

**WAMBO
EROSION AND SEDIMENT CONTROL PLAN**

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Document Control

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1	August 2020	Updated to address changes to DA305-7-2003 (Mod 16) & DA177-8-2004 (Mod 3) and recommendations from the 2017 IEA (description of ESC measures). Relocated background info on Wambo to new Water Management Plan (WA-ENV-MNP-509) and tidied up format to be consistent with new SWMP and GWMP.	WCPL	CB	
2	November 2020	Revised to address minor comment from DPIE	WCPL	-	
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1.0 Introduction

1.1 Purpose and Objectives

This Erosion and Sediment Control Plan (ESCP) has been developed by Wambo Coal Pty Ltd (WCPL) to address WCPL's development consents DA305-7-2003 and DA177-8-2004, as relevant to Phase 2 mining operations at the Wambo Coal Mine (Wambo). This ESCP is also consistent with the Peabody Energy Australia *Erosion and Sediment Control Guideline* (October 2014).

This ESCP has been prepared to:

- Minimise erosion and sediment generation from disturbed areas;
- Maintain water quality in downstream water systems (primarily turbidity or sediment load, as indicated by Total Suspended Solids (TSS)); and
- Reduce the loss of valuable topsoil from land disturbed by mining activities.

1.2 Scope

This ESCP applies to all Phase 2 operational activities at Wambo Coal Mine, including underground mining operations, CHPP and train loading operations (**Figure 1**). It does not apply to open cut mining operations associated with the United Wambo Open Cut Project.

This ESCP applies to all employees and contractors working for, or on behalf of WCPL within the project approval boundary (**Figure 1**).

This ESCP covers all surface disturbance activities undertaken within Wambo's mining authorisations and approved mining areas.

The ESCP will be implemented at a catchment or sub catchment level. The specific controls and the subsequent monitoring and maintenance are outlined in **Sections 4.2.2** and **6.0**.

1.3 Relationship to other Management Plans

This ESCP is part of a set of documents that together form the WCPL Water Management Plan (WMP) for the Wambo Coal Mine (**Figure 2**). The WMP is one of a series of Environmental Management Plans that together forms part of the WCPL Environmental Management System.

This ESCP briefly describes measures for topsoil management however more detailed information is contained in the Wambo **Mining Operations Plan/Rehabilitation Management Plan (MOP/RMP)**.

As part of Phase 2 operations, WCPL has combined the surface and ground water monitoring programs at Wambo with the United Wambo Open Cut surface and ground water monitoring programs. This combined monitoring program is now contained within the new **United Wambo Open Cut and Wambo Water Monitoring Program (WMProg)** (WA-ENV-MNP-509.8). The **WMProg** includes monitoring of some sediment control dams (as described in **Section 6.0** of this ESCP).

This ESCP should be read in conjunction with the other components of the Water Management Plan, particularly the overarching Wambo **Water Management Plan** (WA-ENV-MP-509), **WMProg** (WA-ENV-MNP-509.8) and the Wambo **Environmental Management Strategy (EMS)** (WA-ENV-MNP-501).

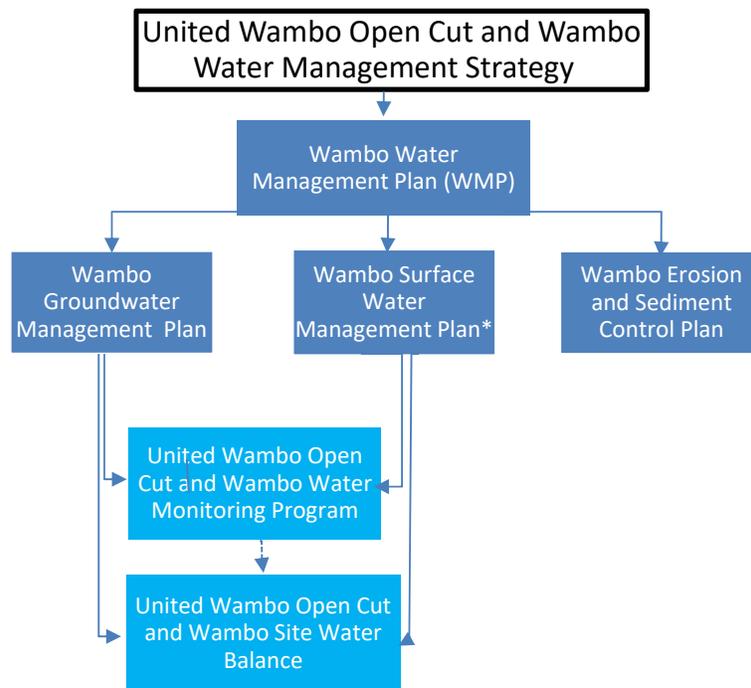


Figure 2: Wambo Water Management Plan

Notes to Figure 2:

- Shared Document with United Wambo Open Cut Operations (refer Table 2 of **WMP**)
- Wambo Document (refer Table 2 of **WMP**)
- * SWMP incorporates the **North Wambo Creek Diversion Management Plan (NWCD MP)**

1.4 Preparation of the ESCP

In recognition of the requirements of Condition B66(a) of DA305-7-2003, this ESCP prepared by WCPL has been reviewed by a suitably experienced and qualified person. WCPL wrote to

the Department of Planning, Industry and Environment (DPIE) requesting endorsement of Mr Chris Bonomini from Umwelt 20 August 2020 (refer **Section 1.5.2**). DPIE provided endorsement for Mr Bonomini in correspondence dated 2 September 2020 (refer to correspondence in **Appendix A**).

1.5 Stakeholder Consultation

1.5.1 History of Consultation

There is a long history of consultation with various stakeholders regarding WCPL's Water Management Plan. Over the years WCPL has undertaken extensive consultation with government agencies, the Wambo Community Consultative Committee (CCC) and affected landholders in relation to management plan updates, including for various extraction plans.

The last update to the ESCP (version 11) was undertaken in consultation with DPIE, as part of the Extraction Plan for South Bates Underground Extension LW17-20. This update addressed comments from the DPIE and built on consultation undertaken on previous versions of the document. The current version has been labelled Version 1A to align with the new water management plan structure (outlined in **Figure 2**).

A summary of historic consultation, including how comments from DPIE Water and DPIE have been addressed in previous versions of the ESCP, is provided in **Appendix A**.

1.5.2 Consultation for this ESCP

On 11 February 2020 WCPL sought approval from DPIE for the appointment of Mr Rohan Lucas as the suitably qualified surface water expert for the preparation of the South Bates Underground Extension (SBUE) Extraction Plan for Longwalls 21-24. Mr Lucas was approved by DPIE on 28 February 2020 (refer to correspondence in **Appendix A**).

In August 2020, WCPL wrote to DPIE requesting endorsement of Mr Chris Bonomini as the appointed expert for the Erosion and Sediment Control Plan required by the Consent. Mr Bonomini was endorsed 2 September 2020.

As required by Condition B66 (b) of DA305-7-2003, WCPL must prepare this ESCP in consultation with DPIE Water and the EPA, to the satisfaction of the Planning Secretary. This ESCP (including all appendices) was supplied to DPIE Water and EPA for review 26 August 2020. The EPA advised in correspondence dated 4 September 2020 that it is not their role to review management plans. No comments were received from DPIE Water. The ESCP was approved by DPIE 20 November 2020. Correspondence in relation to the ESCP is attached as **Appendix A**.

1.6 Statement of Commitments

A Summary of Commitments for this ESCP is included in **Appendix B**.

2.0 Statutory Requirements

This ESCP has been prepared to fulfil all statutory requirements relating to erosion and sediment control at the Wambo Coal Mine, including:

- Relevant legislation, policies, guidelines and standards;
- DA305-7-2003 and DA177-8-2004 Conditions of Consent (CoC);
- Environment Protection Licence (EPL 529) and *Protection of the Environment Operations Act 1997* (POEO Act) requirements;
- Recommendations from the 2017 Independent Environmental Audit (Hansen Bailey, 2018); and
- Recommendations from the 2020 Independent Environmental Audit (GHD, 2020)

There are no commitments in the *United Wambo Open Cut Project Environmental Impact Assessment* (Umwelt, 2016) relevant to this ESCP.

2.1 Legislation, Policies, Guidelines and Standards

The legislation relevant to this ESCP is described in Section 2.1 of the **WMP**.

The policies, guidelines and standards relevant to this ESCP are described in Section 2.2 of the **WMP**.

2.2 DA305-7-2003 Conditions of Consent

WCPL received development consent (DA305-7-2003) in accordance with the Environmental Planning & Assessment Act 1979 (EP&A Act) from DPIE, formerly NSW Department of Planning and Environment (DP&E), on 4 February 2004. The most recent modification to DA305-7-2003 was granted by the Independent Planning Commission of NSW on 29 August 2019 (Modification 16).

DA305-7-2003 requirements related to the development of this ESCP are summarised in **Table 1**. Performance measures relevant to this ESCP, as specified in Condition B62 of DA305-7-2003, are listed in **Table 2**.

Table 1: DA305-7-2003 Requirements for this ESCP

Condition	Condition Details	ESCP Section
B66	(iii) Erosion and Sediment Control Plan, that:	Entire document
	<ul style="list-style-type: none"> • is consistent with the requirements of Managing Urban Stormwater: Soils and Construction - Volume 1: Blue Book (Landcom, 2004) and Volume 2E: Mines and Quarries (DECC, 2008); 	Section 4.0
	<ul style="list-style-type: none"> • identifies activities that could cause soil erosion, generate sediment or affect flooding; 	Section 4.1
	<ul style="list-style-type: none"> • describes measures to minimise soil erosion and the potential for the transport of sediment to downstream waters, and manage flood risk; 	Sections 4.2.2 and 6.0
	<ul style="list-style-type: none"> • describes the location, function, and capacity of permanent erosion and sediment control structures and flood management structures; and 	Section 5.1
	<ul style="list-style-type: none"> • describes what measures would be implemented to maintain (and if necessary decommission) the structures over time; 	Section 6.3

Condition	Condition Details	ESCP Section
	<ul style="list-style-type: none"> a protocol to report on the measures, monitoring results and performance criteria identified above, in the Annual Review referred to in condition D10. 	Section 9.2.1
D5	<p>Management Plan Requirements</p> <p>The Applicant must ensure that the management plans required under this consent are prepared in accordance with any relevant guidelines, and include where relevant:</p> <ul style="list-style-type: none"> summary of relevant background or baseline data; <p>(b) details of:</p> <ul style="list-style-type: none"> the relevant statutory requirements (including any relevant approval, licence or lease conditions); any relevant limits or performance measures and criteria; the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures; <p>(c) any relevant commitments or recommendations identified in the document/s listed in condition A2(c);</p> <p>(d) a description of the measures to be implemented to comply with the relevant statutory requirements, limits, or performance measures and criteria;</p> <p>(e) a program to monitor and report on the:</p> <ul style="list-style-type: none"> impacts and environmental performance of the development; and <ul style="list-style-type: none"> effectiveness of any management measures set out pursuant to paragraph (d); <p>(f) a contingency plan to manage any unpredicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible;</p> <p>(g) a program to investigate and implement ways to improve the environmental performance of the development over time;</p> <p>(h) a protocol for managing and reporting any:</p> <ul style="list-style-type: none"> incident, non-compliance or exceedance of any impact assessment criterion and performance criterion; complaint; or failure to comply with other statutory requirements; and <p>(i) a protocol for periodic review of the plan.</p>	<p>Section 2.1</p> <p>Section 3.0</p> <p>Section 2.0</p> <p>Table 2, Table 3</p> <p>Section 6.4</p> <p>N/A</p> <p>Sections 4.0, 5.0 and 6.0</p> <p>Monitoring – Section 6.0 Reporting - Section 9.0</p> <p>Section 7.2</p> <p>Section 9.2.1</p> <p>Monitoring – Section 6.0 Reporting - Section 9.0</p> <p>Section 8.0</p> <p>Section 7.3</p> <p>Section 9.1</p>

Table 2: DA305-7-2003 Erosion and Sediment Control Performance Measures

Feature	Performance Measure ^{1,2}	ESCP Section
Erosion and sediment control works	<ul style="list-style-type: none"> Design, install and maintain erosion and sediment controls in accordance with the guidance series <i>Managing Urban Stormwater: Soils and Construction – Volume 1 (Landcom, 2004) and 2E Mines and Quarries (DECC, 2008)</i>³ Design, install and maintain any infrastructure within 40 metres of watercourses in accordance with the guidance series for <i>Controlled Activities on Waterfront Land (DPI Water, 2012)</i> Design, install and maintain any creek crossings generally in accordance with the <i>Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (DPI, 2013)</i> and <i>Why Do Fish Need To Cross The Road? Fish Passage Requirements for Waterway Crossings (NSW Fisheries, 2003)</i> 	Sections 4.0, 4.2.2 and 6.0
Sediment Dams	<ul style="list-style-type: none"> Design, install and maintain sediment dams in accordance with the guidance series <i>Managing Urban Stormwater: Soils and Construction – Volume 1 (Landcom, 2004) and 2E Mines and Quarries (DECC, 2008)</i> and the requirements under the <i>POEO Act or Protection of the Environment Operations (Hunter River Salinity Trading Scheme) Regulation 2002</i> 	Sections 4.0, 4.2.2 and 6.0

Notes to **Table 2**:

- The performance measures in **Table 2** do not apply to water management structures constructed prior to the approval of Modification 16 (to DA305-7-2003).
- Performance measures relating to surface water management are addressed in the *SWMP*.
- Also a requirement of Condition B51 of DA305-7-2003.

2.3 DA177-8-2004 Conditions of Consent

WCPL received Development Consent (DA177-8-2004) in accordance with the EP&A Act from the NSW DPIE on 16 December 2004. The most recent modification to DA177-8-2004 was granted by the Independent Planning Commission of NSW on 29 August 2019 (Mod 3).

Performance measures relevant to this ESCP, as specified in Condition B9 of DA177-8-2004, are listed in **Table 3**.

Table 3: DA177-8-2004 Erosion and Sediment Control Performance Measures

Feature	Performance Measure ^{1,2}	ESCP Section
Sediment Dams	<ul style="list-style-type: none"> Design, install and maintain sediment dams in accordance with the guidance series <i>Managing Urban Stormwater: Soils and Construction – Volume 1 (Landcom, 2004) and 2E Mines and Quarries (DECC, 2008)</i> and the requirements under the <i>POEO Act or Protection of the Environment Operations (Hunter River Salinity Trading Scheme) Regulation 2002</i>³ 	Sections 4.0, 4.2.2 and 6.0

Notes to **Table 3**:

- The performance measures in **Table 3** do not apply to water management structures constructed prior to the approval of Modification 3 (to DA177-8-2004).
- Performance measures relevant to surface water management are addressed in the *SWMP*.
- Also a requirement of Condition B4 of DA177-8-2004.

Other DA177-8-2004 conditions relating to general water management are addressed in the *WMP*.

2.4 EPL 529 and POEO Act Requirements

The EPA issued EPL 529 on 27 September 2000 under the *Protection of the Environment Operations Act 1997* (POEO Act). Condition L1.1 of EPL 529 requires compliance with Section 120 of the POEO Act, which prohibits pollution of waters. This will be achieved through the implementation of the management measures outlined in **Section 4.2.2**, minimising sediment generation and transportation to downstream waterways.

Uncontrolled discharge of sediment laden water from sediment basins is not considered an offence under s120 POEO Act if it occurs after receiving rain in excess of the design criteria detailed in the Blue Book within the specified timeframe.

In consultation with the EPA, the EPL is modified (as required) to reflect any relevant modified development consent conditions.

2.5 Independent Environmental Audit Recommendations

In 2017 Hansen Bailey conducted an Independent Environmental Audit of the Mine, in accordance with the requirements of Condition D11 of DA305-7-2003 and DA177-8-2004 (Hansen Bailey, 2018).

In 2020 the Independent Environmental Audit was conducted by GHD (GHD, 2020).

Recommendations from the audit reports relating to this ESCP, and where they are addressed, are contained in **Table 4**.

Table 4: IEA Recommendations relevant to this ESCP

Recommendation	ESCP Section
2017 IEA	
A description of the existing as-built ESC arrangements for each sediment-affected catchment would enhance the current understanding of the site ESC arrangements.	Section 5.1.1
A description of the known issues and actions would be useful in demonstrating that the ESCP is operating effectively and areas for improvement (RE, 2018).	Section 4.1
Additionally, the ESCP structure and text would benefit from a review to improve the general readability of the document. This could involve ensuring that the plan structure is logical, the scope and progression of each section is clear, and overly lengthy or repetitious text is rationalised (RE, 2018).	All Sections
2020 IEA	
Figure 10 to be updated to include flow direction arrows for water run-off diversions and catch drains and any reinstated drainage networks on rehabilitated areas of the site.	Figure 10

3.0 Existing Environment

3.1 Soils

Soil landscapes of the Mine and surrounds were classified and mapped in accordance with descriptions in the *Soil Landscapes of the Singleton 1:250,000 Sheet* (Kovac and Lawrie, 1991) and the *2003 Environmental Impact Assessment (2003 EIS)*. Major soil types identified include alluvial soils along major drainage lines, siliceous sands to the east of Wollombi Brook, yellow podzolics and yellow solodic intergrades adjacent to the alluvials on lower slopes and undulating plains, soloths on moderately elevated slopes and lithosols along the eastern boundary of the Wollemi National Park.

Due to the known variability and distribution of the soils at Wambo, the concept of soil complex units is used to identify the soil types and provide guidance on appropriate stripping depth. The different soil complex units found at Wambo, as identified in the 2003 EIS (WCPL, 2003), include:

- Red Podzolic – found on the ridges and middle to upper slope position of the site. The upper 0.10 m of the profile of each soil type is suitable for use as topsoil. Tunnel and gully erosion risk, high structural degradation risk.
- Yellow Podzolic / Solodic – found on the mid to lower slopes of the hills within the site. The upper 0.20 m of the profile of each soil type is suitable for topsoil. Tunnel and gully erosion risk, high structural degradation risk.
- Lithosols – Stony or gravely soils generally occurring on upper slope and hilltop areas. No depth of the profile is suitable for topsoil.
- Alluvials – found around North Wambo Creek. Suitability for topsoil recovery highly variable from 0.30 m, to limited areas of 1.0 m. Erosion hazard, high structural degradation risk.

Soil types are considered during topsoil stripping, handling and stockpiling operations. Further detail on the implementation of appropriate strategies to manage topsoil is included in **Section 5.2.5**.

3.2 Slope

The topography of the Project Area has been heavily modified by past mining activity which has been occurring at the site since 1969 and in much of the surrounding area. The topography of the undisturbed portions of the Project Area is typical of the central lowlands of the Hunter Valley and is characterised by an undulating and hilly landscape with lower topographic areas associated with drainage lines.

Slope angle and length are important determinants in the erosion risk of site. The Australian Soils and Landscapes Handbook identifies that slopes can be categorised by their percentage or degree of slope. An assessment of the slope and the current and proposed landforms including drainage patterns is required during the planning phase of an activity (refer to **Section 4.0**).

3.3 Hydrology

The Mine is situated adjacent to Wollombi Brook, south-west of its confluence with the Hunter River (**Figure 3**). Wollombi Brook drains an area of approximately 1,950 square kilometres and joins the Hunter River some 5 km north-east of Wambo. The Wollombi Brook sub-catchment

is bound by the Myall Range to the south-east, Doyles Range to the west, the Hunter Range to the south-west and Broken Back Range to the north-east.

The majority of lands within Wambo mining tenements drain via Wambo (also known as 'South Wambo'), Stony, North Wambo and Redbank Creeks to Wollombi Brook, while Waterfall Creek drains directly to the Hunter River (**Figure 3**).

A section of North Wambo Creek has been diverted to avoid the Wambo open cut. The North Wambo Creek Diversion was constructed in accordance with the approved North Wambo Creek Diversion Plan.

Approximately 980 m of the North Wambo Creek Diversion has been undermined by Longwalls 11 to 13 at South Bates Underground Mine. In December 2017, WCPL was granted consent to mine an additional nine longwall panels (LW17 to LW25), to the north-west of the South Bates Underground Mine. An additional 120 metres was undermined by Longwall 17.

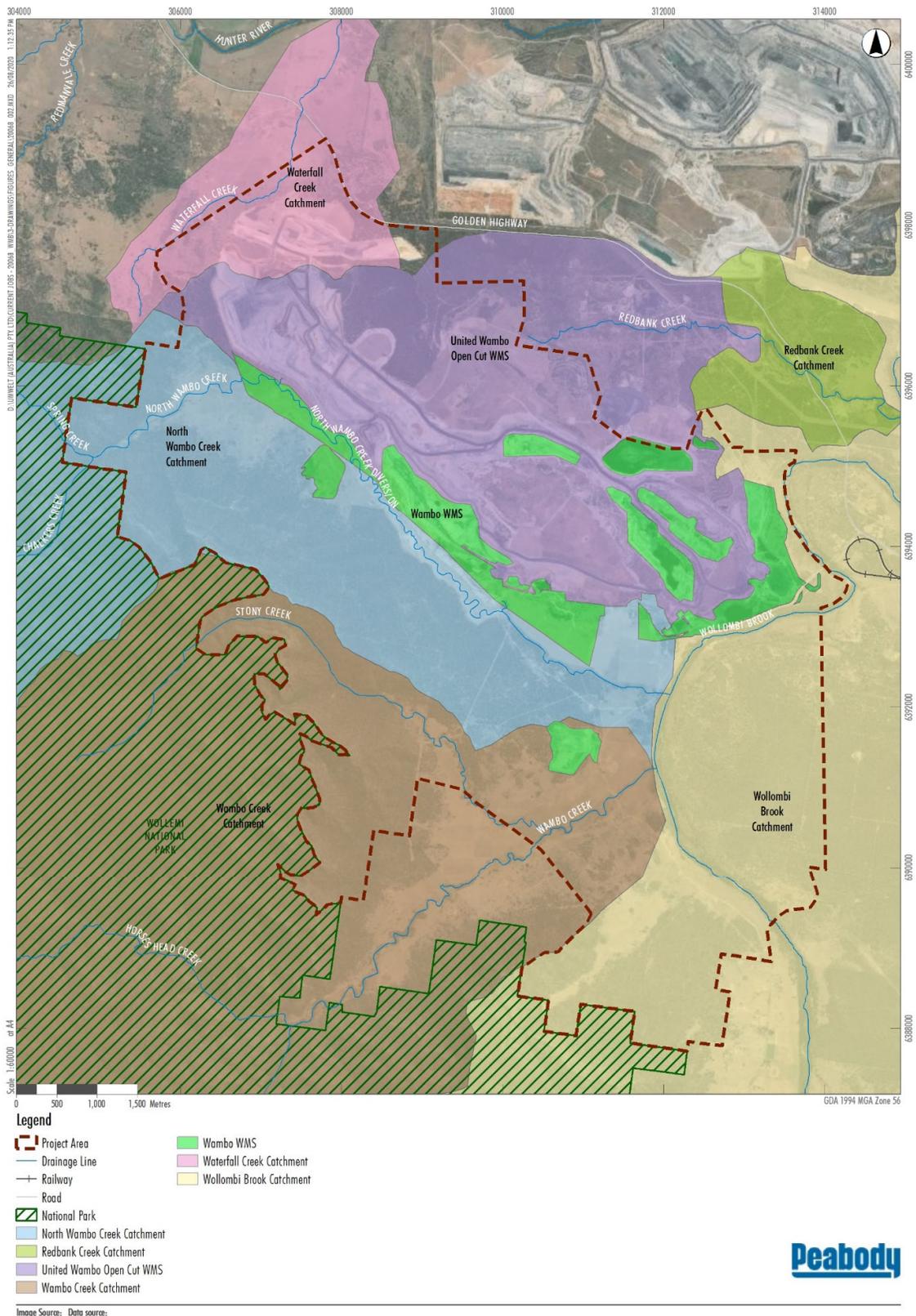


Figure 3: Wambo Project Area Catchment Context

4.0 Planning

4.1 Potential Sources, Impacts and Controls

Mining activities involve disturbance to the lands surface, which has the potential to result in erosion and sediment impacts to the surrounding natural environment. Erosion may result in increased sediment load in downstream drainage systems if appropriate control measures are not implemented. This also has the potential to affect flooding in these systems. The potential sources, impacts and controls for erosion and sedimentation relevant to the Phase 2 operations are listed in **Table 5** below.

Table 5: Sources of Erosion and Sedimentation

Source	Potential Impact	Controls
Topsoil Stripping/ Stockpiling	Loss of topsoil resource, Sediment mobilisation from stockpile entering drainage/waterways.	Battering, revegetation, and sediment control measures, and topsoil striping permits.
Corridor clearing (power lines, pipelines, etc)	Loss of topsoil resource, Sediment mobilisation entering drainage/waterways.	Revegetation of buffer zone with grasses, surface stabilisation of access track (road base or gravel), and rock check dams in drains and on batters of watercourse crossings.
Remote pad construction	Sediment mobilisation from cleared area and pad materials entering drainage/waterways.	Upslope catchment diversion, catch drains, rock check dams and sediment fences.
Access tracks and unsealed roads	Road instability, sediment generation entering waterways.	Cresting of roads, drainage channels, rock chutes, rock check dams and level spreading.
Building sites i.e. workshops, offices within a mine industrial area	Sediment generation blocking stormwater infrastructure.	Upslope catchment diversion, sediment fences and rock check dams in drainage lines.
Subsidence areas	Potential areas of instability, destabilising creek bed and banks, sediment generation entering waterways.	Stabilisation of any areas of surface cracking using erosion protection measures including revegetation.

4.2 ESC Principles and Design Guidelines

4.2.1 Principles

The following principles provide the foundation for this ESCP:

- Ensure erosion and sediment control measures are designed and constructed effectively;
- Minimise surface disturbance and restrict access to undisturbed areas;
- Progressively rehabilitate and stabilise disturbed areas;
- Maximise sediment retention onsite;
- Separate disturbed and undisturbed catchment runoff, where practicable;

- Minimise soil erosion where possible rather than applying down slope sediment controls;
- Utilise existing topography and adopt construction practices that minimise soil erosion and sediment discharge from the area;
- Integrate erosion and sediment control issues/measures into the planning phases of the mine operation;
- Choose the erosion and sediment control technique to account for site conditions such as soil, weather and construction conditions;
- Correct design of surface drains to facilitate the efficient transport of surface runoff (drains will generally be designed using trapezoidal or parabolic cross-sections);
- Construct sediment control structures, or utilize existing mine water storages, to contain runoff from disturbed areas;
- Maintain all erosion and sediment control measures in proper working order at all times; and
- Monitor the site and adjust erosion and sediment control practices to maintain the required performance standard.

