REVIEW OF REHABILITATION COMPONENTS OF THE MOOLARBEN COAL PROJECT STAGE 2 ENVIRONMENTAL ASSESSMENT REPORT

Prepared by:
Global Soil Systems

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1.0 INTRODUCTION AND SCOPE OF REVIEW

Mark Burns of Global Soil Systems has been engaged by the New South Wales Department of Planning (DoP) to review revegetation and rehabilitation components of the Moolarben Stage 2 Environmental Assessment report. In particular, the brief requested the following:

- *Carry out a review of the sections of the EA relevant to revegetation and rehabilitation.*
- *Assess the adequacy of the revegetation and rehabilitation principles, plans and strategies.*
- *Assess the adequacy of the monitoring and maintenance plan.*
- *Advise on the reasonableness and acceptability of the proposed rehabilitation outcomes and final landform plans.*
- *Recommend additional information required to achieve rigorous revegetation and rehabilitation outcomes and to allow a thorough assessment of these aspects of the project.*
- *If considered necessary, liaise with other specialists engaged by the Department to review biodiversity, subsidence, groundwater and surface water aspects of the project.*

The following comments and recommendations follow a review of relevant sections of the EA and particularly those sections relating to ecology, soils, visual amenity, and landscape and rehabilitation. The review also included a site inspection on the 8th July 2009. During the site inspection discussions were held with Moolarben personnel including Steve Peart (Environment and Community Relations Manager) and Matthew Buchanan (Property Manager). The field inspection incorporated a general inspection of Stage 2 areas, with a stronger focus on the proposed location of Open Cut 4 and the tow adjacent out-of-pit emplacement areas.

2.0 ASPECTS OF STAGE 1 REHABILITATION RELEVANT TO THIS REVIEW

The field inspection also included a quick review of initial Stage 1 rehabilitation practices. While it was appreciated that Stage 1 mining is yet to commence, and that it is a separate approval from Stage 2, it was considered appropriate and beneficial to review any evidence of site rehabilitation practice. The principal intention of reviewing Stage 1 practice was to gauge the current level of

rehabilitation expertise and commitment, as one indicator of likely Stage 2 performance.

The three main aspects of Stage 1 rehabilitation practice (currently evident) included:

1. Mulching of felled timer.
2. Construction of surface water management facilities.
3. General erosion and sediment control practices.

(1) Mulching of felled timber.

Current practice involves mulching standing timber immediately ahead of construction and topsoil recovery. This effectively results in a thin layer of mulch spread across the surface of cleared areas (***Plate 1***). During the topsoil stripping process mulch and topsoil are then collected in one pass and consequently mixed. Mixed topsoil and mulch is then either immediately respread or stockpiled until required. Stockpiling is the most likely option at this stage of the mines development. Remnant stumps and logs, too large for mulching, have been stockpiled (***Plate 2***) with the intention of respreading these over recontoured areas at a later date. This process represents best practice and has numerous rehabilitation advantages. In particular, soils across most of the proposed Stage 2 disturbance area are sandy, nutrient deficient, have low water holding capacity, and are subject to erosion (***Section 5.11, Volume 1***). Assuming this practice will be continued for Stage 2, the mixing of mulch (organics) will enhance soil nutrient and organic levels, will increase soil water holding capacity, and will help reduce surface erosion. The overall effect will be to enhance vegetation establishment and long term sustainability.

(2) Surface Water Management.

Appropriate surface water management and erosion and sediment control will be essential to achieving stable and well vegetated areas. While not examined in detail, observed surface water management structures appear well designed and constructed (***Plate 3***), and appear to conform with good practice.

(3) General Erosion and Sediment Control Procedures.

Examined Stage 1 disturbance areas contained well designed and installed sediment control fencing (***Plate 5***). Even at this early stage, mine personnel advised that approximately 50 km of sediment control fencing has so far been installed. This is well above current practice on most other mines and represents good practice.

Other positive environmental practices were observed including minimizing tree clearance along fence lines (***Plates 5*** and ***6***), and rapid sowing of disturbed areas immediately after earthworks completion.

In summary, a positive impression was gained of preliminary Stage 1 rehabilitation practice. Both design and implementation appeared to be of a high standard, and there appeared willingness by the mine to implement good practice, and to minimize environmental impact. These findings provided a useful background to the mines intent for Stage 2 rehabilitation.

3.0 COMMENTS AND RECOMMENDATIONS ON STAGE 2 EA

Comments are sequenced according to work scope provided by Department of Planning and shown in Chapter 1.

3.1 Assess the Adequacy of Rehabilitation Principles, Plans and Strategies

The general impression after reviewing all relevant information is that the rehabilitation strategy is deficient in both detail and logical procedure. While it is traditionally accepted that much of the detail will be provided in reports subsequent to approval of the EA (e.g. the Rehabilitation and Landscape Management Plan), the large area of native forest proposed for clearing, combined with the absence of a proven rehabilitation history, justifies a greater degree of detail earlier in the approval process. Detail should be sufficient to provide confidence that the mines strategy is based on sound ecological principals, demonstrates a logical approach, and incorporates good practice.

The Native Grassland Strategy

The proposed broad acre rehabilitation strategy (away from creek lines) generally involves the establishment of clumps of trees (up to 300m apart), located within large tracts of native grassland dominated by Kangaroo grass (*Themeda australis*). This strategy was justified as promoting biodiversity and connectivity (**Section 5.18: Volume 1**). However, the approach appears to have minimal relevance to the results of the site inspection which demonstrated that undisturbed adjacent areas are predominately dense woodland and forest consisting of distinct vegetation communities. As such, the isolated tree clump strategy appears to more closely reflect the existing disturbed environment on valley floors, more so than the original pre-clearing forested environment. An inspection of remnant forest clumps along creek lines and throughout cleared areas generally showed relatively dense forest cover in these remnant areas (see ***Plates 7*** and ***8***). As such, it is proposed that a more widespread tree cover would be more compatible with both the original forest cover and ecological objectives.

