Life of Project
Quarry Closure and Rehabilitation Plan

Hard Rock Quarry, Karuah East, NSW
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1.0 INTRODUCTION

1.1 Background

GSS Environmental (GSSE) was commissioned by Karuah East Pty Ltd (Karuah East) to prepare a Quarry Closure and Rehabilitation Plan to accompany a new Project Application under Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act) for a proposed hard rock quarry located near Karuah in the Hunter Valley, NSW.

The proposed Karuah East hard rock quarry is located approximately 3 km north of the township of Karuah (shown in Figure 1). The study area for the Quarry Closure and Rehabilitation Plan lies in Lot 12 and 13 of DP 1024564, with the site layout detailed in Figure 2. The extraction area of the quarry would comprise approximately 14.4 ha and would predominately be located within Lot 12, with the associated processing and facilities area located within Lot 13. Together these two areas comprise the ‘Project Site’ with all disturbance areas contained within these two allotments.

The Project Site is surrounded by a predominantly forested area. To the north beyond the edges of this forested area lies agricultural and grazing lands. The Pacific Highway is situated immediately to the south of the Project Site beyond which lies an extensive forested area surrounding an adjacent mountain. An existing Hard Rock Quarry and processing area is located immediately to the west of the Project Site (DA 265/2004).

1.2 Overview of Operations

Karuah East proposes to extract hard black basalt material “andesite” from the Project Site, which will generally involve the following:

- removal and stockpiling of vegetation;
- stripping of topsoil;
- blasting the quarry face;
- ripping and removal of the material by excavator and truck to the stockpile area;
- crushing and sorting of raw material ready for transport; and
- progressive rehabilitation of worked quarry areas when available.

Up to 1.5 million tonnes of material is proposed to be extracted from the site annually from a total resource of approximately 29 million tonnes, over a 20 year extraction period.

The proposed infrastructure at the quarry includes office buildings, workshops, parking areas, crushing plant, wash plant, weigh bridge and product storage areas.

1.3 Purpose & Objectives

The objective of this report is to address the key aspects of quarry closure and rehabilitation so that they will meet the Government, community and company expectations. Specifically, the Quarry Closure and Rehabilitation Plan has been prepared in accordance with the following objectives:
Location Plan

FIGURE 1

Proposed Karuah East Project Location

To be printed A4

V:\HQP05-011\Figures\Final\CAD\Closure 004\Fig1_HQP05-011_LocPlan_121121.dwg
• **Achievement of acceptable post-disturbance land use suitability** – Rehabilitation will aim to create a stable landform with land capability and/or agricultural suitability similar to that prior to disturbance, unless other beneficial land uses are pre-determined and agreed. This will be achieved by setting clear rehabilitation success criteria and outlining the monitoring requirements that assess whether or not these criteria are being accomplished.

• **Creation of stable post-disturbance landform** - Disturbed land will be rehabilitated to a condition that is self-sustaining, or one where maintenance requirements are consistent with the agreed post-quarry land use.

• **Preservation of downstream water quality** – That post closure surface waters that leave the site are not degraded to a significant extent. Current and future water quality will be maintained at levels that are acceptable for users downstream of the site.

In order to achieve this it is necessary to coordinate a practical approach that will include, but not be limited to:

• Conducting proven and resilient revegetation techniques that acknowledge altered landform and soil conditions;

• Undertaking sound landform and surface water management design;

• Implementing effective soil management techniques including stripping, stockpiling, re-spreading and appropriate weed control; and

• Establishing a recognised (statistically viable) monitoring program that can compare the progression of revegetated areas against analogue sites and demonstrate that the rehabilitated areas are moving towards a successful outcome.

1.4 **Director General's Requirements**

The Director-General's Requirements (DGRs) for the Project were provided in a letter from the Department of Planning and Infrastructure (DoP) on 25 November 2010. **Table 1** provides a summary of the DGRs related to closure and rehabilitation, and indicates where the specific issues have been addressed within this document.

**Table 1 – Summary of DGRs Relevant to Closure and Rehabilitation**

<table>
<thead>
<tr>
<th>Agency</th>
<th>Details of Requirements</th>
<th>Location in document where addressed</th>
</tr>
</thead>
</table>
| Department of Planning – DGRs | • A detailed description of the proposed measures that would be undertaken during quarry closure;  
                                  • A detailed rehabilitation strategy, including justification for the proposed final land form and taking into consideration the objectives of any relevant strategic land use plans or polices;  
                                  • The measures that would be undertaken to ensure sufficient financial resources are available to implement the proposed rehabilitation strategy. | Section 4  
                                  Section 2  
                                  Section 4.5 |
1.5 Document Structure

This Quarry Closure and Rehabilitation Plan contains the following components and information:

Section 2.0 - Rehabilitation Management Plan

- Objectives for the rehabilitation of the quarry;
- Conceptual final landform design, including discussion of the proposed post quarry land use;
- Details on the implementation of an effective revegetation program;
- Details of an effective monitoring programme to assess performance of the rehabilitated areas; and
- Objectives and preliminary success criteria for quarry closure.

Section 3.0 - Final Void Management

- Nature of the final void that will remain following cessation of quarry operation;
- Details on the final stability and rehabilitation of the void;
- Summarises actions to address long term void water quality; and
- Post closure safety and final land use options for the void.

