HUNTER VALLEY OPERATIONS

Plan

Agricultural Land Reinstatement Management Plan

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1 Purpose

The purpose of this Agricultural Land Reinstatement Management Plan is to outline reasonable and feasible measures to ensure that alluvial agricultural lands that have been mined, are restored to a productive capacity, at least equivalent to their pre- mining state, and are able to be managed using techniques and equipment typical of the management of equivalent lands in the district.

This Management Plan describes the existing environment within the approved project area, lists the regulatory criteria that apply, defines best management practice (as it applies to the Project) and details the management framework, the long term monitoring programme and the mitigation actions to be taken in operating the Project.

The key elements of the management practices will be:

- the maintenance of topsoil fertility through soil characterisation,
- effective soil stripping,
- best practice topsoil storage, and
- reinstatement of soil profiles through the replacement of the subsoil and topsoil layers post- mining.

Monitoring of the rehabilitated area and the implementation of remedial actions where necessary, will ensure that the agricultural reinstatement will meet the objectives and conditions of approval. HVO has restored the productivity to alluvial lands in post-mined environments previously at HVO North. The techniques utilised, successful remediation strategies implemented and lessons learnt during that trial have been incorporated into this management plan.

1.1 Introduction

Hunter Valley Operations (HVO) is an open cut operation located approximately 24 kilometres north-west of Singleton in NSW. The site is generally bounded by the New England Highway to the north, Jerrys Plains Road to the west and south, and Ravensworth Operations to the east. The Hunter River bisects the mine and, while HVO is managed as one operation, HVO North and HVO South each have separate planning approvals.

The modification of the HVO North Development Consent to include the Carrington West Wing (CWW) extension (the Project) was granted on 19 March 2013. The Development Consent approves the extension of the existing approved Carrington Pit by approximately 137 hectares (ha) to the south-west and extract approximately 17 million tonnes (Mt) of in-situ coal from this area. This Project is described in detail in the Environmental Assessment that supported the application for the Carrington West Wing Project (EMGA Mitchell McLennan, 2010).

The Project will occur in an area where mining is a dominant feature of the landscape and where the vast majority of the area has been modified, initially by agriculture, with little native overstorey vegetation remaining on the Hunter River floodplain where the extension area is located.

The proposed extension area has a land capability that is predominately Class II, III and IV rural land prior to mining as defined by the DECCW's land capability classification system.

1.2 Scope

This Agricultural Land Reinstatement Management Plan (ALRMP) has been prepared in accordance with Schedule 3, Condition 62D of the CWW Development Consent (DA 450-10-2003).

The approved mining area is comprised of various soil types and land capabilities. This ALRMP will focus on the reinstatement of the alluvial lands suitable for irrigation. The reinstatement of the grazing lands will be undertaken as per the established techniques outlined in the HVO Mining Operations Plan (MOP).

This ALRMP is to be applied from the time of approval of this plan, during construction and operation of the Project and incorporates mitigation measures that Hunter Valley Operations will undertake in accordance with Schedule 3, Condition 62D of the Approval. Table 1.1 below highlights the conditions required to be covered by this management plan and the sections within this document in which they are addressed.

Table 1.2 highlights where items in the Statement of Commitments (SOC) related to rehabilitation of agricultural considerations are addressed

Table 1.1 - Consent Conditions Addressed

Consent Condition	Environmental Performance Conditions	Section of ALRMP which addresses this requirement
62D (a)	be prepared in consultation with DPI and to the satisfaction of the	Chapter 4
	Secretary	
62D (b)	be prepared in accordance with any relevant DPI guideline;	Section 2.4
62D (c)	include detailed performance and completion criteria for evaluating the performance of the rehabilitation of the Carrington West Wing revised proposed extension area, and triggering remedial action (if	Chapter 5.
	necessary)	
62D (d)	include a long-term monitoring programme on the success of	Chapter 7
	reinstating alluvial lands, which must: • assess a comprehensive suite of indicators of productivity and environmental sustainability (such as soil settling, soil profile development, other soil characteristics, water transmissivity and soil water availability, agricultural productivity, fertilizer needs, weeds and pests) over an extended period (a minimum of 20 years); • compare the performance of the reinstated alluvial lands with a reference site; and • make monitoring results publicly available	
62D (e)	in accordance with former Condition 4(h) of Schedule 6 (now Conditions 3 and 4 of Schedule 5) provide for reviews of progress against the plan every 3 years (unless otherwise agreed by the Secretary after completion of the second review) and for a final review by the end of 2033	Chapter 9

Table 1.2 - Statement of Commitments Addressed

SOC reference	Commitments	Where Commitment is addressed
Table 6.1 Commitments	Management and mitigation strategies for the stripping, handling and use of topsoil, landform design, erosion and sediment control and seedbed preparation will be implemented to achieve the desired post-mining land capability and agricultural suitability outcomes. The detailed rehabilitation plans, consistent with Figure 3.4, will be documented in the RMP/MOP, and will be tracked for progress in the AEMR.	Chapters 6 and 7
	Rehabilitation will aim to achieve the following objectives: • successful design and rehabilitation of landforms to ensure structural stability, revegetation success and containment of wastes; • development of a final landform with recognition of the pre-mining landform features, which incorporates the existing rehabilitated landforms and is consistent with the surrounding landscape features; and • post-mining land use compatible with surrounding land uses, capable of supporting viable grazing and ecological values and providing environmental and community benefits.	Chapters 2.3 and 3

2 Background

The Carrington West Wing Project oj is an extension to the south-west of the adjacent Carrington Pit which is a truck and shovel operation.

The approval permits the extraction of approximately 17 million tonnes (mt) of in-situ coal from the Vaux, Broonie, and Bayswater seams. The extension area is approximately 137 ha of agricultural land that affords approximately six years of mining.

The extension area consists of low undulating slopes and flat areas that have been previously cleared for agriculture. The local catchment drains from the project area via an unnamed tributary and some minor tributaries to the Hunter River, approximately 250m south of the proposed catchment area. The low lying areas are subject to inundation during flood events and thus, levees have been constructed to prevent Hunter River floodwaters from entering areas of the existing mine.

The approved extension permits the temporary construction of a levee bank and the permanent installation of a groundwater barrier wall along the western arm of the paleochannel that includes Carrington West Wing extension. These features will be further explained in later chapters.

2.1 Project Approval

The Carrington West Wing Project was approved by the Planning Assessment Commission (PAC) on 19 March 2013 as delegate for the Minister for Planning and Infrastructure as a modification to the Hunter Valley Operations North (HVON) development consent (DA 450-10-2003) under Section 75W of the Environmental Planning and Assessment Act 1979 (EP&A Act).

Conditions 62C and 62D of the approval relate to the rehabilitation of post-mined areas within the project area.

A summary of these conditions and where they have been addressed in this document is presented in Table 1.1.

2.2 Previous Experience with Reinstating Agricultural Land at HVO

HVO has been successful in reinstating strategic agricultural land in the Hunter Valley.

In May 1993, consent was granted for the Hunter Valley Operations Alluvial Lands Open Cut Mining Operation which permitted mining an area of 170 hectares of the Hunter River alluvial flood plain (Alluvial Lands Project). The approval required HVO to demonstrate that the mining would not result in the loss of prime agricultural land and that a sustainable post mining land use could be achieved once the coal resource had been recovered. Mining commenced in October 1995 in the area located approximately 1.9 km to the south-east of the proposed extension area.

The consent required the relocation and reinstatement of 63 ha of Class 1 and 2 lands that were able to achieve a lucerne hay productivity yield of ‘at least equivalent to the average crop productivity yields for the Upper Hunter Region for three consecutive years. The remaining land, 102 ha, was required to be rehabilitated to Class 4 land such that it was suitable for grazing.

The production of lucerne hay (and silage) from the rehabilitated land was monitored for the period 2003- 2007. This monitoring occurred in close association with several Government

agencies regarding lucerne species, productivity measurement, agronomic practices, reinstatement techniques and outcomes.

During 2007 it was successfully demonstrated that the production of hay yields on the rehabilitated land were above the district comparison yield for three years of lucerne growth.

To assess whether the reinstated soils had suffered any deleterious effects due to handling practices, the structural characteristics of the reinstated land were compared to a control site (adjoining unmined alluvial soils). This involved the assessment of soil physical and chemical properties over a four year period (2002 to 2006). Soil pits were excavated to depths of 1.7 metres to allow sampling and assessment.

Physical:

It was found that there was no appreciable difference in soil structure between the control land and the rehabilitated area. Surface horizons in both control and rehabilitated sites exhibited moderate pedality. The primary peds had similar shape and were approximately the same size. Porosity and cracking was evident in both areas. Significantly, roots occurred to a depth of 0.9 m in the rehabilitated pits and there was no obvious pans or compacted layers which suggest there was no structural deterioration.

Chemical:

The soil chemical analyses provided insight into the comparability of the nutrient levels between the rehabilitated and control sites. The pH was less alkaline than the controlled soil. Nutrient levels were nearly identical to a depth of 1.2 m and this included the major nutrients. Nitrogen and phosphorus were found to be adequate in rehabilitated land. Exchangeable cations such as potassium were found to be more abundant in the rehabilitated land which was likely to be the cause of the higher cation exchange capacity exhibited in the rehabilitated soil.

Organic carbon was found to be slightly lower in the rehabilitated soil compared to moderate levels in the control and trial areas. This was corrected through the use of green manure crops prior to sowing to Lucerne. In addition, organic carbon will be naturally corrected as soil organisms and plant root material reach a typical level for cropped land.

The surface soil properties were also found to be very similar throughout the three areas (unmined land, trial area and reinstated area) with the only significant difference being the available water holding capacity (AWHC). Both the trial area and reinstated area had higher AWHC's than the control area. Available phosphorus and phosphorus sorption were higher in both the trial and reinstated land when compared to the control area.

The Alluvial Lands Project was a landmark project that demonstrated how a sound rehabilitation plan that uses an adaptive management and monitoring approach can provide for a highly successful outcome with regards to reinstating agricultural lands on disturbed mining footprints. The techniques and lessons learnt from that project have been applied to the proposed reinstatement of agricultural land associated with the Carrington West Wing domain and incorporated in this Agricultural Land Reinstatement Management Plan.

2.3 Commitments Made in Environmental Assessments

A number of environmental commitments were outlined in the CWW Environmental Assessment. The statements outlined in Table 2.1 below have been extracted from Table 6.1 of that document where they relate to the reinstatement of agricultural landscapes within post- mined lands.

The commitments outlined have been incorporated into the rehabilitation procedures in the HVO MOP and this ALRMP.