More Widespread Tree Establishment

The proposed mine provides an opportunity to re-establish lost forest and woodland habitat, and to replace lost forest with something similar, an opportunity not fully capitalized on. This point is particularly relevant if these areas are being claimed as a component of the off-set strategy.

This point is also relevant in terms of maximizing connectivity, a concept strongly promoted in the EA (***Section 5.18, Volume 1***). While connecting north south tree corridors between Munghorn Gap Nature Reserve and the Goulburn River National Park have been proposed on the eastern side of OC4, and between forested areas on the western side of the same area (**Plan 54: Volume 2**), there is minimal east west connectivity due to gaps of up to 300m between tree clumps. As such, the opportunity exists to use the rehabilitation strategy to enhance ecological objectives such as connectivity and habitat restoration through more wide spread establishment of native forest and woodland.

In summary, this approach would have numerous benefits including a more accurate return of pre-disturbance plant communities and ecological function, less debate about the value of these areas as biodiversity off-set areas, and less reliance on unproven native grass establishment techniques.

With respect to the last point, the tree clump strategy relies strongly on the broadacre establishment of large areas of native grassland between tree clumps (***Plan 54, Volume 2***). To the author's knowledge, there has been little long term success with either establishing or sustaining native grasslands on mine sites, and a range of potential problems have been identified. Several of these problems include unreliable seed supply (even for small quantities of seed), unreliable seed viability (often as low as 3–5%), and very often uncertain germination and establishment. Native grasses also compete poorly with exotic weeds, which can become a major problem in topsoil stripped from grazed and cleared grasslands. Tufted native grasses, such as Kangaroo grass, are also not effective erosion control species. In light of potential high erodibility of many of the topsoils (***Section 5.11, Volume1***), surface stability under the proposed revegetation strategy (particularly on slopes), becomes a serious concern.

In conclusion, successful broad acre establishment and sustainability of native grass swards on mine sites (and on other areas) has not been consistently proven. As such, it is considered unwise for the mine to place such a strong reliance on this technique. Further experimentation and demonstration of the viability of this approach is needed. In contrast, direct tree seeding, involving a wide range of over storey and under storey species has been successfully demonstrated on nearby mines, and on many other mines in the Hunter Valley and elsewhere, to reforest large areas. Native grass seed can be added to the mix, and native tree and shrub seed sowing rates can be adjusted to achieve thicker (forest) or thinner stands (e.g. open woodland). Small cleared areas (say

10% to 15% of total area) can still be established across the mine site to enhance small bird habitat (a key objective in ***Section 5.7, Volume 1***). However, it is recommended that these areas be established on flat areas less prone to erosion, and should include a more diverse species mix for erosion control purposes.

In summary, it is recommended that the mine consider the more widespread use of broad acre direct tree seeding with a view to establishing large stands of connecting and variable density native forest. The seed mix can be adjusted to create a predominance of specific targeted species common to adjacent forest communities. This approach would have a greater chance of success, would require minimal long term maintenance, and will achieve greater connectivity (as discussed in the EA). There would also be less debate about the value of these areas as off-sets.

End Land Use

The proposed establishment of large tracts on native grassland also raises the issue of end land use. Assuming large areas of native grassland can be successfully established, their management and maintenance will present several problems. On page S5-173 of Volume 1 it states: '*Revegetation and land management will involve the seeding of Kangaroo grass (Themeda australis), and the control of exotic species using a range of techniques including herbiciding, pulse grazing and slashing'.* These are all high intensity maintenance operations which will require regular and long term maintenance. Proposed grazing of these areas will not be possible for at least 10 years, and until native trees. Regardless of when grazing occurs; grazing will destroy any existing shrub layer. As native grass dominated pastures are also sensitive to cattle or sheep grazing, these may be quickly damaged if grazing intensity is not properly managed. Consequently, if grazing is envisaged, tree clumps will need to be individually fenced (a very big job). Even so, this will not overcome the potential degradation of sensitive native grasslands.

On the issue of end land use there appears to be some uncertainty in the EA. For example, ***Section 5.17, Volume 1*** states an intention to create a final landscape of natural woodland and grassland after mining. **Section 5.17.5** implies that there will be no grazing of these rehabilitated areas (first paragraph page S5-171). This contradicts the intention highlighted in the above paragraph to manage rehabilitated land using pulse grazing (and other techniques). .

In a similar vein, **Section 5.17.5, *Volume 1*** (paragraph 2) proposes that *Land not immediately affected by mining will continue to be used for livestock grazing on a lease back arrangement*'. If so, it is uncertain how this objective will be consistent with the proposed strategy of *revegetating all cleared land within their ownership* (paragraph 1 page S5-172), and with rehabilitation outcomes' stated in **Section 5.18.4**. In short, trees and native ecosystems (whether native grasses or trees), are incompatible with grazing. If grazing is proposed it is

unlikely that key ecological objectives can be meet, or that rehabilitated areas would attract off-set status.

Seed Collection
Regardless of the scale of native tree establishment large quantities if seed will be required, and large scale native seed collection needs to commence immediately. While it is understood that some native seed collection has commenced, this appears to be minimal and needs to be scaled up quickly. A reliance on viable seed being available in the heads of felled trees (as discussed during the site visit) is flawed, and may result in minimal quantities of viable seed collected.

