AngloAmerican

Real Mining. Real People. Real Difference.

REHABILITATION MANAGEMENT PLAN

GROSVENOR MINE

EA: EPML00987013

CONTENTS

1 INTRODUCTION

The Grosvenor Mine is located directly north of the township of Moranbah. The Mining Lease (ML) covers approximately 9,500ha which has predominately been cleared for grazing, although areas of remnant vegetation exist, particularly along the Isaac River.

Anglo American Coal is committed to returning land disturbed by Grosvenor Mine to a post-mining landform that is stable, self-sustaining, safe, requiring minimal maintenance and within similar land capability and ecological values to its pre-mining state. This Rehabilitation Management Plan details the rehabilitation works that will be undertaken to meet these commitments.

1.1 OBJECTIVES

The objective of this Rehabilitation Management Plan is to:

- Define how Grosvenor is going to meet a range of goals, objectives and performance criteria pertaining to the site revegetation and rehabilitation;
- Define the rehabilitation methods and actions forming part of the rehabilitation implementation programme, including general methods and domain-specific methods;
- Identify the success factors and completion criteria for each domain and for the proposed final landform, against which the performance of the rehabilitation program will be assessed;
- Provide a program to monitor and report on the performance and success of rehabilitation activities, including the delineation and use of reference sites;
- Identify the management required to improve the performance of rehabilitation and ensure the completion criteria are met;
- Comply with the Anglo American Underground Rehabilitation Management Strategy.

This management plan discusses these objectives and provides a management framework to ensure that these objectives are fulfilled.

1.2 RESPONSIBILITIES

Personnel listed below have the following responsibilities:

Senior Leadership Team

- Ensure that the required actions specified within this plan are effectively implemented and applied across the Grosvenor Coal Mine;
- Ensure that adequate resources are provided to maintain compliance with the requirements of this plan;
- Ensure that training, supervision and monitoring are provided to those bound by this plan.

Safety, Health and Environment Manager

- Inform the Grosvenor Mine Senior Leadership Team of high-level operational environmental issues relating to the implementation of this plan;
- Allocate sufficient resources to the works necessary to operate within the requirements of this plan, the Environmental Authority as well as other relevant State and Commonwealth legislation;
- Ensure the Environment Superintendent is authorised with sufficient powers to inform external bodies in the case of the occurrence a statutory obligation to notify;
- Ensure long term planning is implemented in order to meet Anglo American Environmental Guidelines and Policies.

Environment Superintendent

- Oversee the development, implementation and review of this plan;
- Ensure adequate resources are allocated to enable the training of staff in the content of this plan;
- Submit the Rehabilitation Management Plan and other relevant information to the Department of Environment and Heritage Protection (DEHP) as required by the EA or on request;
- Notify external bodies in the case of the occurrence a statutory obligation to notify as determined by the Environmental Authority or other relevant State and Commonwealth legislation.

Environment Coordinator

- Implement the protocols outlined in this plan;
- Conduct monitoring in accordance with this plan;
- Identify areas where additional management measures are necessary and facilitate implementation of additional management measures as required;
- Provide the Anglo American Company Representative and Contractor's Supervisor with sufficient technical guidance to carry out their duties in compliance with this plan;
- Undertake inspections of work areas to ensure compliance with this plan;
- Maintain a register of rehabilitation completion and rehabilitation monitoring locations, design detail and maintenance requirements in GIS format.

Other Site Managers/Supervisors and Project Engineers

- Undertake rehabilitation works in accordance with this plan;
- Investigate engineering and technical aspects to support the Environment Superintendent and Coordinator.

Company Representative and Contractor's Supervisor

- Applying for the appropriate permits under the Grosvenor Mine EMS and SHMS;
- Undertake rehabilitation works in accordance with this plan;
- Provide the Environment and Technical Services Departments with sufficient information so as to enable them to efficiently perform their duties.

2 LEGISLATIVE REQUIREMENTS AND REFERENCES

2.1 ENVIRONMENTAL PROTECTION ACT 1994

In Queensland, rehabilitation is required under the *Environmental Protection Act 1994* (EP Act), which has as its object the attainment of ecologically sustainable development. The principles in the National strategy for ecologically sustainable development (NSESD) must be considered in decision-making under the EP Act. Section 4(6) of the EP Act requires that all reasonable and practicable measures are taken to protect environmental values from all sources of environmental harm and requires persons who cause environmental harm to pay costs and penalties for the harm. The fundamental reasons for rehabilitation are to reduce the apparent disturbance caused by authorised mining activities and to minimise the potential for future environmental harm.

Section 264 of the EP Act states that in order to achieve lease relinquishment, a final rehabilitation report must be submitted to the administering authority for assessment. The administering authority reviews the report and considers whether the completion criteria have been achieved before approving the surrender application.

The specific detail on the EP Act requirements for rehabilitation at Grosvenor Mine are detailed within the Environmental Authority (EA).

2.2 ENVIRONMENTAL PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

The Grosvenor Coal Mine was declared a controlled action under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) by the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) on 14 November 2007. The controlling provisions were potential impacts on listed threatened species and communities. The proponent was granted an EPBC Act approval (approval reference 2007/3785) on 14 November 2011 by DSEWPaC under sections 130(1) and 133 of the EPBC Act.

The EPBC Approval, included conditions related to completion and implementation of a rehabilitation management plan as follows:

1. In order to minimise the impacts on any EPBC listed ecological community or species, the person taking the action must, prior to commencement of construction, provide to the Minister a Rehabilitation Management Plan for the project area. The plan must include:

    - The desired outcomes/objectives of implementing the plan;
    - The timing, responsibilities and performance criteria for such actions;
    - Details of the rehabilitation methodology;
    - The development and implementation of a monitoring and management program including monitoring frequencies, parameters and methodology;
    - A description of the potential risks to successful management and rehabilitation, and a description of the contingency measures that would be implemented to mitigate these risks; and
    - Details of parties responsible for monitoring, reviewing and implementing the plan.

2. The Rehabilitation Management Plan must be implemented.

2.3 ENVIRONMENTAL AUTHORITY

The specific conditions within the EA relating to the Rehabilitation Management Plan are:

G28 - Complete a rehabilitation management plan for disturbed areas and submit a report to the administering authority proposing acceptance criteria prior to the commencement of mining activities. The rehabilitation management plan must, at a minimum:

a) develop design criteria for rehabilitation of each domain;
b) identify success factors and completion criteria for each domain;
c) identify three (3) reference sites to be used to develop rehabilitation success criteria;
d) describe the monitoring of reference sites inclusive of statistical design;
e) detail rehabilitation methods applied to each domain;
f) contain landform design criteria including end of mine design;
g) detail how landform design will be consistent with the surrounding topography;
h) provide schematic representation of final landform inclusive of:
    - drainage design and features;
    - slope designs;
    - cover design;
    - erosion controls proposed on reformed land;
i) explain planned native vegetation rehabilitation areas and corridors;
j) describe rehabilitation monitoring and maintenance requirements to be applied to all areas of disturbance;
k) develop a contingency plan for rehabilitation maintenance or redesign;
l) describe end of mine landform design plan and post mining land uses across the mine.

G29 - Once rehabilitation has commenced, the holder of the environmental authority must conduct a Rehabilitation Monitoring Program on a yearly basis, which must include sufficient spatial and temporal replication to enable statistically valid conclusions as established under the rehabilitation program.

G30 - The Rehabilitation Monitoring Program must be developed and implemented by a person possessing appropriate qualifications and experience in the field of rehabilitation management, nominated by the holder of the environmental authority.

G31 - Verification of rehabilitation success, determined by the rehabilitation success criteria developed as per condition F34 is to be carried out as follows:

a) the minimum sampling intensity must be specified for the monitoring of progressive rehabilitation;
b) justification of the suitability of the minimum sampling intensity must be provided;
c) monitoring must include sufficient replication to enable statistical analysis of results at an acceptable power; and
d) undertaken at twelve monthly intervals.

G32 - The Rehabilitation Monitoring Program must be included in the Plan of Operations and updated with each subsequent Plan of Operations, describing:

a) how the rehabilitation objectives as per the Rehabilitation Management Plan will be achieved; and
b) verification of rehabilitation success as per condition G29.

2.4 ANGLO AMERICAN COAL UNDERGROUND REHABILITATION STRATEGY

The Anglo American Coal Underground Rehabilitation Strategy Guideline was developed to ensure a consistent and sustainable approach to rehabilitation across all operational and planned underground sites. This guideline is applicable to all surface disturbances associated with underground mine operations including exploration, longwall panel subsidence, gas drainage and surface infrastructure.

The Anglo American Coal general rehabilitation objective is ‘to rehabilitate areas disturbed by mining activities to a condition that is safe, stable, non-polluting and sustainable that considers stakeholder expectations’.

2.5 DEHP GUIDELINE

The DEHP *Guideline - Rehabilitation requirements for mining resource activities*, provides information on both progressive and final rehabilitation requirements for site specific resource projects operating in Queensland under the EP Act. The guideline assists mining companies to propose acceptable rehabilitation outcomes and strategies during the planning stages of a mine or when changes to the proposed rehabilitation outcomes and strategies become necessary during the operational stages of a mine. The guideline also explains how DEHP will assess whether progressive or final rehabilitation for either new or established mining projects is satisfactory. Assessment will be based on the accepted rehabilitation

objectives for each domain within the mine site and monitoring of indicators to demonstrate that the completion criteria have been met and are likely to be sustained for an acceptable period.

In assessing the acceptability of rehabilitation objectives, indicators and completion criteria that may be proposed for a mining project, DEHP will have regard to a hierarchy for mine rehabilitation that is similar to the waste hierarchy. The strategies listed higher in the hierarchy should be adopted in preference to those listed lower, unless there are significant environmental, economic or social issues that override such a selection. The rehabilitation hierarchy, in order of decreasing capacity to prevent or minimise environmental harm, is:

1. Avoid disturbance that will require rehabilitation
2. Reinstate a “natural” ecosystem as similar as possible to the original ecosystem
3. Develop an alternative outcome with a higher economic value than the previous land use
4. Reinstate previous land use (e.g. grazing or cropping)
5. Develop lower value land use
6. Leave the site in an unusable condition or with a potential to generate future pollution or adversely affect environmental values.

In determining whether it is feasible to achieve levels in the top half of the hierarchy, the applicant and the administering authority should consider the pre-mining land use, any compensation or other agreements regarding the land, the potential uses of likely rehabilitated landforms and existing use or environmental values of surrounding land. Developing a lower value use may be acceptable if that use is acceptable to the relevant stakeholders and all higher strategies are impractical. Leaving the site in an unstable condition or with potential to cause environmental harm will rarely be acceptable.

In general there is a higher risk of future environmental harm after the mine closes if the strategies listed lower in the hierarchy are adopted. However a “lower value” land use may be more sustainable in terms of preventing off-site impacts, especially if the post-mining land use makes an economic return that is sufficient to maintain the rehabilitation. To manage a site so that the potential for on-going environmental harm is kept to acceptable levels, future monitoring and maintenance may be required. For this reason, the acceptance of a rehabilitation strategy involving outcomes lower in the hierarchy may mean that, when progressive or final rehabilitation is assessed, the company may have to make larger payments to cover the remaining residual risk.

3 DESIGN AND COMPLETION CRITERIA

3.1 DOMAINS

The allocation of actions which form part of the planning and implementation of the rehabilitation program are best achieved through the delineation of domains. Domains are land management units characterised by a similar post mining land use objective. It is likely that most domains will require a different rehabilitation methodology to achieve the intended post-mining land use.

Within the context of this Rehabilitation Management Plan, rehabilitation actions apply to the four domains below:

- Domain 1: Surface Facilities Areas
- Domain 2: Subsidence – Non-Riverine
- Domain 3: Subsidence – Riverine
- Domain 4: Exploration

3.1.1 Surface Facilities Areas

Surface facilities areas include all buildings and structures, gas drainage infrastructure, mine portals, ventilation shafts, stockpiles, dams, roads, hardstand areas and service lines present on the Grosvenor Mine. Any infrastructure within surface facilities areas, such as offices, processing plant and conveyors, will be removed prior to the rehabilitation of the underlying surface area, under a site wide demolition contract. Key impacts that may require management when rehabilitating these areas include remediation of contaminated land (if present) and heavy ripping of hardstand surfaces. As the majority of surface facilities areas will be required for the life of mine, this domain will be one of the last to be rehabilitated. Should any areas become available prior to the end of life of mine, then these shall be included in the schedule for progressive rehabilitation.