The above principles take into account the general recommendations for site drainage works as specified in *“Managing Urban Stormwater – Soils and Construction Volume 1”* (Section of housing, 2004) and *“Managing Urban Stormwater – Soils and Construction Volume 2E: Mines and Quarries”* (DECCW, 2008) (Blue Book) as well as the International Erosion and Control Association (IECA) *“Best Practice Erosion and Sediment Control Guidelines* (IECA, 2008), as referenced in Peabody’s Erosion and Sediment Control Guideline (October 2014).

4.2.2 Design Guidelines

As a minimum, sediment control structures at Wambo will be generally constructed in accordance with the guidelines presented in the Blue Book and design guidelines summarised in **Table 6**. However, subject to the potential risk, sediment dams will require construction design by certified engineer if the risk is determined Significant. Further information on risk assessment for sediment dams is included in **Section 5.2.4**.

Table 6: Design Guidelines for Sediment Control Structures

Control Structure	Function	Design Guidelines
Permanent Drainage Control Structures	Permanent drainage refers to diversion channels that will be in place at the end of mine life.	<ul style="list-style-type: none"> • For Life of Mine structures, construction design by certified engineer is required.
Temporary Drainage Control Structures ‘low gradient areas’	Temporary drainage in low gradient areas such as catch drains, diversion channels or flow diversion banks (or contour banks) that either collect concentrated flow or overland flow on rehabilitated areas of the Mine.	<ul style="list-style-type: none"> • Temporary drainage controls that are anticipated to last longer than 2 years would be designed to have a non-erosive hydraulic capacity to convey a 100 year Average Recurrence Interval (ARI) design storm to provide effective separation of diverted and surface water. • Temporary drainage controls that have an anticipated design life of 1 to 2 years would be

Control Structure	Function	Design Guidelines
		<p>designed to have a non-erosive hydraulic capacity to convey a 10 year ARI storm event.</p> <ul style="list-style-type: none"> • Temporary drainage controls that have an anticipated design life of 6 to 12 months would be designed to have a non-erosive hydraulic capacity to convey a 10 Year ARI • Temporary drainage controls that have an anticipated design life of <6 months would be designed to have a non-erosive hydraulic capacity to convey a 5 Year ARI. • Maintain channel velocities to <1.5 m/s where possible.
<p>Temporary Drainage Control Structures 'steeper slopes'</p>	<p>Temporary drainage channels in high gradient areas on rehabilitated areas of the Mine.</p> <p>Rock chutes (or drop structures) are drainage channels designed specifically for steep slopes. They are typically outlet structures for contour banks and primarily convey water from relatively flat longitudinal drains, down a steep slope to a sediment basin or outlet device on rehabilitated areas of the Mine.</p>	<ul style="list-style-type: none"> • Design requirements for ARI events as described for 'low gradient areas'. • Maximum slope of 1V:2H for rock lining stability. • Suitable for flow velocities up to 8 m/s.
<p>Sediment Basins 'surface water'</p>	<p>A sediment basin is a temporary "dam-like" structure used to capture and retain sediment-laden runoff.</p> <p>It is often the last line of defence in a drainage network to prevent sediment laden runoff from discharging off-site.</p> <p>A sediment basin is designed to reduce the inflow velocities. Once below a threshold velocity, bed load materials are settled out.</p>	<ul style="list-style-type: none"> • Detailed design and sizing of a sediment basin will be undertaken by a competent person to ensure the basin has sufficient capacity and the water being discharged is of acceptable quality to meet regulatory requirements. For more information refer to Section 4.2.2.2. All sediment basins are to be Type D sediment basins. • Settling Zone: The required settling zone capacity depends on the duration of disturbance and nature of the receiving environment (standard or sensitive and should be sized in accordance with Table 6.1 of Volume 2E of the Blue Book. Based on a sensitive receiving environment the settling zone should be sized as follows: <ul style="list-style-type: none"> - < 6 months disturbance, 5 day 75th percentile rainfall event (16.5 mm rain depth, refer to Figure 4)

Control Structure	Function	Design Guidelines
		<ul style="list-style-type: none"> - 6 months to 3 years disturbance, 5 day 85th percentile rainfall event. (26.0 mm rainfall depth, Figure 4) - > 3 years disturbance, 5 day 95th percentile rainfall event (48.5 mm rainfall depth, Figure 4). • Sediment Storage Zone: Based on two months calculated soil loss estimated using RUSLE¹ • Embankment and Spillway: The required embankment and spillway design depends on the duration of disturbance and nature of the receiving environment (standard or sensitive and should be sized in accordance with Table 6.1 of Volume 2E of the Blue Book. Based on a sensitive receiving environment the embankment and spillway should be designed to be structurally sound as follows: <ul style="list-style-type: none"> - < 6 months disturbance, 20 year ARI storm event - 6 to 12 months disturbance, 50 year ARI storm event - 1 to 3 years disturbance, 100 year ARI storm event
Sediment Fencing	Sediment fences are temporary devices constructed to reduce sediment transportation by intercepting sheet flows.	<ul style="list-style-type: none"> • Sediment fences will be installed prior to and maintained during all construction earthworks (refer to Blue Book standard drawing SD 6-8 Sediment Fence and 6-9 Alternate Sediment Fence). • Support post spacing maximum 2 m apart, sediment fence material keyed into ground to 200 mm or secured with 300 mm of aggregate on the surface to the upstream. • Installation of sediment fences will be in line with contours and have returns every 20 metres that extend at least 1 metre upslope.
Buffer Zones	A buffer zone is a vegetated area, generally a grassed area, provided around the perimeter of an earthworks footprint. Its primary purpose is to reduce	<ul style="list-style-type: none"> • Where possible, a buffer zone shall generally be located at least 50 metres from the earthworks clearance footprint. A visible structure, such as a fence, will generally be constructed around the

¹ Sediment loading is to be undertaken using the Revised Universal Soil Loss Equation (RUSLE) method as detailed in IECA (2008), the design storm event runoff volume is to be estimated using the methods in Landcom (2004).

Control Structure	Function	Design Guidelines
	sediment transportation by acting as a 'sediment trap'.	buffer zone to clearly identify the area and prevent traffic from driving over it. <ul style="list-style-type: none"> Vegetation shall be a minimum of 50 mm high and must cover at least 80% of the surface to be effective in controlling bed load sediment runoff.
Check Dams	<p>Check dams are formed by created small weir structures in an open channel at regular intervals. They are effective in reducing the flow velocity by creating small ponds of water upstream of these structures. The three main materials used to construct check dams are sandbags, rock and fibre rolls.</p> <p>Note that rock check dams may not be suitable for use in drainage channels that have exposed dispersive soils. If dispersive soils are present, a soil conservation specialist (e.g. Certified Professional in Erosion and Sediment Control) should be consulted to determine whether rock check dams should be used and if they are to be used, identify specific installation measures to reduce the likelihood of scouring.</p>	<ul style="list-style-type: none"> Construction shall commence at the downstream check dam first then progress upstream. Ensure that the toe of the upstream check dam is at the same elevation as the crest of the downstream check dam (refer to Blue Book standard drawing SD 5-4 Rock Check Dam) Construction shall extend up the batters of the channel but will be limited to 500 millimetres from the base of the channel to ensure water does not spill at the edges of the check dam. A weir will be created in the centre of the check dam by allowing at least a 150 millimetre depression. The base of the check dam shall be trenched at least 200 millimetres below the invert of the drain to minimise the risk of undermining or side cutting the structures.

Further details on the specific design requirements for some controls are provided below.

4.2.2.1 Diversion Drains

Diversion drains will be suitably designed, grassed and (if required) protected with rock armouring, geotextile fabric, or similar. Water will be discharged at non erosive velocities downstream of the disturbed area into a suitable receiving environment. Drainage outlets, along with clean water diversion drains, will be appropriately designed in consultation with the Environment and Community Manager (or delegate).

Construction of berms, levees and catch drains to collect runoff from disturbed areas and divert water to sediment dams or other mine water storages, will be undertaken in accordance with the ESCIP, erosion and sediment control principles and design guidelines.

4.2.2.2 Sediment Dams

Sediment dams will be constructed to capture sediment from runoff flowing through site drains and diversions prior to its onsite re-use, or discharge to the Wambo WMS. Design principles for these sediment dams are summarised in **Section 4.2.1** and **Appendix C** and provided below.

Detailed design and sizing of a sediment basin will be undertaken by a competent person to ensure the basin has sufficient capacity and the water being discharged is of acceptable quality to meet regulatory requirements.

A sediment basin fundamentally consists of an inlet, a sediment storage zone, a settling zone and an outlet (spillway). The sizing of a sediment basin settling zone at Wambo is based on the 5-day duration rainfall events specified in **Table 6**. **Figure 4** provides the 5-day rainfall depth data for the site. For example, the 5-day 85th percentile rainfall depth at Wambo is 26.0 millimetres

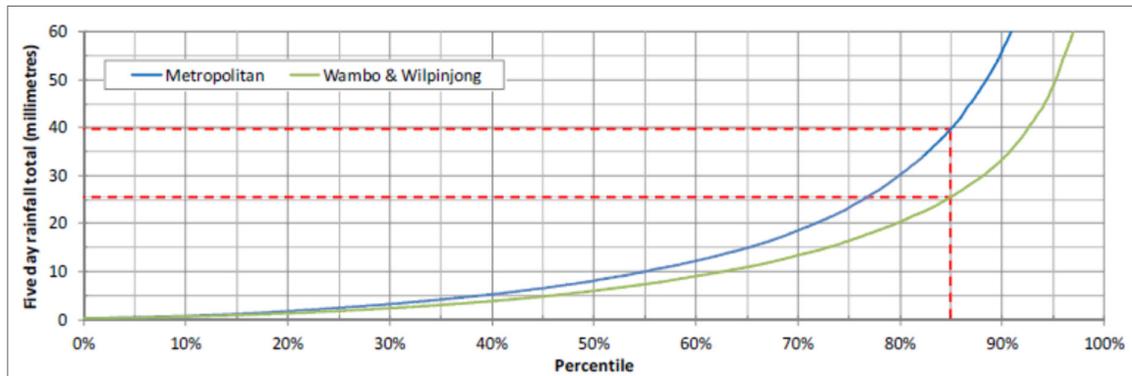


Figure 4: 5-Day Rainfall Depth

The upper zone within the sediment basin is the settling zone and slows the velocity of inflow water and allows suspended particles to settle. The lower zone within the sediment basin is the sediment storage zone and is used as a dead storage area to contain the settled particles. The volume of the sediment storage zone shall be approximately half the volume of the settling zone (**Figure 5**).

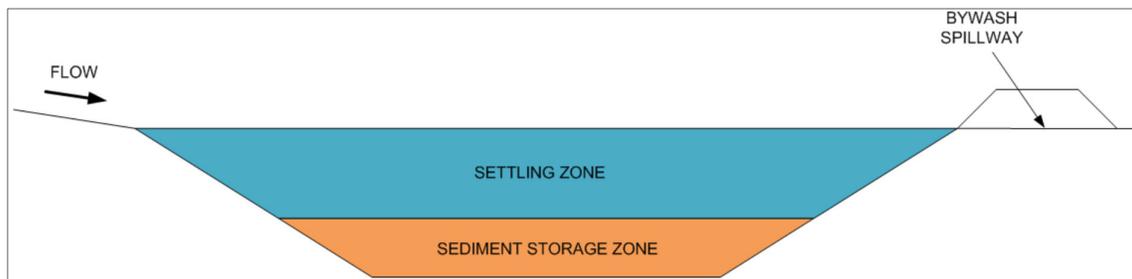


Figure 5: Settling and Storage Zones

Figure 6 provides an indicative overview of the required footprint area needed to construct a sediment basin, however advice from a competent person shall be sought to accurately determine the sizing prior to construction commencing.

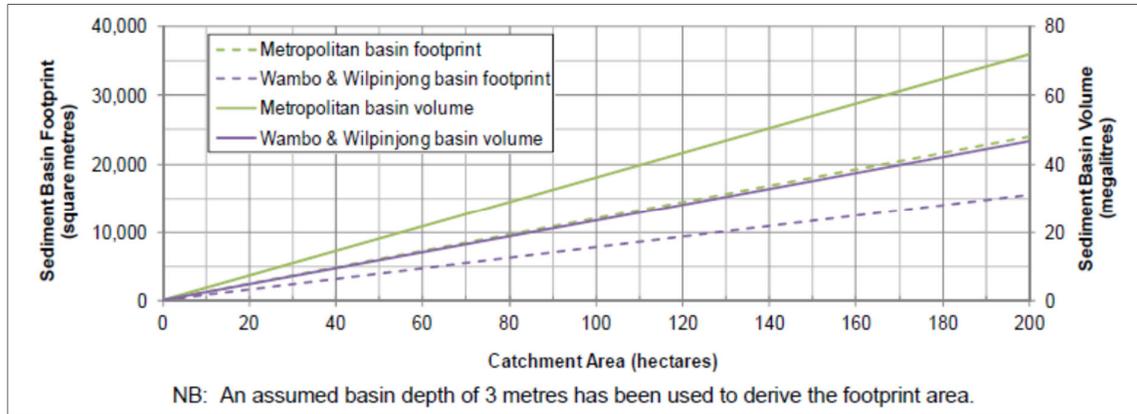


Figure 6: Indicative Sediment Dam Capacity

Sediment basins are typically designed to be filled, treated and discharged within five days following a runoff generating rainfall event to restore the settling zone capacity for containment of sediment laden runoff from subsequent rainfall events will be compared against the pump-out timeframes (Figure 7). In cases where small volumes of water have been retained in the sediment basin and the design settling zone capacity is still available, dewatering will still be undertaken to limit the impacts of evapo-concentration on water quality (i.e. a build up in salinity within the basin that could be later discharged during a runoff event that exceeds the basin design capacity).

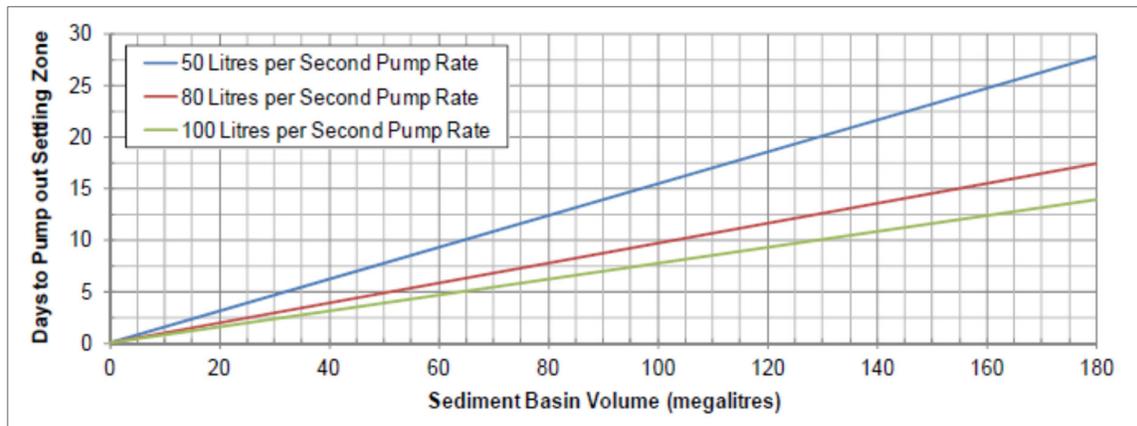


Figure 7: Indicative Pump Out Time Frames

Clean water catchments shall be diverted away from a sediment basin where possible. This will aid in reducing the total storage volume required in the sediment basin.

Sediment basins shall be located above the 2 year ARI flood level and where practicable the 5 year ARI flood level. Planning prior to construction is required to ensure adequate access is provided to and adjacent the sediment basin to allow maintenance and desilting. As previously outlined, detailed design, sizing, safe access for maintaining and cleaning, energy dissipaters etc of a sediment basin must be undertaken by a competent person.

4.2.2.3 Check Dams

Check dams are formed by created small weir structures in an open channel at regular intervals. They are effective in reducing the flow velocity by creating small ponds of water upstream of these structures. The effectiveness of these check dams depend on the selected materials, spacing, channel properties and flow characteristics. Design principles for check dams are provided in **Section 4.2.2.2** and **Appendix C**. An example of a check dam is shown in **Figure 8**.



Figure 8: Example of Check Dams

4.2.2.4 Sediment Fences

Sediment fences are temporary devices constructed to reduce sediment transportation by intercepting sheet flows. Settlement of entrained sediment particles is achieved by reducing the velocity of the overland flow and creating small ponds of water on the upstream side of the fence. Sediment fences will be installed around all construction footprints, as a last line of defence system to contain sediment. Sediment fences are created using special purpose synthetic material laid vertically by securing to stakes and anchored the toe of the fence in to a trench. Design principles for sediment fencing are provided in **Section 4.2.2.4** and **Appendix C**. An example of a sediment fence is shown in **Figure 9**.



Figure 9: Example of Sediment Fencing

5.0 Implementation

5.1 Site Water Management

At Wambo water is categorised to allow effective management and to mitigate any potential environmental harm. Each type of water requires different management measures to minimise the risk of contamination of downstream drainage systems. A description of the water quality and potential sources for the three categories of water are summarised in **Table 7**.

Table 7: Water Categories and Design Criteria

Water Category	Description	Target Design Criteria
Clean Water	Runoff from undisturbed or rehabilitated areas that is diverted around the mine site to ensure no direct impact on the water quality by the mining operations.	Intercept, convey and/or release, where practicable, to downstream environment.
Dirty Water	Runoff from disturbed areas, such as active overburden emplacement areas or overburden emplacement areas where vegetation is not fully established. This runoff does not come into contact with coal or other carbonaceous material and may contain high sediment loads but does not contain contaminated material or high salt concentrations.	Managed in line with the Blue Book (Managing Urban Stormwater: Soils and Construction Volume 1 and Volume 2E).
Mine Water (also referred to as 'Worked Water')	Water exposed to coal or used in coal processing and runoff within mining infrastructure areas or coal stockpile areas. This water may contain high total dissolved solids, elevated EC and/or potential hydrocarbon contamination. Mine water includes water associated with groundwater inflows into open cut pits.	Mine water storages to have sufficient freeboard to contain runoff for events up to and including the 1% 24 hour AEP (annual exceedance probability) storm event.

This ESCP is concerned with the management of 'dirty' water, as described in **Table 7**.

During Phase 2 operations, United will become responsible for all Wambo open cut mining activities. Wambo will maintain responsibility for the underground mining and the CHPP. Water will be managed across the complex with shared water storages and infrastructure. Water from the complex will be discharged via the Wambo licensed discharge point in accordance with Wambo EPL 529 under the HRSTS.

Further detail on the site water management system is contained in the **WMP** and **SWMP**.

5.1.1 Erosion and Sediment Control Management Structures

The purpose and storage capacity of the main dirty water (including sediment control) structures at Wambo are provided in **Table 8**. The locations of these structures are shown on **Figure 10**.

Table 8: Summary of Water Storages Managed and Utilised by Wambo

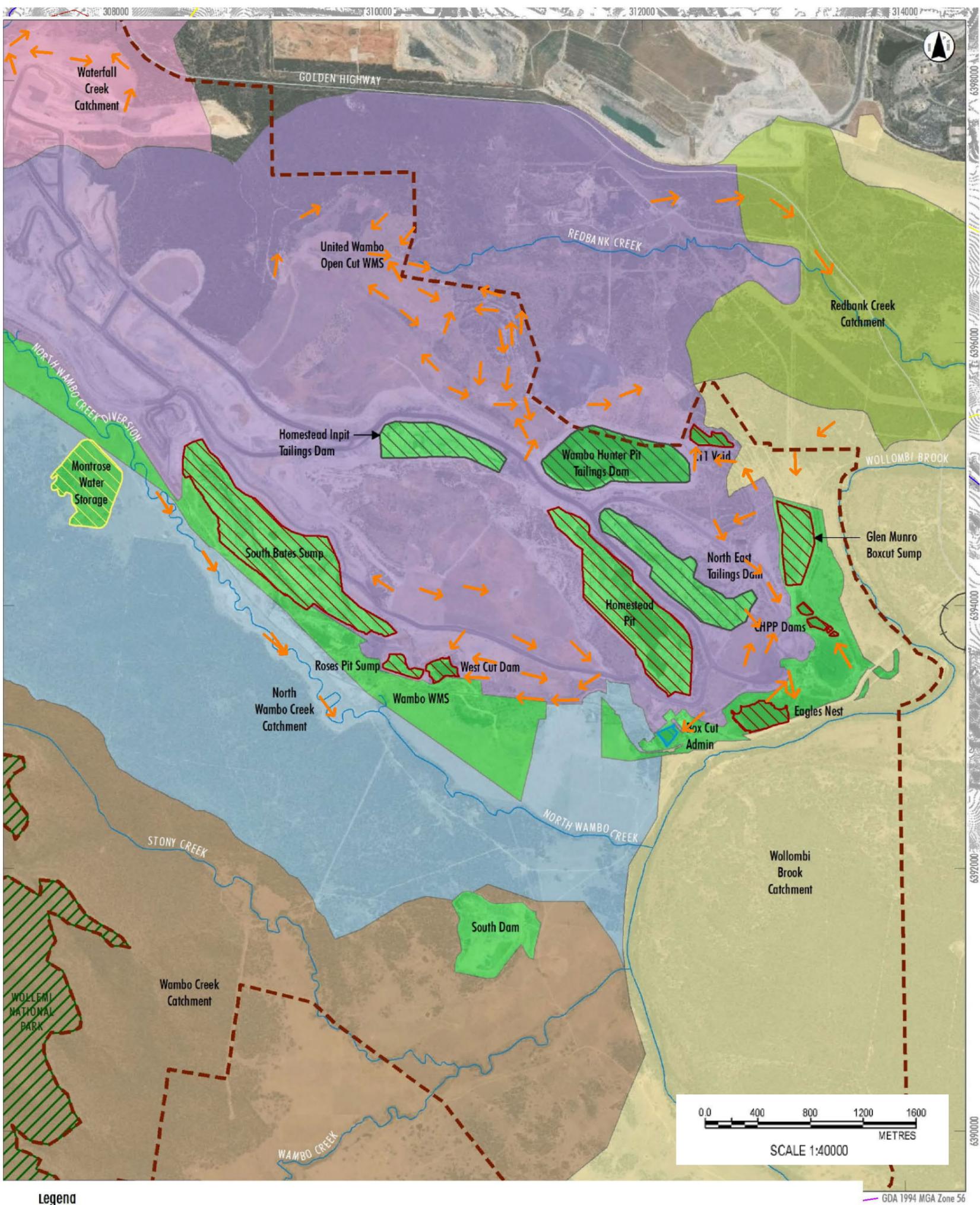
Storage	Max Operational Volume (ML)	Function
Main Homestead ¹	600	Dirty/Mine Water
Eagles Nest	80	Dirty/Mine Water
South Dam ^{2,3}	500	Mine Water Management

Storage	Max Operational Volume (ML)	Function
CHPP Dams (including Gordon Below Franklin)	82	Dirty/Mine Water Management
C11 Void ³	340	Dirty/ Mine Water Management
West Cut Dam	35	Dirty/ Mine Water Management
Roses Pit Sump	35	Dirty/ Mine Water Management
Admin Boxcut	80	Clean Water Storage
South Bates Sump	35	Dirty/Mine Water Management
Glen Munro Boxcut Sump	120	Dirty/Mine Water Management
Underground Workings (including United, Wambo Workings, South Bates and South Bates Extended)	>8,000 ³	Mine water Management
Wollombi Brook Sediment control structures (Hales Crossing)	0.06	Dirty water

1. Scheduled to be decommissioned as a water storage and commence tailings storage in 2021
2. To be recommissioned in 2021, subject to approval
3. Capacity, not operational volume

In March 2018, SLR Consulting Australia (SLR) finalised a high-level assessment of the existing dam capacities at the Wambo Coal Mine against the requirements of the Blue Book and current best practices relating to mine water containment (SLR, 2018). The SLR report concluded *'where the existing dam storage capacity is known, all of the sediment dams comply with the Blue Book requirements and all of the mine water dams are sufficiently sized to contain runoff from the 100 year ARI, 24 hour duration and 72 hour duration design storm events.'*

In addition to the main sediment control structures summarised in **Table 8**, all catchments include permanent and/or temporary upslope ESC measures, as required, to minimise erosion and soil loss in accordance with the Blue Book guidelines.



- Legend**
- Project Area
 - Clean Water
 - Mine/Dirty Water
 - Proposed Water Storage
 - Tailings
 - Drainage Line
 - Railway
 - Road
 - National Park
 - North Wambo Creek Catchment
 - Redbank Creek Catchment
 - United Wambo Open Cut WMS
 - Wambo Creek Catchment
 - Wambo WMS
 - Waterfall Creek Catchment
 - Wollombi Brook Catchment
 - Flow Arrow

Figure 10: Water Storages Managed and Utilised by Wambo

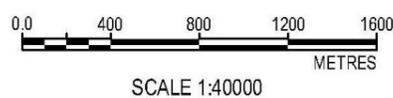


Figure 10: Water Storages Managed and Utilised by Wambo

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5.2 Management Measures and Control Strategies

5.2.1 Surface Disturbance Permit

In accordance with the erosion and sediment control principles outlined in **Section 4.2**, land disturbance at Wambo will be minimised, and limited to those areas outlined in the *MOP/RMP*.

Prior to any surface disturbance activity, a Surface Disturbance Permit (SDP) (**Appendix D**) must be completed, in consultation with the Environment and Community Manager (or delegate).

The SDP process identifies potential erosion and sediment risks associated with proposed disturbance projects and requires appropriate erosion and sediment control measures to be implemented prior to disturbance commencing.

As part of the SDP process, the person seeking to undertake surface disturbance activities **must** provide a specific Erosion and Sediment Control Implementation Plan (ESCIP) to the satisfaction of the Environment and Community Manager (or delegate).

5.2.2 Erosion and Sediment Control Implementation Plan

In preparing an ESCIP, the proposed activity will generally be split into four phases:

1. Planning

- During the planning phase ESC principles (**Section 4.2**) should be incorporated into the design and construction schedule for the activity; and
- An appropriate risk assessment (refer **Section 5.2.4**) of the likely impacts is to be completed. Understanding of the catchment and surrounding area must also be considered.

2. Mobilisation/Pre-construction

- This phase is generally when access is established and hard stands, offices and site set out are prepared.

3. Construction

- In this phase the bulk of the disturbance takes place and the risk of erosion and sediment movement is at its greatest. Great care is to be taken in the selection and siting of erosion and sediment control devices so as not to impede construction or require repeat installation.