Table 2.1 - Environmental Commitments

Attribute	Commitment
Soils and land use	• Management and mitigation strategies for the stripping, handling and use of topsoil, landform design, erosion and sediment control and seedbed preparation will be implemented to achieve the desired post-mining land capability and agricultural suitability outcomes. The detailed rehabilitation plans will be documented in the REMP/ MOP and will be tracked for progress in the AEMR. • Rehabilitation will aim to achieve the following objectives: - successful design and rehabilitation of landforms to ensure structural stability, revegetation success and containment of wastes; - development of a final landform with recognition of the pre-mining landform features, which incorporates the existing rehabilitated landforms and is consistent with the surrounding landscape features; and - post-mining land use compatible with surrounding land uses, capable of supporting viable grazing and ecological values and providing environmental and community benefits.
Air quality	• Only the minimum area necessary for mining will be disturbed. Completed overburden emplacement areas will be reshaped, topsoiled and rehabilitated as soon as practicable after the completion of overburden emplacement. • Long term topsoil stockpiles, not used for over three months, will be re-vegetated.
Ecology	• Management of weeds, landscape disturbance and rehabilitation, and sediment and erosion control will be undertaken in accordance with HVO's environmental procedures.
Visual amenity	• Disturbed areas will be progressively rehabilitated, and revegetation of rehabilitated areas will be undertaken as soon as practical after final landforms and drainage structures are completed.

	• An annual visual assessment of operations will be undertaken, including recommendations for additional mitigation measures where necessary.

2.4 Relevant Standards and Guidelines

In addition to the applicable State and Federal legislation, HVO undertakes all its activities in compliance with a number of internal and external standards and guidelines.

The compliance documents, standards and guidelines that are applicable to the reinstatement of agricultural lands at HVO include:

1. HVO North Development Consent (DA 450-10- 2003).
2. HVO – Disturbance and Rehabilitation procedure.
3. EMGA Mitchell McLennan (2010). Carrington West Wing Environmental Assessment. October 2010.
4. HVO Mining Operations Plan (2020).
5. GSS Environmental (2011) Strategic Agricultural Land & Reinstatement Assessment Report: Carrington West Wing Project. In: EMGA Mitchell McLennan (2011). Carrington West Wing Agricultural Impact Assessment. June 2011.

3 Proposed Operations

Carrington Pit has been approved to be extended to the west with the western boundary being adjacent to Lemington Road. Figure 3.1 has been taken from the CWW EA and illustrates the key landscape features.

Overburden will be emplaced in-pit, as well as two out-of-pit overburden emplacements that will be established on previously disturbed and rehabilitated land immediately north of the approved extension area. The final landform goal for in-pit disposal of overburden is to return the mined out areas of the proposed extension area as close as possible to the pre-mining landform. This was a consideration into the mine planning design and progression and is the reason why the overburden emplacements to the north are required to be enlarged.

The overall objective of rehabilitation at HVO North is to implement successful design and rehabilitation of landforms to ensure structural stability, revegetation success and containment of wastes; and to ensure rehabilitation and revegetation is self-sustaining and follows the principles of sustainable development.

The landscape features and rehabilitation activities to be undertaken in association with the proposed operations are outlined further below.

3.1 Existing Soil Units

The approved mining area is comprised of a number of distinct soil units that are of varying quality for reinstating agricultural enterprises around cropping. These soil units include:

- Brown Uniform Silty Clay Loam (43.9 ha);
- Brown Uniform Silty Clay (56.8 ha); and
- Red Brown Duplex Loam (36.1 ha).

The location of these soil units within the project area are illustrated in Figure 3.2.

Field assessments of these soil units were undertaken for the CWW Environmental Assessment. The soil profiles were examined to a depth of 1.2 m and the results are provided in this ALRMP within Appendix A.

The assessment determined that the top 1.2m of the Brown Uniform Silty Clay Loam was suitable for stripping and reuse as a topdressing medium for land rehabilitation. Depth restrictions on the assessment limited confirmation of the suitability of the soils deeper than 1.2 m but, based on exploration drilling in the area, it is thought that this material would be consistent to at least 2.5 m.

With the Brown Uniform Silty Clay, only the top 0.20m is suitable for use as topsoil rehabilitation. The subsoil is not suitable as topsoil due to the high clay content, massive structure and moderate salinity.

With the exception of the top 0.10 m, the Red Brown Duplex Loams was determined as not being suitable for use as topsoil rehabilitation and was suggested that it be conserved as an intermediate layer between the reshaped overburden and the final topdressing layer.

The laboratory analysis of the soil units indicated that all three soil types were generally non-sodic and thus less prone to erosion and surface crusting. Some potential for dispersion was found within the Brown Uniform Silty Clay and the Red Brown Duplex Loams. The appropriate erosion and sediment control measures will be in place prior to disturbance of these soils to minimise erosion once the subsoil is exposed. These measures are discussed further in Section 6.

3.2 Final Landform

The final landform of the approved CWW extension area is designed to be consistent with the surrounding pre- mining landscape. It is intended that the landscape in the alluvial areas to be mined that are outside the extension to the existing overburden emplacements, will be reinstated as close as possible to their original condition with little change in height, slope, impacts of subsidence and extent of flooding.

The emplacements will be shaped to facilitate agricultural and native habitat development. The detail of the native habitat areas and the final landform design will be outlined in an approved MOP and be undertaken in accordance with contemporary design and best practice techniques.

The Carrington West Wing mining project has an approved levee bank to prevent the Hunter River from entering the mining area during flood events. The levee bank will be removed following rehabilitation of the area to enable restoration of the pre-mining drainage patterns. The existing and proposed groundwater barrier walls will remain in situ to minimise interactions between the mining area and the Hunter River alluvial. The levee bank and barrier walls are discussed further in Section 6.

Rehabilitation and development of the final landform will be undertaken progressively across the mined area during operations. As discussed, this ALRMP has a focus on the reinstatement of the alluvial lands suitable for irrigation. More details regarding rehabilitation of the grazing lands are discussed in the HVO MOP.

3.3 Land Classification Systems

Rural lands in New South Wales are mapped according to two different land classification systems as described below.

3.3.1 Land Capability

Land Capability Class ranks rural land on the basis of the capability of the land to remain stable under particular land uses (Cunningham et al. 1988). The classification recognises three types of land use:

- Land suitable for cultivation;
- Land suitable for grazing; and
- Land not suitable for rural production.

This system identifies eight possible land classes, with land capability decreasing progressively from Class I to Class VIII (Table 3.1). The land is classified in terms of its

inherent physical characteristics, or physical constraints, and denotes measures needed to protect the land from soil erosion and other forms of land degradation.

This system does not imply any aspect of agricultural suitability which requires consideration of proximity to markets or water access among other things.

In determining the extent of agricultural land that would be required to be reinstated within the project area, a land capability assessment was undertaken in accordance with the rural land capability classification system.

As can be seen in Figure 3.3, the rehabilitation of the project area has been designed to reinstate the original land capability or improve it where this can be achieved.

The proposed extension area encompasses Class II, III, IV and V lands. The central portion of the proposed extension area contains 65.0ha of Class II land. The western portion of the proposed extension area is classified as Class III (44.0 ha). Both are suitable for a range of agricultural uses, including regular cultivation.

The eastern portion of the proposed extension area is classified as Class IV land (23.9 ha). Class IV land comprises the better classes of grazing land and whilst it can sustain cultivation for an occasional crop, it is not suitable for cultivation on a regular basis owing to limitations of erosion potential. In addition, there is a small portion of Class V land (3.9 ha) in the south-west corner of the proposed extension area which is unsuitable for cultivation on a regular basis, however, the land can sustain grazing and occasional cultivation, provided structural soil conservation works are in place.

As discussed in Section 3.2, the reinstatement of agricultural areas is achievable and has been demonstrated on the adjacent Alluvial Lands Project at HVO.

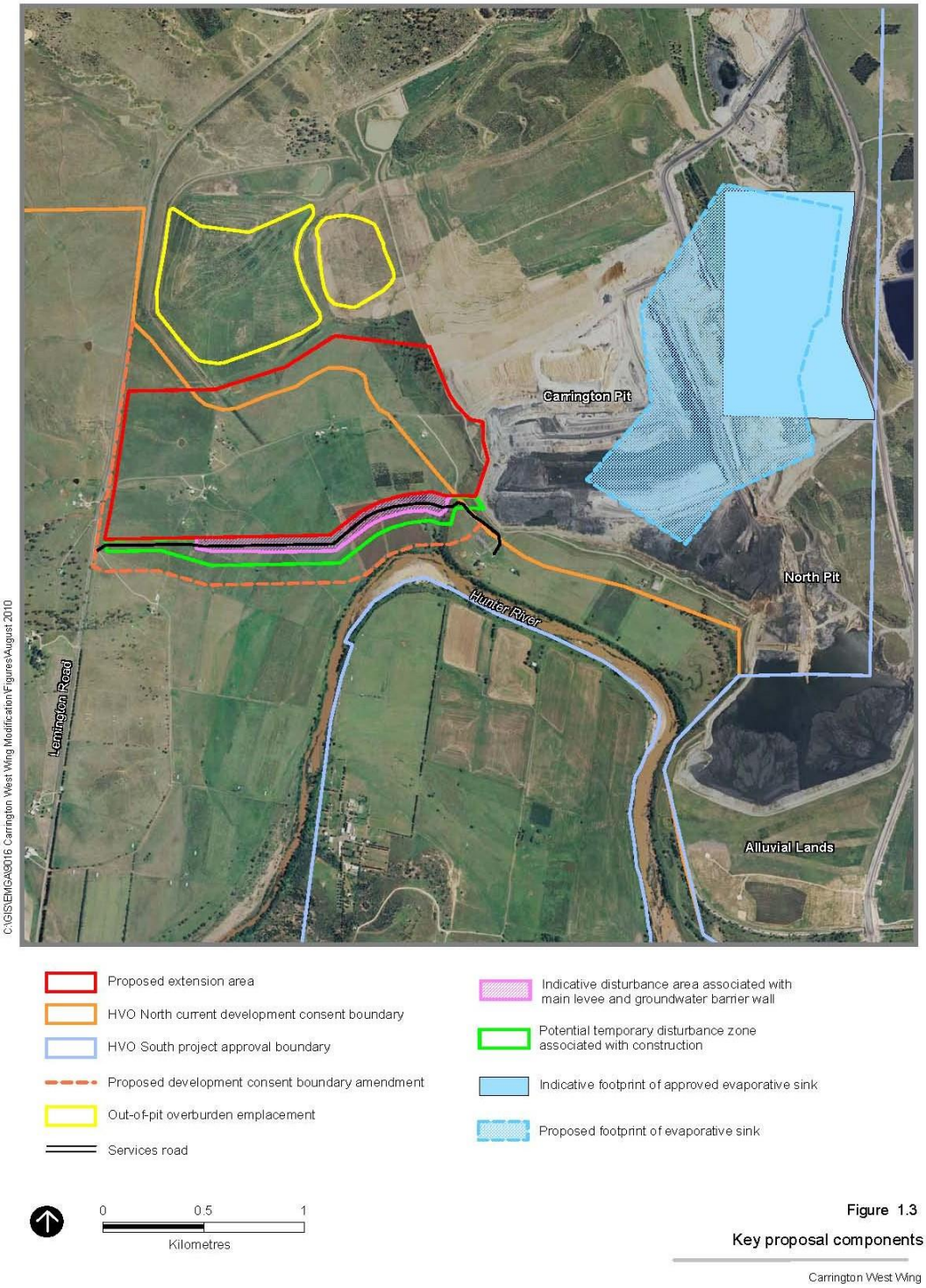

Figure 3.1 - Key landscape features of the approved Carrington West Wing project area as taken from the CWW Environmental Assessment.