Gas drainage infrastructure areas will be rehabilitated as these areas become available and are no longer required to support the underground mine panel. All gas risers, goaf holes and gas wells will be plugged and abandoned as per the requirements of the *Coal Mine Safety and Health Act 1999* and the latest edition of the *Code of Practice for construction and abandoning coal seam gas wells and associate bores in Queensland*, prior to surface rehabilitation works being undertaken.

3.1.2 Subsidence

Subsidence areas at Grosvenor are those land areas subject to vertical movement due to the extraction of the Goonyella Middle (GM) coal seam. Typically the draw angle from the underground workings to the outer extent of the subsidence impacts is 27.5 degrees, so the area of subsidence increases with depth of cover. The vertical displacement is inversely proportional to the depth of cover, a function of redistributing stresses

within the rock mass, therefore shear strength of the overburden strata also has an influence on the displacement and intensity and frequency of cracking. Subsidence areas at Grosvenor can be divided into Non-Riverine and Riverine areas.

Non-Riverine subsidence includes all land within the Grosvenor lease that is subject to the direct or indirect impacts of subsidence and is located outside the riverine areas. Non-riverine subsidence represents the larger part of the total subsidence areas on site. Riverine subsidence includes riverine areas that are subject to the direct or indirect impacts of subsidence. For all creeks and watercourses on sites, riverine land includes the creek/river bed, terraces and associated riparian zone (extending approximately 40 m either side of the creek/river channel). Riverine areas at Grosvenor include creek lines and associated riparian zones of the Isaac River and its Tributaries.

Impacts of longwall disturbance will be relatively minor, given that only one seam of coal will be mined and the maximum depth of subsidence is predicted to be 3.0 m (Alluvium 2016). Subsidence from longwall mining will result in the progressive formation of gentle trough-like depressions on the surface, relative to the natural topography. Subsidence may also potentially give rise to tension cracking and buckling, as well as ponding of water.

Subsidence impacts shall be progressively rehabilitated over the life of mine in accordance with the GRO-7481-PLAN-Subsidence Management Plan, commencing within 12 months when areas become available within the operational land.

3.1.3 Exploration Sites

Exploration Sites are those areas disturbed by surface exploration activities, including exploration drilling (geographically localised impact) and seismic activities (geographically extensive low-order impact). These works have the potential to result in erosion and vegetation impacts, which are managed to minimise cumulative area and point intensity of disturbance.

Exploration activities are carried out throughout the life of the mine and across the lease area to assist in defining the coal resource and refining mining methods. Rehabilitation of areas impacted by exploration activities is undertaken within twelve months of completion of activities in each location.

Drill Sites

For exploration drilling, works will generally comprise the establishment of approximately 30m by 30m drill pads, within which sumps will be excavated for the capture of drill water. The extent of disturbance and environmental controls for drilling activities is managed via the Grosvenor Permit to Disturb Process (GRO-300-HMP) and Soil and Vegetation Management Procedure (GRO-256-PLAN). The disturbance is implemented in a manner that maximises the potential of rehabilitation to succeed through providing adequate topsoil resources and minimising contamination of topsoil with sodic subsoil material.

Seismic Sites

The intensity of disturbance to vegetation communities from seismic activities is dependent on the depth of the coal resource in that area. Grosvenor aims to minimise the footprint of seismic activities through use of a wireless technology to connect receivers and transmitters, minimising the requirement to clear vegetation to run cables on the surface. The disturbance for seismic surveys still requires a grid of transmitters and receivers to be deployed, requiring simple tracks to be created by slashing. The distance between seismic lines will vary depending on the depth to coal.

The Grosvenor coal resource slopes downward from the western boundary toward the east of the ML. As such seismic lines in the east of the ML will be relatively widely spaced leading to disturbance of between 8% and 10% of vegetation in these communities. It is not anticipated that the proposed clearing of seismic lines in the eastern vegetation communities will result in significant impacts due to the naturally open structure of the predominantly eucalypt woodlands. In communities in the western area of the ML, which includes the Isaac River, disturbance of up to 14% of the remnant vegetation may occur.

The impacts of the seismic survey on the non-endangered eucalypt woodland vegetation types present is not anticipated to be significant, particularly given the open nature of the canopy within these communities. In Brigalow communities in the western area, disturbance will be minimised through using natural gaps in the vegetation to traverse the area to deploy the seismic equipment wherever possible. Where insufficient natural gaps occur only a single light vehicle width will be cleared as necessary. Vegetation impacted is predicted to regrow from seed or root stocks in a short period and overall there will be no significant impact from seismic exploration methodologies at Grosvenor.

3.2 DOMAIN DESIGN CRITERIA

As per EA condition G23, all areas significantly disturbed by mining activities must be rehabilitated to a stable landform with a self-sustaining vegetation cover in accordance with Table 1 and 2 below. Pre and Post Mining Land Suitability (Grazing) and Pre and Post Mining Agricultural Classes are illustrated in Figures 1 and 2.

Table 1: Final land use and rehabilitation approval schedule

	Disturbance Type					
	Subsided Areas	**Ponded Areas**	**Worked Water Dam/s**	**Infrastructure**	**ROM, Topsoil Material Stockpiles**	**Road(s) and tracks**
Projective Surface Area (ha)	3,450	25.7	23.1	106.7	5.7	8.2
Pre-mine land use	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing
Post-mine land use	Grazing	Grazing	Grazing	Grazing	Grazing	Grazing
Post-mine land capability classification	Class C Agricultural Land Class 3/4 Land Suitability (Grazing)	Class D Agricultural Land Class 5 Land Suitability (Grazing)	Class C Agricultural Land Class 4 Land Suitability (Grazing)	Class C Agricultural Land Class 4 Land Suitability (Grazing)	Class C Agricultural Land Class 4 Land Suitability (Grazing)	Class C Agricultural Land Class 4 Land Suitability (Grazing)
Projective cover range	70%	N/A	70%	70%	70%	70%

Table 2: Landform Design Criteria

Disturbance Type	Maximum Slope Range (%)	Projected Surface Area (ha)
Subsided Landform	6%	3,450

