thistle was introduced into the rehabilitated areas through the re-use of stripped topsoil. The WCPL mining lease (ML) area had been heavily grazed prior to mining and a protracted drought up until 2007 meant that groundcover levels were low. These conditions were ideal for the establishment and spread of Saffron Thistle and the resultant build up of seed in the soil.

A lower occurrence of Scotch Thistle, Bathurst Burr and Paterson's Curse was recorded in the rehabilitation areas compared with the ECA areas and surrounding grazing country. A similar control strategy for Saffron Thistle of outcompeting weeds by promoting vigorous pasture growth will be effective. However, herbicide spot-spraying should be considered for eradication of Blackberry.

5.4 Vegetation

The establishment and maintenance of high levels of ground cover is essential for maintaining surface stability of rehabilitated land and to encourage rainfall infiltration and thereby reduce runoff. The establishment of ground cover has been achieved largely by the use of introduced pasture species such as Rhodes grass, Phalaris, Consul Love grass and sub clover. In 2013 an N:P:S fertiliser mix, *Starter 15* was applied at a very low rate of 70kg/ha resulting in variable groundcover % and yield. The grass mix was applied at a rate of 15 kg/ha and complemented with a mixture of Acacia and Eucalypt species. Rough Barked Apple should be added to the seed mixture particularly in low lying areas.

Unfortunately, there are no records of the shrub and tree species used in the rehabilitation to 2013.

Groundcover across the 2013 rehabilitation areas was consistent in that the groundcover was variable and the yields were generally low, and so detailed observations were not carried out as was the case in 2012. A series of photographs show the poor vigour of the 2013 rehabilitation areas. Although growth was poor there was little surface erosion, and this can be attributed to the late seeding time (March 2013) and low rainfall.

5.5 Soil fertility and chemistry

Soil analyses conducted at six rehabilitation sites in 2013 showed that the soils had optimum pH, but that Colwell phosphorus (5-21mg/kg) was sub-optimal for plant growth (Table 3). Rehabilitation sites R1-R7 sampled in 2012 were certainly phosphorus deficient, but were also strongly acid and sodic. Liming at a rate of 2.5 tonnes per hectare is recommended to raise pH to around pH 6.5 and reduce sodicity.

Prior to the summer growing season in 2014, an additional application of *Starter 15* fertiliser (230 kg/ha) is recommended for all rehabilitation areas to provide nitrogen and phosphorus. *Starter 15* fertiliser contains 14%N, 12.7%P and 11%S.

Table 3. Fertility analyses in surface soil (0-10cm) for the rehabilitation sites.

		2012								2013						
ECA Area		R1	R2	R3	R4	R5	R6	R7	Rehab. Range	R8	R9	R10	R11	R12	R13	Rehab. Range
pH (H2O)		5.5	5.5	5.4	5.5	5.5	6.4	6.7	5.4 - 6.7	6.9	6.3	5.8	6.4	6.0	5.9	5.8 - 6.9
pH ($CaCl_2$)		4.9	4.3	4.8	4.8	4.8	5.7	6.0	4.3 - 6.0	-	-	-	-	-	-	-
EC	µS/cm	200	45	320	200	190	110	140	45 - 320	34	130	89	33	94	78	33 - 130
Cl	mg/kg	230	16	260	180	130	57	67	16 - 260	-	-	-	-	-	-	-
Total N	mg/kg	1400	1800	780	890	950	850	700	700 - 1800	920	580	470	690	680	1100	580 - 1100
Organic matter	%	3.1	4.3	2.1	2.4	2.0	2.0	2.5	2 - 4.3	2.1	2.1	1.6	1.7	1.4	2.9	1.4 - 2.9
Colwell P	mg/kg	5	8	4	32	4	9	5	4 - 32	16	4	7	21	11	5	5 - 21
SO4- S	mg/kg	30	10	140	63	52	27	55	10 - 140	42	11	25	13	16	24	11 - 42
Exch Ca	meq%	3.9	2.9	2.3	2.8	2.4	4.2	3.9	2.3 - 4.2	9.3	3.5	2.3	4.0	3.0	3.4	2.3 - 9.3
Exch Ca %	%	55	53	33	37	41	53	44	32 - 55	71	61	54	61	67	46	46 - 71
Exch Mg	meq%	1.8	1.6	3.2	3.4	2.5	2.7	3.8	1.6 - 3.8	2.8	1.6	1.4	1.8	0.9	2.9	0.9 - 2.9
Exch Mg %	%	25.2	30.1	45	45.2	42.3	33.9	43.2	25 - 45	21.4	27.8	31.9	27.8	20.0	40.1	20 - 40
Exch K	meq%	0.82	0.68	0.39	0.59	0.52	0.68	0.49	0.4 - 0.8	0.76	0.47	0.37	0.61	0.47	0.71	0.4 - 0.8
Exch K %	%	11.7	12.7	5.6	7.8	8.8	8.6	5.5	6 - 13	5.8	8.2	8.6	9.2	10.5	9.7	6 - 11
Exch Na	meq%	0.54	0.21	1.2	0.75	0.49	0.4	0.68	0.2 - 1.2	0.28	0.19	0.23	0.15	0.10	0.31	0.1 - 0.3
Exch Na %	%	7.8	3.9	16.9	9.9	8.3	5	7.7	4 - 17	2.2	3.2	5.4	2.2	2.3	4.2	2 - 5
CEC	meq%	7	5	7	8	6	8	9	5 - 9	13	6	4	7	5	7	4 - 13
Exch Al	meq%	0.01	0.53	0.02	0.06	0.03	0.01	0.01	0.01 - 0.53	0	0	0	0	0	0	0
Exch Al	%	0.1	9.8	0.3	0.8	0.5	0.1	0.1	0.1 - 9.8	0	0	0	0	0	0	0
Ca/Mg		2.2	1.8	0.7	0.8	1.0	1.6	1.0	0.7 - 2.2	3.3	2.2	1.6	2.2	3.4	1.2	1.2 - 3.4
Cu	mg/kg	1.8	2.1	1.7	0.78	0.69	2.7	2.6	0.7 - 2.7	0.54	0.43	0.34	0.75	0.51	1.0	0.3 - 1.0
Zn	mg/kg	3.5	3.8	1.2	0.51	0.94	1.9	1.6	0.5 - 3.8	0.94	1.1	0.83	0.75	0.90	1.7	0.8 - 1.7

6.0 Final land use implementation and ML relinquishment

The following section outlines suggestions and strategies for implementing the woodland and grazing final land use at WCPL and ML relinquishment. This includes discussions on the following issues:

- Topsoil stripping and management
- Implementation of the final landform land use
- Rehabilitation completion criteria
- Mining lease relinquishment strategy

6.1 Topsoil stripping and management

A topsoil stripping and management strategy should take into consideration the following key principles

- Strip and place topsoil directly onto reshaped spoil areas.
- If direct placement of topsoil is not possible then stockpile topsoil in areas that minimise rehandling.
- Minimise topsoil height. The WCPL Rehabilitation Management Plan requires topsoil stockpiles of less than 3m height to allow rainfall infiltration and some degree of aeration

  Rip, seed and fertilize all stockpiles to encourage water infiltration and to maintain biological processes.
- Maintain a topsoil volume inventory to ensure sufficient topsoil is available for future rehabilitation.

6.2 Implementation of the final landform land use

The proposed post-mining land use for the WCPL mine site was originally set out in the WCPL Environmental Impact Statement. The final land use is a component of the overall Project vegetation offset strategy, which aims to produce a net increase in woodland vegetation and to increase the continuity of woodland wildlife corridors between the Munghorn Gap Nature Reserve and the Goulburn River National Park. Areas between

woodland wildlife corridors on the Mining Lease will be used for grazing. The final land use will therefore be a combination of wildlife corridors and grazing.

The implementation of the proposed post-mining land use necessarily requires each of the 6 Pit areas to be divided into sections for grazing and woodland. The approximate breakdown of woodland and grazing land for each pit area (Pits 1, 2, 3, 4, 5 and 6) is set out below in the Table 4.

Table 4 Allocation of land use (%) to rehabilitation land

Pit	Woodland	Grazing
1	50	50
2	30	70
3	60	40
4	30	70
5	80	20
Average	45	55

Woodland areas will have a greater density of trees and understorey vegetation whereas grazing areas will be predominantly made up of grasslands with a lower tree density. Trees in grazing areas will be used for livestock and fauna shelter. It is recommended that all areas with slopes equal to or steeper than 1:6 have a woodland post-mining land use as these areas are more prone to erosion and instability if overgrazed in the future.