Section 4.0 – Quarry Closure and Decommissioning

- Quarry closure and decommissioning objectives;
- Details on the conceptual quarry closure methodology for the Karuah East Hard Rock Quarry; and
- Proposed measures to manage the environmental impacts of quarry closure.
2.0 REHABILITATION MANAGEMENT PLAN

2.1 Rehabilitation Objectives

The objectives of this rehabilitation plan are to:

- Minimise the environmental impact of the operation during the development and operational phases, ensuring that protection of water quality and erosion control works are key priorities, and to ensure progressive rehabilitation is completed as soon as possible;
- Ensure that site drainage and sedimentation structures remain stable and functional;
- Ensure that vegetative matter and topsoil is made available for the site rehabilitation as required;
- Undertake rehabilitation in a manner consistent with that of the existing adjacent quarry;
- Guarantee that the resource is extracted and the site rehabilitated in a manner that will ensure the quality of surface runoff at all times;
- Produce a final “walk away” landform that is geotechnically stable that blends aesthetically into the surrounding landforms, yet as far as possible does not limit possible future land uses; and
- Minimise visual impact of the operation during the operational phase as well as post-quarrying.

2.2 Conceptual Final Landform

The area currently supports an open eucalyptus woodland forest. The broad rehabilitation objective for the post-quarry landform is to establish a similar landuse on the disturbed areas, with the exception of the final void. The topography of the final landform will consist of a large number of stepped benches formed in an amphitheatre configuration, each with a revegetated bench (refer to Figure 3). Figure 4 shows plan and sectional views of the final landform. The void will be some approximately 3 hectares in area. Until such time that extraction has ceased, rehabilitation will occur around the perimeter of the pit only along the benches, and will not involve the pit floor. The primary purpose of rehabilitation during the operational phase is to mitigate any visual impacts.

![Figure 3 – Example of bench rehabilitation](image-url)
Once operations have ceased, all buildings and infrastructure will be removed from the hardstand. These areas will be reshaped and ripped where necessary for topsoiling and revegetation. The pit floor will be vegetated with appropriate native species to create a stable wetland. The wetland will be formed as a shallow depression with the low point in the location of the final retention pond in the south east corner of the void.
**Plan and Sectional Views of the Final Landform**

**FIGURE 4**

*Base Aerial Source: Google Earth*

NOTES:
- Vertical Exaggeration = 2
- Horizontal Scale: 1:7,500
- Vertical Scale: 1:3,750
2.3 Integration with the Adjacent Quarry

An integrated and coordinated rehabilitation approach will be undertaken to ensure consistency with regards to rehabilitation of the Karuah East Quarry and the existing adjacent Karuah Quarry. The selection of species and timing of rehabilitation will be coordinated such that revegetation works will provide habitat value over a wider geographical area inclusive of both quarry sites.

The approved Rehabilitation Management Plan for the existing Karuah Quarry notes that the area surrounding the quarry consists of native forest vegetation, and proposes to re-establish a similar cover to the majority of the post-quarrying landform. The revegetation program of this quarry will therefore involve the re-establishment of native forest/shrub/ground cover on the stabilised benched areas of the quarry. As discussed below in Section 2.4, this same approach will be applied to revegetation of the post-quarrying landform at Karuah East. In addition, given that the adjacent quarry is in close proximity to Karuah East, and consistent species will be used across both sites in re-establishing native forest vegetation across the area.

2.4 Rehabilitation and Revegetation

Native open woodland currently occurs over most of the proposed quarry site. It is proposed to re-establish a similar cover to the majority of the post-quarrying landform (excluding the void). Native vegetation will largely be established using direct seeding and from the seed store within re-spread topsoil. Supplementary native pasture and/or tubestock seeding will be undertaken where specific species combinations are required.

Rehabilitation of the site will be undertaken once extraction is complete. As the extraction progresses through the resource, 15 m wide benches will be left every 15 m of depth to provide a horizontal platform on which native flora species will be established.

The revegetation program will re-establish native tree / shrub / ground cover and will stabilise reshaped and benched areas. Benches will be deep ripped to actively promote infiltration of water which will enhance soil moisture requirements for direct tree seeding and minimise surface runoff to underlying benches and the pit floor dirty water control system. Revegetation will also visually screen disturbed areas and will re-establish habitat for native fauna.

On completion of quarry operations, the pit floor will be re-shaped and revegetated with wetland plant species to form a wetland environment.

2.4.1 Topsoil Management

Topsoil stripping within the disturbed area will be undertaken when the soil is in a slightly moist condition thus reducing damage to soil structure. Stripped material will be placed directly onto the disturbed areas and spread immediately if excavation sequences, equipment scheduling and weather conditions permit.

A maximum stockpile depth of 3 m will be maintained to preserve viability and reduce soil deterioration.

Stockpiles will be protected with sediment fencing and planted with a sterile cover crop (annual species) to ensure stabilisation. Surface drainage in the vicinity of the stockpiles will be configured so as to direct any runoff around the stockpile.

Where the stockpile is not wholly contained within the “closed loop” water management system, temporary sediment control measures such as sand bags and silt fences will be used to prevent sediment from leaving the disturbed areas. Stockpiles will be placed in areas so as to avoid impediment of natural localised drainage lines and minimise the likelihood of water ponding against the stockpile.
Topsoil will be re-spread in the reverse sequence to its removal, so that the organic layer, containing any seed or vegetation, is returned to the surface. Topsoil will be spread to a minimum depth of 50 mm on 3:1 or steeper slopes and to a minimum depth of 150 mm on flatter slopes. Re-spread on the contour will aid runoff control and increases moisture retention for subsequent plant growth. Re-spread topsoil will be levelled to achieve an even surface, avoiding a compacted or an over-smooth finish.