Creek Rehabilitation
The creek revegetation strategy has generally received greater attention (e.g. ***Plans 40*** and ***41***in ***Volume 2***) and while generally sound, lacks any significant detail as to proposed species, tree densities and other establishment details. Cross sections in Plans 40 and 41 also appear to vary from the vegetation designs shown in ***Figure 5.3*** in ***Volume 1*** **(**Page S5-179)**,** and do not demonstrate either how it will be achieved, nor how rehabilitation will replicate the natural ecology of undisturbed creeks in the area nor how. If grazing is proposed creek lines will need to be fenced to exclude stock. Some guidance on these cross sections will be achieved in light of the very erodible soils along creeks (e.g. ***Figure 5.1*** in ***Volume 1,*** page S5-57))

Recommended Revised Discussion Format
The same request for more detail applies to 'Rehabilitation Concepts' listed in ***Section 5.18.1*** of ***Volume 1***. Proposed concepts generally seem to have missed the point in terms of the logical sequence of steps needed to achieve successful rehabilitation. As an example, the following simple steps are recommended as a logical basis for rehabilitation discussion.

- Planning.
  - Rehabilitation Objectives.
  - Principles of Rehabilitation.
  - Integration of Rehabilitation into Mine Planning.
- Landform design and construction and how it relates to rehabilitation objectives.
- Surface water management and how it will protect and ensure successful rehabilitation.
- The characteristics of soils and overburdens, potential limitation to vegetation establishment, and how any limitations will be overcome (e.g would be beneficial to mention incorporation of mulch into topsoil

currently occurring in Stage 1, but apparently not mentioned in the Stage 2 EA).

- Timber removal and storage and reuse strategy.
- Topsoil Management Strategy.
  - Soil stripping, stockpiling and respreading strategies.
  - Weed control.
  - Location of topsoil dumps to ensure no loss of topsoil volume through later disturbance (security of topsoil dumps is a big problem on many mine sites).
- Selective handling of any overburdens or topsoils to assist rehabilitation. For instance, it would be beneficial to separately strip and manage weed infected topsoil from grazed areas, and cleaner soil stripped from forest areas.
- Site preparation and soil amelioration (if required) techniques (some discussion on this is EA e.g. possible use of biosolids).
- Revegetation techniques and general specifications.
  - Tree seeding.
  - Grass seeding.
  - Tubestock planting.

  How will these achieve surface stability as well as ecological objectives
- Maintenance strategy.
- Rehabilitation monitoring strategy. Main purpose is to provide continuous improvement and the collection of relevant data on rehabilitation performance to promote continuous improvement and to justify lease relinquishment at mine closure. While ***Section 5.18.1*** in ***Volume 1*** describes some very simple monitoring concepts, there is no mention of general procedure or frequency, nor how the results will feed back into a continuously improving rehabilitation program.

Relevance of Other Studies and Experience to EA

While issues such as ecology and soils have been discussed in various sections in the EA, they have generally not been drawn together and presented in a neither systematic nor logical manner, nor has their relevance to rehabilitation been clearly described. While it is accepted that the EA is not intended to address all the details associated with the rehabilitation strategy, a summary and further clarification of the process would be beneficial, as would a clearer list of

commitments. Stepping the reader through the logical steps described above would provide greater confidence in the measures the company intends to employ. At this time the EA contains some good, but often scattered, information (e.g. soil etc.). This has generally not been drawn together in a sequential and logical way, nor has its relevance to rehabilitation been shown.

In addition, the large amount of information collected during the study could be used to greater effect. For example in Volume 1 page S5-173, paragraph 7, it states: '*The final landform and post-mining land use will dictate the composition and structure of species to be established in the rehabilitation phase*'. This information should already be clearly stated and could have been used to go the next step and to describe in general terms, what these plant communities will be and where they will be located.

The rehabilitation experience of nearby operating mines also does not appear to have been considered. For instance in ***Section 5.18***, paragraph 2, page S5-172 it states *Consultation and Collaboration between MCM and Wilpingjong coal mine will enable rehabilitation goals and the best environmental outcomes for the post-mining landscape to be achieved.* What is the Wilpingong strategy, and is it consistent with what is being proposed by MCM

3.2 Assess the Adequacy of Monitoring and Maintenance Plans

Some of these issues have already been partially discussed in **Section 3.1**.

In terms of proposed maintenance **Section 5.18.6, Volume 1** (Rehabilitation) provides little guidance on likely short or long term maintenance requirements, nor how these will be implemented. If broad areas of native grassland are proposed maintenance requirements such as weed control, fertilizing and repair of failed areas are likely to be significant.

This section also mixes monitoring and maintenance issues in no apparent logical order. It is recommended that these two activities be addressed separately. Simple and effective monitoring strategies have been developed for mines in NSW and this information is readily available. To this effect, an example of a continuous improvement strategy, together with examples of completion criteria and a suggested monitoring format have been included in ***Appendix 1***. In this context it is disappointing that the EA does not utilize the substantial experience and guidance provided in commonly available documents such as *Rehabilitation by Design* (New South Wales Mineral Council, 2007), and *Development of Rehabilitation Completion Criteria for Native Ecosystem Establishment on Coal Mines in the Hunter Valley* (Nichols 2005 – ACARP Project C1308).

With reference to completion criteria, the inclusion of some simple criteria in the EA would be beneficial in clarifying what the mine is aiming to achieve through

the rehabilitation process. As mentioned, an example of a representative set of completion criteria has been provided in ***Appendix 1***. Once criteria have been agreed on they can then be compared to collected monitoring data; a process that starts the journey towards lease relinquishment. Such criteria do not have to remain fixed and can change once monitoring results become clearer.

In summary, it is recommended that both monitoring and maintenance procedures be separated, and that a more logical sequence and increased detail be provided for each.

3.3 Advise on the Reasonableness and Acceptability of the Proposed Rehabilitation Outcomes and the Final Landform Plans

Some elements of this request have already been discussed.