The mining process on the other hand involves the mining of the entire pit area within the pit boundary but areas are allocated to provide a combination of woodland and grazing areas that fit within the surrounding country. The allocated percentages of woodland and grazing areas for each pit area across the WCPL operation are shown in Table 4.

This presents a challenge during the seeding component of the rehabilitation process as the woodland and grazing boundaries do not conform with the landform contour whereas ripping and seeding needs to occur on the contour. Seeding could be done by using separate seed mixes for woodland and grazing areas. However, it would be difficult or impractical to have to change seed mixes from the woodland (higher tree seeding rate) to the pasture grazing mix (higher grass seeding rate) during a seeding run along the contour of the reshaped landform.

The most practical way of implementing the post-mining land use strategy is to seed rehabilitated areas with a single seed mix which is a combination of pasture and tree species as has been done successfully in Pits 1, 2, and 5. Fencing of the woodland/grazing boundaries can commence once rehabilitated areas are mature enough to be grazed by stock. Stock grazing will reduce the number of trees in designated grazing areas. However, woodland areas should have stock excluded until trees are mature enough to withstand damage that can be caused by grazing stock. Stock grazing is therefore used as a management strategy to control tree density in rehabilitation areas. The decision to commence grazing would be based on rehabilitated areas achieving the performance criteria set out in Table 5.

Table 5 Performance criteria to be achieved for 5 years prior to grazing

Grazing Criteria	Performance Indicator
Groundcover %	>80%
Groundcover species number	>3
Groundcover species (% perennial)	>50
Dry matter yield (kg/ha)	>2000
Landform stability	No erosion gullies greater than 0.5m wide x 0.5 m deep
Soil chemistry	pH (H_2O) of 6.5 – 8.0, EC < 300µS/cm, Colwell P >30mg/kg

It is recommended that a sustainable stocking rate for cattle be based on the utilization of no more than 50% of available pasture. This will require the development of a practical grazing management plan comprising cattle management (grazing management, water point distribution, fencing and fertilization). It is suggested that cattle grazing initially be undertaken using a put-and-take grazing system, then moving long term to rotational grazing to maintain pasture cover and diversity. Woodland areas would be leniently grazed to avoid damage to maturing trees. However, short term grazing should be considered as a bushfire management strategy. Vegetation and soil fertility monitoring and management will provide a basis for sustainable grazing management.

Delineation of fencing boundaries between woodland and grazing areas can be achieved by using the originally proposed land use boundaries set out in the WCPL Environmental Impact Study to separate woodland areas from grazing areas. Fencing will need to allow for

topography, land form shape and the practicality for moving cattle. Fencing could commence once there is a suitably sized area to justify the time and cost required for fencing and stock management. A suitable area would be at least 20-30 hectares.

6.3 Rehabilitation completion criteria

The WCPL Rehabilitation Management Plan (RMP Tables 11 and 12) set out tentative completion criteria for rehabilitation areas, regeneration areas, ECA's (including WBYBBRG EEC) and ECA's (excluding WBYBBRG EEC). The following section focuses on completion criteria for rehabilitation areas only, that is, woodland and grazing areas on the mining lease.

The current completion criteria set out in Table 12 of the WCPL RMP only lists criteria for woodlands. This should be expanded to include criteria for grazing areas. The grassland criteria for grazing will differ from the woodland criteria due to lower trees and understory species density and more stringent requirements for groundcover. Suitable criteria for grasslands with a grazing final land use would be percentage groundcover, number of groundcover species, percentage of perennial species, dry matter yield, erosion status and soil fertility. Recommended criteria for grassland grazing areas prior to grazing are given in Table 5.

The current completion criteria in the WCPL RMP are time based to achieve completion criteria at set intervals of 1, 5 and 15 years. This time based process was based on achieving criteria such as groundcover, groundcover species, woody plant stem density and woody plant diversity. These criteria are considered to be appropriate for assessing the success of newly created vegetation communities and are based on what would be expected in naturally regenerating systems. However, rehabilitation of mine spoil involves assisting vegetation communities to establish faster than naturally regenerating areas through the use of topsoil placement, ripping, drainage control, targeted seeding, fertilization, monitoring and maintenance. This means that rehabilitated areas will regenerate faster than naturally regenerating areas.

It is therefore suggested that the time based time frames in the current WCPL RMP be changed to a milestone based process as set out below.

- **Milestone 1** – Vegetation completion criteria that would be expected to be achieved in a naturally revegetating system after 1 year
- **Milestone 2** – Vegetation completion criteria that would be expected to be achieved in a naturally revegetating system after 5 years
- **Milestone 3** – Vegetation completion criteria that would be expected to be achieved in a naturally revegetating system after 15 years

Table 6 below sets out a suggested table to replace Table 12 in the WCPL RMP and includes completion criteria for grazing areas as well as a milestone based process to replace the current time based process.

Table 6. Proposed WCPL RMP Completion Criteria (from RMP)

Mine Component	Quantitative Completion Criteria		
	Milestone 1	**Milestone 2**	**Milestone 3**
Rehabilitation Areas - Woodland	• Ground > 80% • Groundcover species > 3 • Stem density of woody plants > 300 stems /ha • Woody plant diversity >3 upper storey species and > 3 under storey species • Erosion less gullies < 0.5m wide and 0.5m deep	• Groundcover > 80% • Groundcover species > 3 • Stem density of woody plants > 100 stems/ha • Woody plant diversity > 3 upper storey species and > 3 under storey species • Erosion less gullies < 0.5m wide and 0.5m deep	• Groundcover > 80% • Groundcover species > 3 • Stem density of woody plants > 800 stems/ha or similar to that in analogue site • Woody plant diversity > 3 upper storey species and > 3 under storey species • Natural regeneration woody species > 10 stem/ha • Erosion less gullies < 0.5m wide and 0.5m deep • Soil chemistry parameters similar to those on analogue sites
Rehabilitation Areas - Grazing	• Groundcover > 80% • Groundcover Species >3 • Dry matter yield >2000kg/ha • Erosion less gullies < 0.5m wide and 0.5m deep • Soil chemistry pH 6.5 – 8 and EC < 500µS/cm Colwell P >30mg/kg • ESP<6%	• Groundcover > 80% • Groundcover Species >3 • Dry matter yield >2000kg/ha • Erosion less gullies < 0.5m wide and 0.5m deep • Soil chemistry pH 6.5 – 8 and EC <300µS/cm Colwell P >30mg/kg • ESP<6%	• Groundcover > 80% • Groundcover Species >3 • Dry matter yield >2000kg/ha • Erosion less gullies < 0.5m wide and 0.5m deep • Soil chemistry pH 6.5 – 8 and EC<300µS/cm Colwell P >30mg/kg • ESP<6%

Mine Component	Quantitative Completion Criteria		
	Milestone 1	**Milestone 2**	**Milestone 3**
Regeneration Areas	• Groundcover > 60% • Groundcover species > 3 • Stem density of woody plants > 100 stems/ha • Woody plant diversity > 3 upper storey species and > 3 under storey species	• Groundcover > 60% • Groundcover species > 3 • Stem density of woody plants > 100 stems/ha • Woody plant diversity > 3 upper storey species	• Groundcover > 60% • Groundcover species > 3 • Stem density of woody plants > 800 stems/ha or similar to that in analogue site • Woody plant diversity > 3 upper storey species and > 3 under storey species • Natural regeneration woody species > 10 stem/ha • Similar species occurrence to adjacent reference sites • Soil chemistry parameters similar to those on analogue sites
Enhancement and Conservation Areas – Enhancement of existing remnant vegetation (including WBYBBRG EEC)	• Groundcover > 60% • Groundcover species > 4 • Stem density of woody plants > 500 stems/ha • Woody plant diversity > 3 under storey species	• Groundcover > 60% • Groundcover species > 4 • Stem density of woody plants > 500 stems/ha • Woody plant diversity > 3 upper storey species and > 3 under storey species	• Groundcover > 60% • Groundcover species > 3 • Stem density of woody plants > 800 stems/ha • Woody plant diversity > 3 upper storey species and > 3 under storey species • Natural regeneration woody species > 10 stem/ha • Similar species occurrence to adjacent reference sites • Soil chemistry parameters similar to those on analogue sites