2.4.2 Surface Preparation

The ripping of soil is important in assisting rapid tree growth through deep root growth and enhanced soil water infiltration. The ripping depth must be sufficient to penetrate any near-surface rock or clay. Inadequate site preparation and weed control are often the two biggest single factors responsible for tree revegetation failure. Thorough site preparation will be undertaken to ensure rapid establishment and growth of seedlings. All areas proposed for seeding will be deep ripped to an approximate depth of 400 – 500 mm. Where ripping on slopes is required, the ripping will be undertaken around the contour of the land at right angles to water flow.

2.4.3 Direct Seeding

Direct seeding (via broadcasting) is preferred over tube stock planting as it enables a far greater success rate, limits the need for ongoing maintenance (e.g. watering) and is the most effective method in achieving a successful rehabilitation outcome. Notwithstanding this, tube stock will be utilised in landscape planting around the site. Not all native trees and shrubs are suited to direct seeding due to their innate germination requirements, therefore, it may be required to supplement with some tubestock to increase biodiversity.

Native Trees and Shrubs

A mixture of native trees and shrubs endemic to the area will be sown onto the majority of the reshaped and benched pit areas following topdressing and site preparation. This tree and shrub seed will complement natural regeneration from seed contained within the soil seed bank. The seed mix used for revegetation of the disturbed quarry area will include many of the major tree and shrub species shown in Table 2 below. This species list is consistent with the recommended species for rehabilitation presented in the Rehabilitation Management Plan for the existing adjacent quarry.

### Table 2 – Recommended Species Mix for Quarry Rehabilitation

<table>
<thead>
<tr>
<th>Genus</th>
<th>Species</th>
<th>Seeding Rate (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acacia</td>
<td>Falcate</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>Longifolia</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>Terminalis</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>Irronata</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>Decurrens</td>
<td>0.4</td>
</tr>
<tr>
<td>Eucalyptus</td>
<td>Globoidea</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>Resinifera</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>Paniculata</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>Tereticomis</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>punctata/propinqua</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Moluccana</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Crebra</td>
<td>0.3</td>
</tr>
<tr>
<td>Angophora</td>
<td>Costata</td>
<td>0.1</td>
</tr>
<tr>
<td>Allocasuria</td>
<td>Torulosa</td>
<td>0.1</td>
</tr>
<tr>
<td>Croymbia</td>
<td>Macultata</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>Gummifera</td>
<td>0.3</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>6.3</td>
</tr>
</tbody>
</table>
The seed will be sourced from reputable seed supply agents. Some native species have difficult dormancy mechanisms that need to be broken before germination can occur. Native seed for revegetation of the quarry will be appropriately pre-treated in order to break dormancy restrictions. Subject to sufficient follow-up rain, high initial tree densities can be expected. These high densities will quickly help stabilise and screen the site and will result in healthy mature tree stands over time. It is intended to create, over time, a mosaic of variable native species and plant densities representative of that currently occurring in the area. Growth rates of between 1 and 2 metres per year can be initially expected for many of the more dominant trees and shrubs.

The correct treatment and application of seed in the appropriate ratios is important in controlling emerging weeds and in allowing the tree stand to develop in a positive direction. The native tree and shrub seed mix will be sown at a total combined rate of approximately 6.3 kg/ha. Seed will be broadcast evenly onto topdressed areas. Care will be taken to ensure it will not be buried. Seeding will be conducted in late spring, summer and early autumn giving superior results due to higher ground temperatures.

**Pasture**

Exotic pasture species (warm season perennial, cool season perennial, year long green perennial and annual) may be sown where the risk of erosion is less and on the more protected aspects of landforms. Introduced, stoloniferous grass species (e.g. Rhodes Grass, Couch, etc) will be sown on the steeper slopes as their growth habit provides more extensive coverage in a shorter time. A recommended pasture specification and seeding rate is provided in **Table 3**.

<table>
<thead>
<tr>
<th>Table 3 – Recommended Pasture Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Species</strong></td>
</tr>
<tr>
<td>Japanese Millet</td>
</tr>
<tr>
<td>Ryecorn/Oats</td>
</tr>
<tr>
<td>Rhodes Grass</td>
</tr>
<tr>
<td>Couch Grass</td>
</tr>
<tr>
<td>Wimmera Ryegrass</td>
</tr>
<tr>
<td>White Cover</td>
</tr>
<tr>
<td>Lucerne</td>
</tr>
<tr>
<td>Sub Clover</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

All legumes will be inoculated and lime pelleted prior to seeding. Oats and/or ryecorn/millet (depending on season) will be utilised as the cover crop species (i.e. a species responsible for rapid and aggressive establishment for erosion control and mulching of perennial species in the mix).

Revegetation activities will generally be undertaken in spring and autumn; however opportunistic revegetation will be undertaken if areas become available for sowing in summer or winter. After surface soil amelioration and tillage is completed for any given area, revegetation will commence as soon as practicable. The proposed method of sowing will be via conventional spreading using agricultural broadcasting equipment, or by hand if the terrain is difficult and machinery use is not possible.

Slope stabilising techniques such as hydro seeding and straw mulching will be undertaken on slopes exceeding 18 degrees (°) for enhancement of pasture germination.
2.4.4 Scheduling of Works

Approximately 14.4 ha of native woodland vegetation will be disturbed by quarrying over the duration of the project. Rehabilitation work will be undertaken progressively as soon as reshaped, benched and topsoiled areas become available. Figure 5 provides an indication of progressive revegetation during operations and shows the proposed final rehabilitation following closure of the quarry. It is noted that the progressive rehabilitation proposed will also ensure visual impacts associated with the top western benches are mitigated through the early establishment of trees on these benches as soon as they are available for revegetation.