Other than general plans and discussion, the EA contains little information on what the proposed rehabilitation outcomes will be. As previously mentioned, no completion criteria have been mentioned. For instance, there is no detail on the composition of clump and creek line tree/shrub plantings, nor how these will reflect adjacent forest communities (amongst other issues)? As already discussed, there appears to be some uncertainty about interim and long term landuse objectives during the mines operation. It is recommended that land use and revegetation objectives, and how these will achieved, be clarified and discussed in more detail. For example (and as previously mentioned), grazing and rehabilitation will not be compatible for many years (or never if a shrub understorey is to be maintained). In addition, the ability to both successfully establish and maintain large areas of native grassland has not been demonstrated within the industry. How such fragile grassland will be sustained and managed, even without grazing, is an area of concern. If large treed areas are to be established, where will the seed be sourced from?

A further concern is that degraded and largely cleared grazing areas, located within the footprint of the proposed OC4 landform and adjacent out-of-pit dumps, have been used as the main model for the rehabilitation strategy. An examination of adjacent forest and remnant forest along creek lines in this area (see protected forest areas in ***Plan 54***) suggests that cleared areas may have originally been much more heavily wooded with a diverse range of native tree and shrub species. If so, the proposed 'clump' model is generally not indicative of the pre-European landscape. A basic assumption of the EA is that the revegetated landform is generally an 'in-kind' restoration. As already discussed, the rehabilitation strategy does not really support this.

In terms of tree establishment in clumps and along creek lines, there is minimal detail on species composition nor procedure, nor how these will achieve ecological objectives; and particularly how it will *integrate key environmental*

gradients supportive of baseline ecological function to embellish and link retained vegetated and revegetated landscapes (point 6 **Section 5.7.6.2**). This sounds impressive (I think), and probably refers to issues such as 'connectivity' etc. However, what does it really mean in practice?

In terms of landform design for OC4 and the two adjacent out-of-pit emplacement areas, there appears to be little information on the design and construction of post-mining landforms, and how these will either resemble (or otherwise) pre-mining landforms and gradients. In ***Section 5*** of ***Volume 1*** (Impact Assessment) there is no specific section on landform design, although ***Plans 5*** *to* ***10*** in ***Volume 2*** provide a general overview of the proposed evolving surface drainage system. However, these show no contours. In light of the presence of very erodible soils discussed earlier, elements of landform design such as slope gradient are critical considerations, and are very relevant to the revegetation strategy. For instance, on steeper slopes, more aggressive exotic grasses may be needed to hold soil in place. Without this information it is not possible to determine how proposed landform design will support ecological and rehabilitation objectives, and indeed whether the whole system will be stable in the long term?

Soils likely to be used during rehabilitation have been identified as being occasionally saline, highly erodible and will require special management to prevent land degradation and offsite sediment transport (**Section 5.11, *Volume 1***). What will this 'special management' involve, and what role does the rehabilitation process play?

As a result of these unfavorable soil parameters it could be reasonably expected that the risk of erosion will increase with increasing gradient and longer water run. Due to uncertainty re the gradient of new mine landforms there is an inherent risk that any increase in grade and other factors will result in increased erosion. This problem may be further exacerbated by proposed widespread use of tufted native grass species such as Kangaroo grass (not a good erosion control species), and uncertainty as to whether large tracts of native grassland can be successfully established and maintained. Consequently, there will need to be a strong reliance on early erosion and sediment control structures while vegetation is establishing. It is recommended that this concern be discussed in more detail in **Section 5.18** (Rehabilitation).

In summary, it is recommended that the rehabilitation section (**Section 5.18, *Volume 1***) provide some comment on general landform design and how this will interact with stability and rehabilitation objectives.

Within the EA the term 'rehabilitation' appears to largely refer to revegetation issues. In practice, rehabilitation is the total process of creating a stable and self sustaining ecosystem in which many factors such as landform design, soil quality and management, surface drainage, and vegetation all have a role. Again, some

comment on the relevance and interaction of these in achieving a stable and healthy ecosystem(s) is recommended in Section 5.18**.**

As an example, the main factors likely to determine vegetation success include:

1. Inappropriate landform design and erosion and sediment control.
2. Poor quality and erodible soils.
3. Weed competition (particularly in topsoils stripped from grazed areas).
4. Vegetation. Inappropriate species and establishment techniques, including incorrect site preparation (no mention of this in the EA).
5. Failure to protect rehabilitated areas from stock and other sources of damage.
6. Availability of suitable quantities of seed and plant material on a staged basis over the life of mine (see comments on need for seed collection).

3.4 Recommend Additional Information Required to Achieve Rigorous Revegetation and Rehabilitation Outcomes and to Allow a Thorough Assessment of These Aspects of the Project

The main criticism of the rehabilitation component of the EA is that it does not sequentially describe the key and linking steps in the rehabilitation process. A recommended sequence for discussion is shown in **Section 3.1** of this report.

Secondly, while there is a lot of good information in other sections (e.g. soils, surface waste, hydrology, ecology), the relevance of this information to rehabilitation has not been clearly described. For example, the linkages between rehabilitation and soils, weeds, surface hydrology and landform design have not been adequately discussed.

Thirdly, and as a consequence of the large areas of native vegetation proposed for clearing, the level of detail provided is insufficient to give the reader confidence as to whether techniques and risk management strategies will do the job and protect the environment. This is a valid request in light of the fact that the mine has no significant rehabilitation history. Further description of key strategies is recommended and, in particular, how specific forest communities will be re-established.

A further concern with the overall revegetation strategy is the strong reliance on re-establishing and maintaining large tracts of native grassland. There is considerable risk in relying on this technique, particularly in light of erodible

soils, unknown weed content of re-spread soils, a largely unknown landform design, and past failures with this approach on other sites.

Of particular concern is that the EA has not utilized readily available key studies nor the extensive experience of other mines in developing the rehabilitation strategy. This is disappointing as these would have provided (at a minimum) a simple format to approach the discussion.