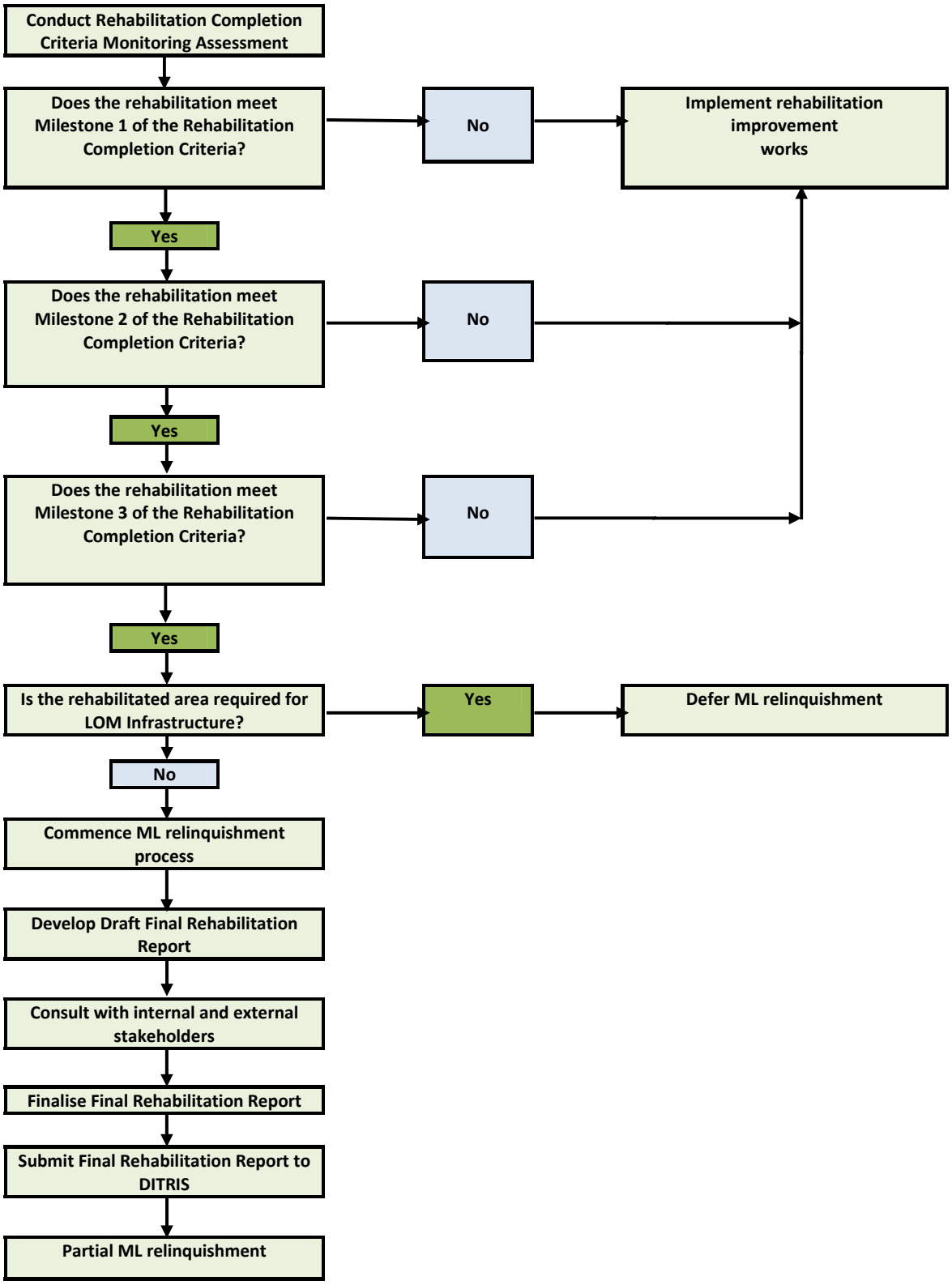
Mine Component	Quantitative Completion Criteria		
	Milestone 1	**Milestone 2**	**Milestone 3**
Enhancement and Conservation Areas – Enhancement of existing remnant vegetation (including WBYBBRG EEC)	• Groundcover > 60% • Groundcover species > 3 • Stem density of woody plants> 500 stems/ha • Woody plant diversity > 3 upper storey species and > 3 under storey species	• Groundcover > 60% • Groundcover species > 3 • Stem density of woody plants > 500 stems/ha • Woody plant diversity > 3 upper storey species and > 3 under storey species	• Groundcover > 60% • Groundcover species > 3 • Stem density of woody plants > 500 stems/ha • Woody plant diversity> 3 upper storey species and > 3 under storey species • Natural regeneration woody species > 10 stem/ha • Similar species occurrence to adjacent reference sites • Soil chemistry parameters similar to those on analogue sites

6.4 Mining lease relinquishment strategy

Mine site rehabilitation at Wilpinjong Coal commenced in 2008 in the northern area of Pit 1. Progressive annual rehabilitation has been ongoing. The rehabilitation in some areas has reached a level of maturity where meaningful comparisons between the rehabilitation and completion criteria can now be done. At this stage of the mine life it is only possible to proceed with partial lease relinquishment as there is still a considerable period of mining remaining which requires that the majority of the ML area will need to be held. A partial lease relinquishment involves relinquishing areas of the ML that are not required for current or future mining. This process will result in the refund of a portion of the security deposit held by the state government.

A comparison of rehabilitation with completion criteria will determine whether the rehabilitation has reached the necessary completion criteria in Table 12 of the WCPL RMP or whether some form of intervention is required to reach the completion criteria standard. This assessment should be done as part of the 2014 annual rehabilitation vegetation monitoring. The rehabilitation assessment can be based on the decision making process set out in Chart 1 below.

Chart 1 – Mining Lease Relinquishment Decision Making Process



7.0 Conclusions

A thorough assessment of current rehabilitation areas shows that the rehabilitation program has progressed successfully. Fixed monitoring transects show that the groundcover is stable, ground cover is adequate and trees and shrubs have colonized the areas. An additional broad assessment of the rehabilitation areas in late 2012 showed that there were some areas of significant erosion often associated with contour banks that had failed. Groundcover was extremely variable, but generally adequate (60%) and there were significant areas showing signs of nutrient deficiency. Deficiency of nitrogen, phosphorus were observed and soil tests also show soil acidity and sodicity will be restricting plant growth. It is recommended that additional nitrogen and phosphorus fertilizer be applied ahead of the 2013/14 summer season and the use of lime across all rehabilitation areas where soil pH (H_2O) is less than 6.5. Areas rehabilitated in March 2013 required a further 230 kg/ha be applied in 2014 and again after three years.

A set of rehabilitation success criteria have been developed for the areas being rehabilitated to a grazing land use and success criteria for all forms of rehabilitation should be tested during the annual monitoring program timed for September 2014 to see which areas meet the success criteria.

LANDLINE CONSULTING

Dr Mike Gilbert

APPENDIX 1

DETAILED SITE DATA FROM VEGETATION MONITORING SITES R1 – R13

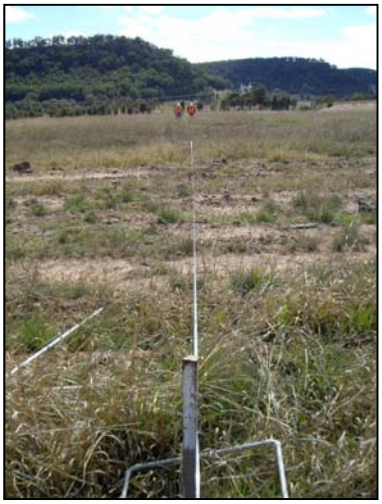
Grid: GDA94 Zone 55 770482 6419353	**Location:** Rehabilitation site **(Pit 1)**	**Site:** *R1*

Site Description

Rehabilitated mine spoil site seeded in 2008 on low slope (<2%).