Figure 5 also illustrates rehabilitation of the adjacent quarry, demonstrating the consistent approach to rehabilitation proposed at both sites. A sectional view of the proposed revegetation treatment for the final landform is provided in Figure 6.
Existing house
and shed

Existing farm dam

Sediment fence

PP

OHP

10 / 7 mm Agg

WB 2 WB 1

WB Office

HEAVY VEHICLES ONLY

MAIN HQ

C/P

TRUCK PARKING

OFFICE

WORKSHOP

FAUL & OIL

C/PLAB

WASH

PUG

MILL

PLANT

20mm Agg

20 / 14 mm Agg

20 / 14 mm Agg DGB 20

DGB 20

20FCR

40 FCR

40mm Agg

14mm Agg

Indicative Progressive and Final Rehabilitation

FIGURE 5
CROSS SECTION A - A'

CROSS SECTION B - B'

CROSS SECTION C - C'

LEGEND:
- Existing Landform
- Finished Design Landform
- Current Surface Level
- Finished Surface Level
- Direct Seeding - Native Trees and Shrubs
- Hydromulching - Exotic Pasture

NOTES:
- Vertical Exaggeration = 2
- Horizontal Scale: 1:5000
- Vertical Scale: 1:2500

Refer Figure 4 for Cross Section locations

Sectional Views of the Proposed Revegetation Treatment for the Final Landform
2.4.5 Final Land Use

The area currently supports open eucalyptus woodland forest. The broad rehabilitation objective for the post-quarrying landform is to establish a similar land use. The topography of the final landform within the void will consist of a number of stepped 15 m high benches formed in an amphitheatre configuration, each with a revegetated berm. The amphitheatre void will be approximately 3 hectares in size. Until such time as all extraction has ceased, rehabilitation will occur around the edges of the pit only, and will not involve benches or pit floor.

Once operations have been completed, all buildings and infrastructure will be removed from the pit. These areas will be reshaped and ripped where necessary for topsoiling and revegetation.

2.4.6 Fencing and Weed Control

Fencing (or a similar barrier) will be erected and maintained to exclude and prohibit the movement of persons and vehicles into areas that have been rehabilitated. The fencing will be routinely checked and repaired where necessary. Signs will be placed in prominent locations to indicate areas that are undergoing rehabilitation.

Weeds present one of the most significant problems to the creation of forest ecosystems. The minimisation of grass and weed competition over the first six to twelve months after seeding is critical to successful tree establishment. Weed control will be undertaken on an “as required” basis should cyclical weed invasion events occur. As trees establish and mature they will compete and eventually eliminate most weeds and grass underneath. For this reason, dense direct seeding (as opposed to planting) is an effective long-term weed control mechanism that reduces maintenance significantly, particularly ongoing weed control. Weeds in most tree-seeded stands typically disappear after 18 months to two years.

2.5 Rehabilitation Maintenance

Due to the hardiness of young directly sown tree seedlings (compared to planted tubestock), these trees require minimal maintenance. Direct seeded trees and scrubs require no watering while planted seedlings (tubestock) may require extensive watering if conditions remain dry. Some maintenance fertiliser will be required for tree areas on one occasion post-closure. Effective control of weed species within rehabilitated areas will be a critical and essential component of the proposed revegetation plan. Weed and noxious animal control will be undertaken on all rehabilitation areas according to relevant state and local government legislation and policy.

All erosion and sediment control measures will be maintained in a functioning condition until individual areas have been deemed “successfully” rehabilitated. Structural soil conservation works will be inspected after high intensity rainfall so that de-silting and prompt repairs and/or replacement of damaged works can be initiated as required.

2.6 Rehabilitation Monitoring

Regular monitoring of the revegetated areas will be required during the initial vegetation establishment period and beyond to demonstrate that the objectives of the rehabilitation strategy are being achieved and that a sustainable, stable landform has been provided. Table 4 presents the monitoring program, including the specific aspects and elements to be monitored and frequencies for those various aspects.

Monitoring will be conducted periodically by independent, suitably skilled and qualified persons at locations which will be representative of the range of conditions on the rehabilitating areas. Annual reviews will be conducted of monitoring data to assess trends and monitoring program effectiveness. The outcome of these reviews will be included in each Annual Environmental Management Report (AEMR).
In addition to the rehabilitated areas, at least two reference sites will be monitored to allow a comparison of the development and success of the rehabilitation against a control. Reference sites indicate the condition of surrounding un-disturbed areas.

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

- Replicated monitoring sites are needed in representative rehabilitation areas of different ages. One monitoring site per 20 to 40 ha is recommended for each major age class of the rehabilitation areas.

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

- A standard monitoring plot design for areas rehabilitated with trees includes:
  - 2 m x 2 m quadrates – these will provide some estimate of statistical variance, so that if required, statistical analyses can be undertaken to objectively compare different rehabilitation treatments and changes over time;
  - a 20 m x 10 m plot overlying the 2 m quadrats and located 5 m either side of the centerline, for ease of monitoring; and
  - a 50 m erosion monitoring transect on contour, running through the centre of the plot.

Figure 7 shows the monitoring plot design that is to be adopted for the monitoring an area revegetated with trees.

![Figure 7 – Typical Monitoring Plot Design](image)

The purpose of the monitoring during operation is so rehabilitation methods can be improved as additional knowledge develops from the monitoring data collected through these programs.
More specifically, monitoring of the key elements in Table 4 will be undertaken.