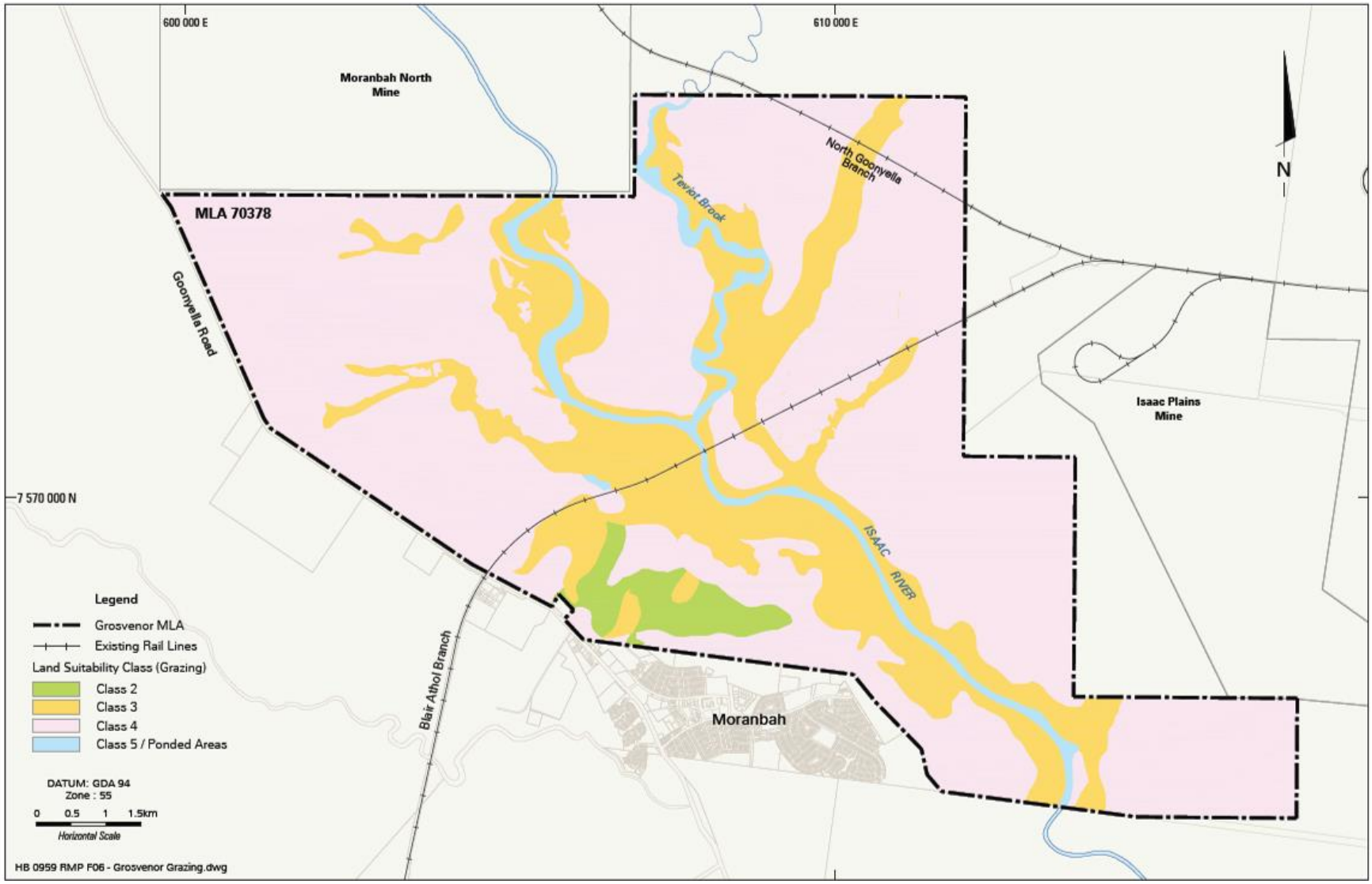

Figure 1 – Pre and Post Mining Land Suitability - Grazing

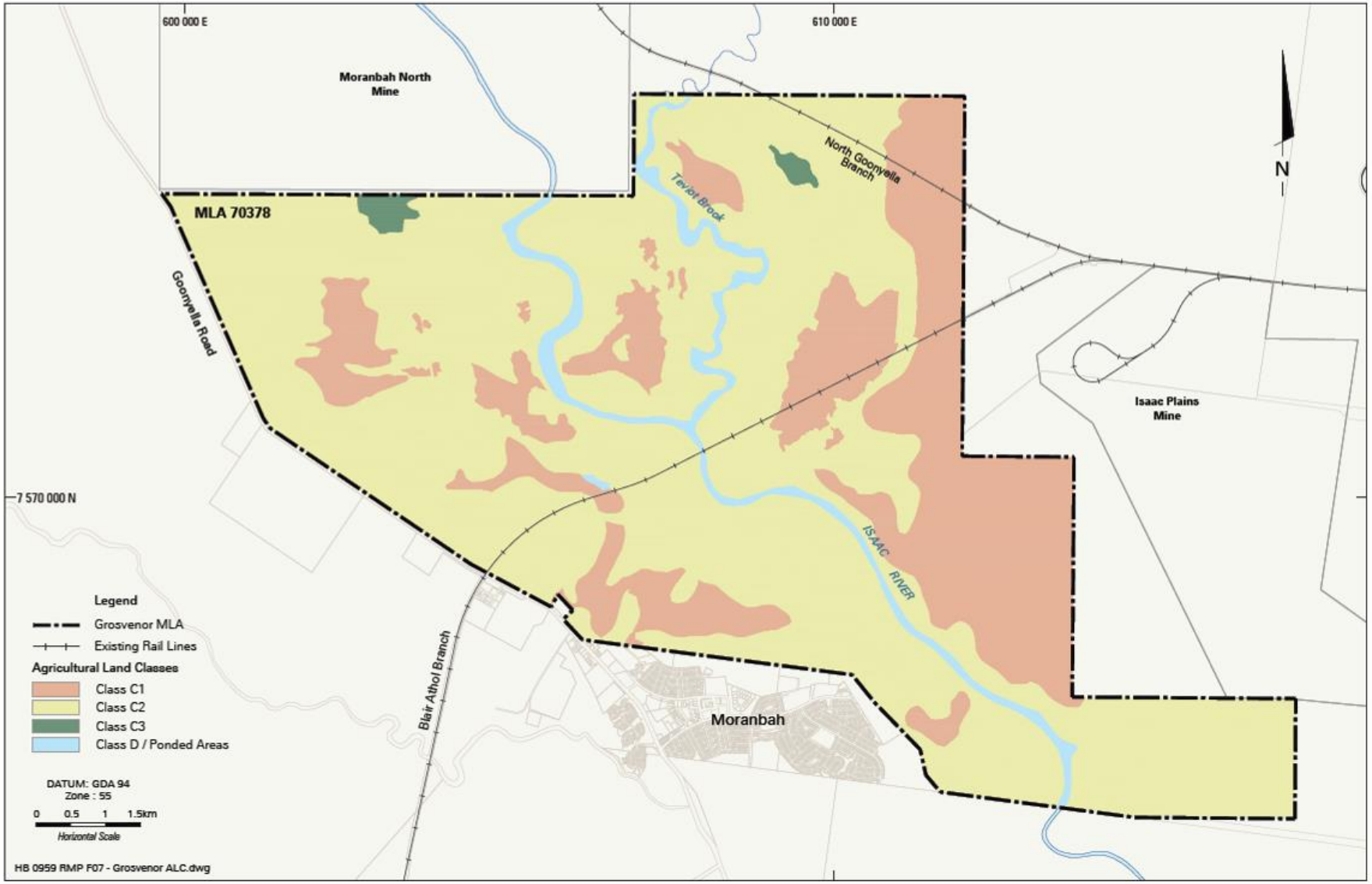

Figure 2 – Pre and Post Mining Land Suitability - Grazing

3.3 DOMAIN COMPLETION CRITERIA

Rehabilitation completion criteria have been developed for the project in line with the DEHP *Guideline - Rehabilitation requirements for mining resource activities (EM1122, Version 2, January 2014)* and the legislative requirements of the EP Act. The rehabilitation goal for each mine domain at Grosvenor is to achieve a landform that is safe, non-polluting, stable and self-sustaining (Table 4).

The rehabilitation completion criteria describe the desired rehabilitation elements to be focused on within each project domain, the indicators which will be measured to identify whether the required level of rehabilitation has been achieved and the criteria which the indicators will be measured against. Each of the rehabilitation elements and their associated indicators has been tailored to reflect the environmental values of each of the project domains.

Definitions relevant to the completion criteria are provided in Table 3.

Table 3: Completion Criteria Definitions

Word	Meaning
Certified or Certification	In relation to any matter other than a design plan, 'as constructed' drawings or an annual report regarding dams means, a Statutory Declaration by a suitably qualified person or suitably qualified third party accompanying the written document stating: • the person's qualifications and experience relevant to the function; • that the person has not knowingly included false, misleading or incomplete information in the document; • that the person has not knowingly failed to reveal any relevant information or document to the administering authority; • that the document addresses the relevant matters for the function and is factually correct; and • that the opinions expressed in the document are honestly and reasonably held.
Characteristic Species	Any species that typically occurs within the vegetation association, regional ecosystem or stratum. This includes any species found at a reference site.
Declared Pest Species	Has the meaning in the *Land Protection (Pest and Stock Route Management) Regulation 2003* and is a live animal or plant declared to be a declared pest under *section 36 (Declaring Pests by Regulation)* or *section 37(2) (Declaring Pest under Emergency Pest Notice)* of the *Land Protection (Pest and Stock Route Management) Act 2002* and includes reproductive material of the animal or plant.

Declared Plant Pest Species	Has the meaning in the *Land Protection (Pest and Stock Route Management) Regulation 2003* and is a plant declared to be a declared pest under *section 36 (Declaring Pests by Regulation)* or section *37(2) (Declaring Pest under Emergency Pest Notice)* of the *Land Protection (Pest and Stock Route Management) Act 2002* and includes reproductive material of the plant.
Predominant (plant) Species	Has the meaning in the *Methodology for Surveying and Mapping of Regional Ecosystems and Vegetation Communities in Queensland (Version 3.2 August 2012)* and means a species that contributes most to the overall above-ground biomass of a particular stratum.
Reference Site(s)	Means an area of land which contains values and characteristics representative of an area to be rehabilitated prior to disturbance. Such values must encompass: • land use; • topographic aspects; • the chemical and physical characteristics of the soil; • vegetation community attributes including species types and diversity; • fire regime; and • other ecological characteristics. Reference sites can be the pre-disturbed site of interest where significant surveying effort has been undertaken to establish benchmark parameters.
Riparian Areas/Corridor	Riparian land is defined as: • any land which adjoins, directly influences, or is influenced by a body of water. • This includes: • the land immediately alongside small creeks and river, including the river bank itself; • gullies and dips which sometimes run with surface water; • areas surrounding lakes; and • wetlands on river flood plains which interact with the river in times of flood.
Riverine	Riverine land includes the creek/river bed and its associated adjoining riparian zone.

Table 4: Completion Criteria

Goal	Objectives	Mine Domain	Indicators	Completion Criteria
Safe	Site is safe for humans and animals now and in the foreseeable future	Exploration	All exploration drill holes undertaken have been rehabilitated or converted to water bores	Evidence of written landholder agreement for the retention of any exploration drill holes to be converted to a water bore.
				Certification that all exploration dill holes not agreed to in writing with the post-mining landholder to be converted to either a water bore or groundwater monitoring bore have been made safe and stable, and will remain safe and stable.
				Certification that all aquifers have been isolated where exploration drill holes have intersected more than one water bearing strata, in accordance with the *'Minimum Construction Requirements for Water Bore in Australia'* (Australian Government, February 2012) or latest edition.
				Certification that all exploration drill holes agreed to in writing with the post-mining landholder to be converted to a water bore, have been converted in accordance with the '*Minimum Construction Requirements for Water Bore in Australia'* (Australian Government, February 2012) or latest edition.
				Certification that all exploration drill holes converted to water bores as per the written landholder agreement, are compliant with the *Water Act 2000.*
			All monitoring bores undertaken have been rehabilitated	Certification that all monitoring bores have been rehabilitated in accordance with the '*Minimum Construction Requirements for Water Bore in Australia'* (Australian Government, February 2012) or latest edition.

Goal	Objectives	Mine Domain	Indicators	Completion Criteria
		Surface Facilities, Subsidence (Riverine), Subsidence (Non Riverine), Exploration	Risk Assessment	A certified risk assessment has been completed and identified mitigation measures have been implemented by a certified person. Where risk mitigation measures have been implemented, this is done in accordance with the most up to date relevant guidelines and Australian Standards.
				Certification that any remaining infrastructure which has the agreement of the post-mining landholder to be retained, is in good working order and in a good state of repair at time of handover.
				Certification that regulated structures have been decommissioned in accordance with the administering authority requirements.
				Certification that landform is safe for animals and humans.
			Geotechnical / Engineering Studies	Certification that all areas of the site (including shafts and portals) are geotechnically stable and safe and will remain so.
			Appropriate decommissioning of infrastructure	Certification that the infrastructure has been decommissioned and rehabilitated. Buildings, water storages, roads (except those used by the public) and other infrastructure have been removed unless stakeholders have entered into formal written agreements for their retention. Access to the area is conducive of the intended post-mining land use as described in Table G2 of the environmental authority.

Goal	Objectives	Mine Domain	Indicators	Completion Criteria
Non-Polluting	Water quality is not impacted post mining.	Surface Facilities, Subsidence (Riverine), Subsidence (Non Riverine), Exploration	Surface Water Quality and Monitoring	Certified evidence that receiving water affected by surface water runoff has contaminant levels that comply with Table C5 – Receiving Waters Contaminant Trigger Levels of the environmental authority and that protects environmental values at the completion of mining and into the future.
			Groundwater quality	Certified evidence that groundwater quality is not negatively impacted by the rehabilitated landform and will continue to not be negatively impacted.
	Areas contaminated by hydrocarbons or other chemicals used during the life of the mine have been treated in-situ or excavated and disposed of appropriately.	Surface Facilities	Site Investigation Report	Certification that contaminated lands do not pose an ongoing risk or require further remedial works.
				Certified evidence that, if deemed necessary by a certified person, measures required by the site contaminated land investigation report(s) have been implemented.
Stable	All tension cracking and/or buckling has been remediated in accordance with the methodology described within the Subsidence Management Plan	Subsidence (Riverine), Subsidence (Non Riverine)	Subsidence Monitoring and Rehabilitation Records	Certified evidence that no subsidence cracks greater than 25mm occur and that appropriate remediation works for all subsidence cracks greater than the 25mm threshold have been undertaken.
				Certified evidence that ponding and subsidence has been managed as per conditions G7 to G20 of the environmental authority.

Goal	Objectives	Mine Domain	Indicators	Completion Criteria
	Landform design achieves appropriate erosion rates	Surface Facilities, Subsidence (Riverine), Subsidence (Non Riverine), Exploration	Erosion	Certification that all land disturbed by mining activities does not exhibit any signs of continued erosion greater than that exhibited at the reference site(s).
				Certification that areas affected by subsidence do not exhibit a slope that is >6% as per Table G3 of the environmental authority.
			Design and stability of drainage lines	Certified evidence that any required contour banks, channel linings, surface armour, engineered drop structures and other required water and drainage management measures are in place and functioning and will continue to satisfactorily function in the foreseeable future.
				Certified evidence that shows whether, and if so how, drainage diversions have changed over the life of mine; that they are stable at closure; and are likely to remain stable into the foreseeable future
	Vegetation growth is promoted to minimise erosion	Surface Facilities, Subsidence (Riverine), Subsidence (Non Riverine), Exploration	Growing medium facilitates vegetation growth	Certified evidence that vegetation species and density are suited to the site's characteristics including soil type, topography and climate.
				Certified evidence that vegetation species and density are appropriate to achieve the ongoing management of erosion on site.
			Ground Cover	Certification that as per Table G2 of the environmental authority, there is minimum of 70% groundcover present, inclusive of leaf litter and timber, and the presence of bare surfaces comparable to the reference site(s).

Goal	Objectives	Mine Domain	Indicators	Completion Criteria
	Geomorphological processes of the Isaac River are maintained	Subsidence (Riverine)	River/Creek Stability	Certified evidence in the rehabilitation report that riparian areas and watercourse(s) impacted by mining activities have geomorphological conditions and processes comparable to the reference site(s).
Suitable Land Use	Maintain or improve agricultural productivity	Surface Facilities, Subsidence (Riverine), Subsidence (Non Riverine), Exploration	Landform can sustain post-mining land use	Certification that grass species present are desirable, perennial, palatable, productive and of good health.
				Certification that the rehabilitated landform can support the post mining land use defined in Table G2 and will continue to do so in the future.
			Access to water sources	Certification that stock have access to water that meets accepted livestock drinking water guidelines as defined in Table 4.3.1 of Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000) or the most up to date version of this guideline.
	Soil properties support the desired land use	Surface Facilities, Subsidence (Riverine), Subsidence (Non Riverine), Exploration	Soil site characteristics	Certification that soil site characteristics have acceptable levels of surface roughness, infiltration capacity, aggregate stability and surface condition as defined in the *Australian Soil and Land Survey Field Handbook* (National Committee on Soil and Terrain 2009) or the most up to date version of this handbook.
				Certification in rehabilitation report that the soil chemical properties do not limit the suitability of the land for the intended post-mining land use and are consistent with comparable reference site(s) for salinity, pH and exchangeable sodium percentage.
				Certification that nutrient accumulation and recycling processes are occurring as evidenced by the presence of a litter layer and adequate macro and micro-nutrients which are consistent with the relevant comparable reference site(s).