4. Post-construction

- The post-construction phase considers how the site is to be stabilised.

Each of these ESCIP phases will require control strategies tailored to address the impacts (and level of risk) of the activities undertaken at the time.

The final ESCIP for the proposed activity shall detail the type, location, specification and installation timing and removal of all control devices identified in the planning phase.

The structure of the ESCIP will be as follows:

- **Proposed activity:**
 - A detailed description of the proposed activity and work site, including the location of offices, accesses, stockpiles, existing drainage and location of services.
- **Site description:**
 - An overview of the local area drainage, catchments, identification of protected areas, protected vegetation and sensitive receptors.
- **Soils description:**
 - A summary of the topsoil and subsoil measured or anticipated conditions, such as their dispersive and erosive nature, K-factor, classification of soils, fines grading, permeability and any relevant information regarding the presence of groundwater interaction i.e. groundwater springs.
- **Identified Erosion, Drainage and Sediment Controls:**
 - As many drawings as required to clearly indicate the type and location of erosion and sediment controls for the duration of the activity such that they can be interpreted and executed appropriately. Design details and calculations for sediment dams, drainage chutes, sediment fences, etc. must also be included, some of which can be displayed on the drawings.
 - A schedule detailing when each control measure is to be installed including emergency controls to be implemented in the event of an impending storm.

Technical specifications for measures requiring inspection and test plans (such as spillways) will also be provided, this is to assist construction and maintenance personnel implement the measure such that it meets the required design standard.

The plan itself is not intended to be an exhaustive document, ideally it will be structured and presented in such a way that it is easily implemented and clearly demonstrates an understanding of how the risk is to be controlled.

Small projects where all the runoff reports to an existing mine water management system capable of accommodating those volumes generally do not need the same level of investigation and control as large greenfield projects that could impact a local waterway.

5.2.3 Erosion and Sediment Control Matrix

The combination of erosion and sediment control measures to be included will be determined on a case-by-case basis. The decision is based on several factors including:

- Site topography;
- Material/soil/surface/strata type;
- Current disturbance category e.g. spoil, topsoil or peripheral lands (such as haul roads, exploration tracks etc);
- Site specific constraints e.g. proximity of a local water-course;
- Length of time that the area will remain at this disturbance category;
- Overall purpose of implementing erosion and sediment control at a particular location; and

- Applicability of the erosion and sediment control measure as per **Figure 11** shows a matrix of land uses and erosion and sediment control measures developed to assist in determining which erosion and sediment control measure is applicable (Peabody, 2014). This tool for selecting appropriate erosion and sediment control measures is based on:
 - The phase of the mine site (operational, non-operational or construction);
 - Land use type (specific to the mining application), adjacent land usage/classification and proximity to watercourses;
 - Level of priority in providing erosion and sediment control measures.

The selection of the appropriate erosion and sediment control measures must be undertaken in consultation with the Environment and Community Manager (or delegate) and person seeking to undertake surface disturbance.

ID	Phase (O = Operational; N = Non-operational; C=Construction)	Land use type	ESC Priority (L= low, M = Medium, H = High, HH = top priority)	Drainage Control								Erosion Control					Sediment Control			
				Contour Banks	Check Dams	Grass	Cellular Confinement System	Rock Mattress	Rock Lining	Level Spreader	Rock Chutes	Cellular Confinement System	Compost Blanket	Mulching	Revegetation	Rock Mulch	Soil Binders	Check Dam Sediment Trap	Sediment Basin (QLD & NSW)	Buffer Zone	Sediment Fence
1	O	Spoil - Draining Externally	HH	✓							✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	O	Spoil - Draining Internally	M	✓	✓						✓		✓			✓	✓			✓
3	O	Spoil Topsoiled (to be revegetated)	H	✓	✓								✓	✓		✓	✓	✓	✓	✓
4	O	Spoil Topsoiled, ripped and seeded	L	✓	✓	✓										✓	✓	✓	✓	✓
5	O	Topsoil stripping area	M	✓	✓								✓			✓	✓	✓	✓	✓
6	O	Topsoil Stockpiles	M	✓	✓	✓						✓	✓	✓		✓	✓	✓	✓	✓
7	O	Exploratory and access tracks	M	✓	✓	✓	✓		✓		✓		✓	✓	✓	✓		✓	✓	✓
8	O	Haul Roads	H	✓	✓	✓	✓	✓	✓	✓						✓	✓	✓	✓	✓
9	O	Industrial Areas	L	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓
10	N	Exploration Activity	M	✓	✓	✓	✓		✓			✓	✓	✓	✓		✓	✓	✓	✓
11	C	Land clearing (woody vegetation)	M	✓	✓				✓				✓				✓	✓	✓	✓
12	O	Drainage channels	HH	✓	✓	✓	✓	✓	✓	✓										
13	N	Licensed stream diversions / Levees	H			✓	✓	✓						✓	✓					
14	C	Construction / excavation work	M	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓

Figure 11 Erosion and Sediment Control Matrix (Peabody, 2014)

5.2.4 Sediment Dam Planning

Table 9 has been developed to assist in assessing the potential risks associated with the construction of sediment dams.

When the need for a sediment dam and type of sediment dam i.e. Type C, F or D has been determined by a competent person; a risk assessment **must** be completed using the Peabody Risk Analysis Matrix (**Appendix E**), prior to the activity commencing.

If the risk assessment determines an activity with a **score ≥ 51** , then the activity must not proceed.

If the risk assessment determines an activity **≤ 50** , then the actions and controls (as a minimum) in **Table 9** must be applied.

During the sediment dam planning phase and risk assessment, the following **key considerations** must be investigated, but not limited to:

- Detailed review of the regulatory requirements, for example, any site specific or general conditions in Development Approvals/Consents (i.e. is the activity approved), EPL conditions, or other commitments made in management plans (e.g. **MOP/RMP**);
- Can the design allow for deeper excavation as opposed to constructing a higher dam wall?;
- Survey and understand the surface and sub-soils, their erodibility, dispersive nature, silt-sand-clay content and risk of mobilisation;
- Review the proposed work site drainage system to understand existing conditions and incorporate any existing drainage, catchments, watercourses or sensitive receiving environments into the plan and identify areas that can be diverted around the work area to minimise the volume of water to be managed;
- Subject to the potential risk, superimpose the proposed activity layout over the area to identify any interactions with the existing drainage network, and identify the locations for site access, site facilities, stockpile areas, hardstand etc. and identify potential areas of non-disturbance and prepare a detailed construction drainage plan showing the water shed and drainage concentration across the work area;
- Develop the proposed schedule of disturbance works and identify and design control techniques for all stages of the proposed activity;
- Subject to the potential risk, undertake an assessment on the local receiving environment based on the risk of the activity and identify suitable controls for all stages of the activity;
- Subject to the potential risk, undertake monitoring of all identified controls through all stages of the activity (e.g. geotechnical surveillance); and
- Subject to the potential risk prepare ESC drawings for the Mobilisation, Construction and Post-construction phases of the activity, these drawings form part of the ESCIP.

Table 9 Sediment Dam Risk Analysis

Low	Minor	Moderate	Significant
<p>Negligible or reversible environmental impact, no clean up required, no breach of regulations and no need to report incident (The likelihood of sediment laden water leaving the existing mine water system, if sediment dam fails, is Rare)</p>	<p>Minor reversible environmental impact, <5 days to clean up, may result in fine and requirement to report incident (e.g. The likelihood of sediment laden water leaving the existing mine water system, if sediment dam fails, is Unlikely)</p>	<p>Moderate reversible environmental impact (short term effect), < 1 month to clean up, may result in a fine or prosecution and requirement to report incident (e.g. The likelihood of sediment laden water leaving the existing mine water system, if sediment dam fails, is Possible)</p>	<p>Significant environmental impact causing medium term harm, >12 months or more to clean up, significant legal issues resulting in fine and prosecution and requirement to report incident (e.g. The likelihood of sediment laden water leaving the existing mine water system, if sediment dam fails, is Likely)</p>
Further Actions/Controls		Further Actions/Controls	
<ul style="list-style-type: none"> • Risk Activity Scores <11: <ul style="list-style-type: none"> - Implement the ESCIP - As a minimum, sediment dam design requires Blue Book concept design by competent person - Built by competent operator - Supervised by WCPL Projects Engineer - Built to design - Confirm controls are in place prior to commissioning dam - Inspection of sediment dam for performance as required by Section 6.0 - Maintain sediment dam as required by Section 6.0 		<ul style="list-style-type: none"> • Risk Activity Scores 11 to 30: <ul style="list-style-type: none"> - Implement ESCIP - Review controls to ensure risks are as low as reasonable possible (ALARP) - Detailed sediment dam design by certified engineer - Survey control - Built by competent operator - Supervised by WCPL Projects Engineer - Built to design with As Built drawings at completion - Confirm controls are in place prior to commissioning dam - Monitor controls for effectiveness through all task stages of dam construction - Inspection of sediment dam for performance as required by Section 6.0 - Maintain sediment dam as required by Section 6.0 • Risk scores 31 to 50; <ul style="list-style-type: none"> - Conduct a formal risk review controls to ensure risks are as low as reasonable possible (ALARP) - Reconsider undertaking activity if additional controls cannot reduce risk level - Built by competent operator - Supervised by WCPL Projects Engineer - Sediment dam requires detailed construction design by certified engineer, material testing, material moisture content, compaction and core wall test (i.e. geotechnical surveillance testing), staged inspected and certified by independent engineer, survey control with As Built drawings at completion - Completion of Certificate of Sediment Dam Construction (example provided in Appendix F) by independent certified engineer - Inspection of sediment for performance as required by Section 6.0 - Inspection of sediment dam wall in accordance with Section 6.0 	

5.2.5 Topsoil Management

Prior to commencing construction, the person seeking to undertake the ground disturbance activities must obtain a Topsoil Stripping Permit (**Appendix G**) consistent with the WA-ENV-PRO-506.4 *Topsoil Management Procedure*. The Topsoil Stripping Permit can be issued in consultation with the Environment and Community Manager (or delegate).

Topsoil will be stripped in accordance with the WA-ENV-PRO-506.4 Topsoil Management Procedure, SDP, and all other procedures outlined in the *MOP/RMP*. Erosion and sediment control measures, as identified in the completed SDP and Topsoil Stripping Permit will be implemented prior to topsoil removal.

Once a Topsoil Stripping Permit is issued, topsoil can be stripped and it will either be placed directly onto shaped overburden and seeded or will be stockpiled for later use. If stockpiling is required, stockpiles will be managed in accordance with the *MOP/RMP*.

5.2.6 Progressive Land Rehabilitation

Progressive rehabilitation is an essential part of the Mine's erosion and sediment control strategy. Mining disturbed land (with altered topography, surface conditions and catchment sizes) represents a high potential for erosion and sediment impacts. The potential for erosion and sedimentation impacts decreases substantially as disturbed land is reshaped and revegetated as part of the land rehabilitation process.

In order to minimise erosion and sedimentation impacts until the rehabilitated area is suitably stable, sediment control structures (such as contour drains, drop structures and sediment control dams) will be designed and constructed in accordance with the design principles provided in **Section 4.2, Appendix C** and Peabody's *Erosion and Sediment Control Guideline (October 2014)*.

5.2.7 Erosion and Sediment Controls

Construction of diversion drains, sediment dams and other erosion and sediment control structures, will be undertaken in accordance with (but not limited to) the ESCIP, erosion and sediment control principles and design guidelines.

Construction or mining activities will not commence until all relevant erosion and sediment controls are in place as required by the SDP, Topsoil Stripping Permit and the accompanying ESCIP. The preparation of the ESCIP is the responsibility of the person seeking to undertake the surface disturbance activities.

5.2.8 Construction

For activities or projects not currently approved as part of existing operations, the requirement for a specific ESC Plan will be identified during the activity or project's planning phase.

A project specific ESC Plan must be prepared in consultation with Environment and Community Manager (or delegate). An SDP and Topsoil Stripping Permit will also be required (**Appendix D and G**).

All proposed sediment control structures will be designed (but not limited to) in consideration of design guidelines provided in **Section 4.2.2** and implemented as described in **Section 5.0**, in consultation with the Environment and Community Manager (or delegate).

5.3 Subsidence Management

Erosion control measures may be required to address destabilised areas and surface cracking as a result of subsidence. This may involve infilling cracks with suitable material, ripping cracks and re seeding with appropriate pasture species (refer *MOP/RMP*) in highly disturbed areas to ensure erosion is not exacerbated by these cracks.

Where cracking occurs on sloped areas, sediment control measures will also be used down slope, such as check dams and sediment fences, in accordance with the Blue Book. Other sediment control measures may be required to minimise impacts until the area is suitably stabilised.

Regular monitoring of ground subsidence and associated surface cracking is undertaken in accordance with the requirements of the relevant Extraction Plan. Should surface cracking be identified as presenting a safety or environmental hazard (including erosion hazard), the area will be repaired and rehabilitated in accordance with Extraction Plan commitments.

5.4 Training

Employees and contractors working on-site will complete a general site induction which will include details on erosion and sediment control and environmental management.

5.5 Auditing

Audits (both internal and external) will be undertaken to assess the effectiveness of environmental controls, compliance with this ESCP, consent conditions, and other relevant approvals, licenses, and guidelines.

Audit requirements are detailed in the *EMS*.

6.0 Inspections, Monitoring and Maintenance

6.1 All Control Structures

All erosion and sediment control measures are maintained in a functioning condition until individual areas have been deemed “successfully” rehabilitated. Where controls are observed to be not functioning correctly, the controls are restored to meet the required standard.

Sediment control structures will be inspected on a monthly basis and/or following rainfall events ≥ 20 mm/day (midnight to midnight), as recorded by the Mine’s meteorological station. If no rain is received for at least a 24 hour period, any subsequent rain event ≥ 20 mm/day will trigger a new inspection. The sediment control structures will be inspected for capacity, structural integrity and effectiveness by Mine’s E & C Manager (or delegate).

Water from sediment control structures may be tested for pH, EC and total suspended solids (TSS), and compared to water quality criteria provided in the **SWMP**, to assess the effectiveness of the sediment control structures.

6.2 Sediment Dams

During construction, the frequency of inspections will be proportional to the level of risk posed by the sediment dam, for example:

- Sediment dams that have been assessed as low to moderate risk, daily inspections and/or key construction milestones by the Mine’s Project Engineer will be undertaken to ensure the dam is being constructed to design; and
- Sediment dams that have been assessed as significant risk, daily inspections by the Mine’s Project Engineer, in concurrence with staged inspections by an independent certified engineer will be undertaken to ensure the dam is being constructed to design.

Post construction, sediment dams will be inspected weekly by the Mine’s E & C Manager (or delegate) to verify dam walls, drainage channels etc have been successfully stabilised by revegetation methods.

All established sediment dams will require regular maintenance to ensure they are operated in line with the requirements of the Blue Book. The requirement of Mine’s E & C Manager (or delegate) to inspect and maintain sediment dams include, but not limited to:

- Monthly inspections;
- Following runoff generating rainfall events to assess requirement for dewatering and de-silting to restore design containment capacity;
- Water quality testing as described in **WMPProg**;
- Ensure dams have been dewatered to restore the design settling zone capacity within 5 days after a rainfall event;
- De-silting of dams (subject to the amount of sediment being accumulated); and
- No excessive erosion is evident and existing erosion and sediment controls remain effective.

6.3 Decommissioning of ESC Structures

ESC structures may be decommissioned once they are no longer required in accordance with the Blue Book requirements. This may be due to the following reasons:

- Runoff from the upslope disturbed catchment area no longer flows to the structure (e.g. pit advancement, mine layout changes etc);
- The upslope catchment area has been adequately rehabilitated such that runoff can be considered clean (e.g. achieved a grass coverage of 70% or greater) and downstream water quality objectives are being met; and
- The upslope disturbance area has been effectively sealed (e.g. bitumen, concrete etc).

Dams could be either removed via earthworks or incorporated into the landscape, mitigating any requirement for ongoing maintenance and management. During decommissioning, any materials associated with the ESC structures will be removed and suitably disposed of.

6.4 Performance Indicators

The performance indicators in **Table 10** will be used to assess the performance of Wambo against the predicted impacts.

Table 10: Performance Indicators

Performance Indicator	Number
Number of complaints received relating to erosion and sediment control	Nil
Number of reportable environmental incidents relating to erosion and sediment control	Nil

WCPL will report on progress against these performance indicators in the Annual Review (**Section 9.2.1**). Contingency plans for unpredicted erosion and sediment control impacts are discussed in **Section 7.0**.

In the event that a complaint is received relating to erosion and sediment control, it will be handled in accordance with the complaint management protocol (**Section 8.0**).

7.0 Adaptive Management

Potential surface water impacts are detailed in the *Wambo Development Project Environmental Impact Statement (EIS)* (Wambo Coal, 2003), the *North Wambo Underground Mine Modification Environmental Assessment* (Resource Strategies, 2012) and the *United-Wambo Project Environmental Assessment* (Umwelt, 2016).

The Water Management Plan, of which this ESCP forms a part, has been developed to manage and monitor water related risks associated with the Wambo Coal Mine, to minimise the risk of exceedances of the criteria and/or performance measures detailed in the relevant development consents and licences. If an exceedance of these criteria and/or performance measures occurs, WCPL will, at the earliest opportunity:

- Take all reasonable and feasible steps to ensure that the exceedance ceases and does not recur;
- Consider all reasonable and feasible options for remediation (where relevant) and submit a report to DPIE describing those options and any preferred remediation measures or other course of action; and
- Implement remediation measures as directed by the Planning Secretary, to the satisfaction of the Planning Secretary.

7.1 Incident Definition

An incident is defined in DA305-7-2003 as:

An occurrence or set of circumstances that causes or threatens to cause material harm and which may or may not be or cause a non-compliance.

Incident reporting will be undertaken in accordance with **Section 9.2.3**.

7.2 Contingency Plan to Manage Unpredicted Impacts

Erosion and sediment controls and monitoring have been implemented to:

- minimise erosion and sediment generation from disturbed areas;
- maintain water quality in downstream water systems; and
- reduce the loss of valuable topsoil from land disturbed by mining activities.

In the event that an unpredicted impact occurs, WCPL will implement the TARP in **Table 11**.

Table 11: Erosion and Sediment Control TARP

TARP Code	Description
Trigger	<ul style="list-style-type: none"> Unpredicted impact occurs as a result of surface disturbance activities at the Mine
Action	<ul style="list-style-type: none"> Review the current erosion and sediment controls and monitoring, to ensure it is effective and Water Management Performance Measures in Table 2 and Table 3 are being met <ul style="list-style-type: none"> If the review finds that the system is not effective and performance measures are not being met, this is considered an incident and it will be reported to authorities (see below) Take all reasonable and feasible steps to ensure that the exceedance ceases and does not recur
Response	<ul style="list-style-type: none"> Report incident (where required, in accordance with Incident reporting procedures) to regulatory authorities in accordance with statutory requirements (refer Section 9.2.3) Develop and implement additional erosion and sediment control management or mitigation measures in consultation with the relevant stakeholders e.g. EPA, DPIE Water, landholders (as appropriate) Undertake follow-up inspections and monitoring to assess the effectiveness of the additional measures.
Plan	<ul style="list-style-type: none"> Review ESCP and resubmit to DPIE in accordance with Section 9.1. Provide details of the incident in the Annual Review.

7.3 Failure to Comply with Other Statutory Requirements

Statutory requirements relating to this ESCP are summarised in **Section 2.0**. These requirements include compliance with DA305-7-2003, DA177-8-2004 and EPL 529.

WCPL monitors compliance with these statutory requirements on an ongoing basis, including during regular reviews and reporting of monitoring data and as part of Annual Reviews and compliance audits (e.g. Independent Environmental Audits).

In the event that WCPL identifies a failure to comply with a statutory requirement (other than those relating to unpredicted impacts – refer **Section 7.2**), WCPL will:

- Undertake an investigation into the failure;
- Identify suitable strategies or actions to be implemented to address the failure (and avoid a recurrence of the failure); and
- Report the non-compliance in accordance with the requirements of the development consents and EPL 529.

8.0 Community Complaint Response

All erosion and sediment control related community complaints received by WCPL will be recorded within the Community Complaints Register. The Environment and Community Manager (or delegate) will investigate the complaint, which will include, where possible, contacting the complainant within 24 hours to discuss the complaint. A review of the effectiveness of the corrective or preventative actions will be conducted within a month of the complaint and the relevant work procedures updated if required.

Preliminary investigations will commence as soon as practicable upon receipt of a complaint to establish if WCPL is responsible. All efforts will be made to determine the likely causes contributing to the complainant's concerns.

WCPL will attempt to address the complainant's concerns such that a mutually acceptable outcome is achieved. If a mutually beneficial outcome cannot be reached, WCPL may refer the matter to the Planning Secretary for resolution.

Details of all community complaints will be included in the Monthly Environmental Monitoring Report. WCPL will retain a copy of the Community Complaints Register for at least four years. The Environment and Community Manager (or delegate) will ensure the latest Community Complaints Register is posted on the WCPL website.

9.0 Review and Reporting

9.1 Review

9.1.1 Environmental Performance

Wambo's performance against management measures outlined in the ESCP will be reviewed annually as part of the Annual Review (see **Section 9.2.1**).

9.1.2 Management Plan Review

This ESCP will be reviewed, and if necessary revised, with any review of the WMP (refer Section 9.1 of the **WMP**).

The ESCP will reflect any changes in environmental requirements, technology, and operational procedures.

The revised ESCP will be re-submitted to the Secretary for approval as required by Condition B66 of DA305-7-2003.

9.2 Reporting

9.2.1 Annual Review

The WCPL E&C Manager will be responsible for reporting any significant findings regarding the implementation of this ESCP in the WCPL Annual Review. The Annual Review report will include details of any incidents or non-compliances relating to erosion and sediment control.

Further detail on reporting for the Annual Review is included in Section 9.1 of the **WMP**.

9.2.2 Reporting of Results

Monitoring of onsite sediment control structures is undertaken for operational management purposes and therefore the results of this monitoring will not be reported publicly.

9.2.3 Reporting of Incidents

Reporting of environmental incidents will be undertaken in accordance with Section 9.2.4 of the **WMP**.

10.0 Responsibilities

Table 12 summarises responsibilities documented in the ESCP. Responsibilities may be delegated as required.

Table 12: Erosion and Sediment Control Plan Responsibilities

No	Task	Responsibility	Timing
1	Conduct environmental training for all contractors and site employees (as part of the site induction)	Site Training Coordinator (or delegate)	Pre-start/then every two years.
2	Persons seeking to undertake activity must complete Surface Disturbance Permit prior to disturbance in consultation with Environment & Community Manager (or delegate)	Projects Engineer, E&C Manager	Prior to general construction/mining activities
3	Persons seeking to undertake activity must identify project specific potential erosion and sediment impacts	Projects Engineer, E&C Manager	Prior to general construction/mining activities and ESCIP.
4	Facilitate the design and implementation of control measures described in this ESCP	Projects Engineer, E&C Manager	Prior to general construction/mining activities and ESCIP.
5	Inspect sediment and erosion control structures	Projects Engineer, E&C Manager	Monthly, and following rainfall events ≥ 20 mm day
6	Maintain erosion and sediment control structures	Projects Engineer, E&C Manager	As required
7	Review ESCP in accordance with Section 9.1.2.	E&C Manager	As required.
8	Notify government departments if an incident occurs in accordance with Section 9.2.3	E&C Manager	As required
9	Submit updated ESCP to DPIE.	E&C Manager	As required
10	Erosion and sediment control related complaints to be responded to in accordance with Section 8.0	E&C Manager	As required
11	Annual Review to include relevant monitoring results, complaints, mitigation measures undertaken and a review of the monitoring undertaken	E&C Manager	Annually
12	Regulator review to be undertaken of the ESCP	E&C Manager	As required
13	Prepare investigation reports and implementation of corrective actions in accordance with Section 7.2.	E&C Manager	As required

11.0 References

- Barclay Mowlem Construction Limited (2005) Soil and Water Quality Management Plan Wambo Coal Rail Construction Project Development Consent (DA305-7-2003) (as modified).
- Development Consent (DA177-8-2004) (as modified).
- DECCW NSW (2008) Managing Urban Stormwater – Soils and Construction Volume 2E. Mines and Quarries. NSW Government, Parramatta, March.
- GHD (2020) Wambo Coal Mine Independent Environmental Audit, July 2021.
- Hansen Bailey (2018). Independent Environmental Audit Report for Wambo Coal Pty Ltd, September 2018.
- Landcom (2004) Managing Urban Stormwater – Soils and Construction Volume 1. 4th ed., NSW Government, Parramatta, March.
- Peabody Energy Australia (2014), Erosion and Sediment Control Guideline. October 2014, Version 1.
- Resource Strategies (2003) Wambo Development Project – Environmental Impact Statement, prepared for Wambo Coal Pty Limited.
- Resource Strategies (2006a) Modification Statement of Environmental Effects, prepared for Wambo Coal Pty Limited.
- Resource Strategies (2006b) North Wambo Underground Subsidence Management Plan, prepared for Wambo Coal Pty Limited.
- SLR Consulting (2018) Dam Capacity Assessment Report Number 630.11971-R01, prepared for Wambo Coal Pty Ltd.
- WA-ENV-PRO-506.4 Topsoil Management Procedure (as modified).
- Umwelt (2016). United Wambo Open Cut Coal Mine Project Environmental Impact Statement.
- Umwelt (2016a). United Wambo Open Cut Coal Mine Project Surface Water Assessment, July 2016.
- Wambo Development Project Environmental Impact Statement (EIS), July 2003.
- Wambo Environment Protection Licence (529).

APPENDIX A: Evidence of Consultation

Mr Peter Jaeger
Environment & Community Manager
Wambo Coal Pty Ltd
PMB 1
Singleton NSW 2330

02/11/2021

Dear Mr Jaeger

**Wambo Coal Mine (DA 305-7-2003)
Erosion and Sediment Control Plan – Request for Additional Information**

I refer to the updated Wambo Erosion and Sediment Control Plan (ESCP) which was submitted in accordance with Condition B66 and D5 of Schedule 2 of the development consent for the Wambo Coal Mine (DA 305-7-2003). After careful consideration, the Department is requesting that you provide additional information.

You are requested to submit a revised document that addresses the following:

- it is noted that in Section 2.0 the ESCP had been prepared to include recommendations from the 2017 Independent Environmental Audit (IEA) (Hansen Bailey, 2018), however there is no reference to the 2020 IEA. Please include reference to the 2020 IEA;
- in Section 2.5, Table 4 outlines the recommendations from the 2017 IEA and where they are addressed but not the 2020 IEA. Please include recommendations from the 2020 IEA and where they have been addressed; and
- the Hansen Bailey (2018) IEA is included in the references, but there is no reference to the 2020 IEA. Please include the 2020 IEA in the reference list.