### Table 4 – Proposed Rehabilitation Monitoring Program

<table>
<thead>
<tr>
<th>Aspect of Rehabilitation</th>
<th>Elements to be Monitored</th>
<th>Monitoring Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecosystem Establishment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Description</td>
<td>• Describe the vegetation in general terms, e.g. mixed eucalypt woodland with grass understorey and scattered shrubs, dense Acacia scrub, etc.</td>
<td>12 months after establishment and then every 2 years</td>
</tr>
</tbody>
</table>
| 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.) | 12 months after establishment and then every 2 years       |
| 20m x 10m plots          | • Count, by species, all trees >1.6m tall.
• 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. | 12 months after establishment and then every 2 years       |
| 50m transect             | • Along the 50m erosion monitoring transect, record the location, number and dimension of all gullies >30cm wide and/or 30cm deep.
• Erosion pins may be established in plots located in newer rehabilitation to record sheet erosion if present | 12 months after establishment and then every 2 years       |
| 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. | 12 months after establishment and then every 2 years       |
<p>| Photographic record      | • For each 20m x 10m plot, a photograph should be taken at each end of the plot, along the centreline looking in. | 12 months after establishment and then every 2 years       |
| Habitat                  | • General observations relating to the availability and variety of food sources (e.g. flowering/fruiting trees, | 12 months after establishment and then every 2 years       |</p>
<table>
<thead>
<tr>
<th>Aspect of Rehabilitation</th>
<th>Elements to be Monitored</th>
<th>Monitoring Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>presence of invertebrates etc.</td>
<td>every 2 years</td>
</tr>
<tr>
<td></td>
<td>- Availability and variety of shelter (e.g. depth of leaf litter, presence of logs, hollows etc).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Presence/absence of free water in the rehabilitated areas</td>
<td></td>
</tr>
<tr>
<td>Fauna</td>
<td>- General observations of vertebrate species (including species of conservation significance).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Detailed fauna surveys including presence and approximate abundance and distribution of vertebrate species (focussing on species of conservation significance).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>After rehabilitation is three years old undertake monitoring in every 2 years after establishment in both Autumn and Spring</td>
<td></td>
</tr>
<tr>
<td>Weeds and pests</td>
<td>- Species identity.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Approximate numbers/level of infestation.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Observations of impact on rehabilitation (if any).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quarterly during the first two years and biennially after that. Inspections should be opportunistic after significant rainfall events.</td>
<td></td>
</tr>
<tr>
<td>Geotechnical Stability</td>
<td>- Assessment of the stability of batters and also looking at surface settlements (sink holes). In particular where these features could impact on the performance of any surface water management system.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Surface integrity of landform cover/capping (measurement of extent of integrity failure).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Presence / absence of landform slumping.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Annually</td>
<td></td>
</tr>
<tr>
<td>Surface and Groundwater</td>
<td>- Groundwater quality and depth.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Efficiency of landform surface water drainage systems (integrity of banks and drains)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Water quality including pH, EC and total suspended solids of water in water storages, and pits, sedimentation dams.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quarterly or following rainfall events</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Monitoring of receiving waters during a rainfall event which results in runoff</td>
<td></td>
</tr>
</tbody>
</table>

2.7 Preliminary Rehabilitation Success Criteria

The following preliminary success criteria for the rehabilitation areas are included in Table 5. The success criteria are performance objectives or standards against which rehabilitation success in achieving a sustainable system for the proposed post-quarry land use is demonstrated. Satisfaction and maintenance of the success criteria (as indicated by monitoring results) will demonstrate that the rehabilitated landscape is ready to be relinquished from the quarry's financial assurance and could be handed back to stakeholders in a productive and sustainable condition.

The success criteria comprise indicators for vegetation, fauna, soil, stability, land use and safety on a landform-type basis that reflects the nominated post-quarry land use of native forest vegetation.

For each element, standards that define rehabilitation success at quarry closure are provided. Based on the generic indicators in Table 5, each criterion will be further developed to be specific, measurable, achievable, realistic and outcome based, and to reflect the principle of sustainable development. This will be based on results of further research and ongoing monitoring of the progressive rehabilitation areas. The
success criteria will be reviewed every three to five years with stakeholder participation to ensure the nominated success criteria remain realistic and achievable.