Goal	Objectives	Mine Domain	Indicators	Completion Criteria
		Surface Facilities, Subsidence (Riverine), Subsidence (Non Riverine), Exploration	Chemical and physical properties of topsoil support the post-mining land use	Certification that the proposed land use achieves the applicable post-mine land use capability classifications as defined in Table G2 of the environmental authority.
				Certification that the post-mining landscape meets the applicable *Good Quality Agricultural Land* post-mining classification listed in Table G2 of the environmental authority.
				Where the land is to be returned to the post-mining land use as per Table G2 of the environmental authority, certification of suitability of the land for beef cattle grazing in accordance with Department of Minerals and Energy (DME) 1995 *Land Suitability Assessment Techniques in technical Guidelines for the Environmental Management of Exploration and Mining* or the most up to date version of this guideline.
	Establishing self-sustaining natural vegetation or habitat	Surface Facilities, Subsidence (Riverine), Subsidence (Non Riverine), Exploration	Presence of predominant plant species	Certification that predominant plant species identified in the reference site(s) occur on the areas of rehabilitation.
			Density of predominant plant species	Certification that the density of predominant plant species in the rehabilitated sites is consistent with the reference site(s).
			Composition of predominant plant species	Certification that the composition of predominant plant species in the rehabilitated sites are consistent with the reference site(s).

Goal	Objectives	Mine Domain	Indicators	Completion Criteria
	Self-sustaining natural vegetation or habitat that supports the intended post-mining land use	Surface Facilities, Subsidence (Riverine), Subsidence (Non Riverine), Exploration	Abundance and diversity of native fauna species.	Certification that native fauna species identified in pre-mining baseline studies and the five years of reference site monitoring prior to the completion of rehabilitation are present, or that indicators of these species or habitat elements are developing within the rehabilitated areas.
			Abundance and health of desired plant species	Certified evidence that plants in rehabilitated areas show flowering, viable seed setting, germination and emergence.
			Abundance of declared plants (weeds) identified through surveys	Certification that the abundance of declared plants (weeds) identified in rehabilitated areas is no greater the reference site(s).
				Certified evidence to demonstrate that action has been taken to eradicate declared plants (weeds) under local or State legislation should they occur on the site.
				Certified evidence indicating that all machinery, plant and equipment used for rehabilitation was free of declared plant seed and reproductive material prior to entering the site.
			Abundance of declared animal identified through surveys	Certification in rehabilitation report that the abundance of declared animals identified in rehabilitated areas is no greater than the reference site(s).
				Certified evidence to demonstrate that action has been taken to control declared animals under local or State legislation should they occur on the site.

4 METHODOLOGY

4.1 GENERAL

4.1.1 Landform

Prior to re-spreading the topsoil, and in areas where the surface topography has been impacted by mining (e.g. areas of subsidence), the surface will be reshaped to re-instate the soils to a stable land formation that is consistent with the final landform as described in Section 3.2. The establishment of the final landform following the major surface disturbances will take place as soon as practical.

Landform reinstatement involves surface contouring to create a stable landform consistent with the surrounding landform and topography. This ensures water flow over the surface is in cohesion with the surrounding landscape and minimises the risk of potential erosion. Surface contouring should be completed prior to re-spreading of topsoil. Contouring should pay particular attention to drainage lines for surface water flows to ensure erosion potential is minimised.

In areas of steeper slopes (e.g. batters of rehabilitated dam walls), the ground surface may be ripped along the contour lines. Ripping assists with binding of the soil layers, increases retention time of water on the slope, aids water infiltration into the soil increasing the opportunity of seed germination success and reduces the volume and velocity of runoff generated from the slope (i.e. reduces erosion).

4.1.2 Soil Management

To ensure adequate availability of topsoil for use in future rehabilitation, topsoil will be stripped and stockpiled in accordance with GRO-256-PLAN-Soil and Vegetation Management Plan. Upon completion of any reshape requirement, placement of topsoil on rehabilitated areas shall be to a depth of typically 300 mm.

Prior to topsoil re-spreading, topsoil that has been stockpiled may be re-analysed for pH, electrical conductivity, chloride, cations (calcium, magnesium and sodium), exchangeable sodium percentage and soil fertility (including nitrogen, phosphorous, potassium, sulphur and micronutrients). Soil amelioration requirements will also be determined by the results and recommendations emanating from the monitoring of reference sites and rehabilitation areas. Soil amelioration techniques that may be used include:

- The addition of fertilisers to achieve desirable nutrient levels;
- The addition of gypsum or lime to regulate the pH levels;
- Incorporation of mulch, compost or other organic matter; and
- Irrigation.

Previous remediation of dispersive soil at Grosvenor has shown that applying approximately 8 kg of gypsum per m^3 of soil provides a good balance between ameliorating strong dispersion characteristics, while not

inhibiting vegetation growth. Applying composted manure immediately prior to seeding has also proven effective at Grosvenor to increase soil carbon, water retention and growth of grasses. The rate of manure per area is modified based on assessment of erosion susceptibility and edaphic characteristics. Trials of up to 50 tons of manure per hectare added using a tractor muck spreader immediately prior to seeding has yielded strong grass growth on rehabilitated areas.

Where soil has been removed, soil preparation will include the re-spreading of topsoil stockpiled from the original clearing. Topsoil spreading will be implemented in accordance with the following specifications:

- Topsoil is to be spread in an even layer and left 'rough' (rather than smooth and compacted). This can be achieved by lightly scarifying the surface once the topsoil has been applied to assist with relief of compaction. Surface scarification enhances water infiltration, promotes plant establishment by trapping resources (seeds, organic litter) and minimises the potential for erosion.

- Scarification will be completed prior to seeding and should ensure no subsoil is ripped to the surface. The scarification should be completed using the rear mounted ripping tynes of a grader or a purpose designed harrowing implement rear mounted on a tractor. Scarification can also be achieved by ploughing of the sub-surface material prior to topsoil reinstatement. A figure eight or zigzag rip lines may be appropriate to prevent rill erosion in flat to low gradient areas.

- Topsoil application will only take place following initial reinstatement of the subsoil, construction of contour banks on steeper slopes, and compaction of subsoils to account for subsidence.

- Topsoil stockpiled for extended periods will be turned over and mixed prior to replacement. However, this is only required if thorough mixing is unlikely to occur during re-spreading.

- Vehicle movement will be restricted following topsoil re-spreading to reduce compaction and degradation of the soil structure.

4.1.3 Seed

Where required, topsoil stockpiles and rehabilitated areas will be seeded with a grass mix suitable to establish the agreed post mining land use (grazing). Seed will also be used for drainage lines, berms and other erosion and stabilisation works. In order to perform well in the dispersive soils at Grosvenor, species must be relatively drought tolerant, establish quickly under the right conditions and preferably be creeping in nature. Those species with large seed will generally germinate the quickest. Species selection for rehabilitation works to meet the above needs may include those provided in Table 5.

Table 5: Suggested Species for Grosvenor Rehabilitation

Common Name	Scientific Name	Typical Application Rate (%)	Comments
Millet	*Echinochloa esculenta*	10	Will establish very quickly following rain and will provide ground cover while other grasses establish.
Rhodes Grass	*Chloris gayana*	20	Easily established. Grows well in lower fertility duplex soils, is salt tolerant with above ground runners and is good for soil stabilisation. Deep root system enables survival during periods of drought.
Seca stylo	*Stylosanthes scabra cv Seca*	10	A hardy shrub tolerant to drought because of its deep tap root. This legume continues to produce fresh green leaves with minimum rainfall, which cattle consume in association with protein rich seed.
Creeping Bluegrass	*Bothriochloa insculpta*	30	Low growing perennial with invasive stolons, providing good erosion and weed control. Tolerant to heavy grazing and drought.
Sabi Grass	*Urochloa mosambicens*	30	Mainly grown for grazing and erosion control. It is persistent and spreads well after bush fires. Fairly tolerant to dry season and spreads rapidly in response to wet weather. Combines well with *Stylosanthes*.

Seed shall be applied at rates from 20 to 40 kg/ha of coated seed, generally via a conventional tractor mounted seeder. The tilth of the soil and the depth to which seed is placed are crucial to obtaining good germination and growth results. The maximum depth of the harrowing shall be no greater than 50mm and the soil's surface must remain uncompacted. Wherever practical, irrigation shall be installed to promote growth of vegetation immediately prior to the wet season to provide cover to the erosive soils. In areas where irrigation is not practical, timing for seeding and fertilising (if applicable) should aim for early August to late October each year. This is dependent upon both the probability of rainfall for the season, availability of suitable regraded and ripped areas, and the availability of suitable seed mixes. This will ensure that seed and (if necessary) fertiliser is applied to coincide with the onset of the average rain season experienced at the Grosvenor Mine.

If vegetation growth remains weak four weeks post germination, the requirement for application of Diammonium phosphate (DAP) fertiliser shall be evaluated and applied at a rate of approximately 100 kg/ha.

Seed suppliers should be provided with required viability standards and present test certificates demonstrating that the seed meets those requirements. Loss of seed viability during storage is common. Seed must be stored at low humidity (<10% relative humidity) and low temperature. It is also important to reduce exposure to pest and pathogens. It is desirable that seed be less than two years old when applied to rehabilitation.

4.1.4 Sediment and Erosion Control

Prior to the re-establishment of vegetation cover, temporary control measures may be put into place for erosion and sediment control. Implementation will be undertaken in accordance with GRO-5317-PLAN-Sediment and Erosion Management. The Sediment and Erosion Management Plan includes detailed schematics and designs for engineered control structures. All controls and measures will be installed and kept in place and maintained in a fully functional state until the area has been effectively rehabilitated and has reached a stable condition.

Rehabilitated areas should be protected from grazing animals for at least two seasons i.e. fenced off.

4.1.5 Weed Management

Many weed species are effective competitors for resources and have the potential to exclude native species from the landscape, resulting in changes in the composition and structure from the desired vegetation communities. The presence of weed species has the potential to have a major impact on revegetation and regeneration outcomes and can negatively impact on biodiversity and native fauna. As such, weed management will be a critical component of the rehabilitation program at Grosvenor, and will be undertaken in accordance with GRO-832-EVP-Declared Pest Management. A program of targeted weed spraying using a selective herbicide, such as metsulfuron-methyl, for control of weeds in pastures shall be implemented at Grosvenor throughout the growing season.

4.1.6 Fauna

Fauna will generally colonise rehabilitated areas if the composition and structure of the rehabilitated vegetation are similar to surrounding areas. During clearing of vegetation for mining purposes timber shall be stockpiled for use on rehabilitated landforms. Where practical, felled trees or logs will be placed on the rehabilitated area to aid in erosion reduction, seed retention and habitat creation within the rehabilitation area. Hollowed out logs and other timber provides an adequate habitat for primary colonisation species such as insects, small reptiles and rodents.

Animal pests have the potential to adversely impact on native wildlife populations, biodiversity, grazing production, spread of weeds and soil stability. Pests declared under Queensland's *Land Protection (Pest and Stock Route Management) Regulation 2003*, will be targeted by a control program in liaison with regional initiatives.

The requirement for pest control will be assessed on the basis of evaluation of the significance of the pest threat – in terms of species, population size, likely consequence of pest presence etc. Available control methods will be assessed to determine the most appropriate, as per GRO-832-EVP-Declared Pest Management.

4.2 SUBSIDENCE AFFECTED AREAS

The specific management of subsidence impacts are detailed in the Subsidence Management Plan (GRO-7481-PLAN) prepared by Alluvium Consulting Australia, in accordance with the requirements of the EA, and submitted to DEHP in March 2016. The plan includes:

- A description of the pre-subsidence situation and survey of all watercourses with the potential to be impacted through subsidence;
- Subsidence predictions;
- Anticipated subsidence impacts on infrastructure and associated mitigation measures;
- Details of preventative works to be undertaken;
- Details of engineered structures required to maintain the stability and function of watercourses impacted by subsidence;
- Identification of erosion zones and measures to avoid erosion;
- Assessment of any groundwater impacts; and
- Baseline monitoring and assessment of cumulative impacts on surface water.

The below sections provide a broad overview of subsidence rehabilitation methods to be employed based on the Subsidence Management Plan (GRO-7481-PLAN).

4.2.1 Subsidence Tension Cracking

Tension cracks will not cover the full extent of the mining area; rather tension cracks are expected to develop in the area above the chain pillars and could potentially occur in a zone extending approximately 25 m beyond each edge of the chain pillars. The exact location of cracks can only be confirmed through monitoring, with the majority of the area not expected to be affected by cracking.