2010

2009



2011

2012

2013

Ground layer characteristics at R1

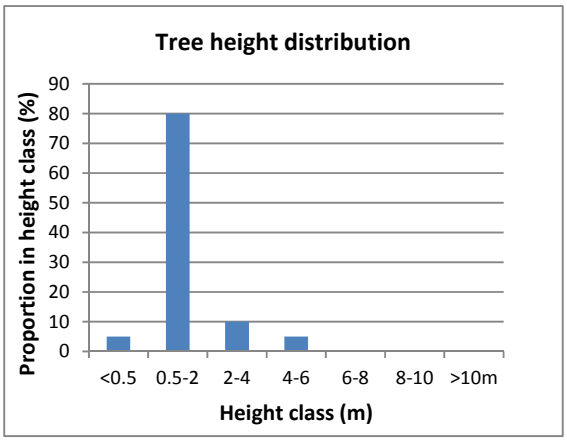
	Cover (%)				Yield	Erosion
	Standing	Litter	Rock	Bare	(kg/ha)	(0-5)
2013	80	17	2	2	2910	0.0
2012	80	17	1	3	2880	0.0
2011	79	19	0	2	2110	0.0
2010	55	33	4	9	2295	0.0

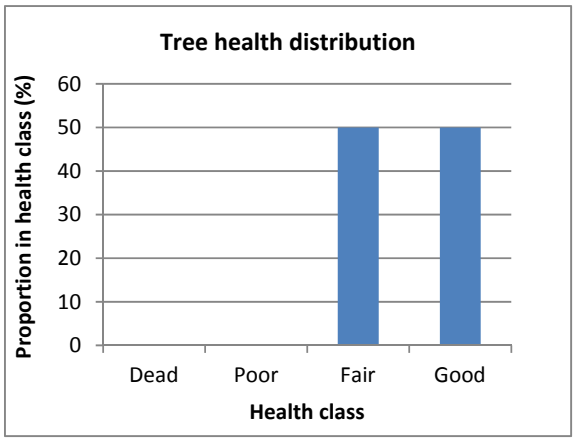
Species %	2013
Phalaris aquatica	34
Chloris gayanus rhodes grass	32
Eragrostis curvula cv Consol	28
Other forbs	4
Taraxacum officinale Dandelion	1
Lolium rigidum	1
Conyza bonariensis Flaxleaf fleabane	1

Tree and shrub layer characteristics at R1

	Density (stems/ha)				Height	Health
	Myrtaceae	Acacia	Others	Total	(m)	(0-5)
2013	467	207	667	1340	1.4	3.4

Tree layer composition %	2013
Cassinia arcuata	45
Eucalyptus blakelyi	20
E. crebra narrow-leafed ironbark	15
A. linearifolia	10
A. ixiophylla	5
Rosa sp. Wild rose	5





Grid: GDA94 Zone 55 770373 6419421	**Location:** Rehabilitation site (Pit 1)	Site: *R2*

Site description
Rehabilitated mine spoil site seeded in 2008 on low slope (<2%).

2010

2009

2011

2012

2013

Ground layer characteristics at R2

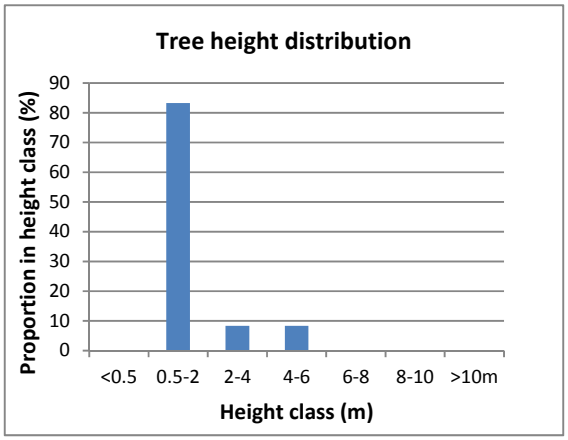
	Cover (%)				Yield	Erosion
	Standing	Litter	Rock	Bare	(kg/ha)	(0-5)
2013	74	17	3	7	2480	0.0
2012	68	15	5	13	1710	0.0
2011	68	15	6	11	1610	0.0
2010	51	27	5	17	1500	0.0

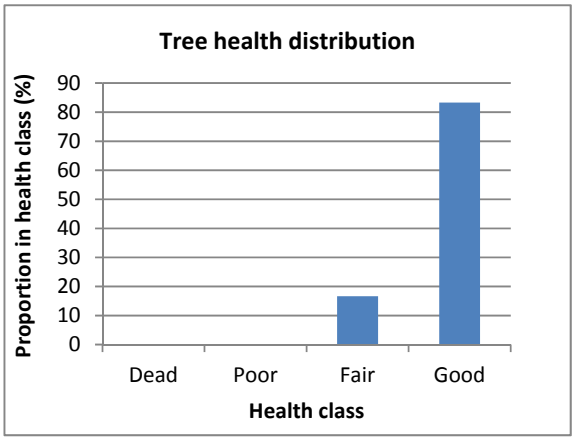
Species %	2013
Plantago lanceolata	45
Eragrostis curvula cv Consol	34
Chloris gayanus rhodes grass	21
Verbena officinalis	0

Tree and shrub layer characteristics at R2

	Density (stems/ha)				Height	Health
	Myrtaceae	Acacia	Others	Total	(m)	(0-5)
2013	600	0	1000	1600	1.8	3.8

Tree layer composition %	2013
Cassinia arcuata	58
Eucalyptus blakelyi	17
E. crebra	13
E. melliodora	8
Other species	4

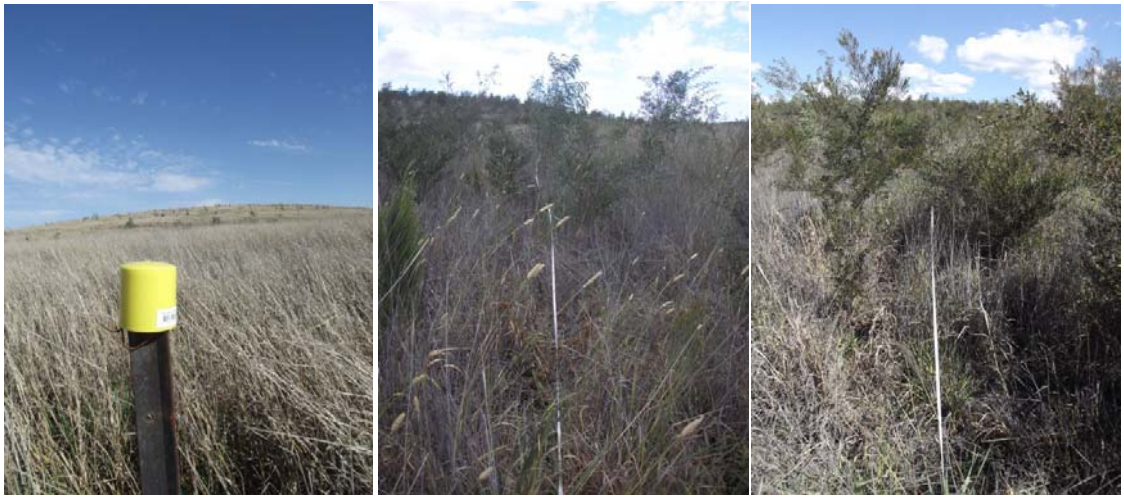




Grid: GDA94 Zone 55 770360 6419262	**Location:** Rehabilitation site (Pit 1)	Site: *R3*

Site description
Rehabilitated mine spoil site seeded in April 2010 on low slope (3-5%).

2011 2012 2013



Ground layer characteristics at R3

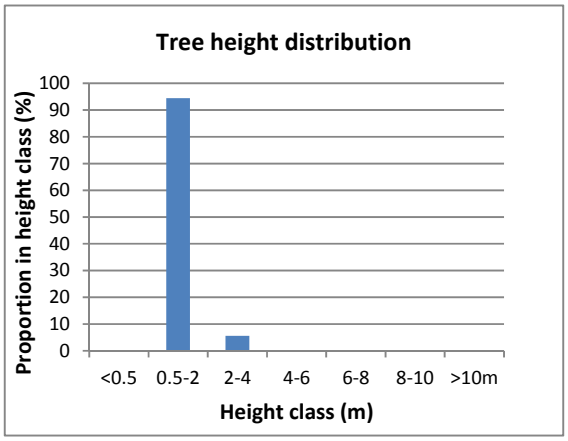
	Cover (%)				Yield	Erosion
	Standing	Litter	Rock	Bare	(kg/ha)	(0-5)
2013	82	18	0	0	3956	0.0
2012	77	14	3	6	1900	0.0
2011	84	12	0	4	2110	0.0
2010	80	7	3	10	1150	0.0

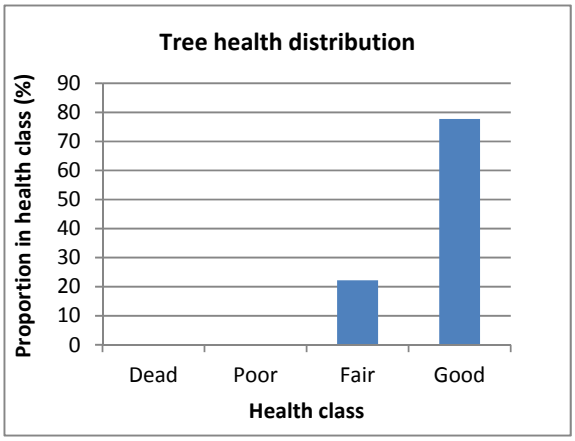
Species %	2013
Chloris gayanus rhodes grass	56
Phalaris aquatica	40
Onopordum acanthium Scotch thistle	4
Plantago lanceolata	1