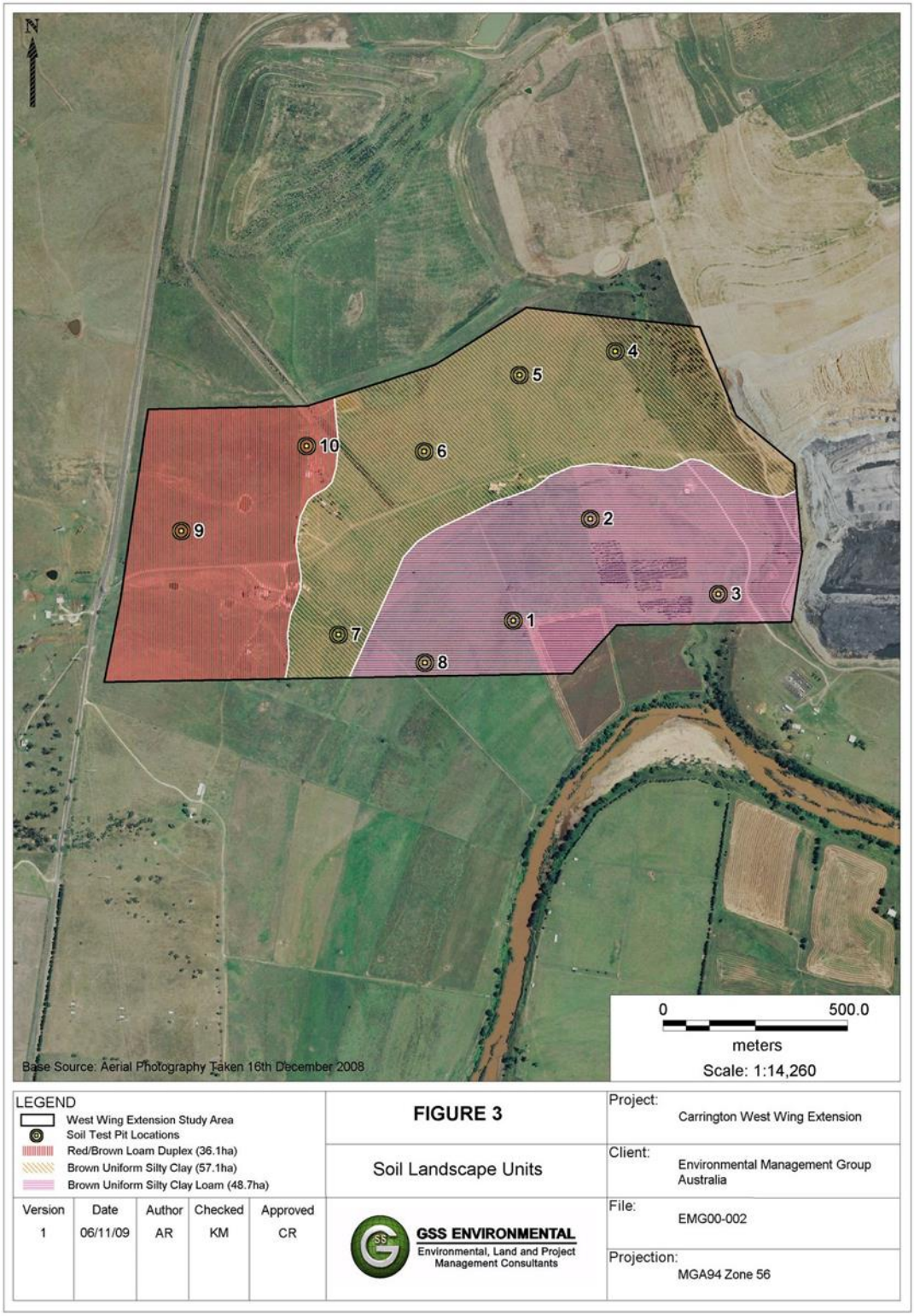

Figure 3.2 - Soil Landscape Units within the approved Carrington West Wing project area as taken from the CWW Environmental Assessment.

Table 3.1 - Land and Soil Capability Classes

Class	Land and Soil Capability
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)	
I	**Extremely high capability land.** Land has no limitations. No special land management practices required. Land capable of all rural land uses and land management practices.
II	**Extremely high capability land.** Land has no limitations. No special land management practices required. Land capable of all rural land uses and land management practices.
III	**High capability land.** Land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation, using more intensive, readily available and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)	
IV	**Moderate capability land.** Land has moderate to high limitations for high-impact land uses. Will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.
V	**Moderate–low capability land.** Land has high limitations for high-impact land uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.
Land capable for a limited set of land uses (grazing, forestry and nature conservation, some horticulture)	
VI	**Low capability land.** Land has very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation
Land generally incapable of agricultural land use (selective forestry and nature conservation)	
VII	**Very low capability land.** Land has severe limitations that restrict most land uses and generally cannot be overcome. On-site and off-site impacts of land management practices can be extremely severe if limitations not managed. There should be minimal disturbance of native vegetation.
VIII	**Extremely low capability land.** Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation

Source: Office of Environment and Heritage (2012).

Figure 3.3 - Pre and post-mining land capability classes within the Carrington West Wing project area as taken from the CWW Environmental Assessment.

3.3.2 Agricultural Suitability

Agricultural suitability classification is determined in accordance with the requirements of the NSW Department of Primary Industries (DPI). This system was introduced by the former NSW Agricultural & Fisheries Service of NSW, and the relevant guideline is the Agricultural Suitability Maps – uses and limitations (NSW Agricultural & Fisheries, 1990).

The system consists of five classes, providing a ranking of rural lands according to their suitability for a wide range of agricultural activities. Agricultural land is classified by evaluating biophysical, social and economic factors that may constrain the use of land for agriculture. Factors such as proximity to markets, water availability, infrastructure and past farming practices are all considered in this classification system. Consequently, a site's agricultural suitability classification may change over time due to market forces and changes to site- specific infrastructure development.

Table 3.2 - Agricultural Suitability Classes

Agricultural Suitability Classification System		
Land Class	**Agricultural Suitability**	**Land Definition**
Class 1	Highly productive land suited to both row and field crops.	Arable land suitable for intensive cultivation where constraints to sustained high levels of agricultural production are minor or absent.
Class 2	Highly productive land suited to both row and field crops.	Arable land suitable for regular cultivation for crops but not suited to continuous cultivation.
Class 3	Moderately productive lands suited to improved pasture and to cropping within a pasture rotation.	Grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with pasture. The overall level of production is moderate and as a result of edaphic or soil structural breakdown limit the frequency of ground disturbance, and conservation or drainage works may be required.
Class 4	Marginal lands not suitable for cultivation and with a low to very low productivity for grazing.	Land suitable for grazing but not for cultivation. Agriculture is basd on native or improved pastures established using minimum tillage. Production may be high seasonally but the overall level of production is low as a result of a number of major constraints, both environmental and edaphic.
Class 5	Marginal lands not suitable for cultivation and with a low to very low productivity for grazing.	Land unsuitable for agriculture or at best only suited to light grazing. Agricultural production is very low or zero as a result of severe constraints, including economic factors, which preclude improvement.

Source: NSW Agriculture & Fisheries (1990)

Class 1 has few constraints to agricultural production while Class 5 has severe constraints and is generally not considered suitable for agriculture. The overall class or suitability classification determined is determined by the most limiting factor.

These classes can be seen in Table 3.2.

Figure 3.4 shows the distribution of the agricultural suitability classes within the approved extension area both pre and post- mining.

The majority of the proposed extension area is classified as Class 2 or 3 agricultural suitability, covering areas of 65.0ha and 67.9ha respectively. Class 2 land includes highly productive land suited to both row and field crops, however, it is not suited to continuous cultivation. It is associated with Brown Uniform Silty Clays and Loams of the lower flat slopes in the central southern portion of the proposed extension area.

Class 3 land includes moderately productive lands suited to improved pasture and cropping within a pasture rotation. Class 3 lands are predominantly located in the eastern and western portions of the proposed extension area on mid to lower slopes. Class 4 land covers 3.9ha and includes marginal lands not suitable for cultivation and with a low to very low productivity for grazing. These lands are located in the south-eastern portion of the proposed extension area on mid to upper slopes.

As observed in Figure 3.4, the change to the agricultural suitability classification within the project area following mining is minimal and restricted to the south-west corner.

3.4 Rehabilitation

The proposed rehabilitation objectives will remain consistent with that stated in the environmental commitments made during the environmental assessment of the project (Table 1.2).

The proposed post-mining rehabilitation will restore land capability of the proposed extension area to that similar to or better than the existing land capability classification.

Similarly, the proposed post-mining agricultural suitability classification is similar to the existing classification. This includes rehabilitation of the 65ha of Class 2 agricultural land (comprising 48 per cent of the proposed extension area) back to Class 2 suitability post mining. Extensive land and soil management and investment by HVO is proposed to achieve this rehabilitation outcome. The methods by which this will be achieved will be outlined later in this document. Additional supporting material can be found in the HVO MOP.

Out-of-Pit Emplacement

The proposed out-of-pit emplacement areas, which currently comprise Class 3, 4 and 6 land capabilities, will be transformed into Class 4 and 6 rural land following mining. This classification change is predominately as a result of the increased slope of the emplacement batters over the previously mined, flat valley areas. Land management

practices including stock control and some structural works will be required to ensure maintenance of ground cover on the batters.