Based on a quick observation of Stage 1 works, there appears little doubt that the mine is committed to best practice rehabilitation, and to achieving the best possible environmental outcome. It is hoped that the above comments and recommendations are viewed in a positive manner and that they will assist in promoting best practice and good environmental outcomes for all stake holders.

Summary of Recommendations

- Restructure the rehabilitation discussion in a more logical and sequential format (see recommended format in Section 3.1). Most of the existing rehabilitation information in the EA can be included in this revised format, but further detail is required.

- Incorporate the relevant findings from other studies in the EA (e.g. soils, landform design, ecology etc) into the rehabilitation (Impact Assessment) section (Section 5 in Volume 1). The recommended revised format will assist this process.

- Revise the revegetation strategy to avoid or minimize reliance on unproven native grass establishment techniques. Recommend more widespread use of trees and forest/woodland establishment to achieve ecological objectives such as connectivity and habitat restoration.

- If broad acre native grass establishment is proposed, outline a research program to test this concept.

- Clarify end land use objectives and how these will be practically achieved and maintained in the long term.

- Provide more detail on rehabilitation procedures (e.g. clearing and use of felled timber, topsoil management and limiting soil factors, monitoring and maintenance procedures etc.), and how these will achieve/support long term stability and end land use objectives. In particular, and in light of very erodible soils, discuss how rehabilitation will achieve effective short and long term erosion control. This is a major concern.

- Provide more detail on the rehabilitation and management of adjacent grazing land that will be claimed as an off-set.

- Provide more detail on creek line rehabilitation and how the revegetation strategy will assist/achieve long term stability and ecological objectives.

- Incorporate the details of relevant current good practice in Stage 1, into the Stage 2 EA.

- Nominate completion criteria and describe the short and long term monitoring programs. Describe how rehabilitation results will be compared with these, and how results will be used to achieve continuous improvement. Briefly describe how the mine will work towards mine closure and lease relinquishment from a rehabilitation perspective.

- Start large scale collection of native seed in anticipation of the large areas that will need rehabilitating. (Collected seed can be used for both Stage 1 and Stage 2 projects).

- If the mine is seeking a link with rehabilitation on adjacent mines, clarify the details of this.

- Rework rehabilitation commitments and relate these to the above expanded format.

PLATES

Plate 1. Stage 1. Mulched timber has been left i*nsitu* and will be mixed with topsoil during the topsoil stripping process.

Plate 2. Stage 1. Timber considered too large for mulching has been stockpiled and will be deposited onto rehabilitated areas.

Plate 3. Stage 1. Surface water management structures appear to be well designed and constructed.

Plate 4. Stage 1. Approximately 50 km of sediment control fencing has been installed. Good techniques appear to have been employed.

Plate 5. Stage 1. Clearing and disturbance has been kept to a minimum along fence lines.

Plate 6. Stage 1. General erosion control structures appear adequate.

Plate 7. Example of remnant forest located within the footprint of OC4 (background).

Plate 8. An example of remnant native forest within the footprint of OC4.