Tree and shrub layer characteristics at R3

	Density (stems/ha)				Height	Health
	Myrtaceae	Acacia	Others	Total	(m)	(0-5)
2013	67	940	533	1540	1.6	3.8

Tree layer composition %	2013
Other Acacias	48
Cassinia arcuata	35
A. linearifolia	9
Acacia implexa	5
Eucalyptus blakelyi	4





Grid: GDA94 Zone 55 770353 6419152	**Location:** Rehabilitation site (Pit 1)	Site: *R4*

Site description
Rehabilitated mine spoil site seeded in April 2010 on slope of approximately 7%

2011

2010

2012

2013

Ground layer characteristics at R4

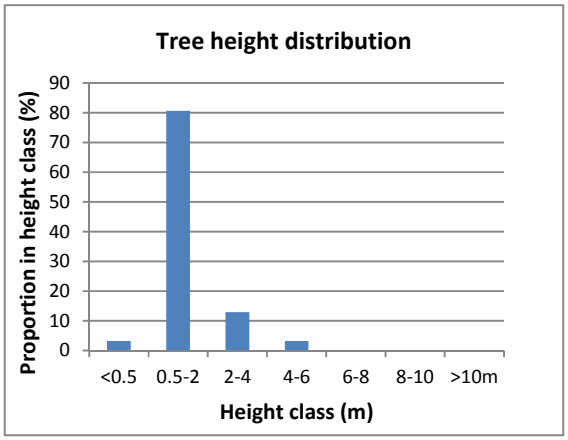
	Cover (%)				Yield	Erosion
	Standing	Litter	Rock	Bare	(kg/ha)	(0-5)
2013	56	20	18	7	1410	0.1
2012	53	9	22	17	765	0.8
2011	48	12	15	26	896	1.6
2010	50	4	17	29	247	1.4

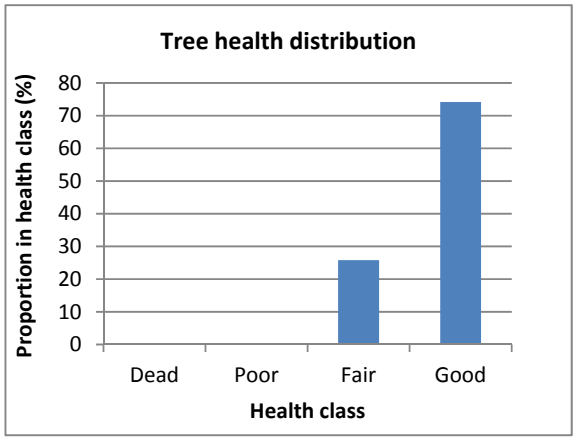
Species %	2013
Chloris gayanus rhodes grass	86
Eragrostis curvula cv Consol	13
Cassinia arcuata	1

Tree and shrub layer characteristics at R4

	Density (stems/ha)				Height	Health
	Myrtaceae	Acacia	Others	Total	(m)	(0-5)
2013	1000	941	1467	3407	1.5	3.7

Tree layer composition %	2013
Cassinia arcuata	43
Eucalyptus blakelyi	22
Other Acacias	14
A. ixiophylla	8
A. linearifolia	4
E. crebra	4
Acacia implexa	2
E. moluccana	1
Other Eucalypts	1



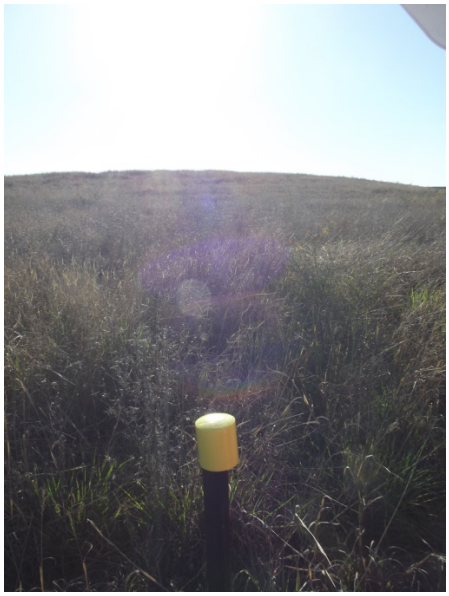


Grid: GDA94 Zone 55 770234 6419256	**Location:** Rehabilitation site (Pit 1)	Site: *R5*

Site description

Rehabilitated mine spoil site seeded in April 2010 on slope of approximately 7%

2011



2010

2012

2013

Ground layer characteristics at R5

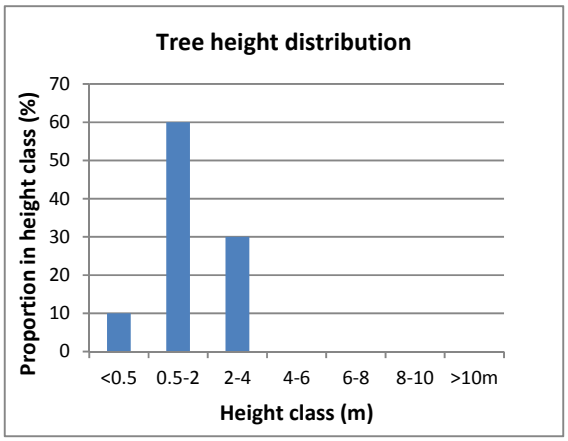
	Cover (%)				Yield	Erosion
	Standing	Litter	Rock	Bare	(kg/ha)	(0-5)
2013	63	12	12	14	1830	0.0
2012	59	8	19	15	1345	0.1
2011	59	10	10	22	1110	0.9
2010	58	7	15	20	255	0.7

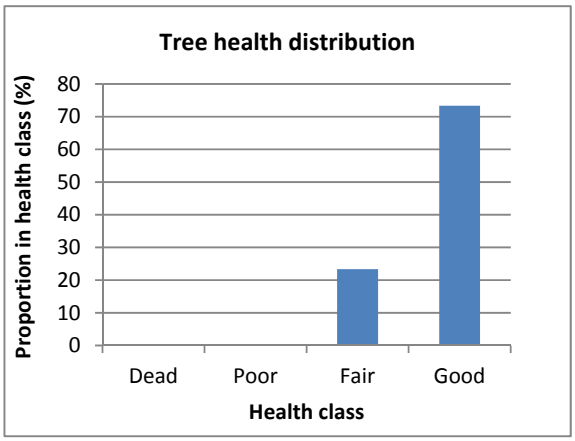
Species %	2013
Phalaris aquatica	53
Chloris gayanus rhodes grass	38
Plantago lanceolata	7
Eragrostis curvula cv Consol	2
Cassinia arcuata	1

Tree and shrub layer characteristics at R5

	Density (stems/ha)				Height	Health
	Myrtaceae	Acacia	Others	Total	(m)	(0-5)
2013	567	1473	0	2041	1.7	3.8

Tree layer composition %	2013
Other Acacias	46
Acacia implexa	13
Eucalyptus blakelyi	11
E. melliodora	10
Acacia decora	10
A. ixiophylla	4
E. crebra	3
E. albens	1





Grid: GDA94 Zone 55 769562 6419517	**Location:** Rehabilitation site (Pit 1)	Site: *R6*

Site description

Rehabilitated mine spoil site seeded in December 2010 on slope of <1%

2011

2012

2013

Ground layer characteristics at R6

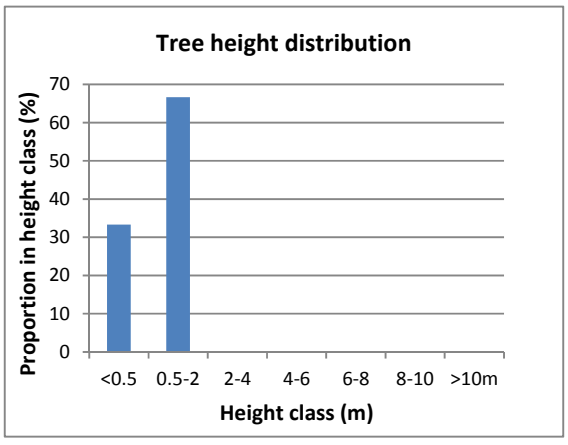
	Cover (%)				Yield	Erosion
	Standing	Litter	Rock	Bare	(kg/ha)	(0-5)
2013	75	7	2	17	2830	0.0
2012	64	7	11	19	1272	0.0
2011	40	0	11	50	526	0.0