If you wish to discuss the matter further, please contact Sarah Clibborn on 02 8837 6095 or via email at sarah.clibborn@planning.nsw.gov.au.

Yours sincerely



Joe Fittell
Team Leader
Resource Assessments



Nicole Dobbins
Senior Environmental Advisor
Wambo Coal Mine
PMB 1
Singleton NSW 2330

20/11/2020

Dear Ms Dobbins

**Wambo Coal Mine (DA 305-7-2003-i)
Water Management Plan**

I refer to the Wambo Water Management Plan (WMP), submitted in accordance with condition B66 of the approval for the Wambo Coal Mine (DA 305-7-2003-i). I understand that revisions to the WMP are required prior to Phase 2 of operations between the Wambo Coal Mine and United Wambo Joint Venture, which are scheduled to start on 1 December 2020.

I note that the WMP includes the following sub – plans:

- Site Water Balance;
- Salt Balance;
- Erosion and Sediment Control Plan;
- Surface Water Management Plan (including the North Wambo Creek Diversion Management Plan);
- Groundwater Management Plan; and
- Water Monitoring Plan.

The Department notes that the Site Water Balance, Salt Balance and Water Monitoring Program cover both the Wambo Coal Mine and United Wambo Joint Venture operations.

The Department has carefully reviewed the WMP and is satisfied that it adequately addresses the relevant requirements of the approval. Accordingly, the Planning Secretary has approved the WMP (Revision 2, November 2020) for Phase 2 of the operations. Please continue to operate in accordance with the previously approved WMP until Phase 2 commences.

Please also ensure that the approved plan is placed on the project website at the earliest convenience. If you wish to discuss the matter further, please contact Melanie Hollis on 8217 2043.

Yours sincerely

Matthew Sprott
Director
Resource Assessments (Coal & Quarries)

as nominee of the Planning Secretary

**Summary of Historic Stakeholder Consultation i.e. for WCPL's Erosion and Sediment Control Plan
(Historical Versions 0 to 11)**

Rev No	Date	Description	By	Checked	Signature
0	June 2005	Original Draft	Gilbert & Associates Pty Ltd	JT/TS	
1	July 2005	Revised Draft	Gilbert & Associates Pty Ltd	JT/TS	
2	July 2005	Final Draft	Gilbert & Associates Pty Ltd	JT/TS	
3	February 2006	Management Plan Consolidation	WCPL	JT/JH	
4	August 2007	Management Plan Consolidation	Hansen Bailey	SW	
5	February 2010	Consent Modification	WCPL	SB	
6	September 2014	Revision 6	WCPL	TF	
7	October 2015	New plan format and revision	WCPL/ Palaris	SP	
8	April 2016	Revised as required by Con 6, Sch 3 of DA305-7-2003	WCPL	SP	
9	March 2018	Revised as required by Con 6, Sch 3 of DA305-7-2003 and MOD17 approval, include Summary of Commitments	WCPL	PJ	
10	April 2018	Revised to address DP&E Comments	WCPL		
11	October 2019	Revised to address IEA 2017 recommendations and include topsoil stripping permit	WCPL		

**Consultation for this ESCP
(For Phase 2 Activities at the Wambo Coal Mine)**

Stakeholder	Consultation
DPIE	Copy of draft Version 1, prepared for the commencement of Phase 2 activities at the Wambo Coal Mine provided 26 August 2020 via the DPIE - Major Projects Planning Portal. A minor comment was received 18 November 2020 which has been addressed in Version 2.
EPA	Copy of draft Version 1, prepared for the commencement of Phase 2 activities at the Wambo Coal Mine provided to the EPA 26 August 2020 via the DPIE - Major Projects Planning Portal. The EPA provided correspondence dated 4 September 2020 advising that it is not the role of the EPA to review management plans. No further comments received.
DPIE Water	Copy of draft Version 1, prepared for the commencement of Phase 2 activities at the Wambo Coal Mine provided to the DPIE Water via the DPIE - Major Projects Planning Portal 26 August 2020. DPIE requested the WMP be sent directly to nrar.servicedesk@industry.com.au . A copy of the WMP was sent to NRAR 31 August 2020. No comments have been received.



Ms Nicole Dobbins
Senior Environmental Advisor
Wambo Coal Pty Ltd
PMB 1
Singleton, NSW, 2330

02/09/2020

Dear Ms Dobbins

**Wambo Coal Mine (DA 305-7-2003)
Endorsement of Water Expert**

I refer to your letter dated 13 August 2020, requesting the Planning Secretary's approval of a suitably qualified person to prepare the Water Management Plan, required by condition B66 of the Wambo Coal Mine Development Consent (DA 305-7-2003).

This plan includes several sub-management plans including a Site Water Balance, Surface Water Management Plan, Monitoring Program, Groundwater Management Plan and Erosion and Sediment Control Plan. I also note that it is proposed to combine the Wambo and United Wambo (SSD 7142) Site Water Balance and Monitoring Program under condition A23(d). These joint aspects of the Water Management Plan would be prepared by Chris Bonomini from Umwelt Australia.

I note that previously endorsed experts for Wambo, Ms Claire Stephenson and Dr Noel Merrick from SLR and Mr Rohan Lucas from Alluvium will remain the endorsed experts for groundwater and the North Wambo Creek Diversion.

The Department has reviewed the nomination and information you have provided and is satisfied that all four experts are suitably qualified and experienced. Consequently, I can advise that the Planning Secretary approves the additional appointment of Chris Bonomini to prepare the relevant sections of the Water Management Plan alongside the existing endorsed experts.

If you wish to discuss the matter further, please contact Sarah Clibborn on (02) 82 896 184 or via email at sarah.clibborn@planning.nsw.gov.au.

Yours sincerely

A handwritten signature in black ink, appearing to read 'M Sprott'.

Matthew Sprott
Director
Resource Assessments (Coal & Quarries)

as nominee of the Planning Secretary



Mr Peter Jaeger
Environment and Community Manager
Wambo Coal Pty Limited
PMB 1
Singleton NSW 2330

28/02/2020

Dear Mr Jaeger

**Wambo Coal Project (DA 305-7-2003)
Endorsement of Experts**

I refer to your letter dated 11 February 2020, requesting the Secretary's approval of suitably qualified persons to prepare the Extraction Plan for Longwalls 21 to 24 for the Wambo Coal Project (DA 305-7-2003).

The Department has reviewed the nominations and information you have provided and is satisfied that these experts are suitably qualified and experienced. Consequently, I can advise that the Secretary approves the appointment of the following experts to prepare the Extraction Plan for Longwalls 21 to 24:

- Mr Joshua Hunt (Resource Strategies) - Extraction Plan preparation;
- Mr James Barbato (Mine Subsidence Engineering Consultants) - Subsidence;
- Mr Rohan Lucas (Alluvium) - Surface Water;
- Dr Noel Merrick (SLR Consulting) - Groundwater;
- Mr Martin Sullivan (Eco Logical Australia) – Biodiversity; and
- Mr Peter Kuskie (South East Archaeology) - Aboriginal cultural heritage.

In relation the upcoming revisions of complex-wide management plans, to align with the commencement of United Wambo Phase 2, it is recommended that the Department's Water Group is consulted on this approach.

If you wish to discuss the matter further, please contact Melanie Hollis on 8217 2043.

Yours sincerely

Matthew Sprott
A/Director
Resource Assessments (Coal & Quarries)

as nominee of the Planning Secretary



Planning Services
Resource Assessments
Contact: Philip Nevill
Phone: 8275 1036
Email: philip.nevill@planning.nsw.gov.au

Mr Peter Jaeger
Environment and Community Manager
Wambo Coal Pty Ltd
PMB 1
Singleton NSW 2330

Dear Mr Jaeger

**Wambo Coal Mine (DA 305-7-2003 & DA 177-8-2004)
Erosion and Sediment Control Management Plan**

The Department has reviewed the revised Erosion and Sediment Control Management Plan for the Wambo Mine Complex, prepared in accordance with the Wambo Mine development consent (condition 32 of Schedule 4 of DA 305-7-2003) and Wambo Rail development consent (condition 17(a) of Schedule 4 of DA 177-8-2004).

The Department is satisfied that the Erosion and Sediment Control Management Plan (Revision 10) dated April 2018 adequately addresses the relevant requirements of DA 305-07-2003 and DA 177-8-2004. As such, the Secretary approves this management plan.

Please note the requirements under condition 12 of Schedule 6 of DA 305-07-2003 and condition 8 of Schedule 6 of DA 177-8-2004 to make copies of all approved plans, programs and strategies publicly available. Should you have any enquiries in relation to this matter, please contact Philip Nevill at the details listed above.

Yours sincerely

A handwritten signature in blue ink that reads 'Howard Reed'.

Howard Reed *27.6.18*
Director Resource Assessments
as the Secretary's nominee

Department of Planning and Environment
320 Pitt Street Sydney NSW 2000 | GPO Box 39 Sydney NSW 2001 | T 1300 305 695 | www.planning.nsw.gov.au



**Planning Services
Resource Assessments**
Contact: Philip Nevill
Phone: (02) 82751036
Email: Philip.nevill@planning.nsw.gov.au

Mr Peter Jaeger
Environment and Community Manager
Wambo Coal Pty Ltd
PMB 1
Singleton NSW 2330

Dear Mr Jaeger

**Wambo Coal Mine (DA 305-7-2003 & DA 177-8-2004)
Erosion and Sediment Control Plan and Environmental Management Strategy**

The Department has reviewed the revised Environmental Management Strategy and Erosion and Sediment Control Plan for the Wambo Mining Complex which have been prepared in accordance with the Wambo Mine Development Consent (DA 305-07-2003) and Wambo Rail Development Consent (DA 177-8-2004).

The Department is satisfied that the Environmental Management Strategy (Revision 5) meets the requirements of condition 1 of Schedule 6 of DA 305-7-2003 and condition 2 of Schedule 6 of DA 177-8-2004. Consequently, the Secretary approves this strategy.

The Department considers that the Erosion and Sediment Control Plan (Revision 9) dated March 2018 does not adequately address the requirements of condition 32 of Schedule 4 of DA 305-7-2003 and condition 17(a) of Schedule 4 of DA 177-8-2004. The Department's comments are enclosed in **Attachment A**.

The Department requests that the Erosion and Sediment Control Plan is re-submitted once the comments have been addressed, by no later than **27 April 2018**.

If you wish to discuss this matter further, please contact Philip Nevill at the details listed above.

Yours sincerely

A handwritten signature in blue ink that reads 'Howard Reed'.

Howard Reed *26.3.18*
Director Resource Assessments
as the Secretary's nominee

Attachment A

Wambo Coal Mine (DA 305-7-2003) Erosion and Sediment Control Plan – DP&E Comments 23 March 2018 and WCPL Responses

Erosion and Sediment Control Plan Rev 9 Condition 32, Schedule 4	Satisfactory	Comments	Action Required	WCPL response to comments
<p>The Erosion and Sediment Control Plan must:</p> <p>(a) Be consistent with the Department of Housing's Managing Urban Stormwater: Soils and Construction Manual</p>	No	<p>THE ESCP does not address the requirements of <i>Managing Urban Stormwater: Soils and Construction – Volume 2E mines and quarries (DECC 2008), Appendix C: Erosion and sediment control planning.</i></p>	<p>Revise the ESCP to ensure consistency with <i>Managing Urban Stormwater: Soils and Construction – Volume 2E mines and quarries (DECC 2008), Appendix C</i></p>	<p>The following sections make reference to <i>Managing Urban Stormwater: Soils and Construction – Volume 2E mines and quarries (DECC 2008), Appendix C</i> (also known as the Blue Book):</p> <ul style="list-style-type: none"> • Section 1.2 – Purpose; • Section 4.1 – Principles; • Table 4 – Sediment Dam Risk Analysis; • Section 5.1 - Design Guidelines ; • Section 6.6 – Worked Water; • Section 6.8 – Subsidence Management; and • Section 7.1 – All Control Structures.
<p>(b) Identify activities that could cause soil erosion and generate sediment;</p>	Yes	<p>Section 2, Table 3 outlines sources of erosion and sedimentation. Figure 4 (erosion and Sediment Control Matrix)</p>	Nil	Nil required
<p>(c) describe the location, function and capacity of erosion and sediment control structures; and</p>	Partial	<p>Section 5. discusses the 'Design Guidelines' and Appendix D 'Design Principles'. However it is unclear if the current sediment and erosion controls have been constructed in accordance with the referenced guidelines and principles.</p>	<p>Integrate the descriptions of erosion and sediment control structures, location, function and capacity. For example, update Table 5 to include the type of erosion and sediment control structure at each location. Include a reference to the relevant design principles applied to each structure.</p>	<p>Refer to Section 5.0. In March 2018, SLR finalised an assessment of existing dam capacities at Wambo against the requirements of the Blue Book and current best practice. The SLR report concludes '<i>where the existing dam storage capacity is known, all of the sediment dams comply with the Blue Book requirements and all of the mine water dams are sufficiently sized to contain runoff from the 100 year ARI, 24 hour duration and 72 hour duration design storm events.</i>'</p>

Erosion and Sediment Control Plan Rev 9 Condition 32, Schedule 4	Satisfactory	Comments	Action Required	WCPL response to comments
(d) Describe measures that minimise soil erosion and the potential for the migration of sediments to downstream waters	Yes	Sections 6 and 7 outline the current and proposed measures. Details outlining the specific design, function and use are included in Tables 6, 7 and 8	Nil	Nil required
General Comments				
<ul style="list-style-type: none"> The use of the word 'should' throughout the ESCP is to be replaced with 'shall' or 'will' or similar. Please check the document for non-committal wording and replace 			Complete, refer to changes throughout in blue font	
<ul style="list-style-type: none"> The ESCP does not reference the additional mining lease required by the approval of the South Bates Underground Extension (MOD17). All mining lease areas need to be included with the lease boundaries shown on the mine layout plan 			A Mining Lease Application has not yet been lodged for the portion of South Bates Underground Extension not currently subject to a Mining Lease. The Approved Wambo Coal Mine Layout (Figure 3) will be revised to include the new Mining Lease, once approved.	
<ul style="list-style-type: none"> Section 3.4 (hydrology) should include comment on the area subject to MOD 17 that comprises a section of North Wambo Creek above the diversion 			See text added to Section 3.4	
<ul style="list-style-type: none"> Condition 4, Schedule 6 outlines the requirements of all management plans. Please ensure the ESCP addresses these requirements. 			The requirements of Condition 4, Schedule 6 are listed in Table 1. This table also provides section links to where each requirement is addressed in the ESCP.	

Contact: Scott Brooks
Phone: 6575 3401
Fax: 6575 3415
Email: scott.brooks@planning.nsw.gov.au
Our ref: 305-7-2003

The General Manager
Wambo Mine
PMB 1
SINGLETON NSW 2330

Attention: Steve Peart

Dear Steve

Wambo Coal – Approval of Water Management Plan

Thank you for forwarding the Wambo Water Management Plan and all its parts as required under project approval DA 305-7-2003 for the Department's consideration.

The Water Management Plan is required by Condition 30 Schedule 4 and the following 5 components of the Plan were reviewed:

- Site Water Balance (30)
- Erosion and Sediment Control Plan (32)
- Surface Water Monitoring Program (33)
- Ground Water Monitoring Program (34)
- Surface and Ground Water Response Plan (35).

The Department has reviewed these plans, and is satisfied that they generally address the requirements set out in the relevant conditions of the project approval. Consequently, I would like to advise you that the Secretary has approved the plans.

These plans come into force on the 30th November 2015 and remains in force until replaced by any future updated approved Plans.

I am aware that DPI Water are expected to comment on the Extraction Plan for the South Bates U/G (Wybrow seam) LW 11-13. Should this comment require significant changes to any component of the Water Management Plan, I ask if these changes could be made and the plans resubmitted for review and approval.

Could you please forward finalised copies of the above plan (preferably in PDF format with a copy of this approval letter appended) for the Department's records by the end of November 2015.

If you require further information or clarification in this matter please contact Scott Brooks on 6575 3401 or by email to scott.brooks@planning.nsw.gov.au.

Yours sincerely



Scott Brooks

Investigations (Lead), Compliance

27-11-2015
As Nominee for the Secretary, Planning & Environment

APPENDIX B: ESCP Summary of Commitments

Erosion and Sediment Control Plan (Version 1a) – Summary of Commitments

Note: The list of commitments in this appendix is in addition to those explicitly required by Development Consent or EPL conditions.

ESCP Section	Commitment	Timing
4.2.1	Erosion and sediment control measures are designed and constructed effectively.	Ongoing
	Surface disturbance is minimised and access to undisturbed areas is restricted.	Ongoing
	Rehabilitation is progressive and disturbed areas are stabilized.	Ongoing
	Disturbed and undisturbed catchment runoff will be separated, where practicable.	Ongoing
	Soil erosion will be minimized rather than employing downslope sediment controls.	Ongoing
	Erosion and sediment control will form part of the planning phases of the mine operation.	Ongoing
	Erosion and sediment control measures will be maintained in proper working order.	Ongoing
	Sediment control structures will be monitored and practices will be adjusted to maintain the required performance standard.	As required
4.2.2	Sediment control structures shall be constructed in accordance with Blue Book design guidelines. However, if risk is deemed significant, sediment dams will require construction design by certified engineer.	As required
4.2.2.1	Diversion drains will be suitably designed, grassed and (if required) protected with rock armouring, geotextile fabric, or similar.	As required
	Water will be discharged at non erosive velocities downstream of the disturbed area into a suitable receiving environment.	As required
	Drainage outlets, along with clean water diversion drains, will be appropriately designed in consultation with the Environment and Community Manager (or delegate).	As required
	Berms, levees and catch drains will be constructed in accordance with ESCIP, erosion and sediment control principles and design guidelines.	As required
4.2.2.2	Sediment dams will be constructed to capture sediment from runoff flowing through site drains and diversions prior to its onsite re-use, or discharge to the Wambo WMS.	As required
	Detailed design and sizing of a sediment basin will be undertaken by a competent person to ensure the basin has sufficient capacity and the water being discharged is of acceptable quality to meet regulatory requirements.	As required
	Advice from a competent person shall be sought to accurately determine the sizing of sediment dams.	Prior to construction commencing
	Clean water catchments shall be diverted away from a sediment basin where possible.	Ongoing
	Detailed design, sizing, safe access for maintaining and cleaning, energy dissipaters etc of a sediment basin must be undertaken by a competent person	As required
5.2.1	Land disturbance at Wambo will be minimised, and limited to those areas outlined in the MOP/RMP.	Ongoing
	A Surface Disturbance Permit (SDP) must be completed, in consultation with the Environment and Community Manager (or delegate), prior to any surface disturbance activity.	As required (prior to any surface disturbance activity)

ESCP Section	Commitment	Timing
	As part of the SDP process, the potential erosion and sediment issues and controls will be documented.	As required
	Appropriate erosion and sediment control measures to be implemented prior to disturbance commencing.	Prior to disturbance commencing
	The person seeking to undertake the surface disturbance activities will prepare an ESCIP (an Erosion and Sediment Control Implementation Plan).	As required
5.2.2	In preparing an Erosion & Sediment Control Implementation Plan (ESICIP), the proposed activity will generally be split into four phases - Planning, Mobilisation / Pre-Construction, Construction and Post-construction.	As required
	During the planning phase ESC principles should be incorporated into the design and construction schedule for the activity	During planning
	An appropriate risk assessment of the likely impacts will be completed. Understanding of the catchment and surrounding area must also be considered.	During planning
	During construction great care will be taken in the selection and siting of erosion and sediment control devices so as not to impede construction or require repeat installation.	During construction
	Control strategies will be tailored to the address the impacts and level of risk of the activities.	As required
	The final ESCIP will detail the type, location, specification and installation, timing and removal of all control devices.	As required
5.2.3	The combination of erosion and sediment control measures to be included will be determined on a case-by-case basis, in consultation with the EC Manager (or delegate) and person seeking to undertake surface disturbance.	As required
5.2.4	When the need for a sediment dam and type of sediment dam i.e. Type C, F of D has been determined; a risk assessment must be completed prior to the activity commencing. If the risk assessment determines an activity with a score ≥ 51 , then the activity must not proceed. If the risk assessment determines an activity ≤ 50 , then the actions and controls (as a minimum) in Table 9 must be applied.	Ongoing
5.2.5	Prior to commencing construction, the person seeking to undertake the ground disturbance activities must obtain a Topsoil Stripping Permit consistent with the Topsoil Management Procedure. Erosion and sediment control measures, as identified in the completed SDP and Topsoil Stripping Permit will be implemented prior to topsoil removal.	Prior to commencing construction
	Topsoil will be stripped in accordance with the Topsoil Management Procedure, SDP and procedures outlined in the MOP/RMP.	Ongoing
	Topsoil will either be placed directly onto shaped overburden and seeded or will be stockpiled for later use. If stockpiling is required, stockpiles will be managed in accordance with the MOP/RMP.	As required
5.2.6	Sediment control structures (such as contour drains, drop structures and sediment control dams) will be designed and constructed in accordance with the design principles provided in Section 4.2, Appendix C and <i>Peabody's Erosion and Sediment Control Guideline</i> (October 2014).	As required
5.2.7	Construction of diversion drains, sediment dams and other erosion and sediment control structures, will be undertaken in accordance with (but not limited to) the ESCIP, erosion and sediment control principles and design guidelines.	As required
	Construction or mining activities will not commence until all relevant erosion and sediment controls are in place, as required by the SDP, Topsoil Stripping Permit and the accompanying ESCIP.	Ongoing
5.2.8	For activities or projects not currently approved as part of existing operations, the requirement for a specific ESC Plan will be identified during the activity or project's planning phase.	During project planning phase

ESCP Section	Commitment	Timing
	A project specific ESC Plan must be prepared in consultation with Environment and Community Manager (or delegate). An SDP and Topsoil Stripping Permit will also be required.	As required
	All proposed sediment control structures will be designed (but not limited to) in consideration of design guidelines provided in Section 4.2.2 and implemented as described in Section 5.0 , in consultation with the Environment and Community Manager (or delegate).	As required
5.3	Where cracking occurs on sloped areas, sediment control measures will also be used down slope, in accordance with the Blue Book.	As required
	Should surface cracking be identified as presenting a safety or environmental hazard (including erosion hazard), the area will be repaired and rehabilitated in accordance with Extraction Plan commitments.	As required
5.4	Employees and contractors working on-site will complete a general site induction which will include details on erosion and sediment control and environmental management.	Ongoing
5.5	Audits (both internal and external) will be undertaken to assess the effectiveness of environmental controls, compliance with this ESCP, consent conditions, and other relevant approvals, licenses, and guidelines. Audit requirements are detailed in the EMS.	As per EMS
6.1	Sediment control structures will be inspected monthly and/or following rainfall events ≥ 20 mm/day (midnight to midnight), as recorded by the Mine's meteorological station. The sediment control structures will be inspected for capacity, structural integrity and effectiveness by Mine's E&C Manager (or delegate).	Monthly and/or following rainfall events ≥ 20 mm/day
	Details of inspections and monitoring results will be recorded on the erosion and sediment structure inspection sheet.	As required
	Required maintenance will be scheduled following the inspection.	As required
6.2	During construction of sediment control dams, the frequency of inspections will be proportional to the level of risk posed by the sediment dam as follows: <ul style="list-style-type: none"> Low-moderate risk - daily inspections and/or key construction milestones by the Mine's Project Engineer to ensure the dam is being constructed to design; Significant risk - daily inspections by the Mine's Project Engineer, in concurrence with staged inspections by an independent certified engineer to ensure the dam is being constructed to design. 	Ongoing
	Post construction, sediment dams will be inspected weekly by the Mine's E&C Manager (or delegate) to verify dam walls, drainage channels etc have been successfully stabilised by revegetation methods.	Weekly
	Dams will be dewatered to restore the design settling zone capacity within 5 days after a rainfall event.	Within 5 days after a rainfall event
	Dams will be de-silted as required (subject to the amount of sediment being accumulated);	As required
6.3	During decommissioning, any materials associated with the ESC structures will be removed and suitably disposed of.	As required during decommissioning
6.4	The performance indicators in Table 10 will be used to assess the performance of Wambo against the predicted impacts.	Ongoing
	WCPL will report on progress against performance indicators in the Annual Review.	Annually

ESCP Section	Commitment	Timing
	In the event that a complaint is received relating to erosion and sediment control, it will be handled in accordance with the complaint's management protocol (Section 8.0).	As required
7.2	In the event that an unpredicted impact occurs, WCPL will implement the TARP in Table 11 .	As required
7.3	In the event that WCPL identifies a failure to comply with a statutory requirement WCPL will: <ul style="list-style-type: none"> Undertake an investigation into the failure; Identify suitable strategies or actions to be implemented to address the failure (and avoid a recurrence of the failure); and Report the non-compliance in accordance with the requirements of the development consents and EPL 529. 	As required
8.0	Erosion and sediment control related community complaints will be recorded within the Community Complaints Register.	Ongoing
9.1.1	Review Wambo's performance against management measures outlined in the ESCP as part of the Annual Review	Annually
9.1.2	Review and, if necessary, revise the ESCP with any review of the WMP. Resubmit to DPIE as required	As required
9.2.1	Report any significant findings regarding the implementation of this ESCP in the WCPL Annual Review	Annually
	Report details of any incidents or non-compliances relating to erosion and sediment control in the WCPL Annual Review	Annually
9.2.3	Report incidents as per the WMP.	As required

APPENDIX C: Design Principles

Description

Contour banks are small, open channels constructed at regular intervals along a slope bank or upstream of a disturbed area. They are also commonly known as diversion banks or contour banks.

Contour banks are typically used to direct flows across a slope, upstream of disturbed areas, and to divert water around a construction area or stockpile.

Contour banks intercept sheet flows and divide slope banks up in to smaller drainage areas, reducing the flow paths and hence velocities down an embankment.

Contour banks typically discharge in to a rock chute which then outlet in to a sediment basin.



Advantages	Limitations
<ul style="list-style-type: none"> • Effective form of drainage control • Can be removed as designs progress • Low maintenance requirements • Can be shaped to allow vehicle crossings 	<ul style="list-style-type: none"> • Lack of grade control in dispersive soils promotes ponding which may lead to tunnel erosion • Suitable for use on embankments with slopes up to 1V:1H • Drain longitudinal slope should ideally be 1V:100H or 1V:67H for dispersive soils

Design Principles

Contour banks are generally required on a slope when the upstream catchment area is greater than 1500 square metres. Below are some typical guidelines for sizing contour banks, although it is recommended that advice should be sought from a competent person prior to commencing construction of contour banks.