### Table 5 – Preliminary Rehabilitation Success Criteria

<table>
<thead>
<tr>
<th>Rehabilitation Element</th>
<th>Indicator</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Final Void</td>
<td>Landform stability</td>
<td>Slope gradient</td>
</tr>
<tr>
<td></td>
<td>Erosion control</td>
<td>Average soil loss per annum per domain unit is &lt;40 tonnes/ha/yr (sheet erosion). Erosion mitigation measures have been applied to ensure slope stability</td>
</tr>
<tr>
<td></td>
<td>Surface Water Drainage</td>
<td>Use of contour banks and diversion drains to direct water into stable areas, sediment control basins or final void.</td>
</tr>
<tr>
<td></td>
<td>Water quality</td>
<td>Salinity (electrical conductivity)</td>
</tr>
<tr>
<td></td>
<td>Topdressing material (including topsoil and clay)</td>
<td>Salinity (electrical conductivity)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sodium content</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nutrient cycling</td>
</tr>
<tr>
<td></td>
<td>Vegetation</td>
<td>Land use</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surface cover</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Species composition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resilience to disturbance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sustainability</td>
</tr>
<tr>
<td></td>
<td>Safety</td>
<td>Risk Assessment</td>
</tr>
<tr>
<td>2. Quarry Plant/Industrial Areas/Stockpiling Areas</td>
<td>Landform stability</td>
<td>Slope gradient</td>
</tr>
<tr>
<td>Rehabilitation Element</td>
<td>Indicator</td>
<td>Criteria</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-----------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Erosion control</td>
<td>Erosion mitigation measures have been applied. Average soil loss per annum per domain unit is &lt;40 tonnes/ha/yr (sheet erosion).</td>
</tr>
<tr>
<td></td>
<td>Surface water</td>
<td>Use of contour banks and diversion drains to direct water into stable areas or sediment control basins.</td>
</tr>
<tr>
<td></td>
<td>Drainage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water quality</td>
<td>As for 1.</td>
</tr>
<tr>
<td></td>
<td>Topsoil</td>
<td>As for 1.</td>
</tr>
<tr>
<td></td>
<td>Vegetation</td>
<td>Land use Buildings, water storage, roads (except those used by the public) and other infrastructure have been removed unless stakeholders have entered into formal written agreements for their retention. Areas are readily accessible and conducive to safe management activities. Predicted economics and /or benefits have been defined and agreed by the stakeholders.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surface cover As for 1.</td>
</tr>
<tr>
<td></td>
<td>Species composition</td>
<td>Subject to proposed land use, comprise a mixture of native trees, shrubs and grasses representative of regionally occurring native woodland where possible.</td>
</tr>
<tr>
<td></td>
<td>Resilience to disturbance</td>
<td>As for 1.</td>
</tr>
<tr>
<td></td>
<td>Sustainability</td>
<td>More than 75% of individual grasses and trees / shrubs are healthy when ranked healthy, sick or dead.</td>
</tr>
<tr>
<td></td>
<td>Fauna</td>
<td>Vertebrate species Representation of a range of species characteristics from each faunal assemblage group (e.g. reptiles, birds, mammals), present in the ecosystem type, based on pre-quarry fauna lists and sighted within the three-year period preceding quarry closure. The number of vertebrate species does not show a decrease over a number of successive seasons prior to quarry closure.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Invertebrate species Presence of representatives of a broad range of functional indicator groups involved in different ecological processes.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Habitat structure Typical food, shelter and water sources required by the majority of vertebrate and invertebrate inhabitants of that ecosystem type are present, including: a variety of food plants; evidence of active use of habitat provided during rehabilitation such as nest boxes, and logs and signs of natural generation of shelter sources including leaf litter.</td>
</tr>
<tr>
<td></td>
<td>Safety</td>
<td>Risk Assessment Risk assessment has been undertaken in accordance with relevant guidelines and Australian Standards and risks reduced to levels agreed with the stakeholders.</td>
</tr>
</tbody>
</table>
3.0 FINAL VOID MANAGEMENT

3.1 Objectives

The primary objectives of the Final Void Management section of this Quarry Closure and Rehabilitation Plan include the following:

- Propose mitigation measures to minimise potential off-site impacts associated with the final void; and
- Propose measures to be incorporated in the final landform which aim to minimise potential safety hazards to the general public.

3.2 Justification for the treatment of the Final Void

The following design and environmental criteria were considered when determining the treatment of the final void. These include:

- Minimising the area of disturbance;
- Diverting clean water around disturbed areas to ensure that water collected within the pit is minimised as much as possible;
- Designing site batters to minimise erosion and enhance rehabilitation opportunities both during operation and post closure;
- Minimising water, noise, and visual impacts generated by the operation;
- Progressively rehabilitating disturbed areas; and
- Rehabilitation of the site in a manner that guarantees the long term environmental, ecological and aesthetic integrity of the area.

3.3 Void Design Criteria and Specifications

In order to minimise any potential adverse impacts associated with the water balance of the final void, the design criteria and specifications have been based on groundwater modelling predictions and an assessment of the post mining groundwater equilibrium.

The groundwater modelling was undertaken by Coffeys (2010) as part of the Environmental Impact Assessment process. Predictive groundwater modelling was undertaken to assess the long-term implications for both local and regional groundwater flows. The model predicted that there would be no adverse groundwater impacts as a result of the proposed void, And that it would not intersect any substantial groundwater resulting in there not being a requirement to manage groundwater inflows post closure.

A Groundwater Monitoring Program (GWMP) has been developed to characterise baseline groundwater conditions and monitor the potential groundwater impact over the life of the quarry (Coffeys 2010).
The proposed post mining land use of the void is a wetland that will receive direct rainfall and local runoff from the pit walls, which will pond in the south-east corner of the void. The benches within the pit will be reseeded using native tree species. The clay overburden material stripped at the commencement of the project and stockpiled on site will be spread along the benches (where safe to do so) to be used as a growing material. Figure 3 shows an example of bench rehabilitation achieved at another rock quarry site in NSW.

3.4 Minimisation of Adverse Impacts from the Final Void

3.4.1 Void Water Quality

Water will only be permitted to accumulate in the void if it maintains a quality that does not compromise its intended final use or surrounding groundwater systems. The aim is to provide a biologically viable water resource for the surrounding environment. The following aspects need to be considered with respect to managing final void water quality:

- Concentration of elements resulting from the quarrying of material;
- Control of surface flow into the void; and
- Rainfall and evaporation.

Post closure a water monitoring program will need to remain in place to closely monitor any changes to chemistry within the void.

3.4.2 Void Slope Stability

To ensure the safety of the final void, the surrounding final slopes should be left in a condition where the risk of slope failure is minimised. This may require the benches to be battered back from the vertical to enable a stable overall slope angle.