Tension cracking itself will not necessarily impact on vegetation communities. However, based on experience at the neighbouring Moranbah North Mine, tension cracks will readily erode if not rehabilitated. Rehabilitation of cracks is therefore necessary to ensure a productive post-mining land use, to limit the possibility of significant erosion developing along crack lines and to alleviate safety risks to humans and fauna associated with open cracks.

Subsidence crack rehabilitation will involve repairing individual cracks that develop. This non-intrusive, targeted method of surface subsidence crack rehabilitation has been proposed in order to minimise disturbance of vegetation. Areas disturbed as part of the tension crack rehabilitation program will generally

comprise a narrow strip no wider than the tracks of a small excavator, for the length of the crack, plus a minimal impact access track.

A high level overview of the tension rehabilitation program is as follows:

- A survey of potential tension cracking areas will be undertaken within twelve months of subsidence to locate individual cracks and assess the level of treatment required to rehabilitate each cracks.
- Crack treatment will be undertaken where required. This may involve:
    - Ripping or ploughing minor cracks using a small dozer, grader or tractor. These areas will be allowed to regenerate naturally through inherent seed resources, vegetation propagation from rootstock and recruitment from adjoining undisturbed edges.
    - Stripping large cracks of topsoil (Figure 3), excavating the cracks and placing clean fill to stabilise and control drainage within the landform (Figure 4). Topsoil will then be respread over the area and the site seeded if natural regeneration is not viable (Figure 5).

Figure 3 – Excavation of Topsoil from significant cracks

Figure 4 - Placing clean fill in an excavated subsidence crack

Figure 5 - Replacing topsoil over the treated subsidence cracks

- The crack rehabilitation work area will be clearly delineated in order to limit disturbance to the minimum area necessary and prevent unnecessary encroachment of disturbance. Disturbance of large trees will be avoided where possible. These requirements will be managed through Grosvenor's Permit to Disturb process.

- Any necessary erosion and sediment controls will be implemented in areas disturbed as part of the tension crack rehabilitation program.

- Grazing will be controlled in areas that have been disturbed for crack rehabilitation. This may involve excluding stock through the use of fencing or using strategic grazing pressure, if appropriate.

- A weed and feral animal control program will be implemented. This program will concentrate on areas that have been disturbed as part of the tension crack rehabilitation program.

- A monitoring program will be established for areas disturbed as part of crack rehabilitation. This program will initiate crack rehabilitation maintenance work, where necessary, and ensure that the cracks have been successfully rehabilitated and that disturbed vegetation is regenerating.

The ultimate aim of the rehabilitation and monitoring program will be to confirm that any areas disturbed as part of the tension crack rehabilitation program re-establish vegetation communities consistent with the completion criteria detailed in this Plan. It is anticipated that natural regeneration will be successful, given that only small areas will be disturbed and the use of the topsoil within the area. Canopy trees will be retained wherever possible and a weed control program will be implemented. However, in the event of monitoring indicating that vegetation is not regenerating successfully, further action may be taken including additional weed eradication and/or seeding.

The ground and shrub layer are expected to recover relatively quickly following disturbance given favourable rainfall and past experience of rehabilitated areas at Moranbah North Mine (Figure 6). However, any canopy trees that may require removal to facilitate the remediation of surface cracks will require longer time frames to regenerate. Any tension cracking will be remediated for individual longwall panels shortly after mining resulting in the disturbance being staged over an estimated 30 year period. Therefore, the disturbance to vegetation resulting from tension crack rehabilitation will occur progressively over the life of the mine with the area of vegetation recently disturbed being relatively small at any one time.

Figure 6 – Regrowth of *eucalyptus populnea* in rehabilitation at Moranbah North Mine

4.2.2 Subsidence Buckling

Buckling effects will be rehabilitated as required through regrading of areas disturbed by buckling. By regrading these areas the inadvertent capture and redirection of overland flows that have the potential to lead to erosion and ponding can be prevented. Regeneration of vegetation and monitoring will be as per the subsidence crack rehabilitation program described above.

4.2.3 Subsidence Ponding

Areas of significant ponding caused by subsidence where this negatively impacts Matters of State Environmental Significance will be mitigated by the installation of remedial drainage earthworks to re-establish free drainage. Drainage works may include the construction of excavated trapezoidal drainage channels, designed with sufficient capacity to cater for contributing catchments and with stable batter slopes. These channels would enable drainage of subsidence troughs along pre-existing drainage lines. Drainage channels will be located to avoid sensitive features and vegetation communities.

While subsidence predictions are sufficiently accurate to determine the potential extent of impacts on surface drainage and conceptual remedial drainage works, the detailed design of remedial drainage works will be based on an accurate survey of the actual subsided ground surface and the potential for impact on Matters of State Environmental Significance.

4.2.4 Isaac River, Tributaries and Associated Riparian Corridor

Subsidence effects from underground longwall mining at Grosvenor Mine will potentially result in the following effects on watercourses:

- Channelising of overland flow paths;
- Increased storage of water in waterways from the creation of pools in subsided sections of the waterways;
- Changes to floodplain flow regime (flooding); and
- Bed and bank instability following channel deepening.

Detail on the measures to avoid and mitigate the impacts of subsidence on the Isaac River, its tributaries and associated riparian corridor are detailed in the Subsidence Management Plan (GRO-7481-PLAN). In brief, stabilisation works over the pillar zones prior to subsidence may include:

- Upstream bed gradient control measures (two sets of full stream width pile fields, pinned and buried large wood debris, armouring cobbles, several bank protection pile fields) (Figure 7). The primary functions of these pile fields are to prevent channel erosion by decreasing flow velocity surrounding the channel banks and to create a depositional environment. Bed protection is provided in the form

of armouring cobbles, which require a greater stream velocity to induce movement than is required to move bed materials, hence reducing bed impacts; and

- Bank protection pile fields over main headings and over pillar zones (Figure 8).

Potential for erosion head cut instigation and channelisation of overland flow paths will require proactive management. Such measures may include vegetation management for maximum coverage, potentially the implementation of grade control measures and flow concentration management (Figure 9).