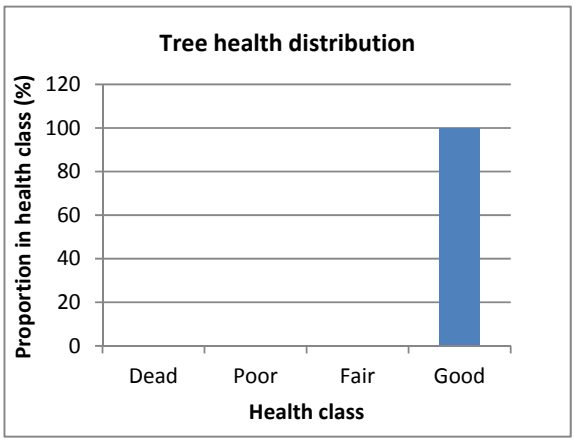
Species %	2013
Eragrostis curvula cv Consol	41
Chloris gayanus rhodes grass	35
Phalaris aquatica	12
Other forbs	6
Lolium perenne	4
Daucus glochidiatus (native carrot)	1
Verbena officinalis	1

Tree and shrub layer characteristics at R6

	Density (stems/ha)				Height	Health
	Myrtaceae	Acacia	Others	Total	(m)	(0-5)
2013	133	67	0	200	0.8	4.0

Tree layer composition %	2013
E. moluccana	67
Acacia ixiophylla	33





Grid: GDA94 Zone 55 769666 6419383	**Location:** Rehabilitation site (Pit 1)	Site: *R7*

Site description

Rehabilitated mine spoil site seeded in February 2011. Transect across a slope of approximately 5%

2011

2012

2013

Ground layer characteristics at R7

	Cover (%)				Yield	Erosion
	Standing	Litter	Rock	Bare	(kg/ha)	(0-5)
2013	69	12	9	11	2135	0.0
2012	63	4	14	20	1315	0.0
2011	67	1	7	25	950	0.0

Species %	2013
Chloris gayanus rhodes grass	51
Eragrostis curvula cv Consol	21
Phalaris aquatica	12
Plantago lanceolata	8
Lolium perenne	5
Trifolium repens	2
Echium plantagineum Salvation Jane	1

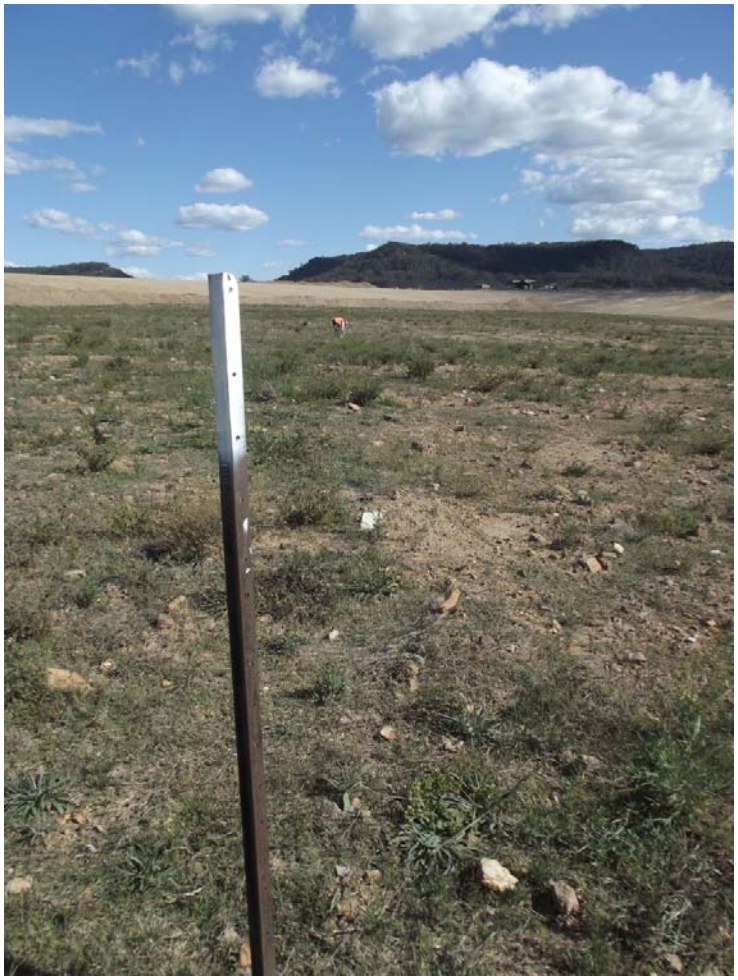
Tree and shrub layer characteristics at R7

	Density (stems/ha)				Height	Health
	Myrtaceae	Acacia	Others	Total	(m)	(0-5)
2013	0	0	0	0		

Grid: GDA94 Zone 55 770231 6418596	**Location:** Rehabilitation site (Pit 1)	Site: *R8*

Site description
Rehabilitated mine spoil site seeded in early 2013. Slope of 5%

2013



Ground layer characteristics at R8

	Cover (%)				Yield	Erosion
	Standing	Litter	Rock	Bare	(kg/ha)	(0-5)
2013	55	2	12	32	290	1.1

Species %	2013
Cynodon dactylon green couch	29
Plantago lanceolata	21
Geranium solanderi	16
Phalaris aquatica	16
Capsella bursa-pastoris shepherds purse	8
Lolium rigidum	7
Anagallis arvensis pimpernel	2
Other forbs	1

Tree and shrub layer characteristics at R8

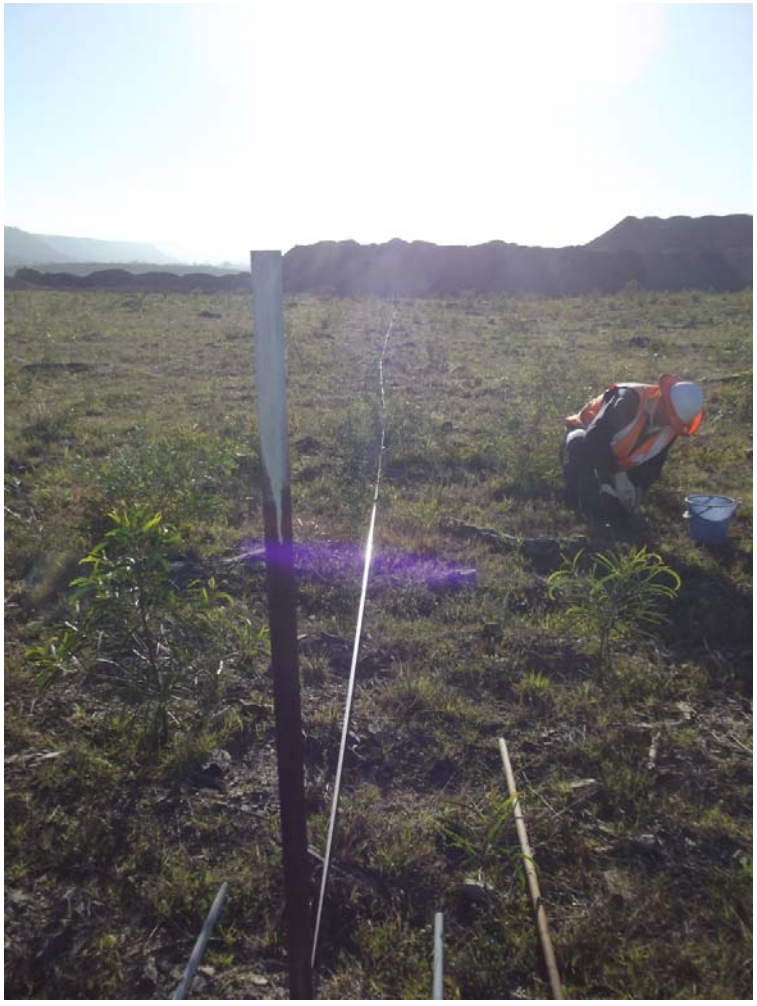
	Density (stems/ha)				Height	Health
	Myrtaceae	Acacia	Others	Total	(m)	(0-5)
2013	0	0	0	0		

Grid: GDA94 Zone 55 769118 6418973	**Location:** Rehabilitation site (Pit 1)	Site: *R9*

Site description

Lightly ripped rehabilitated mine spoil site with logs and rocks. Seeded in early 2013 on a slope of <1%