It is recommended that for the Peabody operations, a longitudinal drain slope of 1V:100H is used; however longitudinal slopes of up to 1V:67H may be required in dispersive soils. Increasing the slope in dispersive soils is aimed to counteract ponding which may lead to tunnel erosion. Tunnel erosion can have a more detrimental outcome than erosion occurring along the base of the drain. Contour banks do not need to be lined when the longitudinal slope is less than 1V:100H, but should be lined when longitudinal slopes exceed 1V:100H (grass lining for velocities up to 1.5 metres per second or rock lining if velocities exceed 1.5 metres per second). Note that grass lined drains are only effective once sufficient vegetation is established to stabilise the drain.

Contour banks are typically formed with a trapezoidal or parabolic cross-section for ease of construction and long-term stability. The nominal drain depth of 1 metre is preferred for ease of construction. The side slopes on the drain and downstream flow diversion bank should be a maximum of 1V:2H, however 1V:4H side slopes are preferable to provide trafficability of the drains. A contour bank shall be sized to convey a 1 in 10 annual exceedance probability rainfall event with 30 centimetres freeboard. Drains spaced too far apart are not effective in containing the sheet flows and can have adverse effects on the downstream surface. A maximum spacing indication is provided in Figure 1, although spacing should be reduced on sites containing highly erodible soils. This spacing is based on the maximum distance it takes for sheet flow to transform into channelized flow on various slopes.

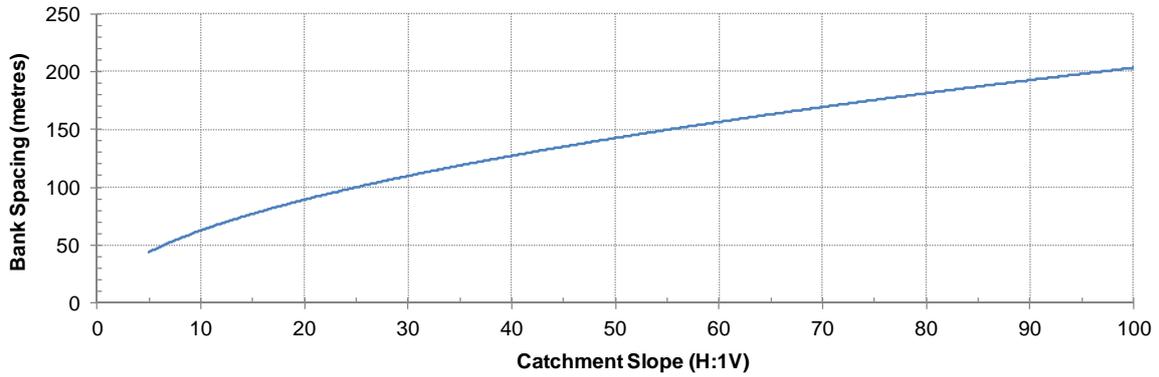


Figure 1

Typical contour bank design depths, flow rates and flow velocities are presented in the figures below. These assume a trapezoidal drain profile, 3.5 metre base width, 40 metre drain spacing, 1V:100H longitudinal slope and 1V:4H side slopes. Firstly, use Figure 2 is used to determine the maximum flow rate in the drain. Figure 3 is used to identify the design drain depth and flow velocity in the drain.

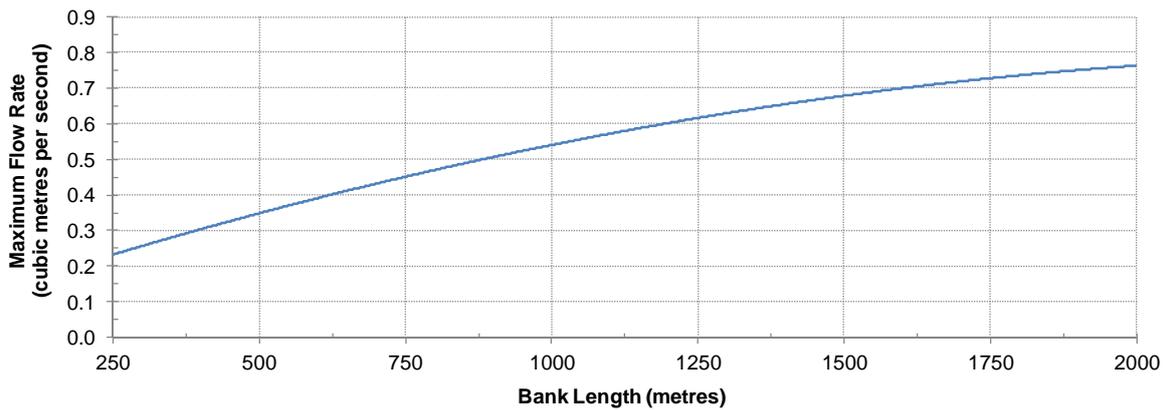


Figure 2

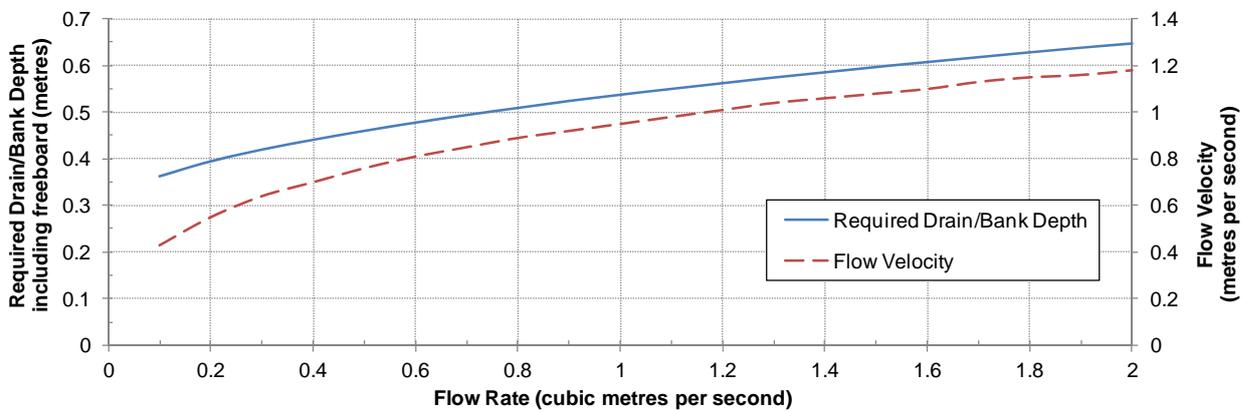


Figure 3

Construction Guidelines

Formation of contour banks is typically achieved using a grader blade or excavator to shape trapezoidal or parabolic profiles. This will result in a nominal drain base width of 3.5 metres to 7.5 metres given the commonly available mining equipment used for drain construction. The excavated material removed from the drain is used to construct a diversion bank on the downhill face of the drain as shown in Figure 4, which requires shaping and compaction.

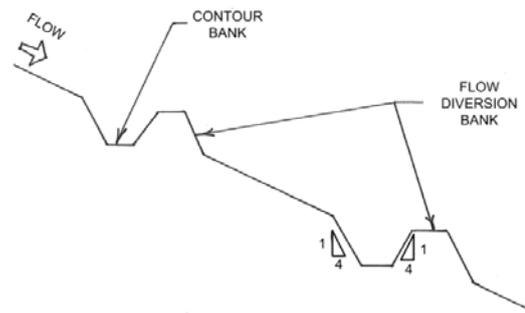


Figure 4

If contour banks are to be constructed on dispersive soils, the drain shall be lined with a minimum 100 millimetre thickness of non-dispersive soil. This is applicable even if the drains will be lined with rock or geotextile.

Construction shall commence with the uphill contour bank first. The spacing of subsequent downstream contour banks shall be as per specified intervals Figure 1 and as shown in Figure 5.

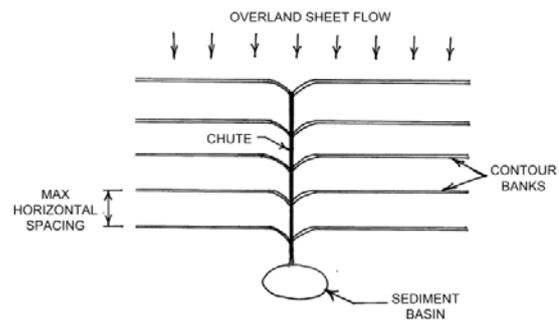


Figure 5

Monitoring

Monitoring and subsequent maintenance of contour banks shall occur pre and post wet season and after specific rainfall events as identified in the *Monitoring Schedule guideline*.

Inspection shall identify:

- Erosion occurring downhill of a contour bank
- Erosion along a contour bank
- Failure of a contour bank
- Ponding within the contour bank

Maintenance

Evidence of erosion downslope of a contour bank signifies that the upslope contour bank capacity has been exceeded. The drain shall be deepened to increase the hydraulic capacity of the drain. Alternatively, intermediate contour bank can be constructed to reduce the catchment area reporting to each contour bank.

Erosion occurring within a contour bank suggests the drain is too steep or the lining mechanism is not adequate for the flow velocities. The longitudinal grade of the contour bank can be reduced to flatten out the drain and reduce the flow velocity. Alternatively, if the contour bank is unlined, consider lining with rock, grass or a geotextile material. The effectiveness of a grass lined contour bank is only available once sufficient vegetation is established. Rock mulch may be used to line long-term contour banks until vegetation is established if erosion is occurring. Tunnel erosion occurring within the channel suggests ponding may be occurring as a result of settlement. This shall be treated by regrading the drain. In dispersive soils, the longitudinal slope of the drain shall be increased to reduce the likelihood of ponding occurring. This may actually increase the erosion in the base of the contour bank but will combat tunnel erosion which can be detrimental to the structure.

If a cascading failure of the contour bank is observed (e.g. an upstream drain has failed causing the drains down slope to fail due to the increased flow), re-establishment of the drains is required and the spacing of the drains shall be reduced. Contour banks are only required to be removed when they are used as temporary flow diversion drains around a disturbed area.

Description

Check dams are formed by created small weir structures in an open channel at regular intervals. They are effective in reducing the flow velocity by creating small ponds of water upstream of these structures. The effectiveness of these check dams depend on the selected materials, spacing, channel properties and flow characteristics.



Advantages	Limitations
<ul style="list-style-type: none"> • Reduce flow velocity without changing channel design • Easy to construct • Secondary benefit of acting as a sediment fence to entrap sediment • Effective velocity control in newly formed channels 	<ul style="list-style-type: none"> • Used in low velocity channels only • Channel banks must not exceed 1V:2H • Suitable for channels with a slope greater than 1V:100H but less than 1V:10H

Design Principles

There are three main material types used in the construction of check dams. These are:

- 1) Sandbags filled with sand, gravel, straw or compost
 - Suitable for shallow drains <500 millimetres deep
- 2) Rock
 - Suitable for deep drains >500 millimetres deep
 - Typically 200 millimetre mean rock diameter (D_{50}) is used, although larger rock may be warranted on steep slopes

Slope	D_{50} Rock Size (millimetres)
1V:100H – 1V:50H	200
1V:50H – 1V:20H	300
1V:20H – 1V:12.5H	400
1V:12.5H – 1V:10H	500

- 3) Fibre rolls
 - Biodegradable logs (e.g. Maccaferri Cocologs) made from a fibre blanket filled with organic material
 - Suitable for wide, shallow drains or in vegetated channels
 - Typically last between 4 and 10 years before biodegrading
 - Standard size of 300 millimetre diameter

Check dams should only be used in drains with a slope of less than 1V:10H, they shall not be used in batter chutes.

Construction Guidelines

Construction shall commence at the downstream check dam first then progress upstream. Ensure that the toe of the upstream check dam is at the same elevation as the crest of the downstream check dam. See Figure 1.

Although rarely required, a geotextile underlay or rock apron can be installed to reduce erosion in dispersive soils. If required, a rock apron should be installed downstream of the check dam to a length equivalent to twice the height of the structure.

Construction shall extend up the batters of the channel but should be limited to 500 millimetres from the base of the channel to ensure water does not spill at the edges of the check dam, see Figure 2. A weir should be created in the centre of the check dam by allowing at least a 150 millimetre depression. The base of the check dam shall be trenched at least 200 millimetres below the invert of the drain to minimise the risk of undermining or side cutting the structures.

Fibre rolls shall be anchored in a trench to a depth of at least one third of the diameter of the roll and fixed with wooden stakes at a maximum spacing of 1 metre. Logs can be stacked to achieve a higher crest level but remain limited to the 500 millimetre total height restriction, see Figure 3.

Monitoring

Monitoring and subsequent maintenance of check dams shall occur pre and post wet season and after specific rainfall events as identified in the *Monitoring Schedule guideline*.

Monitoring shall identify:

- Excess sediment deposit build-up upstream of a check dam
- Failure of a check dam
- Erosion within the drainage channel or adjacent to a check dam

Maintenance

Occasional removal and disposal of sediment deposit behind the check dam is required if the sediment is approaching the top of the check dam or causing flows to divert around the ends of the structures.

If failure of a check dam occurs or erosion is evident, the size of the rock needs to be increased, intermediate check dams could be constructed to reduce the upstream velocity, or a channel liner (as discussed in the *Drainage Control Guidelines*) could be used between the check dams of concern. Observation to ensure flow is concentrated over the weirs and not around the structures necessary. Inspection to ensure the rocks remain sufficiently anchored after extended storm events is required.

Rock and sandbag type check dams are to be removed once vegetation has established sufficiently to stabilise the channel. Seedlings can be planted directly into the fibre log as they are 100% biodegradable. The protective netting should be removed once any planting has become established.

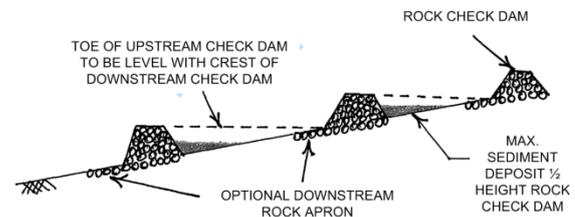


Figure 1

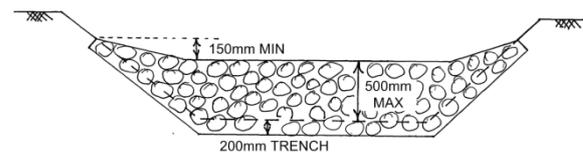


Figure 2

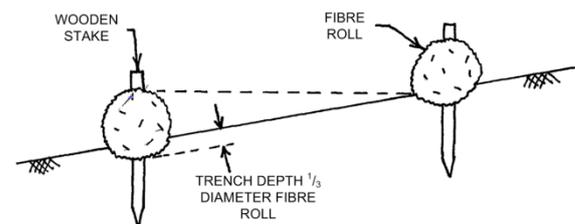


Figure 3

Description

Grass is the most common material used to line channels and embankments to reduce the velocity of sheet flows and minimise the potential for erosion. Grass provides a permanent ground cover on rehabilitated surfaces.

The establishment of grass typically involves ripping and seeding the surface with native grass and broadleaf species.



Advantages	Limitations
<ul style="list-style-type: none"> • Can be applied at majority of site locations 	<ul style="list-style-type: none"> • Suitable for channels with flow velocities less than 1.5 metres per second • Sites should plan to establish ground cover during wet seasons (typically February to May and September to November for Queensland and New South Wales sites) • Not suitable for channels steeper than 1V:10H

Design Principles

The selection of vegetation species is dependent on the site location and the season that the grass is sown.

The minimum recommended height of ground cover shall be 5 centimetres in channels with a velocity up to 1.5 metres per second. The maximum design velocities for dispersive and non-dispersive soil types are as follows:

Slope	Non-dispersive soil maximum velocity (metres per second)	Dispersive soil maximum velocity (metres per second)
0 – 1V:20H	1.5	1.2
1V:20H – 1V:10H	1.0	0.8

Construction Guidelines

Seeding of the final earthworks surface shall occur as soon as plausible after construction completion. Temporary rock mulching may need to be utilised in the short-term to control sediment displacement until grass is sufficiently established. A minimum topsoil depth of 75 millimetres shall be spread across the entire rehabilitation footprint and the surface ripped to promote root establishment.

Seed shall be applied at a rate of 10 kilograms of seed per hectare. Where practical, watering of the seed is advantageous in promoting germination of the seed and establishing grass vegetation. Depending on the location, the grass seed may benefit from a light mulch cover. Germination of seed may take several months, especially at Central Queensland sites, due to defined wet and dry seasons.

Monitoring

Monitoring and subsequent maintenance of grass shall occur pre and post wet season and after specific rainfall events as identified in the *Monitoring Schedule guideline*.

Monitoring shall ensure:

- A minimum of 80% ground cover
- The grass seed has not been dislodged in a rain event

Maintenance

If a minimum of 80% ground cover is not achieved, the surface is required to be re-seeded.

Removal of excess sediment (greater than 50 millimetres deep) will maintain the hydraulic capacity in the channel. Reducing the sediment thickness above the seed will also aid the germination process.

Re-seed if washed away by a large storm event. If consistent dislodgement is occurring, consider using turf reinforcement matting, rock mulch or cellular confinement systems to contain the topsoil and add stability to the surface. Rock mulching may be used on dispersive soils where topsoil and seed is dislodged prior to the establishment of grass roots.

Assessment of areas where grass has been established but has experienced die-back due to events such as bushfires or drought is required to determine the long-term viability of the grass. Revegetation of grass shall take place in areas where losses greater than 20% have occurred. This is only applicable when complete root structure of the grass is lost or re-establishment will not occur naturally.

Description

Cellular confinement systems for drainage control are formed by constructing a series of cells using a high density polyethylene (HDPE) material. Installation of these systems in channels is an effective drainage control technique. The cells essentially create numerous small check dams within the slope, hence reducing the velocities within the channel.



The use of this system as an erosion control device is discussed in more detail in Guideline H347052-0000-10-215-0010 Cellular Confinement Systems (Erosion Control).

Advantages	Limitations
<ul style="list-style-type: none"> • Can be used on slopes up to 1V:1H • Can be used in shady areas where vegetated erosion control techniques are not suited • Smaller rock required than typical rock lined channels • Easy to transport and handle lightweight and collapsible panels • Promotes vegetation • Flexible, durable and easy to install 	<ul style="list-style-type: none"> • Not suited to high velocity channels • Quite expensive and relatively time consuming to construct

Design Principles

Cellular confinement systems are most applicable in the mining sector to stabilise steep embankments and drainage channels. Cell walls can be smooth, textured or perforated. Perforated walls are most commonly used as they allow free-drainage of excess moisture through the structure and add structural integrity by allowing interlocking of particles with the cell walls.

Cellular confinement systems come in standard sizes with depths between 75 millimetres and 200 millimetres depending on the expected flow and the infill material.

Cell Size	Cell Length (millimetres)	Cell Width (millimetres)
Standard Cell	203	244
Large Cell	406	488

The three main materials used to fill the cells are:

- 1) Gravel
 - Best suited to areas where vegetation does not have enough sunlight to establish
 - Suitable for use in higher velocity channels up to 3 metres per second
 - Recommended nominal rock diameters (in millimetres) are as specified:

Cell Depth (millimetres)	Standard Cell	Large Cell
75	38	75
100	50	100
150	75	150
200	75	150

- 2) Vegetated soil
 - Environmentally sensitive solution
 - Best suited to areas of low velocity (up to 1.5 metres per second), intermittent (durations less than 24 hours) flows occur (extended periods of flow creates rills and gullies under the system)
 - Fill cells with topsoil, then seed and water until vegetation is established

- A cell depth of 100 millimetres shall be used unless specified in arid regions where larger cell depths may be required.
- 3) Concrete
- Durable and erosion resistant
 - Used on embankments when high flow velocities (up to 6 metres per second) and turbulence are expected down a slope
 - Should only be used on slopes less than 1V:3H due to concrete slump

Construction Guidelines

The construction area shall be cleared of vegetation and rocks and a geotextile underlay can be installed if the in-situ soils are dispersive. The geotextile fabric is provided for separation, filtration and stability and should be pinned in a minimum 200 millimetre deep trench at the top of the channel, as illustrated in Figure 1. The system shall be aligned so cells can be expanded down the slope. Construction of the cellular confinement system is to commence at the top of the slope, ensuring anchor stakes are installed in every cell along the top row in the trench.

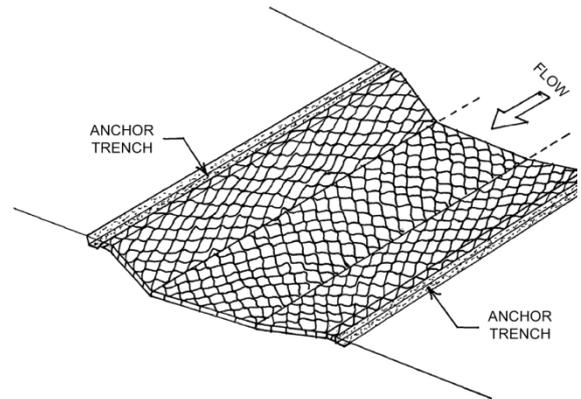


Figure 1

Prior to expanding the cells, as an optional supplied addition, tendons shall be threaded through the tendon slots in the system and knotted at the ends. The tendon strength must be specified by the engineer and must meet design requirements for the application. Stretch the HDPE material to create cells between 23 to 48 centimetres long and 26 to 51 centimetres wide, as shown in Figure 2, depending on the selected system. Anchors shall be inserted every 2 metres down the embankment on slopes greater than 1V:10H. To ensure the cells are kept open during filling, either anchor the material at the toe of the embankment or fill the bottom row of cells with selected material.

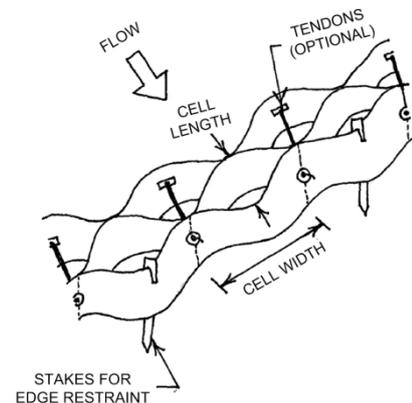


Figure 2

Connection of systems can be achieved by stapling or through the use of a specialised device (eg. ATRA® key connection device).

Monitoring

Monitoring and subsequent maintenance of cellular confinement systems shall occur pre and post wet season and after specific rainfall events as identified in the *Monitoring Schedule guideline*.

Monitoring shall ensure:

- The system remains anchored at the top of the slope and scour is not evident around or under the system
- Infill material still fills the cells and dislodgement or settlement has not occurred

Maintenance

Scour may occur as a result of poor construction or unfavourable soil conditions. Adequate anchorage at the top of the slope is crucial to ensure runoff does not flow beneath the cells and cause undermining of the structure. If localised failure has occurred, the affected panels must be replaced after the subsoil conditions have been improved (or a geotextile has been installed) and the structure needs to be re-anchored in the trench. Additional infill material will need to be added to the cells if settlement results in an infill depth of less than half of the cell depth. The system should be extended to cover any adjacent areas where scour is evident around the structure.

Cellular confinement systems promote revegetation so can be used as permanent erosion control devices and do not need to be removed.

Description

A rock mattress is a shallow wire basket with inner cells and filled with rock. Rock mattresses are similar to gabions but their geometry is thin and rectangular rather than cubic. Rock mattresses are commonly used in high velocity channels, chutes, culvert inlet and outlets and sediment basin spillways where long term scour is prominent.



Mattresses are constructed on the ground and can be linked together to cover large surface areas. The rock fill provides the weight to resist shear flow and the wire cells aid in withstanding movement of the rock.

Advantages	Limitations
<ul style="list-style-type: none"> • Can be used in high velocity flow locations • Mattresses can fold flat for ease of transport • Simple to install • Instant drainage control when installed • Smaller (and hence cheaper) rock sizes can be used 	<ul style="list-style-type: none"> • Not ideal for use on dispersive soils • Typically quite expensive • Recommended for maximum slope of 1V:1.5H • Construction is labour intensive

Design Principles

Rock mattresses are made from a flexible woven wire mesh 60 millimetres by 80 millimetres and are typically zinc coated (a plastic coating is available if used in corrosive conditions). The wire baskets come in standard sizes of 6 metres by 2 metres with thicknesses typically between 170 millimetres and 300 millimetres. The selection of the mattress thickness depends on the erodibility of the bank slope, maximum expected velocity and the bank slope. Internal walls every 1 metre create cells within each mattress to minimise rock movement. Wire mattresses can be cut to size and linked to adjacent mattresses to suit any arrangement.

Flow Velocity (metres per second)	Recommended Mattress Thickness (millimetres)	Rock Infill Size (millimetres)
Less than 4.2	170	75 – 100
4.2 - 6.1	230	75 – 150
6.1 - 6.4	300	75 – 200
6.4 – 8.0	500	100 - 250

By containing rock within the wire baskets, rock mattresses are approximately 4 times more effective than rock lining with the same thickness. Selection of a rock size depends on the slope and velocity in the channel. The rock infill shall be between 75 millimetres and two-thirds the thickness of the mattress, or 250 millimetres, whichever is the lesser. The selected rock material must be hard, durable, well graded and weather resistant with a density no less than 1,700 kilograms per cubic metre.

Construction Guidelines

Geotextile material must be laid under the link mattresses (as shown in Figure 1) to reduce erosion through the rock infill. If the soil is highly dispersive, an allowance shall be made to remove and replace the top 200 millimetres with non-dispersive soil. Ensure the geotextile is not torn or punctured during the installation of the rock mattresses.

The wire baskets shall be shaped, wired-up and inspected for deformities before rock is added to the baskets. Filling shall occur from the downstream cells first and can be done by hand or mechanically. Each cell shall be slightly overfilled to allow for settlement of the rock.

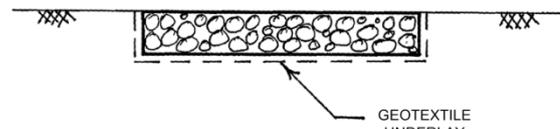


Figure 1

Where rock mattresses are to be installed in a channel bed, the wire baskets shall be installed so that the internal walls (diaphragms) are perpendicular to the direction of flow. Conversely, if mattresses are to be installed on slopes or channel banks, they should be aligned so the diaphragms are parallel to the banks (as shown in Figure 2).