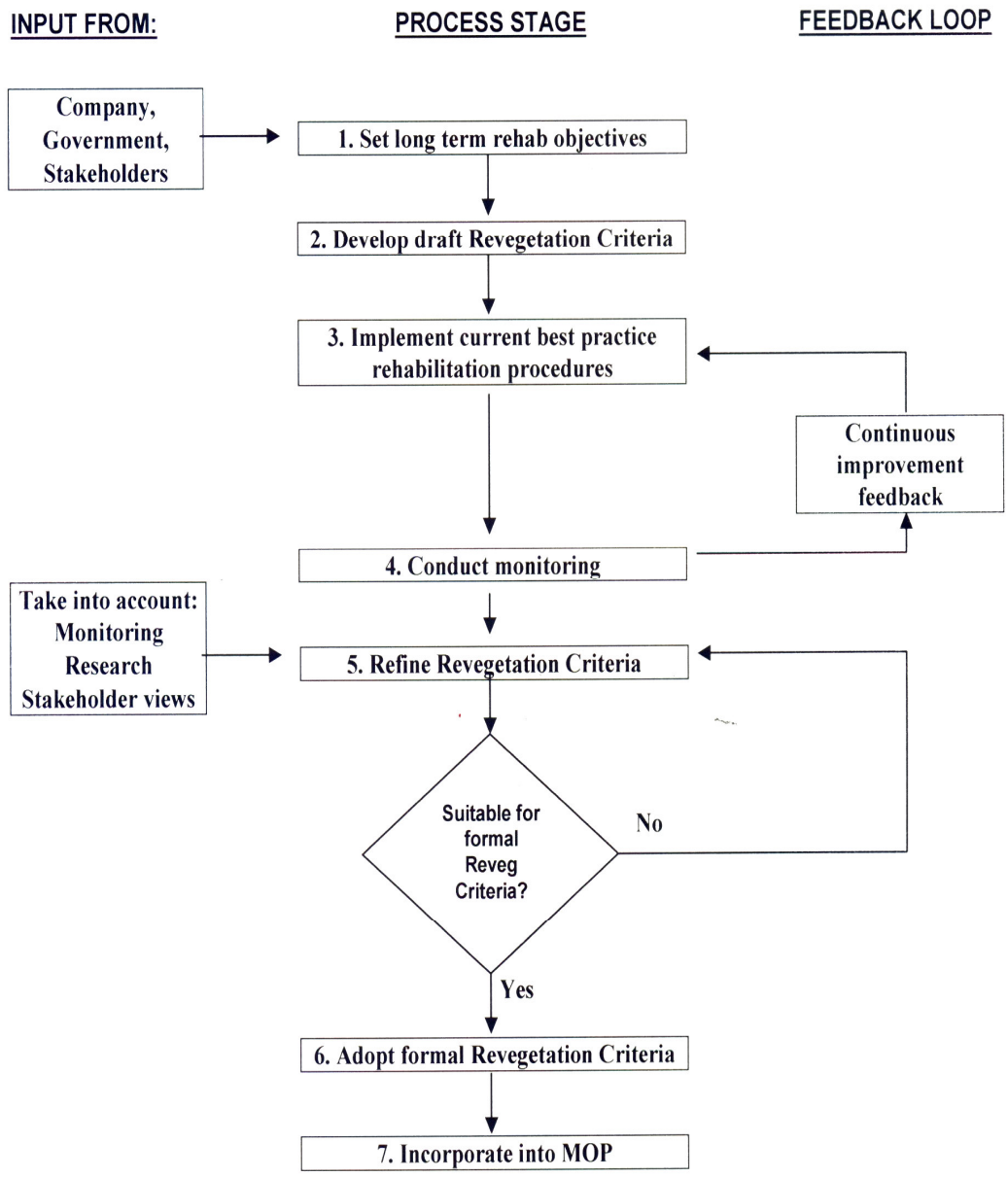
APPENDIX 1

Example of :

(1) Continuous Rehabilitation Improvement Process

(2) Completion Criteria

(3) Native Vegetation Monitoring Format



(1) Figure 1. An example of a continuous improvement process for rehabilitated areas. (From Nichols 2005).

(2) An Example of Specific Completion Criteria for Areas Revegetated with Native Species.

Recommended specific completion criteria for both vegetation and soils for 1 year, 5 year and 15 year time frames. However, experience has shown that there is no single 'quick fix' indicator which unequivocally demonstrates that a rehabilitated ecosystem will be sustainable. The following criteria are proposed as examples on.

Vegetation

The minimum revegetation criteria include the following:

- Species Diversity. The presence of at least four overstorey and four understorey species in each 10m x 20m plot at all ages.

- Stem Densities. Minimum total tree/shrub densities are:

  Year 1 - 3,000 stems/ha

  Year 5 - 1,000 stems/ha

  Year 15 - 500 stems/ha.

- Natural Regeneration. Evidence of natural regeneration at Year 15 for at least four species.

To be researched and agreed on within 5 years:

- Minimum canopy cover in native ecosystem areas.
- Minimum tree height and girth standards for a selected indicator species to be researched and benchmarked for 1, 5 and 15 years.
- Fauna monitoring to be undertaken in revegetated areas and key indicator species established and compared. The monitoring program to be integrated with current fauna monitoring.

The above points highlight the fact that it is not possible to define all completion criteria at this time and that further investigation is needed.

Soil

Physical and chemical soil data should be compared with data from samples from unmined analogue monitoring plots surrounding the mine. The progression of soil parameters towards those typical of undisturbed soils in surrounding areas can then be monitored. This will necessitate a one off assessment of physical and chemical soil parameters in surrounding unmined forest against which soil results from monitoring plots will be compared. Relevant proposed soil parameters are described in the attached **Table 1**. Suggested criteria include:

- Soil pH to be in the range 6.0 to 8.0 after 5 years. (Typical of top soils in un-mined locations.
- Conductivity of replaced topsoil to be below 900uS/cm after 5 years. (Typical of soils in un-mined areas).
- The surface layer to be free of any hazardous material to a depth of at least 1 metre.
- Runoff water quality less than 1000us/cm after 5 years.
- Soil loss less than 40 tonnes/ha/year.
- Soil N and P levels to be within 20% of levels in adjacent analogue site after 10 years.

To be researched and agreed upon within 5 years:

- Salt and pH profile changes to 1m depth to be monitored and compared with analogue sites in unmined bushland.

(3) Example of Monitoring Procedure for Native Vegetation

In developing the rehabilitation monitoring program, the following aspects were taken into consideration.

- Replicate monitoring sites are needed in representative rehabilitation areas of different ages. One monitoring site per 10 ha is recommended for each major age class.

- Sites should be monitored 12 months after establishment then every 2 years.