2013



Ground layer characteristics at R9

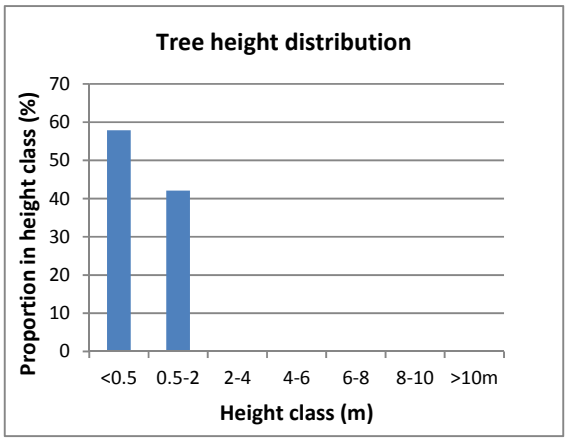
	Cover (%)				Yield	Erosion
	Standing	Litter	Rock	Bare	(kg/ha)	(0-5)
2013	58	14	18	11	160	0.0

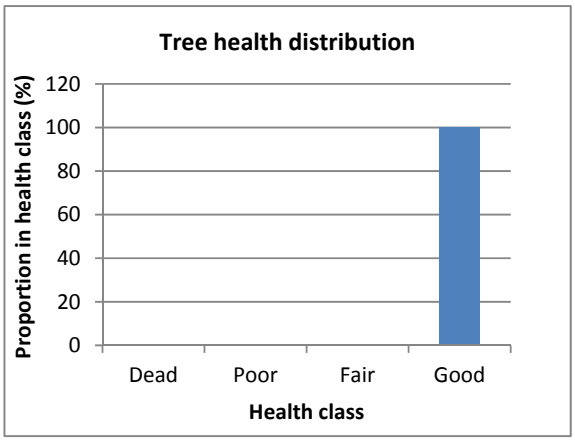
Species %	2013
Cynodon dactylon green couch	88
Lotus sp.	10
Eragrostis curvula cv Consol	2

Tree and shrub layer characteristics at R9

	Density (stems/ha)				Height	Health
	Myrtaceae	Acacia	Others	Total	(m)	(0-5)
2013	0	2533	0	2533	0.5	4.0

Tree layer composition %	2013
Other Acacias	61
A. linearifolia	21
Acacia implexa	18



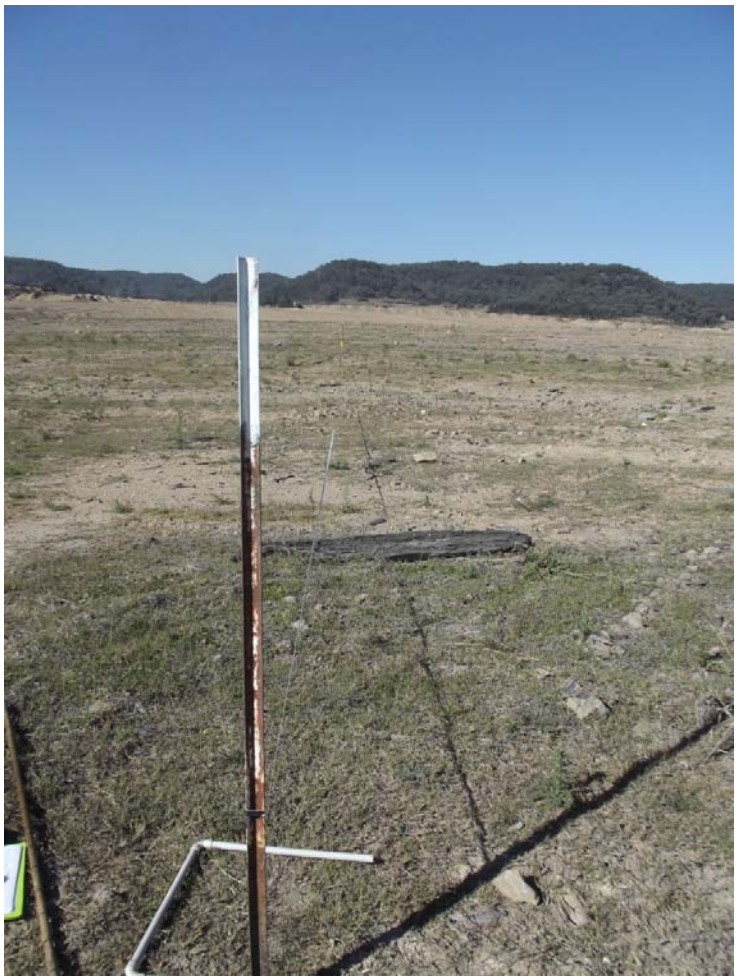


Grid: GDA94 Zone 55 768433 6419301	**Location:** Rehabilitation site (Pit 5)	Site: *R10*

Site description

Rehabilitated mine spoil site seeded in early 2013. Slope of 4%

2013



Ground layer characteristics at R10

	Cover (%)				Yield	Erosion
	Standing	**Litter**	**Rock**	**Bare**	(kg/ha)	(0-5)
2013	15	2	5	78	31	1.5

Species %	**2013**
Cynodon dactylon green couch	78
Digitaria eriantha premier digit grass	15
Lolium rigidum	3
Eragrostis curvula cv Consol	3
Lotus sp.	1

Tree and shrub layer characteristics at R10

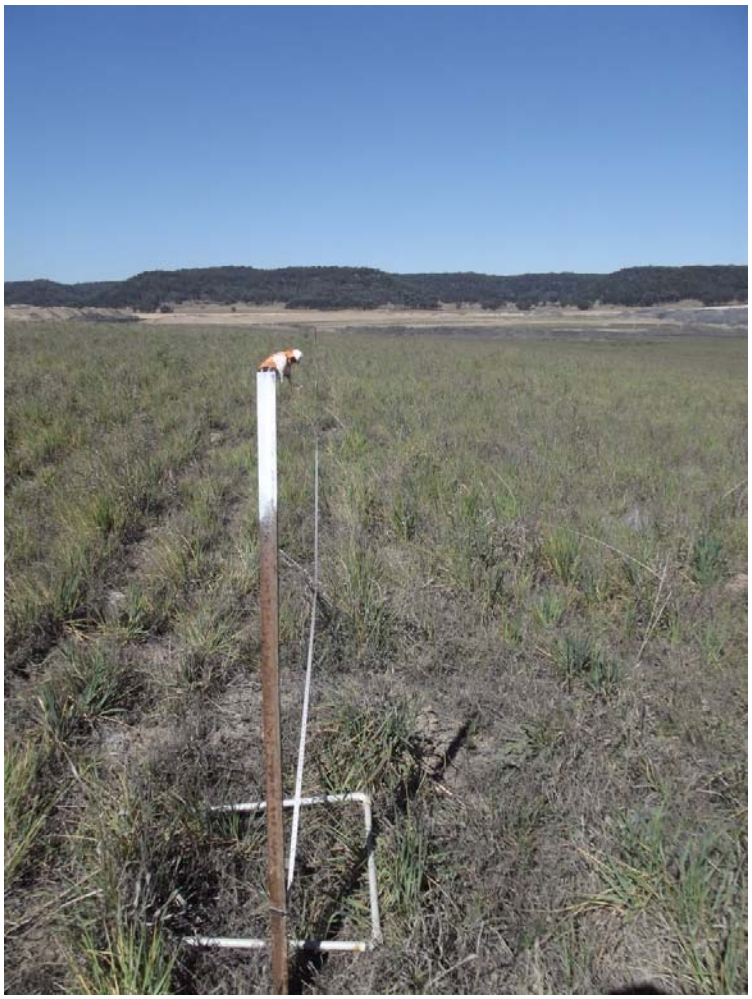
	Density (stems/ha)				Height	Health
	Myrtaceae	**Acacia**	**Others**	**Total**	(m)	(0-5)
2013	0	0	0	0		

Grid: GDA94 Zone 55 768896 6419664	**Location:** Rehabilitation site (Pit 5)	Site: *R11*

Site description

Rehabilitated mine spoil site seeded in early 2013. Slope of 5%

2013



Ground layer characteristics at R11

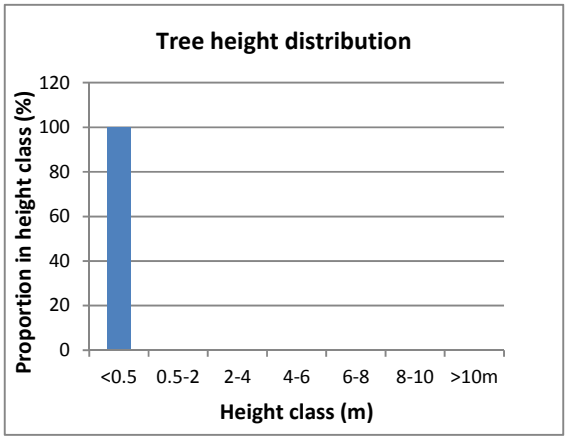
	Cover (%)				Yield	Erosion
	Standing	Litter	Rock	Bare	(kg/ha)	(0-5)
2013	79	17	2	3	1720	0.0