Figure 7 - Completed pile fields at Moranbah North Mine

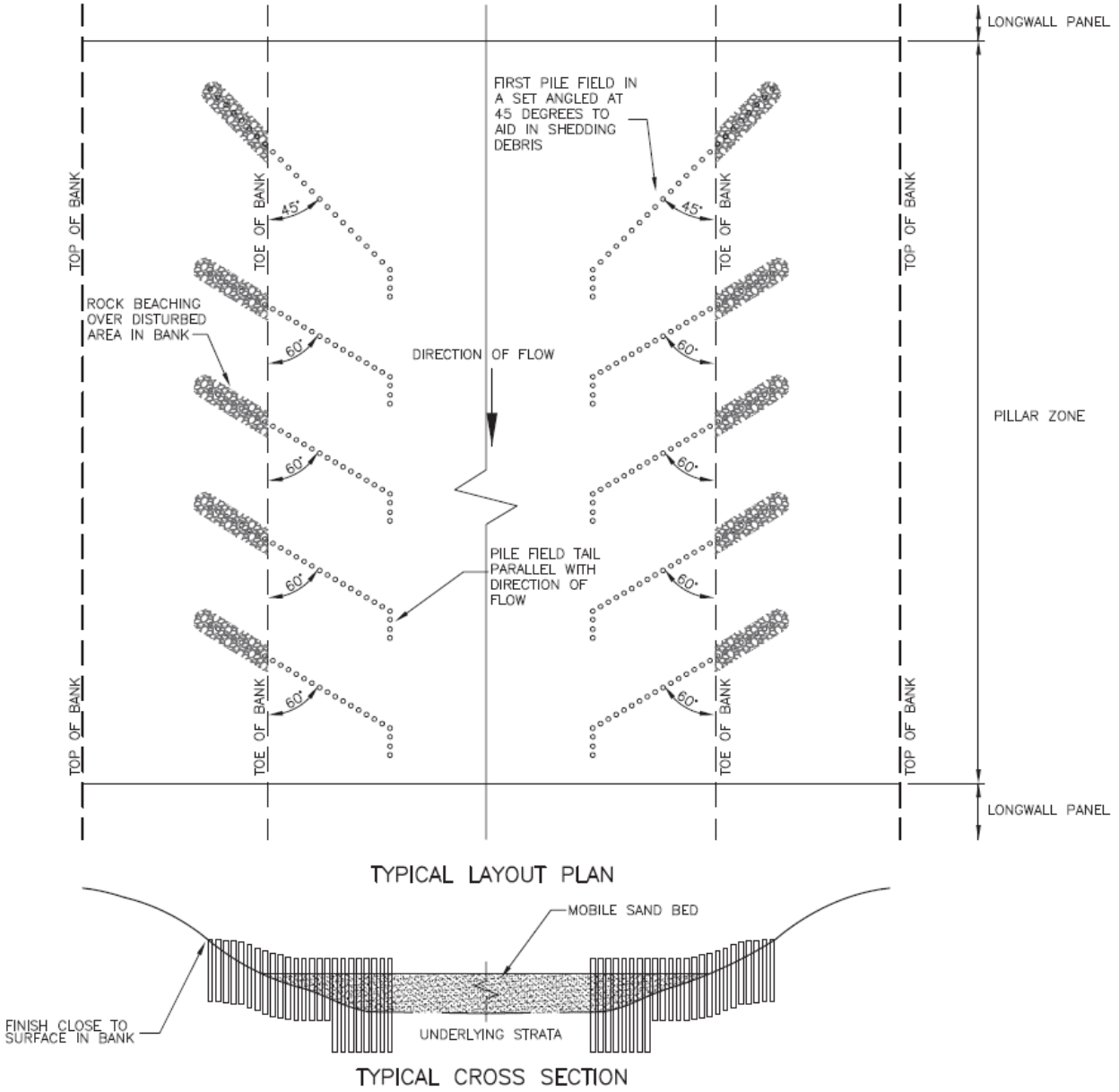

Figure 8 - Pillar Zone Bank Protection - Typical Layout and Cross Section

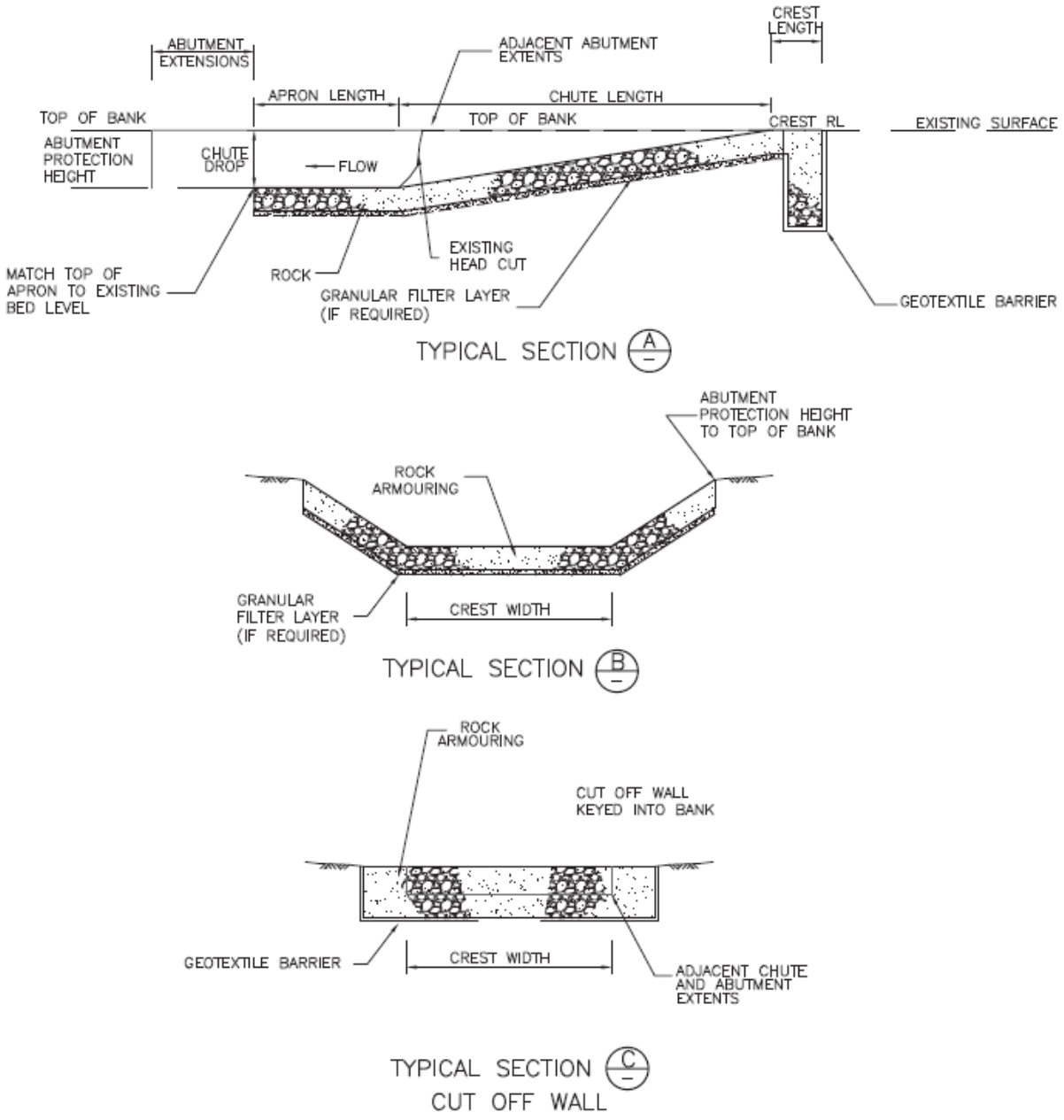

Figure 9 – Floodplian Incision Control - Typical Layout and Cross Section

4.3 EXPLORATION SITES

4.3.1 Drilling

Grosvenor Mine will endeavour to utilize minimum impact clearing methods at exploration sites. All drill holes from exploration activities no longer required for monitoring purposes will be decommissioned and rehabilitated as soon as practical and no later than twelve months after the completion of drilling activities by undertaking the following actions:

1. Where practical all unused drill chips will be disposed of into the hole;
2. The drill hole will be capped at a depth that is consistent with the previous landform of the area;
3. The hole above the cap will be backfilled with the sub-soil and topsoil (in that order) stripped from that specific area;
4. Any vegetation from the initial clearing will be placed back on the surface to provide fauna habitat (Figure 10);
5. Any necessary erosion and sediment controls will be implemented as per GRO-5317-PLAN-Sediment and Erosion Management Plan; and
6. The site will be left to regenerate naturally.

Figure 10 – Example of rehabilitated drill site left to regenerate naturally

Records will be maintained showing the location of all drill holes and any other exploration or test drilling disturbance together with the rehabilitation program conducted. If natural regeneration is unsuccessful, seeding may take place to promote vegetation growth and establish ground cover.

4.3.2 Seismic

All drill holes from exploration activities no longer required for monitoring purposes will be decommissioned and rehabilitated as soon as practical and no later than twelve months after the completion of drilling by undertaking the following actions:

1. Mulch from initial slashing will be spread on the cleared area;
2. Any vegetation from the initial clearing will be placed back on the surface to provide fauna habitat;
3. Any necessary erosion and sediment controls will be implemented as per GRO-5317-PLAN-Sediment and Erosion Management Plan; and
4. The site will be left to regenerate naturally.

4.4 Surface Facilities Management Areas

4.4.1 Water Storages

Consultation with future land users will determine which water storages will remain on site post-mining and which will be removed. The following apply as a minimum for all water storages to remain post-closure:

- Unregulated dams will be stabilised and reshaped to provide safe access to cattle; and
- Regulated dams will be allowed to remain post-closure only if they can be remediated such that they are no longer regulated and then stabilised and reshaped to provide safe access to cattle.

All surface water storages to be removed will be cleaned and decommissioned with any excess water removed prior to reshaping works. The area will then be reshaped and reformed to be overall consistent with the surrounding topography, and drainage channels will be re-established. The surface will be dressed with topsoil and revegetated with species aligned to the land suitability class being reinstated. Dams will likely remain as shallow depressions in the landscape with ponding capacity, and may have possible uses associated with the grazing post-mining land use.

4.4.2 Infrastructure

Unless agreed with the post-mining land user, all buildings and mining infrastructure including gas drainage pipelines, conveyors, underground support facilities, the crushing and sizing station and the drift conveyor will be dismantled and removed from site. A preliminary decommissioning plan has been prepared by a third party in 2015 for Grosvenor Mine. A final decommissioning plan will be prepared prior to mine closure.

Generally, the rehabilitation sequence for infrastructure areas will involve the following:

1. Any metals or materials that may contaminate the site (e.g. batteries, waste oils) will be removed from site and disposed of at an appropriately licensed waste disposal facility;

2. A contaminated land assessment of the coal stockpiles, sewerage treatment plant, fuel farm and refuelling facilities, chemical storage areas, waste transfer station and any other potentially contaminated site will be undertaken to identify any potential contamination. Potentially contaminated areas will be investigated and assessed for the type and amounts of anthropogenic contaminants;

3. All areas with elevated levels of contaminants will be remediated, with contaminated material excavated and transported offsite to a registered landfill;

4. The land will be reshaped in accordance with final Class 4 Land Suitability (Grazing).

5. Topsoil will be spread to a minimum depth of 0.3m.

6. Drainage control will be implemented through ripping, profiling or the provision of erosion control structures;

7. The area will be revegetated with species aligned with Class C Agricultural Land.

A minimum vegetation cover of 70% across all previous surface facility areas will be required. Areas not covered by vegetation will be minimised and vegetation growth will be promoted if required.

4.4.3 Gas Drainage

All gas risers, goaf holes and gas wells will be plugged and abandoned as per the requirements of the *Coal Mine Safety and Health Act 1999* and the latest addition of the *Code of Practice for construction and abandoning coal seam gas wells and associate bores in Queensland*, prior to surface rehabilitation works being undertaken as per steps 4-7 above.

5 REHABILITATION MONITORING PROGRAM

A monitoring program is an essential element of assessing the impacts associated with subsidence and is required as part of the Queensland Government regulatory process.

Monitoring and assessment of progressive rehabilitation processes will be undertaken throughout the life of the mine. The monitoring program is designed to assess the recovery of rehabilitated areas across the site. The objective of the monitoring program and associated methodology is to ensure that suitable data and associated land management actions are in place to ensure that Grosvenor fulfils the rehabilitation commitments in terms of land use and landscape as defined by the rehabilitation completion criteria.

The design of the monitoring program takes into account the following important factors:

- Inclusion of representative reference monitoring sites;
- Select representative rehabilitated sites for monitoring;
- Delineation and monitoring of key indicators over time so as to track their trajectory towards the completion criteria;
- Incorporate the principles of experimental design, and statistically valid sampling procedures, where possible, to maximise quality control over the monitoring process;
- Consider links to other monitoring and research programs, e.g. soil development, nutrient cycling, fauna monitoring; and
- Take into account the practicalities of monitoring, cost and safety.

The Grosvenor rehabilitation monitoring program is presented in Appendix 1.

5.1 MONITORING PROGRAM REVIEW

Reviews of the monitoring program and methodology are conducted to assess the effectiveness of the procedures against the objectives of the EA. The monitoring methodology will be reviewed, and if necessary revised, within three months of the submission of an:

- annual review which has been undertaken as per the requirements of the EA;
- incident report which has been undertaken as per the requirements of the EA;
- audit which has been undertaken as per the requirements of the EA; or
- any modification to the conditions of the EA.

This monitoring methodology may also be revised due to:

- deficiencies being identified;
- results from the monitoring and review program;
- recommendations resulting from the monitoring and review program;
- changing environmental requirements and/or legislation;
- improvements in knowledge or technology become available; or
- where a risk assessment identifies the requirement to alter the methodology.

6 RISKS AND CONTINGENCY MEASURES

The potential risks to successful rehabilitation and a description of contingency measures that would be implemented to mitigate these risks are listed in Table 10.

Table 10 – Risks and Contingency Measures for Grosvenor Rehabilitation

Risk	Contingency
Vegetation not regenerating successfully.	• Determine the likely cause of revegetation failure. Ameliorate soil as required and replant or re-sow appropriate seed mix and application rates, and monitor for success of establishment. • Control of grazing pressure to optimize natural regeneration. • Review adequacy of erosion and sedimentation controls which will be employed during rehabilitation activities, including the repair of subsidence areas. • Additional weed eradication and/or seeding with native species and implementation of GRO-832-EVP-Declared Pest Management. • Vertebrate pest control and management program reviewed and implemented as per GRO-832-EVP-Declared Pest Management. • Review of this Management Plan and Completion Criteria.
Prolonged dry weather conditions.	• Implement irrigation during periods of low rainfall using onsite water resources to enhance establishment of vegetative cover. • If necessary, use of compost materials and mulch to increase organic carbon levels and improve soil structure with resultant increase in infiltration and water holding capacity irrigation. • Implement controls, including mowing, slashing, ploughing and manual removal as required to reduce fuel loads and fire risk in peak seasons. • Establishment and maintenance of fire breaks. • Maintenance of rescue truck / water carts for use in the event of fires.
Tension cracks not located during subsidence monitoring which subsequently erode.	• Immediately implement subsidence rehabilitation works as per rehabilitation methodology (Section 4.2). • Determine the reason that the crack was not identified earlier and put measures in place to prevent problem reoccurring (e.g. additional resources, more intensive inspections).

Risk	Contingency
Remedial drainage works unsuccessful in diverting water and preventing ponding.	• Review the design and installation of works to identify the cause of the failure. • Design and install follow up works.
Inclement weather – significant rainfall event leading to flooding, geotechnical instability, major erosion and/or widespread damage to rehabilitated areas.	• Design final landforms, structures and revegetation to cope with major storm events. • Ensure rapid vegetative cover of all surfaces at completion of final shaping and placement of growing media layer by the use of fast cover species. • Use species suited to the relevant land suitability class. • Ensure erosion and sedimentation controls are designed and maintained to cope with major storm events.
High wind events leading to erosion and/or widespread damage to rehabilitated areas	• Implement irrigation during periods of low rainfall, when wind conditions are most likely to impact establishment of vegetation, using onsite water resources to enhance establishment of vegetative cover. • Undertake soil testing and apply manure and/or gypsum as appropriate to improve soil structure. • Ensure rapid vegetative cover of all surfaces at completion of final shaping and placement of growing media layer by the use of fast cover species.

Surface subsidence is greater than expected.	• Investigate to evaluate the contributing factors to the subsidence exceedance. The investigation may include (where applicable):
	  • Re-survey of the relevant subsidence monitoring lines;
	  • Re-sampling or re-surveying of the applicable environmental monitoring locations (i.e. groundwater bores, surface water monitoring sites);
	  • Review measured subsidence parameters against the observed impact, and latest subsidence predictions.
	• Implement remedial action and/or adaptive management measures, dependent on the outcomes of the above investigation.

7 MONITORING

The rating of the potential consequences of the hazards contained in the site's hazard inventory and baseline WRAC, identified the failure to achieve rehabilitation requirements as a Priority Unwanted Event with the potential to cause serious environmental harm and/or legal non-compliance. In accordance with Anglo American GTS02 Integrated Risk Management Standard, a Bow Tie Analysis was completed for this Priority Unwanted Event including the development of Critical Controls. A list of the Critical Controls that were developed from the Bow Tie Analysis are listed below in Table 11.

Table 11 – Critical Controls and Monitoring Activities for Rehabilitation

Unwanted Event / Risk Description	Critical Control	Critical Control Responsibility	Critical Control Assurance Action	Assurance Frequency Months	Risk Owner
Rehabilitation Requirements not Achieved	Rehabilitation completed as per engineered design / completion criteria	Environment Superintendent	Select two sites which have been rehabilitated in the past 6 months and verify the following: - work scope sign off by environmental department (via PTD or detailed design) - landform design, amelioration technique and seed mix clearly documented and communicated - in field results reflect design and permit requirements for rehabilitation - area has been added to the rehabilitation register - rehabilitation monitoring form has been completed and loaded into GIS (engineered design (if applicable), methodology, depth of topsoil placement, seed mix utilised, amelioration technique applied and if irrigation was utilised)	6 Monthly	SHE Manager
Rehabilitation Requirements not Achieved	Environmental participation / inclusion in the business planning process	Environment Superintendent	Verify that the 3 year rehabilitation is current and has been endorsed by TS Manager, SHE Manager, Commercial Manager and GM.	Annual	SHE Manager

8 PERFORMANCE CRITERIA

The performance criteria for implementation of this Rehabilitation Management Plan are as follows:

- Compliance with the requirements of the Grosvenor EA;
- Management of topsoil resources and vegetation in accordance with this Rehabilitation Management Plan and GRO-256-PLAN-Soil and Vegetation Management Plan; and
- Rehabilitation of land disturbed by the project to a post-mining landform that is stable, self-sustaining, safe, requiring minimal maintenance and within similar land capability and ecological values to its pre-mining state (as assessed against the completion criteria identified in this Rehabilitation Management Plan).