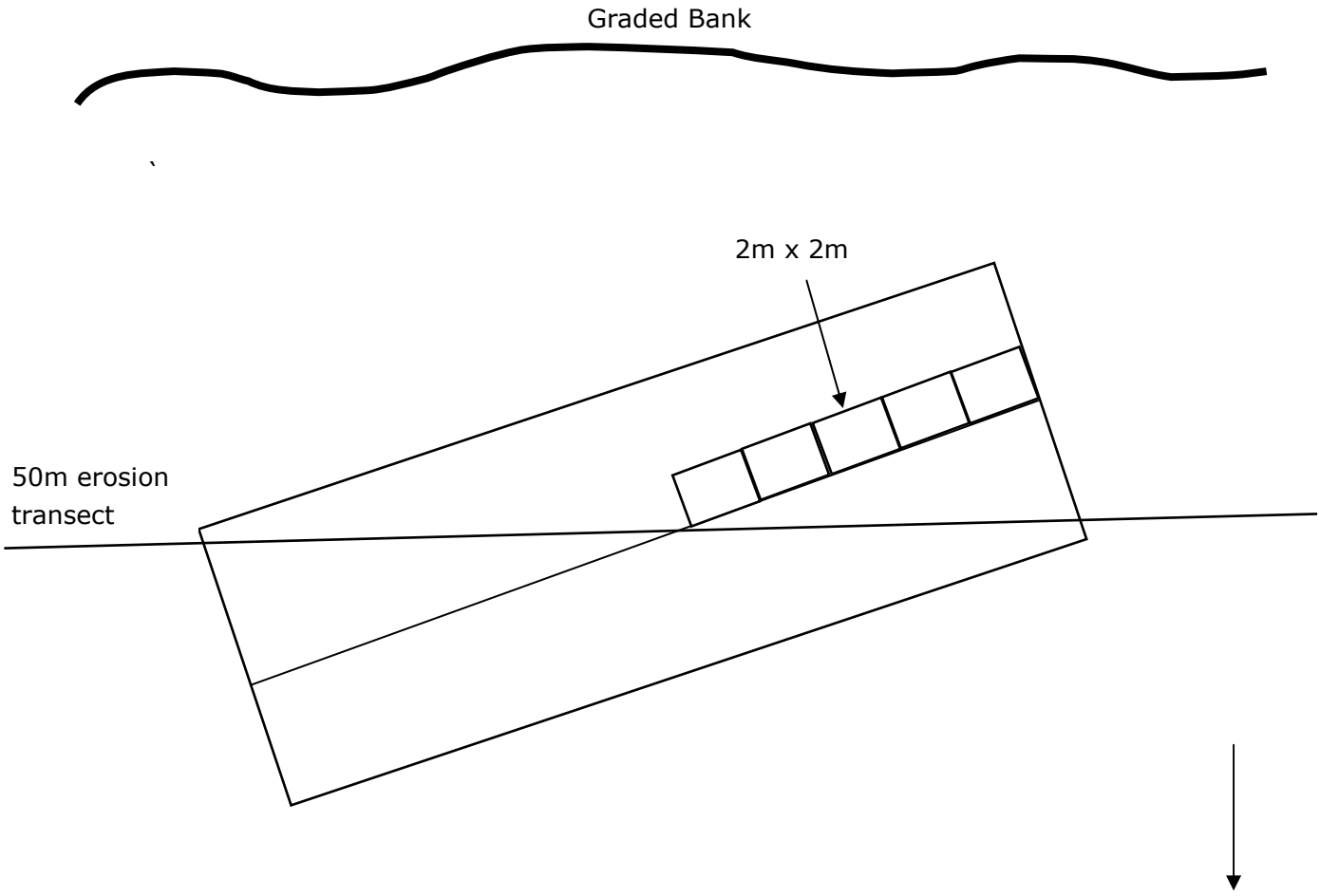
A standard monitoring plot design is shown in below in ***Figure 2***. The design includes:

- Five 2m x 2m quadrates will provide some estimate of statistical variance, so that if required, statistical analyses can be undertaken to objectively compare different rehabilitation treatments, changes over time, and others.

- One 20m x 10m plot overlying the 2m quadrates and located 5m either side of the centerline, for ease of monitoring.

- A 50m erosion monitoring transect on contour, running through the centre of the plot.

- Recommended procedures for monitoring using this plot are shown in the attached ***Table 1.***



From: Nichols 2005

Figure 2. Recommended monitoring plot design.

Table 1 - Recommended procedures for monitoring native ecosystems

Plot Size	Measurement
General description	• Describe the vegetation in general terms, e.g. mixed eucalypt woodland with grass understorey and scattered shrubs, dense Acacia scrub, etc.
2m x 2m quadrats	• Count the number of plants of all species, excluding grass • Measure live vegetation cover for understorey and grasses (separately) using a line intercept method • Record details of ground cover (litter, logs, rocks etc.)
20m x 10m plots	• Count, by species, all trees >1.6m tall (estimate this using su-sampling if there are very large numbers). • Tag and measure DBH of trees >1.6m tall, to a maximum of 10 for any one species. • Record canopy cover over the whole 20m centreline when trees are tall enough • Subjectively describe tree health, by species if relevant, noting signs of drought stress, nutrient deficiencies, disease and severe insect attack. Where health problems are noted, record the percentage of unhealthy trees. • Record any new plant species not present in the smaller plots, including any problem and declared noxious weeds • Take five surface soil samples (e.g. at approx. 5m intervals along the centreline) and bulk these for analyses of: pH, EC, chloride and sulfate; exchangeable Ca/Mg/K/Na; cation exchange capacity; particle size analysis and R1 dispersion index; 15 bar and field capacity moisture content; organic carbon; total and nitrate nitrogen; total and extractable phosphorus; Cu, Mn and Zn.
50m	• Along the 50m erosion monitoring transect, record the location, number and dimension of all gullies >30cm wide and/or 30cm deep. • Erosion pins should be established in plots located in newer rehabilitation to record sheet erosion if present
Rehabilitation in general	• When traversing between monitoring plots, note the presence of species of interest not previously recorded (e.g. key functional or structural species, protected species, noxious weeds), as well as obvious problems including any extensive bare areas (e.g. those greater than 0.1ha). • Observations such as this can provide useful, broad scale information on rehabilitation success and problems.
	•
Photographic record	• For each 20m x 10m plot, a photograph should be taken at each end of the plot, along the centreline looking in.

From: Nichols 2005

REVIEW OF REVISED REHABILITATION STRATEGY FOR THE MOOLARBEN COAL PROJECT STAGE 2 ENVIRONMENTAL ASSESSMENT REPORT

OCTOBER 2009

Prepared by:
Global Soil Systems

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Prepared By:

M. Burns
Principal
Global Soil Systems

1.0 BACKGROUND

Mark Burns of Global Soil Systems has been engaged to review the revised rehabilitation strategy by Coffey Natural Systems on behalf of the Moolarben Coal Project – Stage 2, submitted to the New South Wales Department of Planning (October 2009). This revised strategy was developed in response to earlier comments and suggestions made by Mark Burns (Global Soil Systems 2009) and others on details contained in the EA for this project.

The original brief from the Department of Planning to Global Soil Systems set the following guidelines.