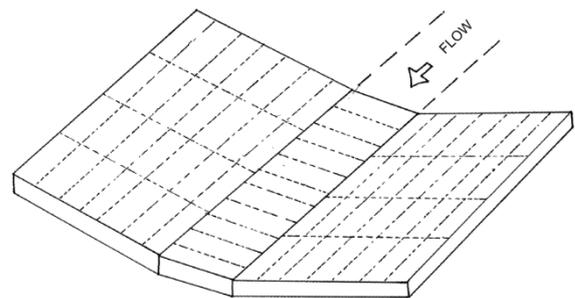


Figure 2

Anchoring of the mattresses is required on slopes greater than 1V:1.5H. Hardwood stakes or star pickets should be temporarily installed every 2 metres inside the upper end panel. The stakes are required to be removed upon completion of filling to maintain flexibility of the structure.

On dispersive soils it may be necessary to fill voids in the mattresses with soil or vegetation to help reduce erosion under the structure. Where rock mattresses are used for spillway construction, an additional layer of concrete shall fill the voids to reduce seepage through the mattress.

Monitoring

Monitoring and subsequent maintenance of rock mattresses shall occur pre and post wet season and after specific rainfall events as identified in the *Monitoring Schedule guideline*.

During the inspection process, particular focus should be on:

- Checking for erosion around and under the mattress
- Ensuring integrity of the wire baskets, ie no breaks in the wire
- Monitoring movement of the rock within the baskets

Maintenance

Rock mattresses are designed to be flexible and have the ability to withstand slight ground deformation. Failure often occurs due to inadequate protection against scour at the downstream edge of the rock mattress and can result in tunnel erosion under the structure. Consider extending the structure or adding downstream rock protection if erosion is evident.

If large breaks are visible in the wire mesh, then a patch should be immediately installed directly over the affected area. Minor deformation and breaks in the wire should not affect the integrity of the structure as the construction technique inhibits unravelling of the mesh.

If the mattresses deform due to settlement of the rock, the lid shall be removed and additional rock placed in the baskets. Exposed surface around the rock mattresses should be rehabilitated upon completion of construction.

Description

Rock lining involves spreading thick layers of rock in a drainage channel or chute to control the flow velocity. The rough surface of the rock lining dissipates flow energy in high velocity and/or steep channels.

Rock lined channels are a highly effective and cost efficient solution for controlling flows.



Advantages	Limitations
<ul style="list-style-type: none"> • Can be used in channels with velocities greater than 2 metres per second • Considered the most effective form of drainage control • Not labour intensive • Environmentally friendly • Cost effective 	<ul style="list-style-type: none"> • Limited availability of rock from mining operations may mean it needs to be sourced off-site • Must be designed to ensure the flow capacity of the drain is not compromised

Design Principles

The rock selected must be well graded, durable, weathered and preferably angular for stability.

The minimum recommended thickness of the rock lining shall be 1.5 times the mean rock diameter (D_{50}). Example D_{50} rock sizes are presented in Figure 1.

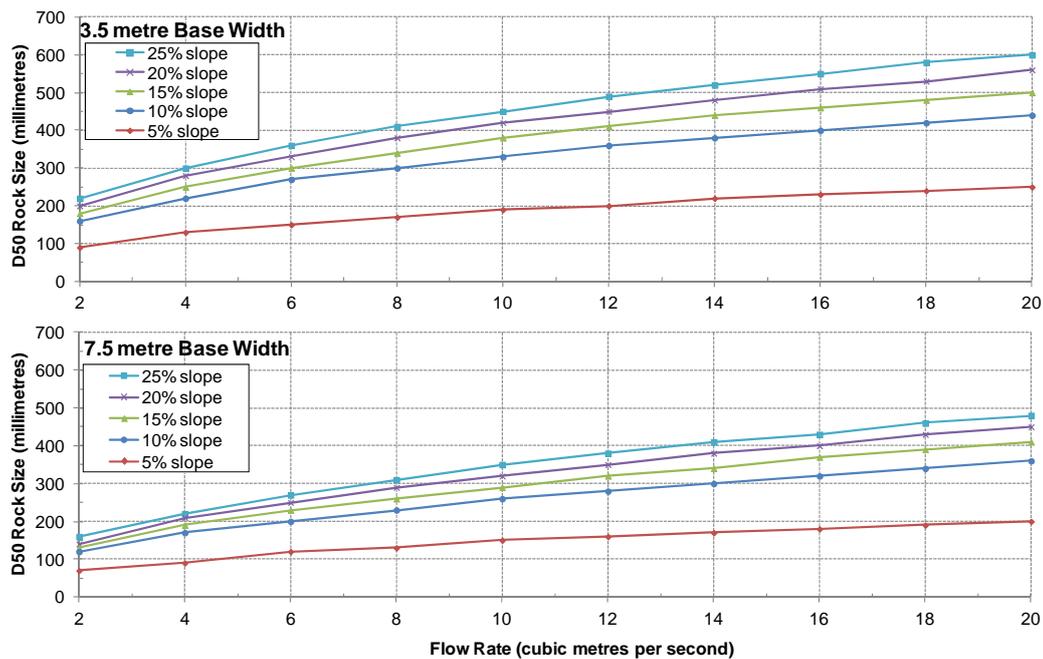


Figure 1

Construction Guidelines

The channel shall be excavated and shaped to the design elevations. The thickness of rock is to be allowed for during excavation to ensure the top of the rock surface is level with the adjacent ground level. The use of a heavy duty geotextile (minimum A24) underlay is advised, especially if the rock lining is to be placed on dispersive soils or if the rock is not well graded i.e. there may be voids in the lining.

Dump rock in the channel ensuring 100% coverage of the flow surface is achieved. A minimum thickness of at least 1.5 times the rock diameter is required and shall extend up the channel banks to reduce scouring of the banks as shown in Figure 2.

The rock lining shall extend at least 1 metre upstream and 1 metre downstream of the channel as shown in Figure 3.

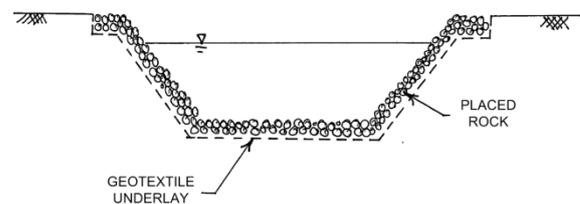


Figure 2

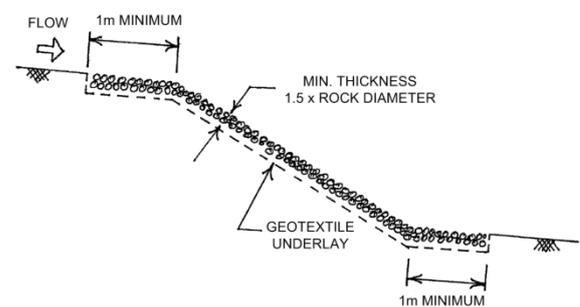


Figure 3

Monitoring

Monitoring and subsequent maintenance of rock lined channels shall occur pre and post wet season and after specific rainfall events as identified in the *Monitoring Schedule guideline*.

When conducting periodic inspections of the rock lining, identify any:

- Scour occurring below or adjacent to the rock lining
- Displacement of the rock
- Excess deposits of sediment in the channel
- Break down of the rock material

Maintenance

Evidence of scour below the rock lining is generally a result on dispersive soils where a geotextile underlay has not been utilised. Scour occurring adjacent to or downstream of the rock lining should be treated by increasing the rock coverage area. Erosion along the edges may be a result of flows being channelised in to the drain. Extend the rock lining further up the banks and ensure sheet flows can freely enter the drain.

Displacement of rock from sections within the channel indicates that flow velocities exceed the design velocity for the chosen rock size. Larger rock shall be placed in the channel, replacing the original undersized rock.

Excessive vegetation growth within the rock voids can restrict the channel capacity and should be removed. Upstream rock check dams or sediment fences may aid in reducing the amount of sediment transported downstream into the rock lined channel.

Weathering and breakdown of the rock lining may occur if non-durable rock is used. If evidence of weathering is observed, the rock lining may need to be replaced to ensure on-going protection of the drain or chute.

Rock lining can be utilised as a permanent structure and therefore does not need to be removed.

Description

A level spreader is an outlet control structure used in drainage channels. They consist of a small stilling basin at the downstream end of a channel with a small weir outlet discharging perpendicular to the flow direction in the channel. Level spreaders work by converting minor channelised flows back into sheet flows in order to minimise velocity and reduce erosion.

Level spreaders can also be used to divert flows around a soil disturbance area.



Advantages	Limitations
<ul style="list-style-type: none"> • Relatively inexpensive form of drainage control 	<ul style="list-style-type: none"> • Most effective where outlet is constructed on a non-dispersive and vegetated surface • Outlet velocity limited to 1.5 metres per second • Large footprint required for construction • Construction with a dozer D5 or smaller • Suitable for slopes up to 1V:10H

Design Principles

Upstream flow entering a level spreader can be via pipes or contour banks. The downstream 6 metres of the inlet channel shall have a maximum gradient of 1V:100H to reduce inlet velocities and prevent scouring of the outlet structure. A level spreader should be lined with rock, concrete or grass depending on the application and upstream channel material.

The outlet sill (weir type structure) shall have a minimum length of 4 metres and a maximum length of 25 metres. The length of the sill depends on the contributing catchment, slope and expected flow rates and velocities. The design sill length shall be a maximum of 0.1 cubic metres per second per metre of length based on a 10 year storm event.

The sill must be constructed horizontal to ensure flows are not concentrated over the crest.

Construction Guidelines

Once the channel has been excavated and trimmed, the level spreader can be constructed at the outlet.

The sill is to be constructed to the specified length and level with no crossfall along the outlet weir as shown in Figure 1. An erosion control matting (e.g. jute mesh, geotextile) shall be installed at the sill crest. The matting shall be anchored at least 300 millimetres upstream of the sill and to a minimum depth of 150 millimetres, as illustrated in Figure 2. On dispersive soils, the erosion control matting shall extend a minimum of 5 metres downslope of the sill to ensure scour does not undermine the level spreader structure. A level spreader should discharge on to vegetated or rock mulched areas.

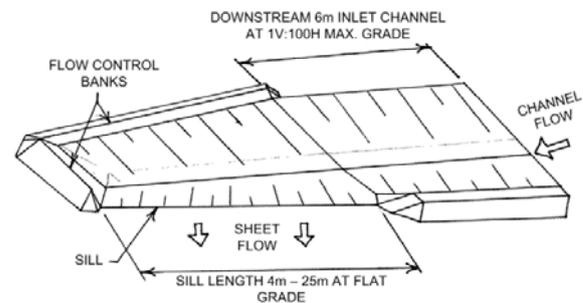


Figure 1

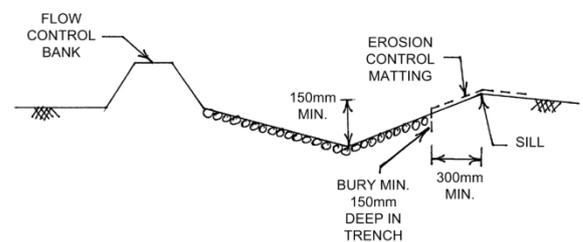


Figure 2

Upon construction completion, vegetation should be established for long term durability of the structure.

Monitoring

Monitoring and subsequent maintenance of level spreaders shall occur pre and post wet season and after specific rainfall events as identified in the *Monitoring Schedule guideline*.

Inspection of the structures shall identify:

- Excess sediment deposits exceeding one third of the total basin depth
- Concentrated flows over and downstream of the sill crest identified by failure of the sill or downstream surface erosion
- Erosion within and adjacent to the structure

Maintenance

The presence of excess sediment in the outlet structure signifies that the in-situ soil material is most likely dispersive. A geotextile material or grass lining shall be installed in the upstream channel to reduce the amount of sediment being dislodged during rain events. Excess sediment needs to be removed from the outlet to ensure capacity is available to allow settling of the flow before discharge.

Concentrated flows over the sill crest identifies that the elevations along the sill are not perfectly horizontal. Ensure there is no crossfall on the sill crest and reconstruct the weir if necessary.

Erosion downstream of the outlet structure suggests that the crest length is too short to spread the flows. Additional construction shall be done to provide a longer crest at the design crest elevation. Flows and velocities may be too high over the outlet weir, causing erosion of both the outlet structure itself and the downstream environment. The flow rate shall be checked to ensure it does not exceed the maximum design flow rate of 0.1 cubic metres per second per metre of sill length in a 1 in 10 year rainfall event.

24Description

Rock chutes are drainage channels designed specifically for steep slopes. They are typically outlet structures for contour banks and primarily convey water from relatively flat longitudinal drains, down a steep slope to a sediment basin or outlet device as shown in Figure 1 and Figure 2.

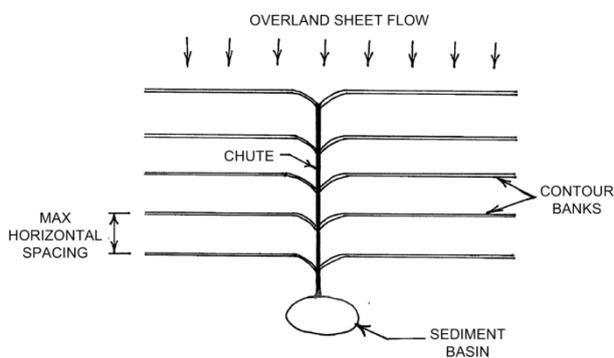


Figure 1

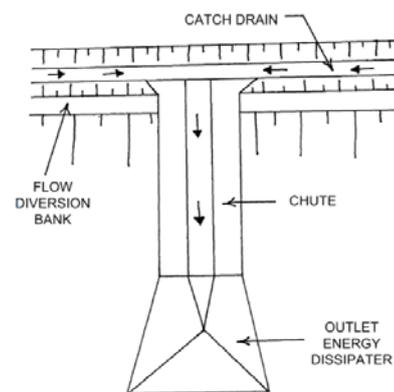


Figure 2

Advantages	Limitations
<ul style="list-style-type: none"> • Typically constructed on slopes greater than 1V:10H • Relatively cost effective and simple to construct • High flow capacities 	<ul style="list-style-type: none"> • Maximum slope of 1V:2H for rock lining stability • Suitable for flow velocities up to 8 metres per second • Prone to erosion if inadequate design

Design Principles

The design of a chute shall generally be undertaken by a competent person as chutes are susceptible to failure and can fail quite quickly. Inadequate design of a chute can compromise the whole structure including upstream and downstream devices. The construction material must be flexible enough to handle movement when constructed on a spoil pile.

A chute has three primary components:

- 1) Inlet
 - Inflow water received from contour banks
 - Flow diversion bank shall direct flow into the chute, maintaining a minimum 150 millimetre freeboard
- 2) Chute structure
 - Can be a parabolic, rectangular or trapezoidal profile but must be perfectly straight
 - Can be lined with rock, concrete or flexible fabric depending on the flow velocity and design duration requirements
 - Minimum 300 millimetre chute depth with sufficient capacity to ensure flows do not overtop the structure

- 3) Outlet energy dissipater
 - Reduces flow energy to minimise scour downstream
 - Constructed at the base of the chute
 - Technical design is required to ensure the outlet does not fail and compromise the stability of the entire chute structure
 - Can be a flat pad or a sunken basin with sill depending on the tailwater conditions

Construction Guidelines

A chute structure should ideally be constructed after the completion of the outlet sediment basin but prior to the construction of contributing contour banks.

Excavate the chute profile and install a geotextile underlay prior to placing rock in the chute.

Rock lining shall extend a minimum length of 5 times the depth of approach flow upslope of the chute for scour protection as shown in Figure 3. Rock lining shall be extended up the sides of the chute to reduce the effects of scour from adjacent flows. The chute structure shall be sufficiently tied in to upstream and downstream systems to reduce the risk of water flowing under the chute and undermining the structure.

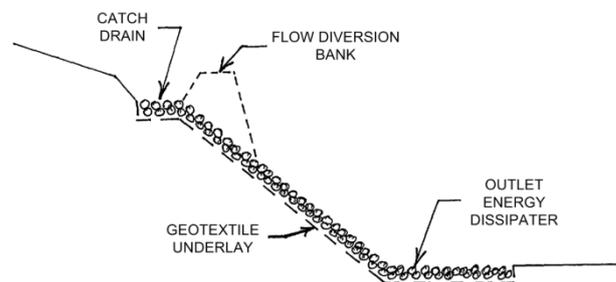


Figure 3

Monitoring

Monitoring and subsequent maintenance of rock chutes shall occur pre and post wet season and after specific rainfall events as identified in the *Monitoring Schedule guideline*.

Monitoring shall identify any:

- Scour at the inlet, outlet, adjacent to or within the chute
- Flows bypassing the chute
- Movement of channel linings

Maintenance

Scour at the inlet to the chute indicates that flows are not freely entering the chute and ponding may be occurring. Ensure the invert of the chute is below the invert of the contributing contour bank. Extend the rock lining into the contour banks to reduce the inlet velocity.

Water must flow into the chute, not divert around the inlet. If flows are bypassing the chute, extend the diversion banks along the catch drains all the way to the edge of the chute. Flows shall not spill out of the chute as this will potentially undermine the chute. If flows are overtopping the chute, increase the depth of the chute to gain additional capacity.

Dislodgement of rocks identifies that the flow turbulence and velocities are too great for the rock sizing. Consider increasing the rock size or lining the chute with a stronger material such as concrete.

Removal of the chute shall occur only after rehabilitation or removal of the contributing contour banks has occurred.

Description

Cellular confinement systems are formed by constructing a series of cells using a high density polyethylene (HDPE) material. Installation of these systems on channel slopes and embankments improves the slope stability and reduces the impact of high velocity/impact water. The creation of small check dams down the slope reduces the flow velocity, in turn reducing the effects of erosion.



The use of this system as a drainage control device is discussed in more detail in Guideline H347052-0000-10-215-0004 Cellular Confinement System (Drainage Control).

Advantages	Limitations
<ul style="list-style-type: none"> • Can be used on slopes up to 1V:1H • Can be used to stabilise dry, sandy bed streams where temporary vehicle crossing is required • Can be used in shady areas where vegetated erosion control techniques are not suited • Easy to transport and handle, lightweight and collapsible panels • Promotes vegetation • Flexible, durable and easy to install 	<ul style="list-style-type: none"> • Quite expensive and relatively time consuming to construct

Design Principles

Cellular confinement systems are most applicable in the mining sector to stabilise steep embankments and drainage channels. Cell walls can be smooth, textured or perforated. Perforated walls are most commonly used as they allow free-drainage of excess moisture through the structure and add structural integrity by allowing interlocking of particles with the cell walls.

Cellular confinement systems come in standard sizes with depths between 75 millimetres and 200 millimetres depending on the expected flow and the infill material.

Cell Size	Cell Length (millimetres)	Cell Width (millimetres)
Standard Cell	203	244
Large Cell	406	488

The three main materials used to fill the cells are:

- 1) Gravel
 - Best suited to areas where vegetation does not have enough sunlight to establish
 - Suitable for use on slopes where higher velocities are expected (up to 3 metres per second)
 - Recommended nominal rock diameters (in millimetres) are as specified:

Cell Depth (millimetres)	Standard Cell	Large Cell
75	38	75
100	50	100
150	75	150
200	75	150

- 2) Vegetated soil
 - Environmentally sensitive solution
 - Best suited to areas where low velocity (up to 1.5 metres per second), intermittent flows occur
 - Fill cells with topsoil, then seed and water until vegetation is established

- A cell depth of 100 millimetres shall be used unless specified in arid regions where larger cell depths may be required.
- 3) Concrete
- Durable and erosion resistant
 - Used on embankments when high flow velocities (up to 6 metres per second) and turbulence are expected down a slope
 - Should only be used on slopes less than 1V:3H due to concrete slump

Construction Guidelines

The construction area shall be cleared of vegetation and rocks and a geotextile underlay can be installed if the in-situ soils are dispersive. The geotextile fabric is provided for separation, filtration and stability and should be pinned in a minimum 200 millimetre deep trench at the top of the embankment, as illustrated in Figure 1. The system shall be aligned so cells can be expanded down the slope.

Construction of the cellular confinement system is to commence at the top of the slope, ensuring anchor stakes are installed in every cell along the top row in the trench. Prior to expanding the cells, as an optional supplied addition, tendons shall be threaded through the tendon slots in the system and knotted at the ends. The tendon strength must be specified by the engineer and must meet design requirements for the application. Stretch the HDPE material to required dimensions, as illustrated in Figure 2, depending on the selected system. Anchors shall be inserted every 2 metres down the embankment on slopes greater than 1V:10H. To ensure the cells are kept open during filling, either anchor the material at the toe of the embankment or fill the bottom row of cells with selected material. Connection of systems can be achieved by stapling or through the use of a specialised device (e.g. ATRA® key connection device).

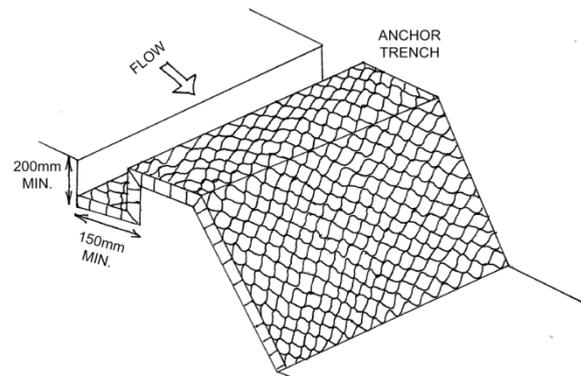


Figure 1

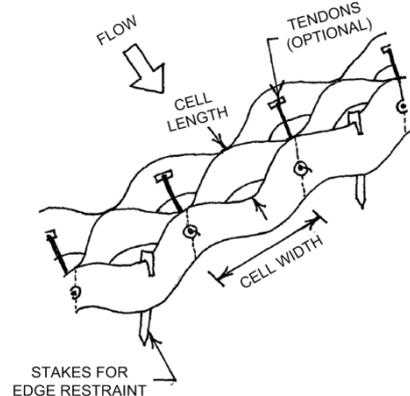


Figure 2

Monitoring

Monitoring and subsequent maintenance of cellular confinement systems shall occur pre and post wet season and after specific rainfall events as identified in the *Monitoring Schedule guideline*.

Monitoring shall ensure:

- The system is still anchored at the top of the slope
- Infill material still fills the cells and dislodgement or settlement has not occurred
- Scour is not evident around or under the system

Maintenance

Scour may occur as a result of poor construction or unfavourable soil conditions. Adequate anchorage at the top of the slope is crucial to ensure runoff does not flow beneath the cells and cause undermining of the structure. If localised failure has occurred, the affected panels must be replaced after the subsoil conditions have been improved (or a geotextile has been installed) and the structure needs to be re-anchored in the trench. Additional infill material will need to be added to the cells if settlement results in an infill depth of less than half of the cell depth. The system should be extended to cover any adjacent areas where scour is evident around the structure.

Cellular confinement systems promote revegetation so can be used as permanent erosion control devices and do not need to be removed.

Description

A compost blanket is formed by applying a thick layer of high quality compost onto a surface. The compost material has already biologically degraded to generate a stable product.

Compost blankets are generally applied as a form of revegetation.



Advantages	Limitations
<ul style="list-style-type: none"> • Can be used on relatively steep slopes up to 1V:2H • Can withstand larger rainfall events than mulch • Topsoil not required for establishment of vegetation • Does not require tackifiers to anchor the mulch • Environmentally friendly as it reduces the risk of introducing imported weed species due to the biological degradation of organic matter • Highly durable form of erosion control • Effectively controls the impact of raindrops • Can be used with seeding 	<ul style="list-style-type: none"> • Can be quite expensive • Tackifiers may be required to anchor the compost on steep slopes

Design Principles

The selected compost material shall be 100% organic matter produced by controlled aerobic decomposition and must comply with the properties specified in AS4454: Compost, Soil Conditioners and Mulches. Key properties are summarised in the table below.

Property	Acceptable Range
Inert material	1% maximum
Soluble salt concentration	5 dS/m
pH range	5.0 – 8.0
Moisture content	30% - 50% (prior to application)
Electrical Conductivity (EC)	Maximum 10 μ S/cm

Compost blankets are suitable to use in wet areas and are twice as effective as hydromulch at reducing the amount of run-off after a rain event.

Construction Guidelines

A layer of compost should be spread evenly over the surface to a thickness specified by the specialist contractor. The general thickness of a compost blanket is around 50 millimetres but will vary depending on the slope and underlying soil composition.

The compost blanket shall be continued at least 1 metre beyond the top of the slope to minimise the risk of water flowing under the blanket and washing the compost away.

Generally tackifiers are not required, however in locations where high rainfall and wind events are experienced, tackifiers may need to be applied.

Monitoring

Monitoring and subsequent maintenance of compost blankets shall occur pre and post wet season and after specific rainfall events as identified in the *Monitoring Schedule guideline*.

Inspections shall be undertaken to identify any:

- Evidence of concentrated flows
- Areas where compost has been displaced

Ongoing monitoring is required until establishment of vegetation is sufficient to reduce the effects of erosion.

Maintenance

Additional upstream flow control structures are required when concentrated flows are evident through the compost blanket. Reshaping of the upslope surface may be required to produce even sheet flows down the slope.

Replacement of compost to the original specified thickness shall be undertaken when compost has been displaced.

Removal of compost blankets is not required as the system aids revegetation.

Description

Organic mulching is the process of spreading a protective layer of organic material on the soil surface. Mulching aims to limit runoff turbidity, reduce erosion caused by sheet flow and promote vegetation regrowth.



Advantages	Limitations
<ul style="list-style-type: none"> • Particularly useful in tropical areas • Most effective way of reducing rain droplet impact. 	<ul style="list-style-type: none"> • Not suitable in all ecosystems as some seeds are considered weeds • Must have uniform cover to perform effectively • Easily washed away in flood areas and on steep embankments • Short-term option only

Design Principles

Mulching materials include but are not limited to:

- Bark chips
 - Shall not be used on low pH soils
- Hydromulching or hydroseeding
 - Mix of seed, fertilizer, paper pulp and bitumen emulsion or tackifier with water
 - Sprayed on as a slurry mixture
 - Only suitable on slopes up to 1V:6H
- Wood chips
 - Consist of mulched trees or processed hardwood
 - Used as weed control or in areas where not closely mowed
 - Application of nitrogen rich fertilizer may be required
 - Effective on slopes up to 1V:3H
- Straw
 - Most commonly used material
 - Ideal when minimal water is available
 - Effective on sites with high soil erosion hazard or where soil moisture is likely to be inadequate for successful plant establishment
 - Generally applied to small areas such as embankments and stockpiles
 - Should be mechanically anchored as a minimum

Technique	Application Rate
Bark chip	2.5 cubic metres per hectare
Hydromulching or hydroseeding	30,000 to 40,000 litres per hectare (bituminous emulsion 1,500 to 2,000 litres per hectare)
Wood chip	11 to 14 tonnes per hectare
Straw	250 bales per hectare or 3.4 to 4.5 tonnes per hectare

Selection of mulch type must be considered where the mulch may be dispersed should failure occurs e.g. Will it end up in a sensitive ecosystem downstream?