9 REFERENCES

9.1 INTERNAL

- GRO-800-EVP-Environmental Incident Reporting Procedure
- GRO-832-EVP-Declared Pest Management Procedure
- GRO-256-PLAN-Soil and Vegetation Management Plan
- GRO-5317-PLAN-Sediment and Erosion Management Plan
- GRO-7481-PLAN-Subsidence Management Plan
- GRO-2722-PLAN-Grosvenor Receiving Environment Monitoring Program
- GRO-300-HMP-Disturbance, Penetration, Excavation and Rehabilitation
- Coal_8-13-3_GUIDE_Underground Rehabilitation Strategy Guideline
- Baseline Monitoring for Grosvenor Subsidence Management Plan (Alluvium 2015)
- Environmental Authority EPML00987013 – Grosvenor Coal Mine
- Grosvenor Mine Vegetation Monitoring Reference Sites (LRS Environmental 2015)
- Grosvenor Project Environmental Impact Statement (Hansen Bailey 2011)

9.2 EXTERNAL

- *Assessing Pasture Diet Quality (NIRS)* (QLD Department of Agriculture, Fisheries and Forestry)
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality (October 2000)* (Australian and New Zealand Environment and Conservation Council)
- *Australian Soil and Land Survey: Field Handbook (3rd Edition, 2009)* (National Committee on Soil and Terrain)
- *BioBanking Assessment Methodology and Credit Calculator Operational Manual (September 2014)* (NSW Office of Environment and Heritage)
- *Coal Mine Safety and Health Act 1999*
- *Code of Practice for construction and abandoning coal seam gas wells and associate bores in Queensland (Edition 2.0, October 2013)* (Queensland Department of Natural Resources and Mines)

- *Collecting Feed Samples Form (Version 2, November 2007)* (NSW Department of Primary Industries)
- *Environmental Protection Act 1994*
- *Environmental Protection and Biodiversity Conservation Act 1999*
- *Guideline - Rehabilitation requirements for mining resource activities (EM1122, Version 2, January 2014)* (Queensland Department of Environment and Heritage Protection)
- *Land Protection (Pest and Stock Route Management) Act 2002*
- *Land Protection (Pest and Stock Route Management) Regulation 2003*
- *Land Suitability Assessment Techniques in technical Guidelines for the Environmental Management of Exploration and Mining (1995)* (Department of Minerals and Energy)
- *Methodology for Surveying and Mapping of Regional Ecosystems and Vegetation Communities in Queensland (Version 3.2, August 2012)* (Queensland Government)
- *Minimum Construction Requirements for Water Bore in Australia (Edition 3, February 2012)* (Australian Government)
- *Petroleum and Gas (Production and Safety) Act 2004*
- *Tropical perennial grasses – pasture quality and livestock production (Primefact Issue 1070, September 2010)* (NSW Department of Industry and Investment)

10 DOCUMENT CONTROL

Version	Date	Description	Author	Approved
1	24/05/12	New Document	Hansen Bailey	Ben Saunders
2	04/08/16	Updated Document – full review, inclusion of reference sites and completion criteria	Kate Bachmann	Justin Joubert
3	20/09/16	Updated Document – inclusion of monitoring program and feedback from EHP	Kate Bachmann	Justin Joubert

APPENDIX 1 – REHABILITATION MONITORING PROGRAM

1 MONITORING SITES

1.1 REFERENCE SITES

A reference site is an ecosystem that serves as a model for restoring another ecosystem. The use of reference sites to set the benchmark for rehabilitation is considered an appropriate way to track rehabilitation progress and outcomes. The data collected and derived from the reference sites more accurately reflect the local environmental conditions for a vegetation type. This data can also be used to establish target values for key biophysical parameters and indicators related to vegetation diversity/structure and habitat complexity, and provide data on the long-term goal for the rehabilitation areas.

Assessing the reference sites is an integral part of monitoring rehabilitation and is used to generate a "band" of values depending on seasonal effects as well as stochastic events like storms, droughts and fire. In addition, data recording the response and recovery dynamics to stochastic disturbances of the reference site would provide a test of the resilience of a rehabilitated site (rate of recovery of function after specified disturbance). The purpose of the reference sites is to represent as close as possible the landform, aspect orientation and the proposed vegetation characteristics of the rehabilitation areas. The appropriate selection of relevant reference sites is paramount to the effectiveness of the monitoring program, as they will ultimately set the benchmark for rehabilitation measures and completion criteria to be met for closure.

The location of reference sites is selected with consideration of the final land use and rehabilitation objectives for each site. Consequently, reference sites are located and established in undisturbed areas corresponding to each land use type occurring on site and that will be reinstated as part of the rehabilitation program. Additional reference sites may be established as mining progresses. The reference sites forming part of this rehabilitation monitoring program are listed in Table 1.

Table 1 – Grosvenor Reference Sites

Reference Site	Domain Reference	Latitude (GDA94)	Longitude (GDA94)	Description
Rehab R1	Subsidence - Riverine	-21.9286	148.0221	Isaac River – Upstream
Rehab R2	Subsidence - Riverine	-21.9317	148.0187	Isaac River – Upstream
Rehab W1	Subsidence – Non Riverine	-21.9637	148.0115	Woodland – RE 11.3.2
Rehab W2	Subsidence – Non Riverine	-21.9434	148.0161	Woodland – RE 11.4.9
Rehab W3	Subsidence – Non Riverine	-21.9157	148.0511	Woodland – RE 11.5.3

Rehab G1	Surface Facilities, Exploration and Subsidence – Non Riverine	-21.9302	148.0257	Grassland
Rehab G2	Surface Facilities, Exploration and Subsidence – Non Riverine	-21.9336	148.0275	Grassland

1.2 REHABILITATION SITES

Rehabilitation sites are those areas of post-mined lands where vegetation communities and ecosystems are being re-established in accordance with the EA. Monitoring sites are established in rehabilitation areas to assess the recovery of post-mined lands across the site.

The locations of monitoring sites are aligned to the final land suitability classes and land use types being reinstated post mining. The number of rehabilitation sites is dependent on the rate at which rehabilitation activities are undertaken at the site and the methodologies that are used, and will increase in number as new areas are being rehabilitated and/or rehabilitation methodologies are amended.

Rehabilitation monitoring sites will be located within each area being reinstated to a particular land suitability class and landuse type. The density of monitoring sites will be dependent on the total area being reinstated to a particular land suitability / landuse, the larger the area the higher density of transects required. The minimum rehabilitation transect density as a function of the area being rehabilitated of each is presented in Table 2. This Table is based on the NSW Office of Environment and Heritage *BioRanking Assessment Methodology and Credit Calculator Operational Manual (September 2014).*

Table 2: Number of Rehabilitation Monitoring Sites

Land Suitability Class / Land Use Rehabilitation Area (ha)	Minimum number of rehabilitation monitoring sites
0-4	1
>4-20	2
>20-50	3
>100-250	4
>250-1000	5

2 MONITORING PROGRAM IMPLEMENTATION

2.1 TRANSECT AND PLOT ESTABLISHMENT

Consistent with the neighbouring Moranbah North Mine, monitoring transects and plots consist of a 50 m linear transect with nested 20 x 50 m and 20 x 20 m plots, along which data attributes are measured and collected. The transect/plot layout is represented graphically in Figure 1. The following apply while establishing the monitoring transects/plots:

- Transect lines are located directly downslope and aligned with the maximum slope, where possible;
- Transects/plots are permanently located to facilitate repeated measurements over time. This is essential for long term monitoring to be meaningful;
- The start and end points of each transect are marked by a metal star picket; and
- Transects/plots are located by GPS readings of starting and ending points.

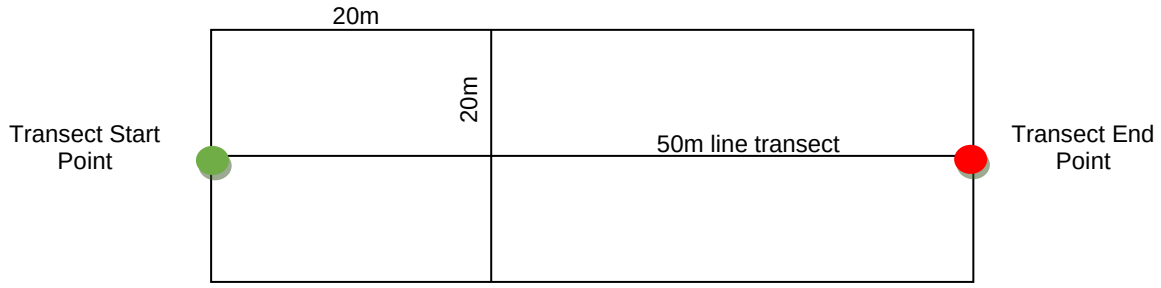

Figure 1: Transect and Plot layout

Transects shall be first established randomly within the monitoring area so that the assessment includes the range of variation in condition of that land use area. Transects/plots can be placed randomly by:

- Marking points randomly within each vegetation zone on an aerial photograph of the site and establishing transects/plots at these points; or
- Pacing a predetermined and random distance into the vegetation zone, establishing a transect/plot at this point, and then repeating the process.

It is noted that the location of reference plots will need to seek to sample relatively undisturbed vegetation. It is therefore anticipated that the location of these plots will be the subject of discussion with landholders so as to achieve this aim whilst minimising impacts from ongoing monitoring.

2.2 RESOURCES

The following resources will be required to undertaken rehabilitation monitoring:

- 50 m transect tape;
- 20m transect tape;
- 50 cm plot delineators;
- Star pickets;
- Digital camera;
- Global Positioning System (GPS);
- Plant identification books (not essential);
- Flagging Tape (not essential).

3 MONITORING METHODOLOGIES

The monitoring methodology utilises a combination of tools to monitor the success of rehabilitation and is based on the EA completion criteria. The applied methodology provides quantitative data that allow an assessment of the changes occurring over time. The methodologies applied to monitor the success of rehabilitation activities against completion criteria are listed in Table 3.

Table 3: Monitoring Methodology for Rehabilitation Indicators

Parameter	Monitoring Methodology
Post Mine Land Use Capability	Pasture Productivity Assessment
Land Suitability	Land Suitability Assessment
Soil Characteristics	Soil Analysis
Water Course Stability	Index of Diversion Condition (IDC) Photographic Monitoring
Species Density / Richness	Vegetation Dynamics Photographic Monitoring
Ground Cover	Vegetation Dynamics Photographic Monitoring
Fauna Diversity	Rapid Visual Monitoring – Habitat Complexity Photographic Monitoring
Erosion	Rapid Visual Monitoring – Disturbance Photographic Monitoring
Weeds and Vertebrate Pests	Visual Monitoring – Disturbance Photographic Monitoring
Water Quality	Monitored under Grosvenor *Receiving Environment Monitoring Plan*
Subsidence	Monitored under Grosvenor *Subsidence Management Plan (GRO-7481-PLAN)*

3.1 PASTURE PRODUCTIVITY ASSESSMENT

The productivity of pastures (i.e. quality of feed available) will be assessed for those areas returning to grassland post-mining.

Pasture samples are collected randomly in the areas containing the rehabilitated pasture transects following the *NSW Department of Primary Industries Collecting Feed Samples Form (Version 2, November 2007)*. The sample consists of 15-20 grab samples of vegetative material cut approximately 5cm from ground height (at grazing height) and mixed together. The sample is then sent via courier to an accredited laboratory for testing of the quality of feed available.