With respect to agricultural suitability, the proposed out- of-pit emplacement areas currently comprise Class 3 and 4 lands and will be rehabilitated back to Class 3 and 4 suitability, though with 26 per cent more Class 4 lands, again, due the increased slope that results from the emplacement batters. Accordingly, these lands will be suitable for improved pasture, cropping within a pasture rotation (on Class 3 land) and low productivity grazing on Class 4 areas. The proposed rehabilitation strategy includes restoration of both agricultural and biodiversity values of the land, and accordingly, in addition to the proposed agricultural land uses, considerable portions of the out-of-pit emplacement areas are proposed to be rehabilitated with woodland.

The rehabilitation undertaken at HVO considers five consecutive phases as required by the NSW Trade & Investment, ESG3: Mining Operations Plan (MOP) Guidelines. These phases are applicable to the successful reinstatement of agricultural lands and are as such:

1. Decommissioning; includes the removal of infrastructure and removal/containment of any hazardous material.
2. Landform establishment; design and installation of structural soil conservation and drainage works eg contours/sediment dams/diversion structures, to ensure the long term stability and productivity of the rehabilitated land. Slope gradients will vary according to erosion hazard, stability and drainage requirements, though will generally be less than 10 degrees. Visual amenity and public, stock and fauna safety will also be addressed.
3. Growth media development; ensures physical, chemical and biological characteristics of the growing media to optimise conditions for the preferred vegetative cover.
4. Ecosystem establishment; includes species selection, revegetation and habitat augmentation, and weed and pest management.
5. Ecosystem sustainability; incorporates assessment against performance indicators for components including floristic structure, nutrient cycling, recruitment and recovery, and vegetation community structure and function.

These phases are addressed in detail in the HVO MOP but have been considered in the development of the reinstatement protocols outlined in this document.

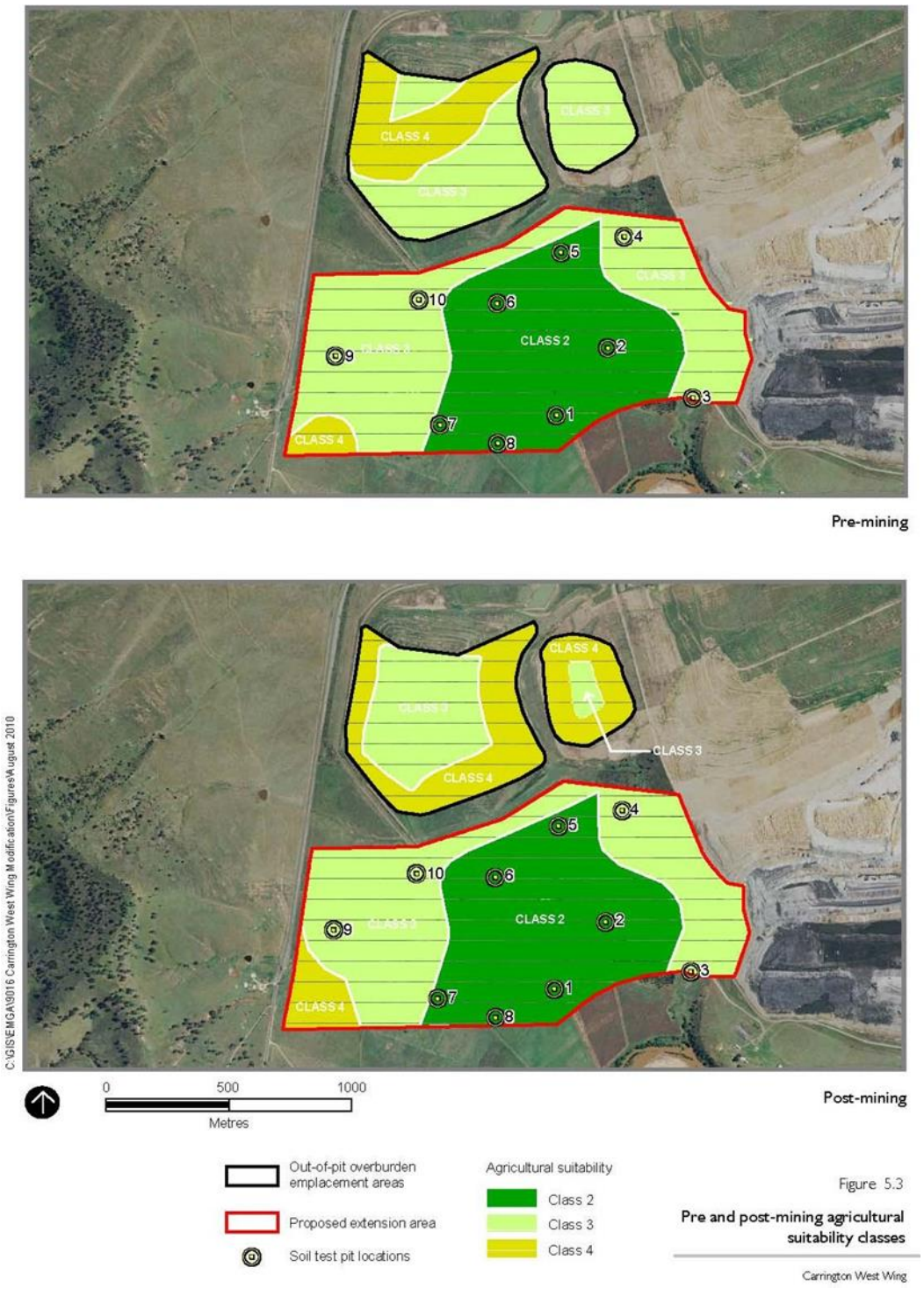

Figure 3.4 - Pre and post-mining agricultural suitability classes within the Carrington West Wing project area as taken from the CWW Environmental Assessment.

4 Consultation

During the Alluvial Lands Project, HVO maintained close coordination with various Government Departments. This included the following former agencies:

- DIPNR for the use of various soil types, land classes and reinstatement methodology;
- DPI NSW (Agriculture) regarding Lucerne species, productivity measurements and agronomic practices; and
- DPI NSW (Minerals) for reinstatement techniques and outcomes and adherence to MOP/RMP requirements.

It is intended that consultation will again be undertaken with the applicable contemporary agencies for the reinstatement of agricultural land associated with the CWW extension.

Schedule 3, Condition 62D(a) of the HVO North Development Consent requires the ALRMP be prepared in consultation with DPI and to the satisfaction of the Secretary. The following subsections address the requirements of this consultation condition and discuss the pending management plan review commitments.

4.1 Government Agencies

DPI (Agriculture) was provided with the ALRMP on 27th September 2013 and was asked to provide feedback for consideration and potential inclusion into the Management Plan where appropriate. No feedback was initially received however HVO followed up with DPI Agriculture and received feedback on the ALRMP on 5th July 2016. The ALRMP and HVO MOP were amended to address the feedback.

Further opportunities to amend the Plan will be available when the ALRMP is reviewed in accordance with Schedule 3 Condition 62D (e) of the Approval.

5 Completion Criteria

The objective of the post-mining rehabilitation works is to reinstate the Land Capability Class II and III land as well as rehabilitate the surrounding Class IV and VI lands.

The success criteria that the reinstated Class II and III land will be assessed against are presented in Table 5.1. All other classes will utilise the criteria as outlined in the HVO MOP.

The performance indicators presented below are attributes that can be measured and used to approximate the progression of a biophysical process. They will be used to demonstrate the trajectory of an aspect of rehabilitation to ensure it is on the correct path towards the desired completion criterion.

These progressive indicator measurements will be assessed against that recorded within nominated control site(s). Specifically, these control sites will be utilised as a comparison to permit the demonstration of successful Class II and III reinstatement of agricultural lands. The final assessment of the performance of rehabilitated agricultural land shall be undertaken following at least one stress event on the land, to measure the resilience of the rehabilitated land. A stress event may be drought or high impact fire etc.

A Lucerne hay yield measure will be utilised to record the agricultural productivity of the Class II cropping lands.

The performance target is for the yield obtained from the reinstated cropping lands to be equivalent to the district average. In this manner, variabilities attributed to climate, irrigation water availability, crop rotation or other factors beyond the control of HVO, can be considered and accounted for in determining the success of the reinstatement activities. This measure was utilised successfully with the Alluvial Lands Project where it was demonstrated that with three years of monitoring, a yield equivalent to that produced in non-mined areas was able to be produced.

In assessing the stability of the Class II and III land, the area will be regularly surveyed to check for subsidence of the soil profile. Areas of subsidence that will impede the functioning of the agricultural land i.e. areas of prolonged water logging, will be remediated either by refilling and/or regrading. Management of subsidence is discussed further in Section 6.7.

Table 5.1 - Success Criteria for Reinstatement of Class II and III Land Capability Lands.

Criteria	Performance Measures	Performance Indicator/Target	Timing/Frequency
Landform Stability	Slope Gradient	Less than 3%.	Completion of Landform Establishment.
	Erosion Control	Erosion control structures are installed commensurate with the slope of the landform.	Completion of Landform Establishment.
	Surface Drainage	Use of contour banks and diversion drains to direct water into stable areas or sediment control basins.	Completion of Landform Establishment.
	Subsidence	Subsidence not affecting the function of agricultural land.	Annual surveys until subsidence is shown to be at negligible levels.
Soil Properties	Soil Structure	Structural attributes to be on par or better relative to the control site. The target attribute is pedality and it is predicted that optimal structure will be represented by 'moderate structure; evidenced by presence of moderate peds.	Completion of Growth Medium Development
	Permeability	Permeability attributes to be on par or better relative to the control site. The target attribute level is predicted to be moderate permeability, which can be measured directly by hydraulic conductivity or inferred from bulk density measurements.	Annually during the Lucerne cropping trial then 5 yearly.
	Salinity (EC)	Soil salinity content is <0.5 dS/m.	Annually during the Lucerne cropping trial then 5 yearly.
	pH	Soil pH is between 5.5 and 8.5.	Annually during the Lucerne cropping trial then 5 yearly.
	Sodium Content	Soil Exchange Sodium Percentage (ESP) is <6%.	Annually during the Lucerne cropping trial then 5 yearly.