Construction Guidelines

The site shall be cleared of large rocks, logs and other objects which may reduce the effectiveness of the contact between the mulch and the soil. Mulching shall not occur during windy conditions and should occur as soon as practically possible after seeding.

Mulch shall be applied and spread evenly to a maximum depth of 50 millimetres, ensuring a minimum 80 to 100% coverage of the entire surface. An increased depth of 75 to 100 millimetres should be applied where weed control is the primary objective.

Chemical tackifiers may be warranted on slopes greater than 1V:2H and mechanical anchors on slopes up to 1V:2H. Anionic bitumen (AS 1160) is an example of a chemical tackifier and should be covered with a net. Environmental constraints and local jurisdiction should be considered before a tackifier is applied. A mechanical anchor may include running a disk harrow or special crimper over straw to press it into the soil after the mulch is spread.

Monitoring

Monitoring and subsequent maintenance of mulched areas shall occur pre and post wet season and after specific rainfall events as identified in the *Monitoring Schedule guideline*.

Monitoring shall identify:

- Areas where mulch has become dislodged

Maintenance

Mulching aims to provide erosion control during storm events, however it is not uncommon for mulching to fail locally during intense storm events. If local failure occurs, the area will need to be re-established by replacing seed and mulch to the original depths. If mulch continuously dislodges on steep slopes, tacking or netting may need to be applied.

Due to the ability of the mulch to decompose, no removal of the material is required.

Description

Revegetation involves the establishment of trees and grasses to achieve a pre-disturbance habitat.

Revegetation can be applied to disturbed surfaces both on slopes and at the outlet of drainage channels.



Advantages	Limitations
<ul style="list-style-type: none"> • Can be applied to all sites • Environmentally acceptable approach to controlling erosion 	<ul style="list-style-type: none"> • Vegetation takes time to establish, requiring additional temporary devices to control erosion in the short term • Limited to slopes less than 1V:3H • Not suitable for trafficked areas

Design Principles

Revegetation techniques vary from site to site and must be analysed as location specific. Soil samples shall be taken at the site and analysed to determine the suitability of the soil prior to vegetating. Consultation with the site environmental team will ensure site specific standards are met.

Site revegetation can include the establishment of trees and/or grasses, both of which are typically germinated by spreading seed over a topsoiled and ripped surface. The minimum height of the established grass shall be 5 centimetres and shall cover a minimum of 80% of the surface to effectively dissipate flow energy.

Revegetation can be aided by applying other short-term erosion control devices such as erosion control blankets and mulching.

If revegetation works are undertaken as part of the permanent design, the final landform needs to be considered.

Construction Guidelines

Prior to seeding, the application surface shall be ripped to loosen the soil. The revegetated slope shall be limited to 1V:3H for stable soil conditions or 1V:4H for dispersive soils. Seed shall be applied at a rate as specified in the "Grass" guideline for drainage control or as suggested by the seeding contractor. A uniform spread of seed shall cover a minimum of 80% of the disturbed surface.

Ensure there is good contact between the seed and the topsoil. If applicable, mulch may be spread over the surface once the seed has been sowed. Mulching can provide temporary erosion control until the vegetation is established.

A barrier shall be constructed around the seeded site to prevent vehicles from accessing the area.

Monitoring

Monitoring and subsequent maintenance of revegetated areas shall occur pre and post wet season and after specific rainfall events as identified in the *Monitoring Schedule guideline*.

Inspection shall identify:

- Areas where the vegetation has not established
- Areas where topsoil and seed have been dislodged (whether be from a rain or high wind event)

Maintenance

Until a minimum of 80% coverage of the area is achieved, the effectiveness of the vegetation as an erosion control device is reduced. Ideally, germination should occur within 6 weeks of application. However, when self-germination of the seed is required, growth may not be visible for several months, depending on the regional rainfall and soil moisture conditions. Installation of temporary erosion control devices, such as mulching, is recommended until vegetation is established.

Areas where seed has been washed away by a large storm event shall be re-seeded. If consistent dislodgement is occurring, consider using turf reinforcement matting to add structural integrity to the surface or review the need for upstream contour banks.

Assessment of areas where vegetation has been established but has experienced die-back due to events such as bushfires or drought is required to determine the long-term viability of the vegetation. Revegetation shall take place in areas where losses greater than 20% have occurred. This is only applicable when complete root structure of the vegetation is lost or re-establishment will not occur naturally.

Where necessary, slash the temporary vegetation cover to allow the successful growth of the underlying permanent vegetation cover. Vegetated areas do not need to be removed unless they were established with the primary purpose of only providing temporary erosion control.

Description

Rock mulching is the process of applying a layer of rock on a surface to reduce flow velocities and increase infiltration. Rock mulching is a commonly used alternative to vegetation in arid / semi-arid regions. This technique is effective in reducing erosion on a disturbed site by dampening raindrop impact and reducing turbidity and velocity of runoff.



For rock lining in concentrated flow paths, refer to the drainage control "rock lining" guideline.

Advantages	Limitations
<ul style="list-style-type: none"> • Can withstand high velocity overland flows • Does not require watering, unlike vegetated surfaces • Increases soil moisture • Provides weed control • Aids rehabilitation as vegetation can be established in rock mulch 	<ul style="list-style-type: none"> • Up to slopes 1V:3H or 1V:2H with the aid of mechanical anchoring or cellular confinement systems • Not to be used in channels

Design Principles

The rock type selected for mulch must be weather resistant, durable, angular and well graded e.g. basalt and sandstone. The average rock size (D_{50}) is can vary between 50 millimetres and 750 millimetres depending on the slope and expected maximum velocity as well as the rock available on site. The thickness of rock mulch shall be a minimum of 1.5 times the average rock size or 300 millimetres, whichever is greater. Thicknesses of up to 1 metre are stable on rehabilitated embankment slopes up to 1V:3H.

Rock mulching is preferred over hydromulching in areas where concentrated overland flows are expected.

Construction Guidelines

Where in-situ soil is dispersive, the top 200 millimetres of soil shall be topsoiled and ripped before the rock mulch is placed. Alternatively, a geotextile can be placed under the rock or an increased thickness can be used to improve the durability of the rock mulch.

Rock shall be placed starting from the downstream slope and continuing up slope. Rock mulching shall have a minimum thickness of 300 millimetres or 1.5 times the average rock size, whichever is greater and must cover the entire surface.

At the downstream end of a slope, a splash apron shall be constructed. By extending the rock a minimum of 1 metre downstream, the splash apron reduces the effects of scour at the toe of the slope. The rock mulch shall be slightly buried in a trench at the upstream face and downstream splash apron so that approximately 50 millimetres of the rock protrudes above the ground.

Where vegetation is to be established, a fine gravel or topsoil mixed with seed can be used to fill the rock voids and promote vegetation growth. The construction of a shade cloth fence across the rock can trap fines and assist with grass growth.

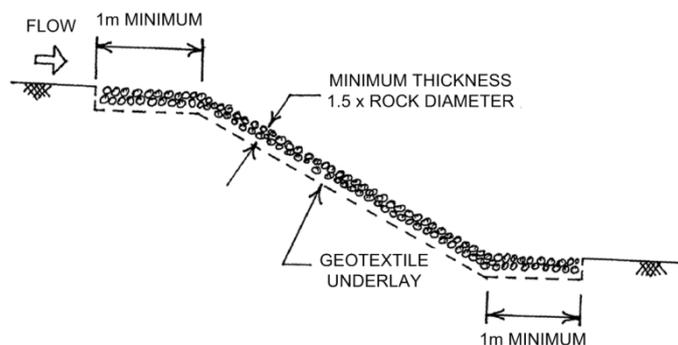


Figure 1

Monitoring

Monitoring and subsequent maintenance of rock mulching shall occur pre and post wet season and after specific rainfall events as identified in the *Monitoring Schedule guideline*.

Inspections should be concentrated on identifying:

- Areas where rock has been displaced and determining why it has occurred
- Evidence of scour under and around the rock mulching footprint
- Concentrated flow paths through the rock mulched area

Maintenance

Displacement of rock indicates that concentrated flows are occurring. Re-shaping the upstream surface may produce more even sheet flows down the slope. Consistent displacement of the rock mulch requires repair of the slope and replacement of the displaced rock with larger diameter rock.

Scour around the rock mulched area shall be fixed by extending the surface of the rock mulching or altering the upslope surface to guide the runoff into the mulched area. If scour is evident under the rock mulch, the inclusion of a geotextile underlay is necessary.

Rock mulch does not need to be removed as vegetation is likely to establish through the rock mulch.

Description

Soil binders are used as a chemical surfacing stabiliser or soil-bonding agent. They are applied on an exposed surface to form a seal and provide temporary erosion control. Soil binders are generally applied in areas where earthworks are expected to resume in a time-frame that will not allow vegetation to establish. Soil binders are effective in preventing both water and wind erosion of soils.



Soil binders can either be sprayed directly over an exposed surface or applied as tackifiers in conjunction with mulching and seeding applications.

Advantages	Limitations
<ul style="list-style-type: none"> • Good alternative to mulches in areas where construction works will soon resume • Can be used on mild and steep slopes 	<ul style="list-style-type: none"> • Not suitable for area with concentrated flows • Require long curing times (up to 24 hours) • Only used in temporary applications generally less than 3 months • Not suitable for trafficked areas • May not be effective on silty or clayey soils or in highly compacted areas • May have impacts on water quality

Design Principles

The selection of a soil binder is dependent on the regional soil type, frequency of application and the intended length of time soil stabilisation is required. There are five primary types of soil binders:

- 1) Plant-material based short lived binders e.g. Guar, psyllium and starch
 - High resistance to leaching
 - Moderate resistance to abrasion
 - Short to medium longevity
 - 9 to 18 hour curing time
 - Compatible with existing vegetation
- 2) Plant-material based long lived binders e.g. Pitch and rosin emulsions
 - High resistance to leaching
 - Low resistance to abrasion
 - Medium longevity
 - 19 to 24 hour curing time
 - Not compatible with existing vegetation
- 3) Polymeric emulsion blend binders e.g. Synthetic composite materials
 - Low to moderate resistance to leaching
 - Moderate to high resistance to abrasion

- Medium to long longevity
 - 0 to 24 hour curing time
 - Not compatible with existing vegetation
- 4) Cementitious-based binders e.g. Gypsum
- Forms a crust over the surface which is water permeable
 - Moderate resistance to leaching
 - Moderate to high resistance to abrasion
 - Medium longevity
 - 4 to 8 hour curing time
 - Not compatible with existing vegetation
 - Application rate typically 4,500 to 13,500 kilograms per hectare.
- 5) Bitumen-based binders
- Consist of a mixture of bitumen, emulsifying agent, stabilising agent and water
 - Anionic bitumen emulsion used for erosion control as it is slow-breaking.
 - Generally sprayed at an application rate of 2,500 litres per hectare on batters and 4,000 litres per hectare in areas of minor concentrated flow

Construction Guidelines

The application surface shall be prepared before the soil binder is applied. Preparation includes pre-wetting and roughening of the surface. If cementitious-based binders are to be applied, lime shall be used to treat the in-situ soil before application.

The chosen soil binder shall be applied in accordance with the manufacturer's instructions for application rates and specialist procedures. The recommended minimum curing period shall be allowed for before application of a second treatment (if required).

Ensure vehicular and pedestrian traffic are excluded from the treated zone.

Monitoring

Monitoring and subsequent maintenance of soil binders shall occur pre and post wet season and after specific rainfall events as identified in the *Monitoring Schedule guideline*.

Monitoring of the treated areas shall identify:

- Areas where scour has occurred
- Spot failure locations

Maintenance

Soil binders are susceptible to the natural weathering process and may require reapplication after a few months. Heavy rainfall events may cause erosion and areas of spot failure. If erosion is evident, repair areas and reapply original soil binder as needed to maintain effectiveness. Localised spot failure may be caused by water penetrating the soil at the top of the embankment slope and undermining the stabilised soil layer.

Soil binders do not typically need to be removed as they are exposed to the sun, oxidation, heat and biological organisms which break down the binder over time.

Description

Check dams are formed by creating small weir structures at regular intervals along an open channel. They may be used as a sediment control device by capturing bed load sediment washed into the open channel from the upstream catchment. Check dams function as a sediment control device by reducing the flow velocity in the open channel, thus allowing bed load sediment to settle behind the check dam structures.



Check dams may also be used as a drainage control, and although the intended function is different, the design and construction methodology remains the same.

Advantages	Limitations
<ul style="list-style-type: none"> • Captures sediment without changing channel design • Easy to construct • Effective sediment control in newly formed channels 	<ul style="list-style-type: none"> • Channel banks must not exceed 1V:2H • Suitable for channels with a slope greater than 1V:100H but less than 1V:10H • Catchment area shall not exceed 2 hectares • Designed to contain bed load sediment but less effective in capturing smaller suspended sediment particles

Design Principles

There are three main material types used in the construction of check dams. These are:

- 1) Sandbags filled with sand, gravel, straw or compost
 - Suitable for shallow drains <500 millimetres deep
- 2) Rock
 - Suitable for deep drains >500 millimetres deep
 - Typically 200 millimetre mean rock diameter (D50) is used, although larger rock may be warranted on steep slopes

Slope	D ₅₀ Rock Size (millimetres)
1V:100H – 1V:50H	200
1V:50H – 1V:20H	300
1V:20H – 1V:12.5H	400
1V:12.5H – 1V:10H	500

- 3) Fibre rolls
 - Biodegradable logs (e.g. Maccaferri Cocologs) made from a fibre blanket filled with organic material
 - Suitable for wide, shallow drains or in vegetated channels
 - Typically last between 4 and 10 years before biodegrading
 - Standard size of 300 millimetre diameter

Check dams should only be used in drains with a slope of less than 1V:10H. They shall not be used in batter chutes.

Construction Guidelines

Construction shall commence at the downstream check dam first then progress upstream. Ensure that the toe of the upstream check dam is at the same elevation as the crest of the downstream check dam.

Although rarely required, a geotextile underlay or rock apron can be installed to reduce erosion in dispersive soils. If required, a rock apron should be installed downstream of the check dam to a length equivalent to twice the height of the structure. See Figure 1.

Construction shall extend up the batters of the channel but should be limited to 500 millimetres from the base of the channel to ensure water does not spill at the edges of the check dam, see Figure 2. A weir should be created in the centre of the check dam by allowing at least a 150 millimetre depression. The base of the check dam shall be trenched at least 200 millimetres below the invert of the drain to minimise the risk of undermining or side cutting the structures.

Fibre rolls shall be anchored in a trench to a depth of at least one third of the diameter of the roll and fixed with wooden stakes at a maximum spacing of 1 metre. Logs can be stacked to achieve a higher crest level but remain limited to the 500 millimetre total height restriction, see Figure 3.

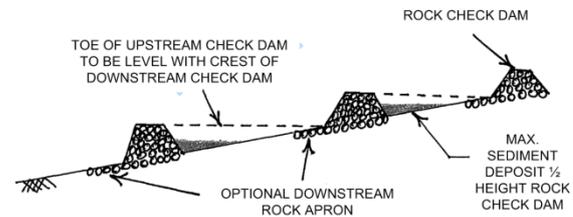


Figure 1

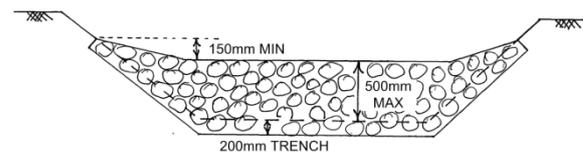


Figure 2

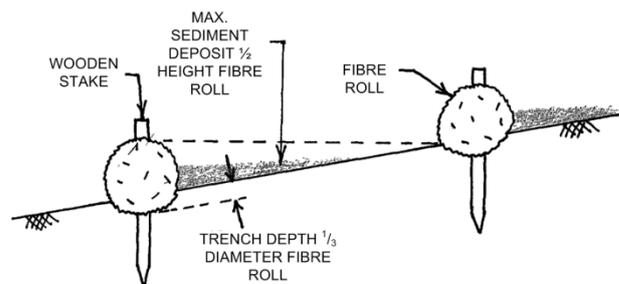


Figure 3

Monitoring

Monitoring and subsequent maintenance of check dam sediment traps shall occur pre and post wet season and after specific rainfall events as identified in the *Monitoring Schedule guideline*.

Inspections shall identify:

- Excessive deposits of sediment behind the check dam
- Failure of a check dam
- Erosion occurring underneath or adjacent to the check dam

Maintenance

Occasional removal and disposal of sediment deposit behind the check dam is required if the sediment build up exceeds half of the height of the original check dam or it is causing flows to be diverted around the ends of the check dams. Ensure the removed sediment is deposited in a location such that it won't end up back in the channel.

If failure of a check dam occurs or erosion is evident, the size of the rock needs to be increased or intermediate check dams could be constructed to further reduce the upstream velocity. Observation to ensure flow is concentrated over the weirs and not around the structures necessary. Inspection to ensure the rocks remain sufficiently anchored after extended storm events is required.

Rock and sandbag type check dams are to be removed once vegetation has established sufficiently to stabilise the channel.

Seedlings can be planted directly into the fibre log as they are 100% biodegradable. The protective netting should be removed once any planting has become established.

Description

A sediment basin is a temporary “dam-like” structure used to capture and retain sediment-laden runoff. It is often the last line of defence in a drainage network to prevent sediment laden runoff from discharging off-site. A sediment basin is designed to reduce the inflow velocities and allow suspended sediment to settle. They also aim to intercept bed load material before it can reach a downstream system.



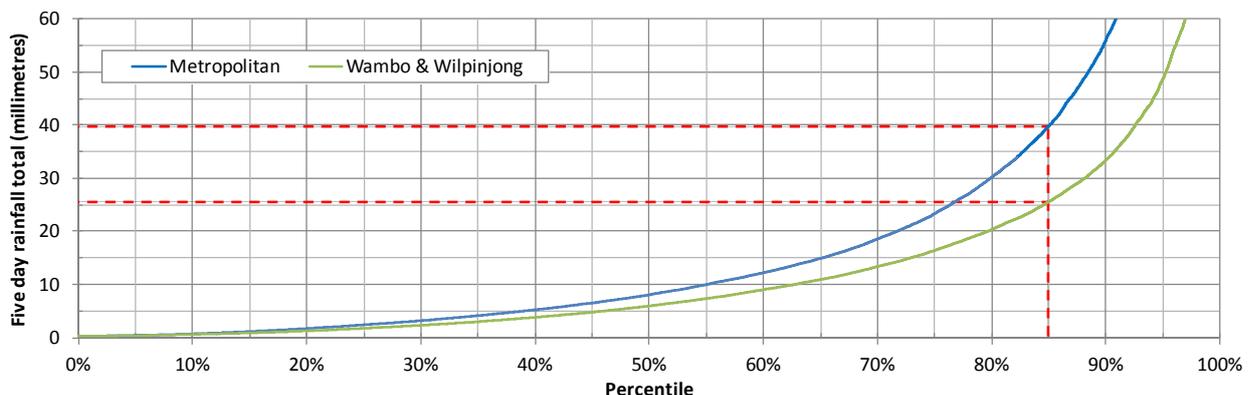
Advantages	Limitations
<ul style="list-style-type: none"> • Effective form of water treatment 	<ul style="list-style-type: none"> • Should be constructed as low in a catchment as practical but should not be constructed near a watercourse • Construction locations are constrained by appropriate geometry requirements • Not as effective during large storm event

Design Principles

Construction of a sediment basin is generally required on sites where the upstream catchment is greater than 2,500 square metres and upstream erosion and sediment controls are not fully effective.

The design principles vary depending on whether the soil is classified as coarse, fine or dispersive. It is assumed that the New South Wales Peabody mine sites are likely to be fine or dispersive. Therefore, the construction of a “wet basin” is likely to be the most appropriate for the New South Wales operations. Detailed design and sizing of a sediment basin should be undertaken by a competent person to ensure the basin has sufficient capacity and the water being discharged is of acceptable quality to meet regulatory requirements.

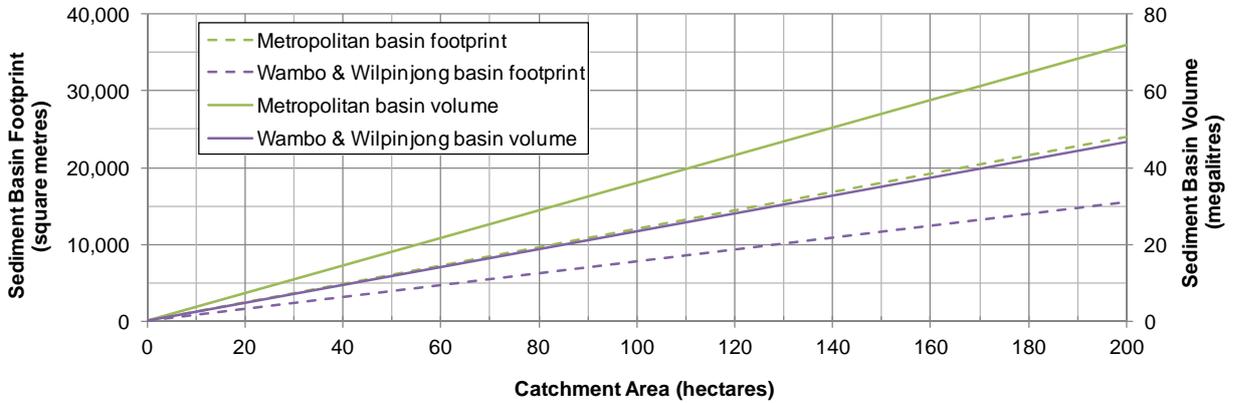
A sediment basin fundamentally consists of an inlet, a sediment storage zone, a settling zone and an outlet. Bypass systems are also constructed when a piped outlet is provided. The sizing of a sediment basin is based on the 85th percentile of the 5-day rainfall depth for the site. For the Wambo and Wilpinjong Peabody sites the 5-day rainfall depth is an average of 26 millimetres and the Metropolitan Mine is 40 millimetres, as shown below:



The upper zone within the sediment basin is the settling zone and slows the velocity of inflow water and allows suspended particles to settle. The lower zone within the sediment basin is the sediment storage zone and is used as a dead storage area to contain the settled particles. The volume of the sediment storage zone shall be approximately half the volume of the settling zone.

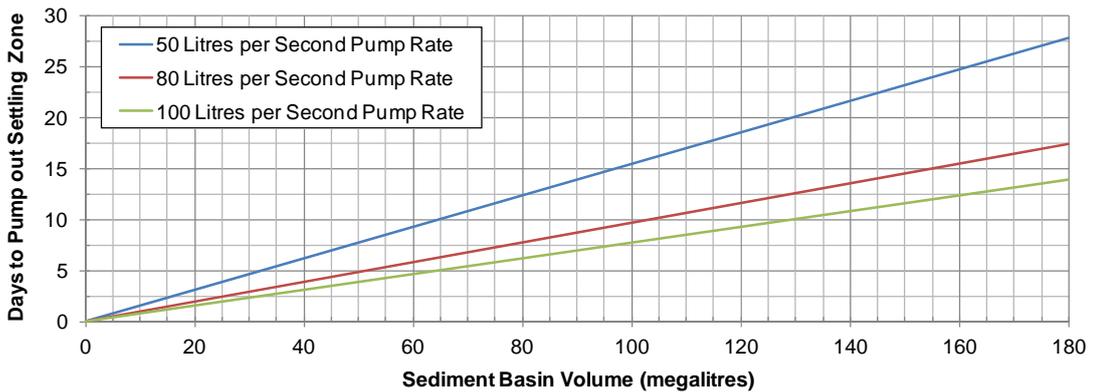


Below is an indicative overview of the required footprint area needed to construct a sediment basin, however advice from a competent person shall be sought to accurately determine the sizing prior to construction commencing.



NB: An assumed basin depth of 3 metres has been used to derive the footprint area.

Wet basins are typically designed to be filled, treated and discharged during a maximum 5 day cycle period.



The figure above should be compared against the pump-out time-frames that a specific site has committed to. Dewatering is undertaken to prevent salinity build-up within the basin.

Clean water catchments shall be diverted away from a sediment basin where possible. Although clean water diversions are still subject to sediment and erosion control standards, correct management of these systems shall reduce the sediment runoff. This will aid in reducing the total storage volume required in the sediment basin as well as reduced costs associated with the construction.

Construction Guidelines

Sediment basins shall be located in an area clear of construction activities and above any existing 1 in 5 year flood level. Planning prior to construction is required to ensure adequate access is provided to and adjacent the sediment basin to allow maintenance and desilting. Clearing of the construction footprint shall be undertaken to ensure the site is free of debris.

The basin shall be excavated and shaped ensuring the final basin length to width ratio is 3:1. Side slopes should not exceed 1V:5H for safe access during maintenance periods. The minimum recommended embankment crest width is 4 metres unless recommended otherwise by a geotechnical professional.

It is recommended that the sediment basin be 5m wide with an access road along one side of the basin if maintenance is expected to be undertaken using a moxy. Alternatively, if the basin is excavated to a width of 10m then an access road shall be provided along both sides of the basin for clean out purposes.

A wet basin overflow shall be lined with a geotextile material before dumping rock over the surface for stability and to dissipate flow energy over the overflow.

Monitoring

Monitoring and subsequent maintenance of sediment basins shall occur pre and post wet season and after specific rainfall events as identified in the *Monitoring Schedule guideline*.

Inspections shall identify:

- Basins which are receiving flows from clean water catchments.
- Excess sediment deposits exceeding the design sediment storage zone volume. This can easily be identified by driving a depth indicator post into the basin clearly indicating the sediment storage depth.
- Erosion occurring downstream of the overflow outlet.

Engineering design of a sediment basin should ensure captured water is discharged with acceptable water quality parameters, negating the need to constantly monitor water quality within the basin after every storm event.

Maintenance

When the basin is full (i.e. exceeds the marked sediment storage zone depth indication) an excavator shall be used to clean out the basin. Prior to de-silting, the basin will need to be drained or pumped completely empty. An additional period shall be allowed for drying of the sediment.

Water quality parameters must meet the regulatory requirements at the point where runoff leaves a site. However, it shall be noted that it may still be acceptable for the water quality at the sediment basin discharge point to not meet these requirements if additional downstream sediment control devices are located downstream of the basin i.e. a grass buffer zone.