The following will need to be considered when assessing the geotechnical stability of highwalls:

- Long term final void water levels;
- Height and inclination of slope and number and spacing of intermediate benches;
- Shear strength of the highwall soils and rocks;
- Density and orientation of fractures, faults, bedding planes, and any other discontinuities, and the strength along them; and
- The effects of the external factors, such as surface runoff.

Prior to closure, investigations will be undertaken to confirm the criteria above.

3.4.3 Control of Surface Inflow

The control of surface inflow into the final void is essential for the long term management of water quality within the void and will also aid in the control of erosion.
Surface water is a possible cause of slope deterioration and ultimate failure. Drainage will be directed away from the highwall face through the construction of interceptor channels around the perimeter of the highwall and spoon drains will be utilised on the upslope side of all benches.

The catchment area of the final void will be minimised by the installation of diversion drains where required. This will reduce the amount of water reporting to the final void.

3.4.4 Safety

At quarry closure, one of the main priorities for the void will be to render it safe in terms of access by humans, livestock and wildlife. The following will be considered at the time of closure to ensure that the void is left in a safe manner. These include:

- Instability of the high wall can induce failures or mass movement. All high walls are to be left geotechnically stable;

- A barrier at a safe distance from the perimeter of the void to prevent human access will be constructed. The highwall areas will be secured by the construction of a trench and a safety berm, as well as a security fence along the entire length of the remaining high wall. This is to provide an engineered barrier between the pit and the surrounding area. The trench and berm is to be constructed in such a way that it will physically stop most vehicles;

- Suitable signs, clearly stating the risk to public safety and prohibiting public access will be erected at 50 m intervals outside the safety fence;

- Surface runoff from land surrounding the void will be diverted from entering the void so as to prevent the instability of the walls; and

- Shrub and/or tree planting along the outside edge of the bund wall will be implemented where practicable to lessen the visual impact of the wall, and will be in accordance with the agreed post-mining rehabilitation criteria and land use.

3.4.5 Monitoring and Management

After decommissioning works have been undertaken, whether progressive or final, a monitoring program will be designed to demonstrate that the completion criteria have been met and that the site is not resulting in any off site effects.

This period should also be used to plan for remedial action where monitoring demonstrates completion criteria are unlikely to be met. If progressive rehabilitation has been successful, with stabilisation and revegetation meeting completion criteria this last phase of closure may be shortened. It is, however, unlikely to be less than five years in duration (ANZMEC/MCA 2000).

The post closure monitoring and measurement program will be similar to that undertaken during operation of the quarry only scaled back to focus on those aspects of the site that have the potential to cause pollution or is being used as an indicator to verify the success or failure of the rehabilitation works (e.g. noise monitoring will not be required once all decommissioning and rehabilitation activities at the quarry have ceased).

3.5 Final Void Rehabilitation

As discussed above in Section 2.3, it is proposed to re-establish a native open woodland vegetation cover to the majority of the post-quarrying landform. Native vegetation will largely be established using directly
applied seed and from the seed store within re-spread topsoil. Supplementary native pasture and/or tubestock seeding will be undertaken where specific species combinations are required.

Rehabilitation will be undertaken once extraction has been completed. As the surface quarry progresses, 15 m wide benches will be left every 15 m of depth to provide a horizontal platform on which native flora species will be established.

The revegetation program ("terrace landscaping") will progressively re-establish native tree / shrub / ground cover and will stabilise reshaped and benched areas. Benches will be deep ripped to actively promote infiltration of water which will enhance soil moisture requirements for direct tree seeding and minimise surface runoff to underlying benches and the pit floor dirty water control system. Revegetation will also visually screen disturbed areas and will re-establish habitat for native fauna.

On completion of mining, the pit floor will be re-shaped and revegetated with wetland plant species to form a wetland environment.
4.0 QUARRY CLOSURE AND DECOMMISSIONING

4.1 Quarry Closure Objectives

The principal objectives of quarry closure planning incorporated into this decommissioning and quarry closure section include:

- Providing an overall framework for quarry closure including rehabilitation and decommissioning strategies that are consistent with stakeholder expectations;
- Establishing clear and agreed criteria, which can be used to provide the standard against which the final quarry rehabilitation and post quarry land use can be assessed;
- Reducing or eliminate adverse environmental effects once the quarry ceases operation;
- Ensuring closure is completed in accordance with good industry practice; and
- Ensuring the closed quarry does not pose an unacceptable risk to public health and safety.

4.2 Closure Methodology – Decommissioning of Infrastructure, Plant and Buildings

The following sections summarise the key aspects related to the decommissioning and closure of the site infrastructure, plant and buildings. It assumes that all buildings and other infrastructure are demolished and removed from the site despite the potential for them being used after quarrying (subject to the landholders requirements). It is considered likely that at least some aspects of the existing infrastructure will be used post quarrying, however they are not able to be identified at this time.

4.2.1 Site Services

All services including power, water, data and telephone on the site should be isolated, disconnected and terminated to make them safe. Generally all underground services should be made safe and left buried in the ground. Overhead power lines (where they are not used by others) should be removed and the materials (i.e. poles and wire) recovered for potential re-sale or recycling as applicable.

4.2.2 Infrastructure and Buildings

All sumps will be de-watered and de-silted prior to the commencement of demolition. In addition all items of equipment will be de-oiled, degassed, depressurised and isolated and all hazardous materials (HAZMATs) removed from the site.

All infrastructure, including the office buildings, workshops, parking areas, crushing plant, wash plant and product storage areas will be demolished and removed from the site. Where possible assets may be re-used or sold to other operations.