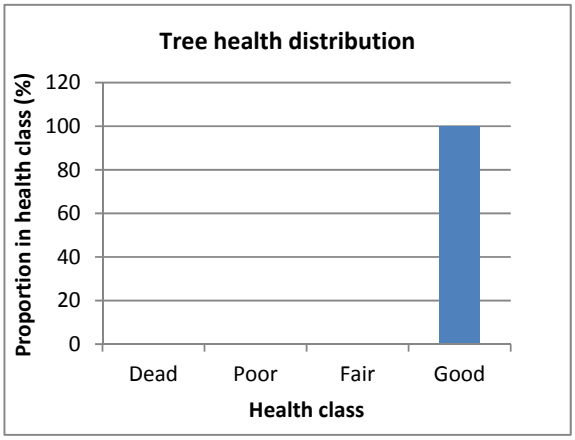
Species %	2013
Digitaria eriantha premier digit grass	59
Cynodon dactylon green couch	30
Bromus wildenowie Prairie grass	9
Verbena officinalis	1
Lolium rigidum	1
Trifolium subterraneum	1

Tree and shrub layer characteristics at R11

	Density (stems/ha)				Height	Health
	Myrtaceae	Acacia	Others	Total	(m)	(0-5)
2013	333	134	0	467	0.3	4.0

Tree layer composition %	2013
Eucalyptus blakelyi	71
A. linearifolia	14
Other Acacias	14



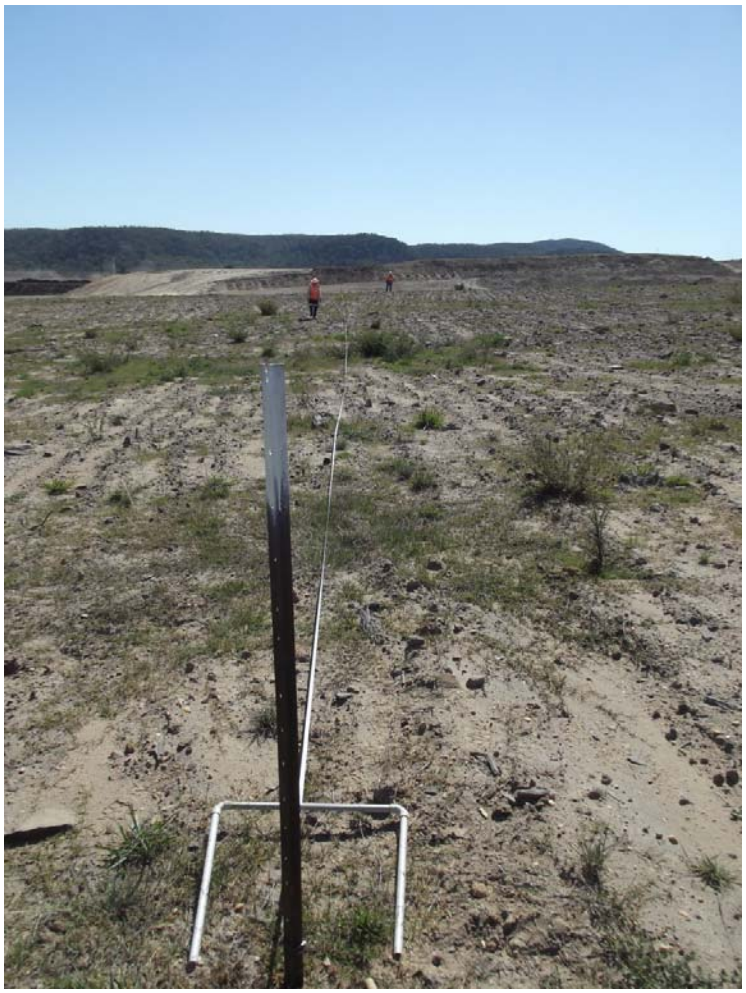


Grid: GDA94 Zone 55 768934 6419710	**Location:** Rehabilitation site (Pit 5)	Site: *R12*

Site description

Rehabilitated mine spoil site of low fertility seeded in early 2013 on a long slope 5 %

2013



Ground layer characteristics at R12

	Cover (%)				Yield	Erosion
	Standing	Litter	Rock	Bare	(kg/ha)	(0-5)
2013	20	3	7	70	115	1.5

Species %	2013
Cynodon dactylon green couch	38
Geranium solanderi	31
Forb	16
Digitaria eriantha premier digit grass	8
Pennisetum clandestinum kikuyu grass	7

Tree and shrub layer characteristics at R12

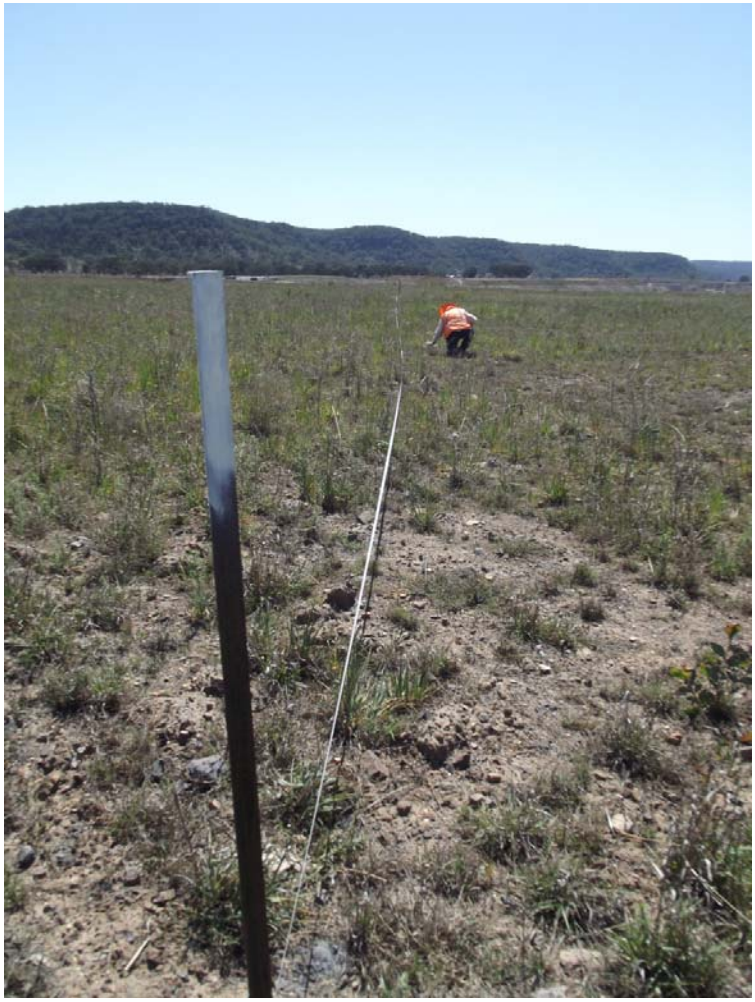
	Density (stems/ha)				Height	Health
	Myrtaceae	Acacia	Others	Total	(m)	(0-5)
2013	0	0	0	0		

Grid: GDA94 Zone 55 770872 6418901	**Location:** Rehabilitation site (Pit 2)	Site: *R13*

Site description

Rehabilitated mine spoil site seeded in early 2013 on slope of approximately 0%

2013



Ground layer characteristics at R13

	Cover (%)				Yield	Erosion
	Standing	Litter	Rock	Bare	(kg/ha)	(0-5)
2013	54	15	14	18	1140	0.0

Species %	2013
Digitaria eriantha premier digit grass	60
Cynodon dactylon green couch	19
Bromus wildenowie prairie grass	14
Eragrostis curvula cv Consol	2
Lolium rigidum	2
Carthamus lanatus Saffron thistle	1
Onopordum acanthium Scotch thistle	1
Plantago lanceolata	1

Tree and shrub layer characteristics at R13

	Density (stems/ha)				Height	Health
	Myrtaceae	Acacia	Others	Total	(m)	(0-5)
2013	1140	67	0	1207	0.4	4.0

Tree layer composition %	2013
E. crebra	50
Eucalyptus blakelyi	28
E. melliodora	6
Acacia ixiophylla	6
Corymbia tessellaris	6
Other eucalypts	6