	Dispersiveness	Emerson Aggregate Test Class equivalent to 'slight' dispersivity or lower.	Annually during the Lucerne cropping trial then 5 yearly.
	Nutrient Cycling	Major or macro nutrients similar to a control site. These include N, P and cation exchange capacity, S, K and Zn.	Annually during the Lucerne cropping trial then 5 yearly.
		Nutrient accumulation and recycling processes are occurring as evidenced by the presence of a litter layer, mycorrhizae and/or other microsymbionts.	Annually during the Lucerne cropping trial then 5 yearly.
	Soil Fauna	Representation of a range of soil species such as earthworms, springtails and fungi relative to the control site.	Annually during the Lucerne cropping trial then 5 yearly.
Cropping Productivity	Lucerne Hay Yield	Lucerne Hay Yield is equivalent to the district average.	Annually for three consecutive seasons. Trial period to follow at least one stress event i.e. drought, high impact fire etc.
Ecosystem Resilience	Resilience to Disturbance	Weeds are not a dominant feature of the cropping area and are representative of equivalent areas.	Annually during the Lucerne cropping trial then 5 yearly.
		Pests do not significantly impact the yield obtained from the cropping area and have an impact representative of equivalent areas.	Annually during the Lucerne cropping trial then 5 yearly.

6 Mitigation Measures / Management Controls

6.1 Principles[1]

The objectives of the reinstatement management plan have been outlined in Section 1.2. To achieve these objectives and ensure that the rehabilitated land is undertaken to an acceptable standard, a number of principles and best practice techniques will be utilised.

The reinstatement techniques that were employed in successfully reinstating alluvial land at Hunter Valley Operations will be applied in the proposed extension area. These techniques were documented in: Alluvial Lands Project: Soils Management Plan (Venness & Associates, 1995), and An Assessment of Soil Structure on the Floodplain at Hunter Valley Mine (Department of Land and Water Conservation, 1994).

The design and management measures that will be implemented to enable the reinstatement of agricultural activities to mined land within the CWW project area are discussed in the sections below.

6.2 Design Considerations

The western arm of the paleochannel that occurs in the area runs north from the Hunter River and its alluvials and through the approved mining area. Measured groundwater levels in the paleochannel alluvium have demonstrated a northward flow system through the project area. The hard rock coal measures strata provide very limited groundwater storage and transmission capacity. Jointing and fracturing are sparse and groundwater flow is more generally governed by matrix permeabilities except for the coal seams, which are regarded as being more permeable. For this reason, a barrier wall has been proposed to separate the alluvials from the mining area based on the successful utilisation of this technology in the Alluvial Lands Project. This is discussed further below.

6.3 Flood Levee and Barrier Wall

To protect the Hunter Valley Operations Alluvial Lands Open Cut Mining Operation (Alluvial Lands Project) from flooding events from the adjacent Hunter River, and to minimise groundwater losses from the river into the open cut pit, levee banks and an in-ground clay barrier wall was installed along the length of the river adjacent to the open cut pit.

The hard rock coal measures strata provide very limited groundwater storage and transmission due to sparse jointing and fracturing. The coal seams are more permeable and for this reason, the barrier wall that was keyed into the hard rock was effective in preventing groundwater flows between the alluvials and the mining area.

These features were effective in allowing the mining operation to continue without detrimental impacts to the river system and have been approved to be installed with the Carrington West Wing Extension. The following sections describe these features based on the experience with the Alluvial Lands Project.

6.3.1 Flood Levee

Temporary levee banks will protect the approved Carrington West Wing operation from regional flooding from the Hunter River. These temporary levees would prevent flooding of the proposed extension area for events up to the 100-year ARI event.

These levees will be constructed in a similar manner to those successfully utilised in the Alluvial Lands Project. The height of the final levee will afford a one metre freeboard on the 1:100-year flood level and was designed to provide the highest flood protection without causing significant alterations to upstream flood patterns of the Hunter River.

The 100-year ARI design flood levels across the approved extension area are about 75m AHD. Ground levels across the extension area range from 70m to 74m AHD. The modelling predicted that the greatest change to flood levels as a result of the installation of the levee banks would be an increase of 0.1m to 0.14m for the 100-year ARI event, at some locations on HVO owned land.

At the conclusion of mining and rehabilitation, the levees are to be removed and the ground levels across the extension area returned as close as possible to the pre- mining landform. This will allow the natural Hunter River flood regime to be reinstated while affording protection to the operations whilst they are active.

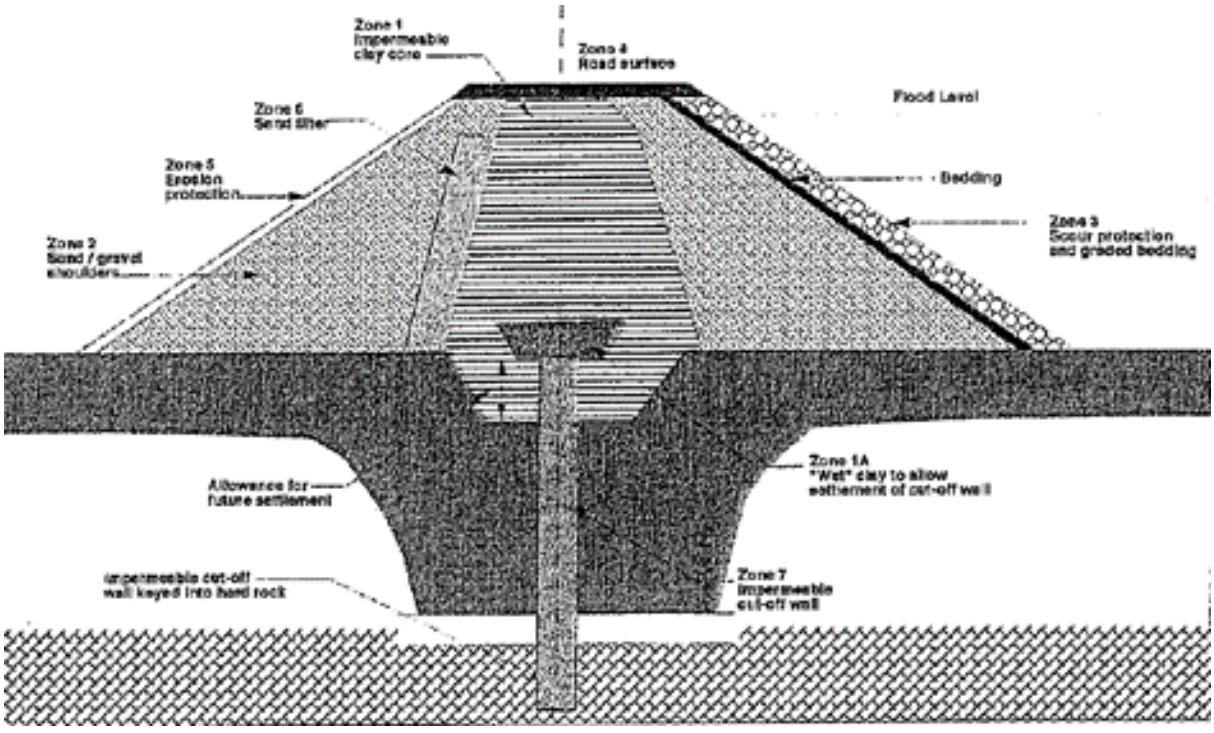

Figure 6.1 - Cross section of the Levee and In-ground Barrier Wall

6.3.2 In-ground Barrier Wall

The in-ground bentonite barrier wall will be constructed along the alignment of the levees. This wall will be keyed into unweathered rock to inhibit groundwater flows from the highly permeable alluvials into the mining area. In addition, as stated in the CWW Environmental

Assessment, the barrier wall would effectively isolate the potential impacts of mining from the alluvium and prevent saline groundwaters from reaching the Hunter River.

At the conclusion of mining, it is not proposed that the barrier wall will be removed and, in being left intact, will continue to assist with reducing the egress of potentially saline groundwater from the mined lands from reaching the Hunter River and the adjacent alluvials.

6.4 Soil Management

To ensure effective reinstatement of the agricultural lands following mining, best practice soil management strategies and procedures will be enforced to minimise the impact of soil stripping, storage and replacement on soil structure, fertility and stability in the mined areas.

These techniques are further discussed in detail below.

6.4.1 Operator Management

Soil stripping, stockpiling, surveying and audits will be managed by HVO in accordance with best practice management procedures. All persons involved in the stripping, stockpiling, recovery and reinstatement of soils in the CWW project area will be made aware of:

- The value of soils on agricultural areas,
- Stockpile control and signage, and
- Rules when working on or around stockpiles.

This information will be regularly reinforced during toolbox talks to ensure that topsoil stockpiles are effectively and efficiently managed in accordance with best practice techniques.

6.4.2 Soil Plans

The soil landscape units presented in Figure 3.2 and the soil assessments undertaken for the CWW EA, and summarised in Section 3.1 and Appendix A, will be used as a guide to the topsoil and subsoil stripping depths.

The soil analytical results and field assessments were able to determine the most appropriate stripping depth for each soil unit based on a variety of limiting factors. These recommendations are presented in Table 6.1.

During extraction, the actual depths and locations of the soil types will be surveyed and recorded. The records will be used to reconcile the actual soils and soil quantities stripped with those estimated to ensure that soils of sufficient criteria are obtained to permit the restoration of the post-mined land to an acceptable standard and enable the approved post-mine land use to be established.

The soil investigations undertaken in the CWW Extension area indicated that there may be suitable soils for use as topsoil in rehabilitation below 1.2 m depth in the areas containing the Brown Uniform Silty Clay Loam soil unit. All suitable soil materials will be stripped from the Brown Uniform Silty Clay Loam soil unit and excess quantities will be used to alleviate soil deficits on other areas of HVO.

Table 6.1. Recommended Topsoil Stripping Depths by Soil Unit.

Soil Unit Type	Recommended Stripping Depth (m)	Area (ha)	Volume (m^3)
Brown Uniform Silty Clay Loam	1.20	43.9	526,800
Brown Uniform Silty Clay	0.20	56.8	113,600
Red Brown Duplex Loam	0.10	36.1	36,100
	Total Volume		676,500
	Total Volume (allowing 10% handling loss)		608,850

6.4.3 Soil Stripping and Transfer Procedures

Stripping operations for mining will not commence until the cut off wall is complete and overlying levee is built to the design limit.

Prior to stripping activities, inspections will be undertaken to identify the extent of weed establishment and control measures that may be required to manage weed germination from the topsoil.

The stripping operations will only be undertaken during daylight hours.

Wherever possible, the stripped material will be placed directly onto reshaped overburden and spread immediately to avoid the need for stockpiling. Where mining sequences, equipment scheduling and weather conditions prevent this, stockpiling of the soils will be required.