- *Carry out a review of the sections of the EA relevant to revegetation and rehabilitation.*
- *Assess the adequacy of the revegetation and rehabilitation principles, plans and strategies.*
- *Assess the adequacy of the monitoring and maintenance plan.*
- *Advise on the reasonableness and acceptability of the proposed rehabilitation outcomes and final landform plans.*
- *Recommend additional information required to achieve rigorous revegetation and rehabilitation outcomes and to allow a thorough assessment of these aspects of the project.*
- *If considered necessary, liaise with other specialists engaged by the Department to review biodiversity, subsidence, groundwater and surface water aspects of the project.*

The review of the revised strategy therefore similarly addresses these criteria and particularly the mines response to issues raised in Global Soil Systems initial report (July 2009).

2.0 COMMENTS ON THE REVISED REHABILITATION STRATEGY

In general, the revised strategy was a pleasure to read and systematically addressed the relevant issues. As such, it is considered that all the major issues have been addressed and sufficient detail has been provided to give a clear picture of the strategy that the mine intends to employ during the different stages of rehabilitation. Expected outcomes were generally clearly described, as were the processes involved in achieving these outcomes. Where uncertainty exists the mine has outlined the investigative process that will be followed to develop solutions. The revised strategy has successfully identified most of the important basic rehabilitation procedures needed for long term rehabilitation

success, as well as the need to research techniques specific to local conditions and rehabilitation objectives. A successful overall rehabilitation outcome should be achieved if the strategy is implemented.

2.2 2.1 Assess the Adequacy of Rehabilitation Principles, Plans and Strategies

As stated above, the revised strategy now flows much more smoothly as a consequence of the sequence of rehabilitation events now being presented in a logical step by step manner. It is considered that sufficient detail has now been given to provide confidence and clarity on the approach to be adopted.

Earlier concerns about excessive reliance on an unproven native grassland strategy have been adequately addressed, and proven and more widespread (but species targeted) native tree and shrub establishment has been proposed. The proposed strategy, subject to some early clarifying trials, appears sound. Earlier connectivity concerns have been addressed.

In summary, the revised approach will have numerous benefits including a more accurate return of pre-disturbance plant communities and ecological function, less debate about the value of these areas as biodiversity off-set areas, and less reliance on unproven native grass establishment techniques. In so doing, earlier uncertainty about end land use has also been clarified.

It was encouraging to see the increased emphasis on local and systematic native seed collection, and that this has already commenced.

Considerable detail and clarification of creek diversion cross sections has been supplied by Worley Parsons in their supporting report (*Moolarben Coal Project – Stage 2. Concept design for Proposed Diversions of Murragamba and Eastern Creeks,* 20th October 2009). and earlier concerns have been well addressed.

The revised strategy has drawn well on other relevant reports and studies and has incorporated key concepts from these into the revised strategy. It has also drawn together other relevant information from within the EA and described their relevance to rehabilitation (e.g. the effects of dispersive soils).

2.3 Assess the Adequacy of Monitoring and Maintenance Plans

The proposed monitoring strategy has been described in adequate detail and again provides confidence in the strategy to be employed. It was pleasing to see some preliminary completion criteria. The maintenance strategy, while brief, covers the main issues to be addressed in subsequent expanded management

plans. At this time it is considered adequate. It was also good to see maintenance and monitoring strategies separated.

2.4 Advise on the Reasonableness and Acceptability of the Proposed Rehabilitation Outcomes and the Final Landform Plans

Rehabilitation outcomes have been generally described in the revised strategy and the level of detail is considered adequate at this stage. Clarification of end land use objectives has assisted in this regard. The elimination of grazing, and a clearer focus on re-establishing native ecosystems, has better focused the whole rehabilitation strategy.

Provision of detailed contour plans in attached figures has provided a clearer picture of both the proposed landform as well as the surface water management strategy. Both appear adequate and well thought out, although it would be disappointing to see benched landforms as in Figure 7 (b) on the mine. Having said this, and in a similar regard, the management of dispersive soils and erosion on steeper slopes as shown in Figures 1 to 6 will still need very targeted management. In this context it would be good to see dispersive soils listed as a separate risk factor in Section 11.

Proposed measures to address potentially unfavorable soil and overburden conditions are considered adequate

2.5 Recommend Additional Information Required to Achieve Rigorous Revegetation and Rehabilitation Outcomes and to Allow a Thorough Assessment of These Aspects of the Project

Criticism in the original review (Global Soil systems July 2009) on the format and sequencing of the report has been addressed (see earlier comments), and earlier recommendations have been generally adopted. Information in other sections of the EA has generally been well drawn together and its relevance to rehabilitation clearly stated.

In summary, the revised strategy addresses earlier concerns raised under this heading.

2.6 MINOR COMMENTS AND SUGGESTIONS

- Page 2-2. Add soil processes to dot point 1 under Section 2.2.1.
- Page 2-4. Add exclusion of stock in third dot point from top of page.

- Page 3.1. Comment on no ongoing maintenance in para 2 is a worthwhile objective but exactly when maintenance can cease will be determined through the monitoring program. Needs minor qualification.
- Page 5-1 Table 2. May be worthwhile to add weed control to third column in table.
- Page 6-1 Vegetation Management. Need to ensure mulch used either separately, or mixed with topsoil, is composted and well broken down before use in revegetation. Otherwise applied seed may be consumed in the composting process (a common problem). Also para 6 same page lists the option of burning or burial. This is not recommended.
- Page 6-2 Section 6.3 Long-term stockpiles. Unsure what 'rough' means? Topsoil dump design parameters are good but topsoil dumps need to have an even surface to allow easier weed scalping (should this be a problem) and recovery. Deep ripping once soil is emplaced is good but don't want an otherwise uneven topsoil dump surface with irregluar peaks and troughs. A minor point of clarification only.
- Page 6-4 Soil Reinstatement.. second dot point. Not sure why one would want to compact topsoil when intend to deep rip? Deep ripping will key topsoil into underlying overburden and will help bind both As a general rule compaction should be minimize in order to maximize root growth.
- Page 10-3 Section 11. As mentioned add dispersive soils to risk factors.