The remaining items will be demolished, removed and transported from the site as required. All recoverable scrap steel will be sold and recycled, with the remaining non-recyclable wastes being taken to a licenced landfill. Prior to disposal, all wastes will be assessed and classified in accordance with Waste Classification Guidelines (DECC, 2008).

All concrete footings and pads will be broken up to at least 1.5 m below the surface. The waste concrete will be crushed to produce an aggregate that can either be used on the site or sold for some other beneficial use.
All remaining areas will then be reshaped, deep ripped, topsoiled and seeded in accordance with Section 2.0 above.

4.2.3 Roadways, Car Parks and Hardstands

The roadways, car parks and hardstand areas around the processing and administration areas will be ripped up.

All areas will then be reshaped, deep ripped, topsoiled and seeded in accordance with Section 2.0 above.

4.2.4 Fuel Farm and Lubricant Storage Area

Leading up to closure, a preliminary sampling and analysis programme (Phase 1) will be implemented to determine whether a more detailed assessment (Phase 2 – detailed investigation of contamination involving drilling, etc) should be conducted. This will quantify the amount of contaminated material that will need to be bio-remediated on site or sent off site for disposal at a licenced facility.

4.3 Closure Methodology – Earthworks and Rehabilitation

4.3.1 Dams, Diversions and Surface Water Features

Sedimentation dams which assist in the water flow from the final rehabilitated surface will be retained following mine closure. All dams will be assessed for structural integrity and upgrade works completed if the dam is to be retained. Any of the remaining dams that would not be required would be removed and the original drainage paths re-established wherever possible.

4.3.2 Quarry Void

With the completion of quarrying, the benches within the pit will remain. They will be spread with top dressing material and native tree and shrub species will be sown directly in these areas. The main aim will be to ensure that the pit is left geotechnically stable.

The pit floor will be leveled to allow water to drain away from the base of the highwall and spread with top dressing. This area will be seeded in a similar manner to the benches, using a mix of native tree species. As water will drain naturally away from the top of the highwall, surface water control structures will not be required in this area, however a safety bund and security fence will be constructed around the highwall.

The rehabilitation will involve the following:

- Surface preparation of the area by ripping;
- Placement of at least 100 mm of top dressing on a 15 m wide area of the benches around the edge of the pit; and
- Planting of native shrubs and trees on the topsoiled bench. It is proposed to undertake some tree planting in the early stages of the project. These rehabilitated areas will assist in minimising the visual impacts of the mining activities from the adjacent landowners. By the time open pit operations have reached an advanced stage, these rehabilitated areas will be well established and these terraces will form part of the final landform.

The areas to be rehabilitated can be prepared, topsoiled and revegetated using the working bench for access. The site topography will allow for continued access to all benches.

At quarry closure, the final bench will be shaped and the pit floor will be re-profiled and revegetated with local plant species conducive to a wetland environment.
4.4 Post Mine Land Use

4.4.1 Land Capability

The proposed quarry activities will not have a significant impact on land capability in the area. No impacts will occur on adjacent lands and the only impacts will be associated with the area immediately impacted by the quarry operation.

The area contains a valuable state resource and the proposed development will involve extracting this resource prior to returning the area to native vegetation.

Following completion of extraction, the area surrounding the open cut void will be rehabilitated and returned to native vegetation. The land capability of this area will not alter from current land capability although the area of the void will be altered in terms of topography. The land is currently not suited for grazing or agriculture and is best vegetated. It is not proposed to use this area for grazing or other agricultural purposes after mining. Rather, the mined area will be revegetated to create an open forest environment.

4.5 Rehabilitation and Closure Liability

The closure liability has been estimated generally in accordance with the Department of Trade and Investment, Regional Infrastructure and Services (formally Industry and Investment NSW) ESG1 - Rehabilitation Cost Estimate Guidelines (I&I NSW 2010), with the following key assumptions:

- That all infrastructure can be demounted and sold at a neutral cost to the site; and
- That all plant will be skid mounted and easily removable from the site, therefore limited costs associated with the removal of concrete pads and footings.

The closure liability for the Karuah East Hard Rock Quarry has therefore been estimated at $468,134.
5.0 ROLES AND RESPONSIBILITIES

The Quarry Manager (or their nominated representative) is responsible for overseeing the implementation of this Quarry Closure and Rehabilitation Plan, including:

- Delegating tasks associated with this Quarry Closure and Rehabilitation plan where necessary;
- Providing adequate resources to implement this Quarry Closure and Rehabilitation Plan; and
- Providing adequate training to employees and contractors regarding their requirements under this Quarry Closure and Rehabilitation Plan.

5.1 Review

The quarry operation has a life of approximately 20 years, during which time the quarry plan may be changed or altered depending on operational circumstances. Therefore this Quarry Closure and Rehabilitation Plan will be regularly updated, where needed, to capture these quarry plan changes. Five years prior to quarry closure the Quarry Closure and Rehabilitation Plan will be reviewed addressing the final quarry plan and any changes that may have occurred since the previous Plan.
6.0 REFERENCES


GSS Environmental (2011) Surface Water Assessment, Karuah East Hard Rock Quarry

I&I NSW (2010) ESD1: Rehabilitation Cost Estimate Guidelines

Mine Rehabilitation – Leading Practice Sustainable Development Program for the Mining Industry (Commonwealth of Australia)

Mine Closure and Completion – Leading Practice Sustainable Development Program for the Mining Industry (Commonwealth of Australia)