Topsoil will be maintained in a slightly moist condition during stripping and transfer operations. Where possible, material will not be stripped when excessively dry to prevent pulverisation of soil aggregates, or excessively wet to minimise compaction damage. The theoretically desirable moisture range for stripping for each texture group is:

- Loamy sands and clayey sands: 9-11%
- Sandy clay loams, clay loams, sandy clays: 12-14%
- Silty clays, light clays: 20-22%

Should stripping outside these ranges be required, the stripping procedure and amelioration will be reassessed and adjusted accordingly to minimise soil compaction and maximise soil structure within the transferred horizons.

Placement at wetter than the above limits may necessitate deep ripping once the profile has been dried to below the plastic limit. It is preferable that stripping not occur at wetter than the plastic limit except where the normal moisture regime is above this level.

Pending further information or studies, the vegetative growth-limiting bulk density, or critical dry densities for root growth, will be taken as 1300 kg/m3 for silty and light clays, 1500 kg/m3 for sandy clay loams and sandy clays and 1600 kg/m3 for loamy sands and clayey sands. This information is linked to the 'Permeability' measure in Table 5.1 and will be assessed as one of the performance criteria that determine the success of the reinstatement activities.

The plant and equipment utilised for stripping, stockpiling and return of the soils will be selected to minimise compaction and avoid breakdown of the soil structure.

Soil penetrometers will be used to provide a field-based assessment of soil compaction issues across the Class II and II land.

The stripping programme will be designed to minimise the number of times vehicles traverse across the soil to be stripped. To accomplish this:

- Access roads will be constructed into defined stripping areas from which topsoil will be removed in advance,
- Heavy vehicles will only travel on these approved access roads to and from defined soil stripping areas,
- Sequencing of stripping operations will be established to minimise machinery traversing the soil to be stripped, and
- Light vehicles will access areas only as approved by the Project Manager.

If severe wheel compaction is likely, soil transfer would best be done by following set tracks and subsequently ripping those tracks rather than compacting the whole emplacement surface.

6.4.4 Soil Stockpiling

Topsoil will be stored separately from subsoil. Topsoil from the various soil units will be separated and the specific details of each stockpile recorded for future reference. The location of the soil stockpiles will be recorded in the HVO Topsoil Stockpile Inventory.

All stockpiles will be clearly signposted with the identification details and marked as open or closed. All vehicle access to these areas will be restricted to avoid unnecessary compaction of the stockpile.

Temporary signs will be erected indicating the stockpile number, soil type and soil class. These signs will be located in a prominent position and be readily visible to an approaching operator.

The maximum height of stockpiles will be:

All topsoils: 2 metres maximum

Subsoils to 2.5m: 3 metres maximum.

Subsoils below 2.5m: 5 metres

Existing topsoils that are weed contaminated and not adequately treated prior to stripping will be stockpiled separately for use on Class 4 lands where alternate suitable sources of topsoil are available.

Stockpiles are not to be disturbed until required for rehabilitation, weed and erosion control, seeding and fertilising purposes or in accordance with HVO's stockpile management procedures.

Sediment and erosion controls will be established around the stockpiles. This may include contour drains upslope of the stockpile to direct surface flow around the stockpile and sediment fences to minimise loss through erosion from the stockpiles. More detail on the proposed erosion and sediment controls are discussed in Section 6.8.1.

Once stockpiling operations have been completed, topsoil and subsoil stockpiles will be left with a coarse texture to promote infiltration and minimise erosion. Stockpiles will be stabilised with an annual cover crop into which a permanent cover crop has been sown. The annual cover crop will provide sufficient competition for emerging weed species and will enhance the desirable micro-organism activity in the soil. A deep-rooted perennial, such as Lucerne, may be sown into the stockpile with the cover crop to promote moisture infiltration, provide organic matter and encourage favourable micro-organism activity at depth.

Due to the large quantity of subsoil and topsoil required to be stockpiled from the project, areas of existing rehabilitation at HVO North may be required to be used as temporary stockpile locations.

6.5 Landform Establishment

The landform will be designed to promote an agricultural post-mining land use as discussed in Section 1.3. To obtain this, the proposed mining area will be reinstated as close as possible to the original landform with additional overburden taken to the out-of-pit emplacement areas as illustrated in Figures 3.1.

During landform construction for areas to be reinstated to Class II and III Land Capability, dump heights will be restricted to a maximum of 15 metres, and the final two dump lifts will be a maximum height of 10 metres. This measure will improve the landform stability and reduce the amount and duration of settlement experienced in cropping areas. Monitoring of the settlement rates of the constructed spoil dump will be carried out and final rehabilitation will be delayed until monitoring results indicate that the landform has stabilised. Surcharging the top spoil layer with subsoil or topsoil stockpiles may be used to accelerate settlement.

Class II and III areas are then selectively covered with subsoil and shaped with dozers. Slope gradients on overburden emplacements may vary according to erosion hazard, stability and drainage requirements, though will generally be less than 10 degrees. As indicated in Table 5.1, it is intended that cropping areas be reinstated with a slope less than 3%.

The area is deep ripped and rock raked to remove surface and near-surface rocks. These are either removed to deeper areas of the pit where they can be buried or if suitable, are temporarily stored for use as construction materials.

6.6 Reinstatement of Soil Profiles

The priority would be given to the use of the best quality topsoil and subsoils within the reinstated cropping areas.

The soils profile proposed for the restoration of Class II and III land is 1m of subsoils and overlain by 0.4m of topsoil. This was shown to be effective in the Alluvial Lands Project and has been recommended.

To obtain Class 4 land capability, it is proposed to replace an average of 0.1m of topsoil over backfilled and reshaped areas.

The following process will be used to re-establish the soil profile:

- Overburden will be shaped to the desired level and the surface of the overburden is left in a rough condition to maximise infiltration and minimise surface erosion.
- An assessment of weed infestation on stockpiles will be undertaken to determine if individual stockpiles require herbicide application and/or scalping of weed species prior to topsoil spreading.
- Subsoils and topsoils are placed by truck and spread by dozers to the required thickness. The subsoil is left roughened prior to topsoil spreading. Travel lanes are established on areas being rehabilitated to reduce the potential for soil compaction during placement.
- If required, soil conservation and drainage works are installed to encourage stability, minimise erosion and control potential surface water flows.
- Soils on Class II and III areas will be deep ripped to alleviate any compaction of the soil profile that may have occurred during placement.
- Surface cultivation will be undertaken using an aerator to prepare a seedbed and create a rough surface that enhances water infiltration. Pastures or Lucerne crops are sown and fertilisers applied.
- Soil ameliorants and fertilisers will be applied as required. Green manure crops may be sown to increase organic matter levels in the topsoil and provide additional opportunities for weed control prior to sowing perennial pastures and crop species.

6.7 Mitigation of Subsided Areas

As stated in Chapter 5, Class II and III lands will be regularly assessed to check for subsidence of the soil profile. Areas of subsidence that will impede the functioning of the agricultural land i.e., areas of prolonged water logging, will be remediated either by refilling and/or regrading.

In addition to the annual surveys, more regular monitoring will be undertaken due to the agricultural activities within the reinstated area. The site will be inspected on a frequent basis by the contractor employed to manage the cropping and grazing activities.

An allowance for settlement of the spoil base will be factored into the initial landform reconstruction based on the extensive experience at HVO in settlement of replaced soil profiles. Initial Class II and III reinstated areas will be surcharged with topsoil and subsoil stockpiles and monitored to confirm the amount of settlement occurring. This information will be used to inform the timing of final rehabilitation and adjust constructed landform levels in the project area as required.

Given the Class II lands will be irrigated and tilled, settlement of the profile to the final AHD is anticipated to occur more rapidly than in non-agricultural areas.

6.8 Control and Maintenance of Stockpiles

6.8.1 Erosion Control and Drainage

The stockpile area will have contour drains constructed around the perimeter to divert water away and minimise erosion resulting from runoff from adjacent areas. These contour drains will direct surface water into the existing mine sedimentation dams.

The soil will be stockpiled on surfaces with less than a 5% grade.

Scouring and erosion due to runoff from the stockpile itself will be monitored and managed where it is beginning to occur. The stockpiles will be constructed and aligned across the contour wherever possible to minimise erosion from rainfall events. Gaps between the stockpiles will minimise water pooling and allow the water to exit and minimise scouring of the piles.

Erosion controls in the form of straw bales and/or silt fences will be installed across drainage paths downslope of the stockpiles to prevent any off site movement of silt.

Runoff originating from within the stockpile area will be managed in accordance with the mine water management system. The risk of any off site impacts originating from the soil stockpile areas will be managed and prevented.

The stockpiles will be seeded as quickly as possible following construction to minimise scouring from rainfall events and loss of valuable topsoil. The species selected to revegetate the soil stockpiles will be chosen from Table 6.2 and 6.3.

6.8.2 Dust Control

Dust resulting from the operations will be managed in accordance with the site air quality and greenhouse gas management plan. The establishment of vegetation on completed stockpiles will minimise any dust generation from these areas.

6.8.3 Stockpile Monitoring and Remediation

The stockpile areas will be inspected regularly, particularly following significant rainfall events to assess:

- Integrity of sediment control structures,
- Effectiveness of drainage,
- Integrity of erosion control measures,
- Vegetative cover,
- Weed infestation.

Remedial measures will be undertaken as necessary.

6.9 Pasture Rehabilitation

Pasture will be preferentially sown in spring or autumn, depending on rainfall. This gives the best opportunity for seeds to germinate and become established. Typical pasture species and rates of application are shown in Table 6.2 and 6.3.

The pasture will be maintained through periodic aerial applications of fertiliser (currently 100-250 kg/ha DAP) until they become established.

Regular weed management and control is undertaken to the satisfaction of the Rural Lands Protection Board using control methods such as spraying, wick weeding, cultivation and grazing.

Stock grazing will not commence until the pasture is well established and the area securely fenced. Stocking rates will be carefully monitored to ensure that the areas are not overgrazed. Vehicular traffic will be generally kept off revegetation areas and restricted to designated access tracks.

6.10 Surface Water Management

Surface water flows across the project area will be managed in accordance with the HVO water management system.

Management measures will include the following.

- Water quality monitoring will be continued.
- The HVO water balance model will be regularly updated to ensure currency with the operational configuration of the mine water management system.
- Runoff from undisturbed catchments will be diverted away from disturbed areas using surface drains.
- Surface runoff from disturbed areas will be treated through sedimentation basins prior to discharge from the site. All new sediment dams and water management systems will be designed in accordance with relevant standards.
- Sedimentation basins will be used to treat surface runoff from rehabilitated areas until the quality of runoff is suitable for release. These will be maintained or constructed as required and will be designed in accordance with relevant design standards.