The most useful measure of pasture quality is its digestibility, as it is directly related to the energy content of a pasture and has a positive relationship with protein. As such, the parameters of highest interest include:

- The Metabolisable Energy (ME) of the pasture, i.e. the amount of energy in the feed that is available to an animal to utilise for maintenance, production and reproduction;
- The crude protein content of the feed, i.e. the amount of nitrogen content in the feed.
- Dry Matter Digestibility, i.e. the percentage of feed consumed that is broken down and absorbed by the animal.

3.2 LAND SUITABILITY ASSESSMENT

Land Suitability Assessment will be conducted in accordance with the most recent Department of Minerals and Energy Land Suitability Assessment Techniques Guideline.

Land suitability class involves an interpretation of data collected on the physical, chemical and nutritional characteristics of the soil to rank the land according to a five class system that applies to the end land use (i.e. grazing).

The classes are described as:

- Class 1 - Suitable land with negligible limitations which is highly productive requiring only simple management practises to maintain economic production.
- Class 2 - Suitable land with minor limitations which either reduce production or require more than the simple management practices of Class 1 land to maintain economic production.
- Class 3 - Suitable land with moderate limitations which either further lower production or require more than those management practices of Class 2 land to maintain economic production.

- Class 4 - Marginal land with severe limitations which make it doubtful whether the inputs required to achieve and maintain production outweigh the benefits in the long term (presently considered unsuitable due to the uncertainty of the land to achieve sustained economic production).
- Class 5 - Unsuitable land with extreme limitations that preclude its use for the proposed purpose.

Based on soil analysis completed, data ranked for each soil type will include:

- Plant available water capacity
- Nutrient deficiency
- Soil physical factors
- Salinity
- Rockiness
- Micro relief
- pH
- Exchangeable Sodium Percent
- Wetness
- Erosion
- Flooding

3.3 SOIL ANALYSIS

Soil characterisation and analyses are performed to determine the physical and chemical properties of the growing media. This provides valuable information on the type of soil amelioration, stability and fertiliser regime that may be developed and implemented. In turn, this information assists in enhancing vegetation establishment and improving the plant growing conditions of the rehabilitation areas, whilst also assisting in the management of sediment and erosion control and ultimately the creation of stable and suitable landforms. The National Committee on Soil and Terrain's Australian *Soil and Land Survey Field Handbook (3rd Edition, 2009)* will be referenced when undertaking soil testing.

Soil samples will consist of two 250g samples collected at the start and end of the transect location and mixed together to produce the sample for each transect. All samples will be sent via courier to an NATA-accredited laboratory for testing. Routine soil characterisation tests are performed to determine the physical and chemical properties, plant available nutrients and organic material present. Data from testing will normally include:

- pH
- Sodicity
- Electrical conductivity
- Electrochemical Stability Index
- Plant available nutrients (Nitrogen, Phosphorus and Potassium, Sulphur)
- Infiltration capacity
- Aggregate stability
- Surface roughness
- Micro / macro nutrients
- Cation balance (calcium, magnesium, sodium)
- Soil organic matter content
- Fertiliser application rates as relevant for the proposed plant community

3.4 INDEX OF DIVERSION CONDITION

Monitoring of water course stability will be undertaken as part of the Subsidence Management Plan (GRO-7481-PLAN), however the below provides a summary of the methodology to be utilised.

The Index of Diversion Condition (IDC) is the method accepted by the Queensland Government of recording and monitoring the condition of diversions and adjacent upstream and downstream reaches. It is an integrated suite of indicators that measures the geomorphic and riparian condition of a diversion and its upstream and downstream reaches. IDC provides a rapid assessment and is designed to flag potential management issues rather than provide a detailed scientific assessment of the waterway. In the instance of Grosvenor, the diversion reach is replaced by the subsidence reach.

IDC monitoring involves assessment of geomorphic and vegetation sub-indices which are scored out of 10. The IDC being the sum of the two sub-indices has a maximum possible score of 20 for any reach. If a reach were to achieve this score it would be in a stable geomorphic condition with a natural rate of erosion, sediment transport and deposition. It would also have continuous and dense ground, midstorey and overstorey vegetation. Even outside of mining areas this score would be rare because most streams are subject to pressures of human use including grazing, infrastructure and other activities. A more realistic goal is to have the diversion functioning with the geomorphic and riparian sub-indices being at least equal of the adjoining reaches with vegetation similar to that in equivalent regional ecosystems.

3.5 VEGETATION DYNAMICS

Ground Cover

The following data is recorded for each transect / plot:

- Percentage cover of lower stratum vegetation (all species combined) - forb, grass, sedge, vine, shrub, etc.;
- Percentage cover of litter; and
- Percentage cover of bare ground.

Percentage cover is visually estimated to the nearest 10% using a 1 x 1m frame, divided into a 0.1 x 0.1m grid. Estimations are carried out at every 5m point along the 50 m transect for a total of ten sampling quadrats. The overall scores for the site are calculated by averaging the scores of the ten sampling quadrats.

Vegetation Cover

The density of woody plants is recorded along the 50 m transect. The transect is divided into 5m sections and all woody plants in the middle and upper strata are counted and recorded within each 5 x 5m quadrat. This enables the calculation of woody species density for each height class for the transect, providing an overview of the vegetation structure.

Each woody plant recorded is classified into a stratum with the following strata (i.e. height classes) used:

- Strata 1: 0 – 1.0m;
- Strata 2: 1.0 –3.0m; and
- Strata 3: > 3.0m.

Flora diversity was also be recorded within each 5 x 5m quadrat which is be used to estimate the woody plant richness for the transect. Note, not all species are individually identified.

Flora Species Composition

The dominant species present within the 20 x 20 m monitoring plot are identified. Dominant species are recorded for each stratum, i.e. ground cover species, lower, mid and upper strata. Dominant species are those representative of the vegetation community occurring in the area, and several individual of a particular species need to present within the plot boundaries to be recorded. Notes are also made on species that are flowering or fruiting.

3.6 VISUAL MONITORING

Habitat Complexity

As vegetation develops in size and diversity, more environmental niches for fauna emerge, and the faunal habitat structure becomes more complex and possibly more conducive to faunal colonisation. The “habitat complexity” index assesses the extent to which habitat and shelter for vertebrate fauna are developing. It is an index of habitat quality, not presence of animals. Habitat complexity was assessed on the basis of six features:

- Canopy cover
- Shrub cover
- Ground vegetation cover
- The amount of litter, fallen logs and rocks
- Free standing water and available soil moisture
- The presence and amount of hollow bearing trees

This data is captured through a visual assessment of the area along the transect extending approximately 10m either side of the transect (i.e. an overall area of 50m x 20m is surveyed). Each feature is assessed on a scale of 0–3 with the scores of the five features being summed to give an overall habitat complexity score. Details on these ratings are provided in Table 4.

Table 4: Habitat Complexity Ratings

Structure	Score			
	0	1	2	3
Tree Canopy (%)	0	<30	30-70	>70
Shrub Canopy (%)	0	<30	30-70	>70
Ground Herbage	Sparse <0.5m	Sparse >0.5m	Dense <0.5m	Dense >0.5m
Logs, rocks, debris etc (%)	0	<30	30-70	>70
Free standing water and available soil moisture	Dry	Moist	Permanent water adjacent	Water-logged
Amount of hollow bearing trees	0	1-5	5-10	>10

Disturbance

Disturbance monitoring is a field based, rapid assessment tool to visually assess and award a score to various contributors. The objective is to identify factors and processes that occur at the landscape/catchment scale and have the potential to impact on the monitoring site. The disturbance categories (and associated disturbance factors) monitored and assessed for each monitoring site are summarised in Table 5.

Each of these factors is assessed in terms of its frequency (i.e. the longevity of the effects of the activity or disturbance event) and intensity (i.e. the degree to which the site has been/is being affected) and awarded a score which corresponds to the sum frequency + intensity. The conditions of criteria for each component are detailed in Table E. An overall result (i.e. disturbance status) for each site is then generated by adding individual scores for each disturbance factor.

As this monitoring intends to identify factors and processes occurring at the landscape/catchment scale, the monitoring area is larger than just the transect/plot area. Rather, the occurrence and impact of the disturbance factors are assessed in the broader surrounding area containing the nominated transects/plots, usually while travelling to and from and traversing each monitoring site on foot.

Overall, this visual monitoring process allows for comparison between different sites and over time. It will also allow for a prompt feedback system whereby disturbed revegetated areas that require maintenance can be efficiently and objectively prioritised for remedial works.

Table 5: Disturbance Ratings

Disturbance Factor	Frequency	Intensity	Height (Fire Only)
Mining Activity			
Wheeled Vehicles Tracked Vehicles Excavation Foot Mine Rubbish	Absent (0) Present season (1) 1-2 years previous (2) >2 years previous (3)	No damage (0) <5% growth removed/damaged (1) 5-25% growth removed/damaged (2) 25-50% growth removed/damaged (3) 50-75% growth removed/damaged (4) >75% growth removed/damaged (5)	N/A
Non Mining Activity			
Grazing Animal Pads Feral Animals Rubbish	Absent (0) Present season (1) 1-2 years previous (2) >2 years previous (3)	No damage (0) <5% growth removed/damaged (1) 5-25% growth removed/damaged (2) 25-50% growth removed/damaged (3) 50-75% growth removed/damaged (4) >75% growth removed/damaged (5)	N/A

Weeds			
Environmental and/or noxious weeds	Absent (0) Present season (1) 1-2 years previous (2) >2 years previous (3)	<5% area weed infested (0) 5-25% area weed infested (1) 26-50% area weed infested (2) 51-75% area weed infested (3) >75% area weed infested (4)	N/A
Fire			
Fire	Absent or >5 years (0) Present season (1) 1-2 years previous (2) >2 years previous (3)	No damage or recovered plant community (0) Minor scars on some trees/shrubs (1) Minor scars on most trees/shrubs (2) Major scars on trees/shrubs (3) Some trees/shrubs killed (4) Most trees/shrubs killed (5)	None or recovered plant community (0) <1m (1) 1-4m (2) >4m (3)
Erosion			
Erosion	Sheet Rill/Gully Pedestal Terracette Scalding	Nil to Low – no sheet or gully present (0) Moderate – sheet and gully erosion present – gullies restricted to major flow lines (1) High – severe sheet and gully erosion present – rills clearly evident, subsoil and C horizons clearly exposed in many areas, clearly evident depositional areas adjacent to fences and roads- gullies are deep and active (2) Very High – severe sheet erosion present causing bare ground and scalding – subsoil and C horizons or bare rock exposed in many areas – clearly evident areas of deposition on lower slopes, adjacent to fences / roads; gullies active and strongly branched; gullies often show tunnelling (3) Majority of area is bare and scaled, usually extensive areas of active rilling and gullying present – gullies may occupy the majority of the area (4)	N/A

3.7 VISUAL MONITORING

Photographs will be taken at monitoring points and other features of relevance within the study area to enable comparison and visual assessment of changes over time.

Photographs must be clearly catalogued with the GPS location and direction of the photograph to ensure consistency in the view represented.

3.8 MONITORING TIMING AND FREQUENCY

Monitoring will be conducted periodically by appropriately qualified and skilled persons at locations which will be representative of the range of conditions on the rehabilitating areas. Note that monitoring of areas of the Isaac River, tributaries and associated riparian corridor affected by subsidence, including pre-subsidence monitoring and reference sites will be detailed in the Subsidence Management Plan (GRO-7481-PLAN).

All monitoring sites, inclusive of analogue and rehabilitation sites, will be monitored on an annual basis. Whilst the particular season for undertaking the monitoring is relatively unimportant, it is imperative that both analogue and rehabilitation sites are monitored at the same period in time, to reduce seasonal variations. It is equally important that the annual monitoring is undertaken during the same season every year, this ensures that meaningful and scientifically robust comparisons and analyses can be made between years.

3.9 STATISTICAL VALIDITY

The methodology employs statistically valid sampling procedures, to maximise quality control over the monitoring process. The combination of tools used for the monitoring methodology provides quantitative data that can be used for statistical and trend analysis. This allows a site to be assessed over time enabling Grosvenor to assess the trajectory of the ecosystem being re-established in rehabilitation areas. In turn, this data can be used to decide if the site is converging on a target functional state (i.e. completion criteria or analogue site benchmarks) or requires further works.