Table 6.2 Typical Exotic Pasture Species and Application Rates

Species	Autumn sowing rate (kg/ha)	Spring sowing rate (kg/ha)
Wimera Rye	5	n/a
Sirosa Phalaris	5	n/a
Lucerne	4	4
Sephi Medic	3	n/a
Haifa White Clover	3	n/a
Seaton White Clover	2	4
Kikuyu*	4	4
Setaria (Kazungulu)	4	3
Woolly Pod Vetch	n/a	4
Couch (hulled)	n/a	1
Green Panic	n/a	3

* Mainly in drainage areas

Table 6.3 Typical Native Pasture Species and Application Rates

Native Species		Grassy Mix kg/ha
Grasses primary colonising	*Austrostipa densiflora, Austrostipa scabra, Bothriochloa macra, Chloris truncata, Digitaria brownie, Elymus scaber, Panicum effusum*	6
Grasses long term understorey	*Aristida ramosa, Austrodanthonia ramosissimo, Bothriochloa decipiens, Capillipedium spicigerum, Chloris ventricosa, Cymbopogon refractus, Dicanthium sericeum, Dichelachne crinita, Erogrostis leptostachya, Poa labillardieri, Sporobolus creber, Themeda triandra*	10.5
Grasses long term understorey shade tolerant	*Austrostipa verticilliata, Aristida vagans, Dichelachne micrantha, Echinopogon caespitosus, Echinopogon intermedius, Echinopogon ovatus, Entolasia stricta, Imperata cylindrical, Joycea pallida, Microleana stipiodes, Oplesminus aemulus*	1.5

7 Monitoring Program

Information regarding the monitoring techniques implemented at HVO can be found in the HVO MOP. The components applicable for the monitoring of the reinstated Class II and III land capabilities have been included below in addition to specific measures required by the HVO North Development Consent approval for the CWW Extension. Land classified as Class IV and VI land capability are monitored in accordance with the information presented in the HVO MOP.

7.1 Monitoring Frequency

It is intended that the monitoring frequency will be more intense as the site is establishing only for the duration between monitoring periods to be lengthened once the site has stabilised. The proposed monitoring programme will be on-going until the reinstatement objectives have been successfully achieved and agreement is obtained from the applicable agencies at the time (currently DP&E, DRG and DPI (Agriculture)) for the monitoring programme to be scaled back to that typical of adjacent mine-owned, agricultural lands in the district.

7.2 Methodology

The monitoring programme will be based on the performance indicators indicated in Table 5.1 and Chapter 5. It will include methodologies that provide quantitative data to assess changes that occur over time. An annual monitoring programme will be required as the reinstatement phase is implemented. Many aspects are part of routine agricultural activities and will be assessed more regularly as a function of contractors being present in the locality as the works are being established. Others will require specific inspections or sampling to ensure that the areas reinstated are on the correct trajectory to meet the intended final land use.

The monitoring methodology adopted is a standard and simple procedure that may be replicated to allow comparisons of similar agricultural areas. The methodology uses a combination of:

- Accredited soil analyses, and
- Assessment of pasture productivity, carrying capacity and stocking rates.

This combination of approaches allows a site to be assessed over time with the resultant data enabling the user to assess the site and determine if further works are required to ensure the land capability will be met.

7.3 Soil Analysis

Soil samples will be undertaken using standard soil sampling techniques with a core sampler within the monitoring quadrat. Multiple cores are to be taken within each soil classification and bulked together. The soil samples will be sent to an accredited laboratory for analysis. Soil analysis consist of assessing the parameters, pH, EC, Available Ca, Mg, K, Ammonia, sulphur, organic matter, exchangeable Na, Ca, Mg, K, H, Al, cation exchange capacity, available and exchangeable phosphorous, micronutrients (Zn, Mn, Fe, Cu, B), Total Carbon and Nitrogen. To assist in the interpretation of this data, a report with the analysis and appropriate recommendations are to be provided by the laboratory.

7.4 Pasture Productivity, Carrying Capacity and Stocking Rates

The assessment of pasture productivity is to be undertaken utilising a range of pasture samples collected randomly from within each soil classification following industry technique guidelines. An analysis of each sample is undertaken at an accredited laboratory to ascertain the quality of feed available.

Utilising this data, carrying capacity calculations will be undertaken for each pasture type sampled from the pasture transects. Approximate minimum area for breeding unit will also be determined for both ‘Weaner’ and ‘Dry Stock’ production using the industry guidelines. Calculations utilising information from each transect such as typical fertiliser use and the available phosphorous would also be reviewed based on the analysis results together with Dry Stock Equivalent (DSE) reference tables.

Using this information site personnel would be able to predict with a degree of certainty the future carrying capacity and potential stocking rates for the site.

Additionally, this information would then be used to underpin land and cattle management practices, whilst also being able to objectively answer stakeholder questions relating to land management and post-mining land use.

7.5 Crop Records and Performance Monitoring

The agreement with the managing contractor will require recording of the following information:

- Irrigation rates and timing;
- Fertiliser application rates and variety;
- Herbicide/chemical usage and rates;

- Machinery/labour used, including type, size and hours;
- Seed variety and application rates; and
- Marketing arrangements.
- Crop quality: (digestible dry matter, crude protein and metabolisable energy as provided by consulting agronomist), and
- Crop quantity: (dry matter percentage, number of bales and weight of bales as provided by the irrigated Lucerne crop contractor).

Copies of all production records associated with the irrigated Lucerne crop arrangement are kept by the HVO Environment and Community Coordinator – Rehabilitation.

7.6 Subsidence

As discussed in **Section 6.7**, monitoring of the reinstated lands for any detrimental impacts resulting from settling of the mined areas will be ongoing. While formal surveys will be undertaken annually, the agricultural activities being undertaken within the reinstated area will result in any subsided areas or uneven settlement being identified early by the contractor employed to manage the cropping and grazing activities. As cropping is a more intensive agricultural activity than grazing, the presence of the contractor on-site will mean that the Class II lands under irrigation will be examined regularly.

7.7 Surface Water

Monitoring of surface water within the CWW project area is undertaken in accordance with the HVO Water Monitoring programme.

The surface water monitoring is recorded in accordance with the HVO EMS and interpreted in the Annual Review (AR) for HVO.

7.8 Groundwater

Monitoring of the groundwater within the CWW project area is undertaken in accordance with the Groundwater Monitoring Plan for HVO.

HVO will continue the groundwater monitoring that includes:

- two-monthly monitoring of water levels in any new standpipe piezometer in proximity to the proposed extension area and quarterly monitoring elsewhere, unless water level changes dictate otherwise;
- daily or more frequent monitoring of pore pressures by installed auto recorders at some existing piezometers, in order to discriminate between oscillatory groundwater movements attributed to rainfall recharge, and longer term pressure losses related to open cut and underground mining; and
- construction of additional piezometers where deemed necessary, as information is generated from within the existing network during the course of mining. Permeability testing will be completed on new piezometers in order to facilitate estimation of leakage and subsurface flows.
- two-monthly or quarterly (depending upon location) monitoring of basic water quality parameters, pH and EC, in existing and any new piezometers; and
- six monthly measurement of TDS and speciation of water samples in piezometers.

Monitoring has demonstrated that management measures implemented for existing operations have been successful and has verified previous groundwater modelling predictions.

8 Implementation

8.1 Environmental Management

In accordance with the development consent conditions for HVO North, the detailed rehabilitation plans will be documented in the HVO MOP. These plans will illustrate the planned mining and rehabilitation progress at nominated intervals and will outline the final land use on completion of the rehabilitation. The approved MOP is publicly available for viewing from the DRG and can be downloaded from the HVO website.

8.2 Reporting

The AR is a comprehensive reporting document that is prepared each year by HVO in accordance with the reporting requirements of the DP&E and DRG. Where applicable, the document includes information required by other agencies and forms a thorough assessment of the activities and progress of the operations for that year.

A summary of the agricultural reinstatement activities and monitoring results (when available) will be reported in the AR for HVO North and assessed against the commitments made for the Project. These findings will also be presented and discussed at the HVO Community Consultative Committee (CCC) meetings which are held three times per calendar year.

The AR is publicly available on the HVO website.

8.3 Roles and Responsibilities

The roles and responsibilities of HVO personnel associated with aspects of this plan are listed below.

Manager – Technical Services

- Ensure development of geological plans
- Provision of mine plan

Environmental and Community Coordinator – Rehabilitation

- Coordinate implementation of management plan
- Coordinate rehabilitation activities
- Coordinate monitoring activities
- Coordinate reporting requirements

Project Approval Specialist

- Facilitate DPI review of management plan
- Update management plan following stakeholder feedback

Supervisors / Shift Co-ordinator

- Implement mine plan
- Implement management plan

All personnel and contractors

- Ensure effective management of topsoil
- Ensure delineation of soil horizons as per mine plan

9 Review

As discussed in Chapter 4, the previous version of the ALRMP has been provided to DPI (Agriculture) for consultation and was revised to incorporate this feedback.

Schedule 3 Condition 62D of DA 450-10-2003 requires a review of progress in accordance with Condition 4(h) of Schedule 6. It is noted that Schedule 6 no longer occurs within DA 450-10-2003. As such, reviews of the management plan will occur in accordance with Schedule 5 Conditions 3 and 4. These conditions require the ALRMP to be reviewed within three months of the submission of an incident report, Annual Review, an environmental audit or any relevant modification to the conditions of the Approval.

In accordance with the intent of the condition, a review of progress against the plan will occur every 3 years following commencement of mining within the Carrington West Wing extension area unless otherwise agreed by the Secretary after completion of the second review.

Any major amendments to the ALRMP that affect its application will be undertaken in consultation with the appropriate regulatory authorities and stakeholders. Minor changes such as formatting edits may be made throughout the operation without notification but will be indicated as such with version control.

The ALRMP may also be revised due to:

- deficiencies being identified;
- introduction of additional mitigation measures or controls;
- results from the monitoring and review programme, including exceedances of criteria;
- recommendations resulting from the monitoring and review programme;
- changing environmental requirements;
- improvements in knowledge or technology becoming available;
- changes in legislation;
- identification of a requirement to alter the ALRMP following a risk assessment; or,
- updating of the HVO MOP.

10 Document Information

10.1 Records Information

Records information, listed in the table below, are records produced from the below documents as part of this procedure.

Records	

10.2 Reference Information

Reference
Cunningham, G.M., Higginson, F.R., Riddler, A.M.H. and Emery, K.A. (1988) Systems used to classify rural lands in New South Wales. NSW Land and Water Conservation.
EMGA Mitchell McLennan (2010). Carrington West Wing Environmental Assessment. October 2010
GSS Environmental (2011) Strategic Agricultural Land & Reinstatement Assessment Report: Carrington West Wing Project. In: EMGA Mitchell McLennan (2011). Carrington West Wing Agricultural Impact Assessment. June 2011
NSW Agriculture & Fisheries (1990). Agricultural Suitability Maps – Uses and Limitations. Agfact AC.9.
NSW Trade & Investment, ESG3: Mining Operations Plan (MOP) Guidelines. September 2013. www.resources.nsw.gov.au/environment
Office of Environment and Heritage (2012). The Land and Soil Capability Assessment Scheme; Second approximation.
Coal & Allied (2004). Alluvial Lands Management Plan. GSS Environmental for Coal & Allied.
Venness & Associates (1995). Alluvial Lands Project: Soils Management Plan. In: Alluvial Lands Management Plan. GSS Environmental for Coal & Allied.
Department of Land and Water Conservation (1994).An Assessment of Soil Structure on the Floodplain at Hunter Valley Mine.

10.3 Change Information

Full details of the document history are recorded in the document control register, by version. A summary of the current change is provided in table below.

Version	Date	Review Team	Details of Change
1.0	25.09.2013	*Bill Baxter, Michael Lloyd*	*New document.*
1.1	01.06.2017	*Bill Baxter*	*Inclusion of DPI Ag feedback*
1.3	[Effective Date]	*Andrew Speechly, Michael Lloyd, Greg Peard*	*Reflect ownership change to HVO, change to Glencore document template, update Consent Condition numbering*

Appendix A - Soil Landscape Unit Descriptions

Brown Uniform Silty Clay Loam

Description: The Brown Uniform Silty Clay Loam soil unit generally consists of yellowish brown and brown silty clay loams throughout the profile. These moderately structured soils range from slightly alkaline to moderately alkaline at depth. The soils are generally non-saline and have moderate fertility. The topsoil and subsoil are non-sodic.

Location: These soils cover 32% or 43.9ha of the pit extension area and are present on the lower slopes near the southern boundary of the project area. Profile sites 1, 2, 3 and 8 occur within this unit.

Landuse: The land overlying these soils is dominated by open grazing farmland. Farm tracks and sparse low lying shrubs transect the area.

Management: The top 1.20m of this soil is suitable for stripping and reuse as a topdressing medium in rehabilitation. Soil at further depths may be suitable; however restrictions on pit depth prevented further investigation. This soil requires only the standard erosion and sediment control measures if disturbed.

Table 1 – Brown Uniform Silty Clay Loam Profile

LAYER	DEPTH (m)	DESCRIPTION
1	0.00 to 0.20	Brown (10YR 4/3), moderate consistence silty clay loam. A weak to moderate pedality (angular blocky 20-50mm) soil with slight to moderate alkalinity (pH 7.6 to 8.1), very low to low dispersion (Emerson Aggregate Test (EMT) 5 & 3(1)), non-saline (0.05 – 0.09dS/m), roots common to many and nil stones. Approximate sample depth 0.20m. Clear even boundary to Layer 2.
2	0.20 to 0.45	Brown (10YR 4/3) moderate consistence silty clay loam. Moderate pedality (angular blocky 10-20mm) soil with moderate to strong alkalinity (pH 8.2 – 9.1), very low to low dispersion (EAT 5 & 3(2)), non-saline (0.08 – 0.15dS/m), roots few to common and nil stones. Approximate sample depth 0.40m. Clear and even boundary to Layer 3.
3	0.45 – 1.20 +	Brown (10YR 4/3), moderate consistence silty clay loam. Moderate pedality (angular blocky 10mm) soil with moderate alkalinity (pH 8.1 – 8.7), very low to low dispersion (EAT 5 & 3(2)), non-saline 0.06 to 0.10dS/m), no roots or stones. Approximate sample depth 1.00m.

Plate 1 – Brown Uniform Silty Clay Loam Profile

Plate 2 – Brown Uniform Silty Clay Loam Landscape

Brown Uniform Silty Clay

Description: The Brown Uniform Silty Clay soil unit generally consists of brown to dark greyish brown silty clays to medium clays throughout the profile. These moderately drained soils range from neutral to moderately alkaline at depth. The soils are generally non-saline with moderate fertility. The topsoil and subsoil are non- sodic to moderately sodic.

Location: These soils cover 41.52% or 56.8ha of the pit extension area and are found on the mid to lower slopes and flat areas located near the northern portion of the pit extension area. Profile sites 4, 5, 6 and 7 occur within this soil unit.

Landuse: The land overlying these soils is dominated by open grazing farmland. Farm tracks and sparse low lying shrubs transect the area.

Management: The top 0.20m of soil is suitable for stripping and reuse as a topdressing medium in rehabilitation. The subsoil is generally not suitable for stripping and re-use during rehabilitation operations due to very high clay content, massive structure and moderate salinity. Whilst this subsoil is unsuitable for use as a topdressing material, consideration may be given to selectively stripping and conserving this material for use as an intermediate layer between reshaped overburden and the final topdressing layer.

Table 2 – Brown Uniform Silty Clay Profile

LAYER	DEPTH (m)	DESCRIPTION
1	0.00 to 0.20	Brown (10YR 4/3) to Dark Greyish Brown (10YR 4/2), moderate consistence silty clay. Moderate pedality (angular blocky 10-50mm) soil with neutral to slight alkalinity (pH 6.6 to 7.7), slight to nil dispersion (EAT 3(3) to 3(1)), non-saline (0.05-0.06 dS/m), roots many (upper level to common at depth) and <2% stones (5-20mm). Approximate sample depth 0.10m. Clear even boundary to Layer 2.
2	0.20 to 0.90	Dark Greyish Brown (10YR 4/2) moderate to strong consistence silty clay. Weak to moderate pedality (angular blocky 20-50mm) soil with slight to moderate alkalinity (pH 8.0 to 8.8), very low to low dispersion (EAT 5 to 3(1)), non saline to moderately saline (0.08 to 0.56 dS/m), roots few and stones nil. Approximate sample depth 0.70m. Clear and even boundary to Layer 3.
3	0.90 – 1.20 +	Brown (10YR 4/3) to Dark Greyish Brown (10YR 4/2) strong consistence medium clay. An apedal massive soil that is moderately alkaline (pH 8.5 to 8.8), low to moderate dispersion (EAT 5 to 2(2)), moderately saline (0.22 to 0.88 dS/m), roots and stones nil. Approximate sample depth 1.10m.

Plate 3 – Brown Uniform Silty Clay Profile

Plate 4 – Brown Uniform Silty Clay Landscape

Red Brown Duplex Loam

Description: The Red Brown Duplex Loam soil unit generally consists of reddish brown to brown loams and silty clay loams which overlie a texture contrast to brown to reddish brown clay subsoil. These moderately drained soils range from moderately acidic to neutral in the upper layers, to moderately and strongly alkaline at depth. The soils are non-saline in the upper layers, ranging to saline at depth. The topsoil and subsoils are non-sodic.

Location: The soils cover 26.38% or 36.1ha of the pit extension area and are found on the mid to lower slopes in the north western portion of the pit extension area. Profile sites 9 and 10 occur within this soil unit.

Landuse: The land overlying these soils is dominated by open grazing farmland. Farm tracks and sparse low lying shrubs transect the area.

Management: The top 0.10m of soil is suitable for stripping and reuse as a topdressing medium in rehabilitation. The lower layers are generally unsuitable due to the limiting factors of massive structure, moderate potential for dispersion and high alkalinity. Whilst this subsoil is unsuitable for use as a topdressing material, consideration may be given to selectively stripping and conserving this material for use as an intermediate layer between reshaped overburden and the final topdressing layer.

Table 3 – Red Brown Duplex Loam Profile

LAYER	DEPTH (m)	DESCRIPTION
1	0.00 to 0.10	Brown (7.5YR 5/3) weak consistence silty clay loam. A moderate pedality (10-50mm angular blocky peds) soil that is neutral to moderate acidity (pH 6.8 to 5.8), very low to low dispersion (EAT 5 & 3(1)), non-saline (0.07 to 0.11dS/m), roots common and 2% to 10% stones (<10mm). Approximate sample depth 0.05m. Sharp and even boundary to Layer 2.
2	0.10 to 0.80	Brown (7.5YR 5/3) moderate consistence clay. A weakly structured (20-40mm angular blocky peds) soil that is neutral to moderately alkaline (pH 7.5 to 8.8), moderately dispersive (EAT 2(2)), non-saline (0.08dS/m), roots few to none and <10% stones (<10mm). Approximate sample depth 0.70m. Clear and even boundary to Layer 3.
3	0.80 to 1.20m +	Strong Brown (7.5YR 5/6) strong consistence clay. An apedal massive soil that is strongly alkaline (pH 9.4), low dispersion (EAT 3(1), saline (1.60dS/m), roots none and stones <10%. Approximate sample depth 1.00m.

Plate 5 – Red Brown Duplex Loam Profile

Plate 6 – Red Brown Duplex Loam Landscape

Appendix B - Department of Planning and Environment Approval

Department of Planning and Environment

DA 450-10-2003-PA-58

Mr Andrew Speechly
Manager Environment and Community
1011 Lemington Road Lemington NSW 2330

20/06/2022

Subject: Agricultural Land Reinstatement Management Plan for Hunter Valley Operations North (62D of DA 450-10-2003)

Dear Mr Speechly,

I refer to your submission dated 23 May 2022, requesting approval of the revised Agricultural Land Reinstatement Management Plan (version 1.3, dated May 2022).

The Department has carefully reviewed the document and is satisfied that it has been updated to reflect the findings of the 2021 Annual Review, noting the changes are largely administrative in nature.

As nominee of the Planning Secretary, I approve the revised Agricultural Land Reinstatement Management Plan (version 1.3, dated May 2022) under Condition 62D of Schedule 4 of DA 450-10-2003.

I also agree, in accordance with condition 3 of Schedule 5, that due to the administrative nature of the revisions that consultation with the public authorities listed in condition 62D of Schedule 3 was not required.

You are reminded that if there is any inconsistency between the approved document and the conditions of approval, then the requirements of the conditions of approval prevail. Please ensure you make the document and this approval letter publicly available on the project website at the earliest convenience.

If you wish to discuss the matter further, please contact Joe Fittell on 02 4908 6896.

Yours sincerely

Stephen O'Donoghue
Director
Resource Assessments

As nominee of the Planning Secretary