Evidence of scour downstream of the sediment basin discharge point indicates concentrated flows with high velocities. Consider rock lining the overflow outlet to aid in dissipating the flow energy. The overflow outlet may be flared to spread the flow and reduce the discharged flow depth.

Sediment basins shall be filled in and rehabilitated only after all construction and rehabilitation works have been finalised. The sediment basin can be abandoned only once sufficient vegetation cover is achieved, minimising erosion. The basins will eventually silt up and disappear into the catchment.

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Description

A sediment basin is a temporary “dam-like” structure used to capture and retain sediment-laden runoff. It is often the last line of defence in a drainage network to prevent sediment laden runoff from discharging off-site. A sediment basin is designed to reduce the inflow velocities. Once below a threshold velocity, bed load materials are settled out.



Advantages	Limitations
<ul style="list-style-type: none"> • Effective form of water treatment 	<ul style="list-style-type: none"> • Should be constructed as low in a catchment as practical but should not be constructed near a named watercourse • Construction locations are constrained by appropriate geometry requirements • Not as effective during large storm events

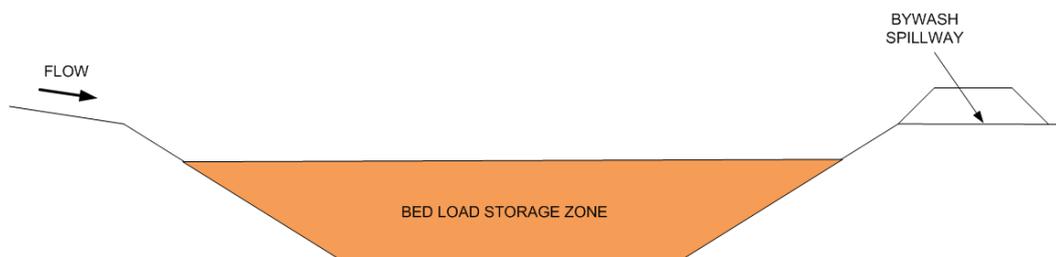
Design Principles

Construction of a sediment basin is generally required on sites where the upstream catchment is greater than 2,500 square metres and upstream erosion and sediment controls are not fully effective.

The design principles vary depending on whether the soil is classified as coarse, fine or dispersive. It is assumed that the Queensland Peabody mine sites are likely to be fine or dispersive. Therefore, the construction of a “wet basin” is likely to be the most appropriate for the Queensland operations. Detailed design and sizing of a sediment basin should be undertaken by a competent person to ensure the basin has sufficient capacity and the water being discharged is of acceptable quality to meet regulatory requirements.

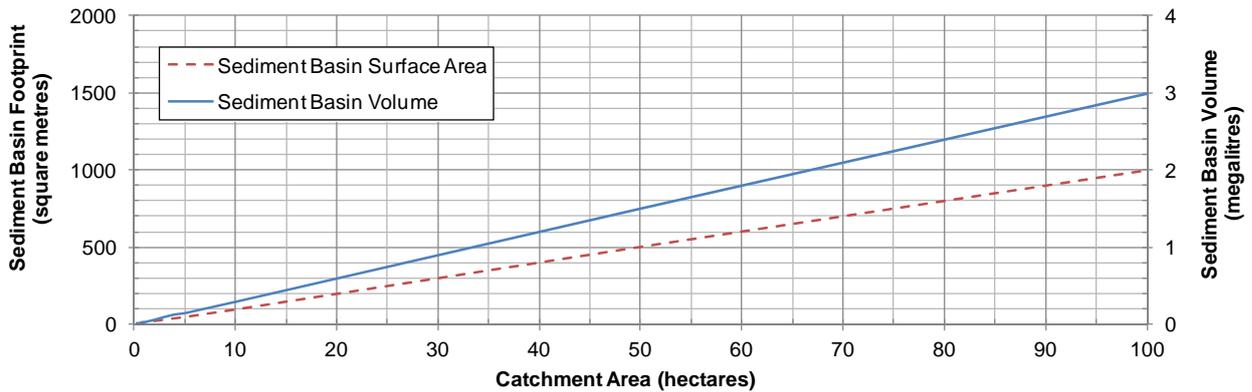
In Queensland, a sediment basin fundamentally consists of an inlet, a bed load storage zone and an outlet. Queensland sites only capture bed loads (not suspended sediment) and hence the generic sediment basin sizing guidelines are not applicable to the Queensland operations.

The bed load storage zone is used as a dead storage area to contain the settled particles.

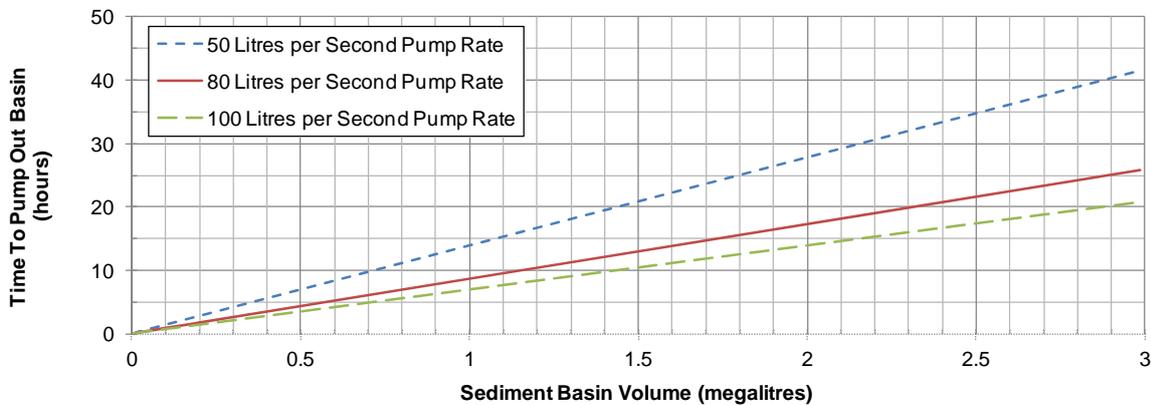


Below is an indicative overview of the required footprint area needed to construct a sediment basin, however advice from a competent person shall be sought to accurately determine the sizing.

Sediment Basin (QLD)



NB: An assumed basin depth of 3 metres and a target particle size of 500 micrometres has been used to derive the footprint area.



The figure above should be compared against the pump-out time-frames that a specific site has committed to. Dewatering is undertaken to prevent salinity build-up within the basin. Similarly, the geometry of the basin is also an effective way of controlling salinity, i.e. the design of a shallow basin ensures water spills regularly.

Construction Guidelines

Sediment basins shall be located in an area clear of construction activities and above any existing 1 in 5 year flood level. Clearing of the construction footprint shall be undertaken to ensure the site is free of debris. The basin shall be constructed so the overflow is at natural ground level, negating the need to build a dam wall and engineer a major spillway.

The basin shall be excavated and shaped ensuring the final basin length to width ratio is 3:1. Side slopes should not exceed 1V:5H for safe access during maintenance periods. The minimum recommended embankment crest width is 4 metres unless recommended otherwise by a geotechnical professional.

It is recommended that the sediment basin be 5 metres wide with an access road along one side of the basin if construction is undertaken using a moxy. Alternatively, if the basin is excavated to a width of 10 metres then an access road shall be provided along both sides of the basin or an internal access ramp would be required.

A wet basin overflow shall be lined with a geotextile material before dumping rock over the surface for stability and to dissipate flow energy over the overflow.

Monitoring

Monitoring and subsequent maintenance of sediment basins shall occur pre and post wet season and after specific rainfall events as identified in the *Monitoring Schedule guideline*.

Inspections shall identify:

- Basins which are receiving flows from clean water catchments.
- Excess sediment deposits exceeding the design sediment storage zone volume. This can easily be identified by driving a depth indicator post into the basin clearly indicating the sediment storage depth.
- Erosion occurring downstream of the overflow outlet.

Engineering design of a sediment basin should ensure captured water is discharged with acceptable water quality parameters.

Maintenance

Clean water catchments and drains shall not be discharged into a sediment basin. Catch drains shall divert clean water around a sediment basin and discharge directly into the environment. This will aid in reducing the total storage volume required in the sediment basin as well as reduced costs associated with the construction.

When the basin is full (i.e. exceeds the marked sediment storage zone depth indication) an excavator shall be used to clean out the basin. Prior to de-silting, the basin will need to be drained or pumped completely empty. An additional period shall be allowed for drying of the sediment.

Water quality parameters must meet the regulatory requirements at the point where runoff leaves a site. However, it shall be noted that it may still be acceptable for the water quality at the sediment basin discharge point to not meet these requirements if additional downstream sediment control devices are located downstream of the basin i.e. a grass buffer zone.

Evidence of scour downstream of the sediment basin discharge point indicates concentrated flows with high velocities. Consider rock lining the overflow outlet to aid in dissipating the flow energy. The overflow outlet may be flared to spread the flow and reduce the discharged flow depth.

Sediment basins shall be filled in and rehabilitated only after all construction and rehabilitation works have been finalised. The sediment basin can be abandoned only once sufficient vegetation cover is achieved. The basins will eventually silt up and disappear into the catchment.

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Description

A buffer zone is a vegetated area, generally a grassed area, provided around the perimeter of an earthworks footprint. Its primary purpose is to reduce sediment transportation by acting as a 'sediment trap'. The zone reduces velocities of overland flow to allow settlement and entrapment of suspended particles.

A strip of vegetation should be well established prior to utilising the buffer zone for sediment control.



Advantages	Limitations
<ul style="list-style-type: none"> • Mostly suited to sandy soil to control bed load sediment runoff • Can provide some degree of turbidity control while the buffer zone remains unsaturated 	<ul style="list-style-type: none"> • Appropriate for sheet flows only • Limited to slopes less than 1V:10H • Most suitable for bed load sediment but less effective for capturing suspended solids

Design Principles

Buffer zones are formed by establishing vegetation around the perimeter of the disturbed site. The wider and more dense the buffer zone is, the more effective this control method is at reducing sediment runoff. Buffer zones shall be a minimum width of 6 metres or 5 times the upstream slope percentage, whichever is greater.

Buffer zones need to be of adequate length that sheet flow does not run off the surface and around the vegetated zone. As a general rule, the minimum length of a buffer zone should be the same as a sediment fence. That is, 15 metres or 5 times the percentage of the upstream slope, whichever is greater.

Upstream Slope	Buffer Zone Length (metres)
Up to 1V:33H	15
1V:25H	20
1V:20H	25
1V:10H	50

If a large amount of sediment is expected, the construction of a sediment fence upstream of the buffer zone will improve the overall performance of the sediment control. The upstream erosion controls shall also be improved to limit the amount of sediment in a buffer zone.

Construction Guidelines

A buffer zone shall generally be located at least 50 metres from the earthworks clearance footprint. A visible structure, such as a fence, should generally be constructed around the buffer zone to clearly identify the area and prevent traffic from driving over it.

The upstream surface must be shaped to ensure sheet flows are produced evenly along the buffer zone. Similarly, the buffer zone shall be a constant grade and free of gullies and rills.

Buffer zones are most effective in areas where vegetation is well established prior to allocation of the buffer zone. Vegetation shall be a minimum of 50 millimetres high and must cover at least 80% of the surface to be effective in controlling bed load sediment runoff.

Monitoring

Monitoring and subsequent maintenance of a buffer zone shall occur pre and post wet season and after specific rainfall events as identified in the *Monitoring Schedule guideline*.

Monitoring inspections should involve:

- Identifying concentrated flow paths within the buffer zone and bypassing flows around the zone.
- Investigation into where excess sediment deposits are coming from and why they are occurring. It is to be noted that sediment is expected to be contained within the first half of the buffer zone.
- Ensuring no traffic disturbance in the area.

Maintenance

Channels and deformations in the ground shall be filled in and re-seeded. If concentrated flow persists, upstream conditions shall be investigated or an alternative type of sediment control should be utilised.

Removal of excess sediment deposits in the buffer zone should be undertaken when they exceed the minimum grass length of 50 millimetres. Broadleaf weed control must be maintained during the construction period to promote the growth of grass vegetation.

Maintenance of fences around the zone shall occur until construction works are complete. Buffer zones do not need to be removed upon completion of the works.

Oc Description

Sediment fences are temporary devices constructed to reduce sediment transportation by intercepting sheet flows. Settlement of entrained sediment particles is achieved by reducing the velocity of the overland flow and creating small ponds of water on the upstream side of the fence. Sediment fences should be installed around all construction footprints, as a last line of defence system to contain sediment.



Sediment fences are created using special purpose synthetic material laid vertically by securing to stakes and anchored the toe of the fence in to a trench.

Advantages	Limitations
<ul style="list-style-type: none"> • Cost effective • Easy to install • Can be installed at any construction site • Suitable for all soil types • Highly visible form of sediment control 	<ul style="list-style-type: none"> • Should only be used as temporary structures • Traps coarse sediments only • Not to be used in concentrated flow paths • Suitable in low flow situations only • Limited to contributing catchment areas up to 0.6 hectares per 100 metres of fence

Design Principles

There are two main material types used for sediment fences and selection typically depends on soil classification and duration of use.

- 1) Woven fabric
 - Sandy soils
 - Longer duration construction sites
 - Used when water control required
- 2) Non-woven composite fabric
 - Clayey soils
 - Short duration construction sites

Hardwood timber stakes (minimum 1250 square millimetre cross section) or steel star pickets (minimum 1.5 kilograms per metre) can be used as support posts depending on availability. Posts are to be spaced at 3 metre centres if wire backing is used, or 2 metre centres if no wire backing. The minimum total length of any sediment fence is 15 metres or 5 times the upstream percentage slope, whichever is greater. Spacing between sediment fences depends on the slope of the upstream catchment.

Slope	Max fence spacing (metres)
1V:50H – 1V:12.5H	35 - 28
1V:12.5H – 1V:8H	28 - 23
1V:8H – 1V:6H	23 - 18
1V:6H – 1V:4H	18 - 15

Construction Guidelines

Sediment fences should be installed prior to and maintained during all construction earthworks. A clear width of 2 metres between the toe of an embankment or stockpile and the fence shall be maintained, or greater if construction access requires. Installation of sediment fences should be in line with contours and have returns every 20 metres that extend at least 1 metre upslope. The ends of the fence should turn upslope to prevent water from diverting around the end of the structure and discharging to surrounds. If for construction reasons the fence needs to be installed at an angle to the contours, then regular returns with 5 to 10 metre spacing will promote ponding along the length of the fence. Adequate anchorage at the fence base is essential for the long-term durability of these structures. The synthetic material shall be buried at least 200 millimetres into the trench and backfilled and compacted using in-situ material. If a woven material is used, a wire mesh backing is normally placed behind the fabric to provide additional support. If a non-woven material is used, the non-woven (green) face must point up-slope.

A minimal number of joins should be used when construction a sediment fence. Joins are to be created by overlapping the ends of the fabric and securing to the posts.

Monitoring

Monitoring and subsequent maintenance of sediment fences shall occur pre and post wet season and after specific rainfall events as identified in the *Monitoring Schedule guideline*. Monitoring shall identify:

- Excess sediment deposit against the fence
- Tears in the fence material
- Failure of a sediment fence or evidence of concentrated flow paths

Maintenance

Sediment deposits exceeding one quarter of the fence height shall be removed and disposed of in a location not within the fence catchment area. The condition of the fencing material should be inspected to ensure there are no tears in the fabric or sagging in localised areas and the material remains anchored in the trench. Replacement or repair of the fence shall occur before the next rainfall event. During the inspection process, it is vital to ensure the sediment fence is not creating adverse results by concentrating flow to a particular point along or at the end of the fence.

Sediment-laden water should be contained by a singular sediment fence. If a fence fails, additional posts with a spacing of approximately 0.5 metres should be used for additional strength or intermediate fences should be constructed to reduce the catchment area.

Sediment fences should be removed upon completion of the works and rehabilitation of the site. This is applicable after a minimum of 80% of seed has germinated.

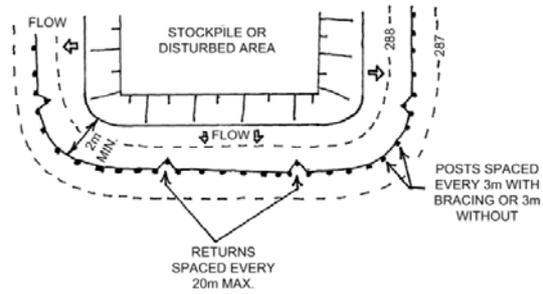


Figure 1

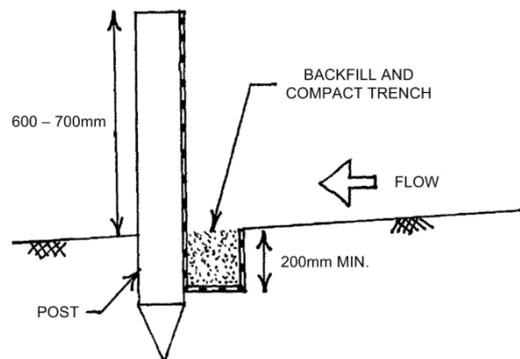


Figure 2

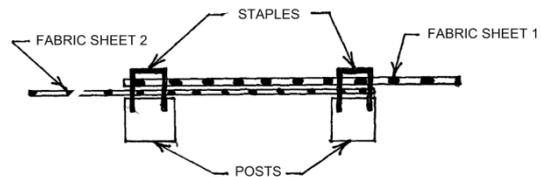


Figure 3

Overview

The philosophy behind the erosion and sediment control (ESC) management for each operation relies on the ability of Peabody to demonstrate that each catchment has suitably designed ESC works that have been installed and maintained. As such, monitoring and maintenance of the ESC works is a commitment by Peabody to demonstrate on-going regulatory compliance. This guideline covers the monitoring requirements deemed to meet this commitment.

Erosion and sediment control (ESC) works are generally designed to perform during the less intense, more frequent rainfall events. Although some works may be designed to withstand the more intense and less frequent rainfall events (e.g. sediment basins), damage may be sustained to the works during these larger events. As such, the monitoring and subsequent maintenance of ESC works is imperative to ensure that the performance of the devices is not compromised due to damage or excessive wear.

A monitoring regime needs to be implemented that ensure the integrity of the devices is maintained while not placing an unnecessary burden on operational personnel. An indicative monitoring regime has been established that includes consideration the ESC works location, pre wet season preparedness, post wet season condition and the intensity of site rainfall. Based on these items, the proposed monitoring regime is summarised in Table 1. Definitions for the items in the table are detailed in the following sections.

Table 1 – Monitoring regime requirements

ESC Works	Pre wet season	Post wet season	Trigger storm event	Significant storm event
Critical	✓	✓	✓	✓
Non-critical	✓	✓	✗	✓

Location of the Works

Failure of ESC works may have varying impact on the off-lease receiving environment depending on the works and location within the mining operation. As such, it is recommended that classification of ESC works be undertaken to identify the critical and non-critical works, defined as:

- **Critical ESC works** are those that through poor performance or failure of the works are likely to result in release of sediment either off-lease or on-lease into areas of identified sensitive or protected vegetation, or failure is likely to result in a cascading failure of downstream ESC devices (e.g. failure of large areas revegetation erosion control located upstream of grass buffer strip sediment control works).
- **Non-critical ESC works** are works that are unlikely to result in loss of sediment off-lease through poor performance or failure. This includes works where sediment release will be captured by downstream on-lease ESC works or captured into the site's worked water dams or mining pits.

Identification of *critical* and *non-critical* works shall be undertaken by site personnel through a risk review process.

Post Wet Season

At the end of the wet season, all ESC works (critical and non-critical) shall be inspected during April. The intent of this inspection is to monitor the ESC works to ensure that over the preceding five month wet season, damage or loss of performance of the ESC works has not occurred.

The condition and any identified remedial works identified during the inspection shall be documented for each ESC structure. Identified maintenance requirements shall be undertaken during May to reinstate the ESC works to the design condition to ensure continued performance and compliance with the site's ESC commitments.

Pre Wet Season

For both the New South Wales and Queensland operations, the wet season is generally defined as 1st November to the 31st March, although the distinction is more pronounced in Queensland due to the influence of tropical weather conditions. Remedial works identified in the post wet season inspection should have occurred in the post wet season maintenance period. To ensure the ESC works are in a functional condition prior to the wet season, inspection of the ESC works shall be undertaken again during September, with the intent that any additional identified maintenance will be undertaken in October, prior to the wet season.

The pre wet season inspection is required for all ESC works (critical and non-critical). The condition and any identified remedial works identified during the inspection shall be documented for each ESC structure. Identified remedial works shall be undertaken during October to ensure the ESC works are fit for use.

Storm Events

The intent of the storm event triggers is to ensure that monitoring of the ESC works is responsive to the climate conditions experienced at the site. It is recommended that two trigger values be selected, defined as:

- **Trigger storm event** is the rainfall depth that if received in a 24 hour period will require site personnel to inspect and document the condition of the *critical* ESC works.
- **Significant storm event** is the rainfall depth that if received in a 24 hour period will require site personnel to inspect and document the condition of the *critical* and *non-critical* ESC works.

Review of long term historical rainfall data for a number of the New South Wales and Queensland operations has been undertaken to establish a relationship between daily rainfall totals and average yearly occurrence. It was found that this relationship did not vary greatly between the operations, with the developed trend shown in Figure 1.

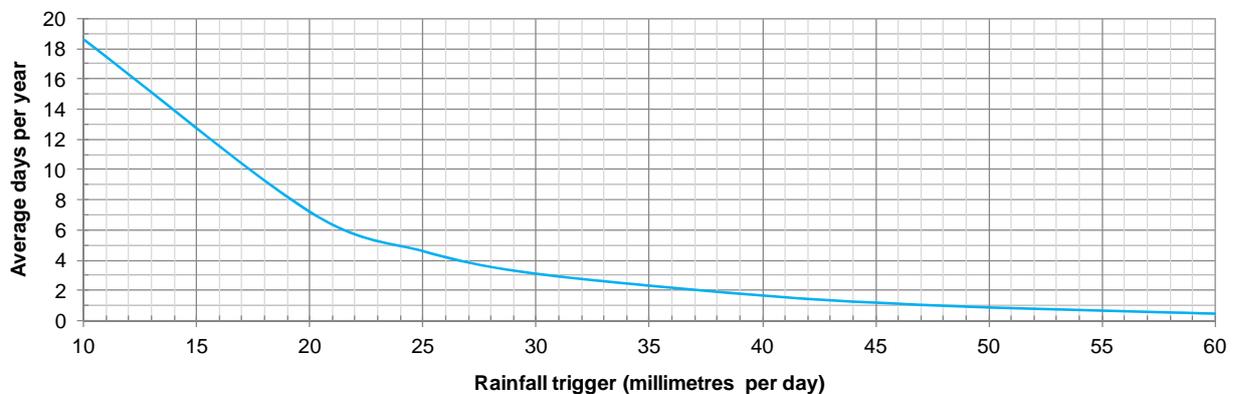


Figure 1 – Rainfall trigger

Based on the Figure 1, it is recommended that the following trigger values be adopted:

- **Trigger storm event:** 22 millimetres per day to 25 millimetres per day
- **Significant storm event:** 45 millimetres per day to 50 millimetres per day

Documentation Requirements

At a minimum, each inspection shall be documented by photographs and a summary of the identified maintenance requirements for each inspected ESC device. This information shall be captured into the site's data management system to ensure that required maintenance may be tracked.

Capture of the monitoring inspections into the data system forms part of the requirements to demonstrate compliance with regulatory requirements. Failure to suitably document monitoring inspections may expose Peabody to regulatory non-compliance risk.

APPENDIX D: Wambo Coal Surface Disturbance Permit

WA-SAH-PER-305.22 SURFACE DISTURBANCE PERMIT



The Surface Disturbance Permit is to be used when assessing and approving mine related activities requiring ground disturbance within exploration and mining leases

SDP Number:	
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Activity Description:			
Responsible Person:		Statutory Area Manager:	
Project Start:		Project Finish:	
Disturbance Area (ha):	Easting:	Northing:	

ALL PERMITS REQUIRE A FIGURE SHOWING RELEVANT: ABORIGINAL ARCHAEOLOGY, THREATENED ECOLOGICAL COMMUNITIES, MONITORING LOCATIONS, DEVELOPMENT CONSENT, MOP, MINING/EXPLORATION LEASE AND LAND OWNERSHIP.

Approvals and Constraints	Y	N	N/A	Boundaries and Conditions	Y	N	N/A
For exploration activities, are regulatory approvals/notifications required?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Is the proposed activity <i>located outside</i> the following boundaries:			
Landholder notification/access agreement required?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Wambo land ownership	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Flora/fauna or archaeological constraints?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	AHIP	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Erosion and Sediment Control Implementation Plan (ESCIP) required? <i>Review pre- and post-disturbance flow paths.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Mining and/or Exploration Leases	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Will any surface infrastructure be impacted? (e.g. access tracks, pipelines, monitoring)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Approved Surface Development boundary	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Dust, noise, and/or lighting impacts?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
Does the SDP boundary require fencing?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Is the proposed activity <i>inconsistent</i> with the following conditions:			
Topsoil resource identification and an appropriate stockpile location required? <i>If YES, complete Topsoil Stripping Permit</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	MOP	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Are exotic flora species (weeds) present? <i>If YES, undertake follow-up weed inspection and control post disturbance.</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Development Consent/s	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Activity within 40m of a riparian zone and/or on waterfront land?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Environmental Management Plans	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Is an Excavation Permit required?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Relevant regulation and planning policies eg. SEPP	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Activity within the notification areas for tailings dams?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				
Is rehabilitation required prior to SDP Completion Sign Off?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>				



ALL UNNECESSARY INFRASTRUCTURE, EQUIPMENT AND MATERIALS ARE TO BE REMOVED AND THE SITE LEFT IN A CLEAN AND TIDY MANNER.

SDP Completion Sign Off			
Role	Name	Signature	Date
Responsible Person			
Environment and Community Manager			

ONCE THE SDP COMPLETION HAS BEEN SIGNED OFF, THE ENVIRONMENT AND COMMUNITY MANAGER SHALL FILE IN THE SITE SDP REGISTER.

APPENDIX E: Risk Assessment Matrix

Likelihood	Likelihood description	Probability	Consequence					
			Low (1)	Minor (2)	Moderate (5)	Significant (10)	Major (25)	Catastrophic (50)
5 - Very Likely	Likely to occur repeatedly – Expected in the work team	10% - 100%	5	10	25	50	125	250
4 - Likely	Probably will occur several times - Expected at this location	1% - 10%	4	8	20	40	100	200
3 - Possible	Could occur intermittently - Expected within Peabody	0.1% - 1%	3	6	15	30	75	150
2 - Unlikely	Could occur but hardly ever - Expected within the mining industry	0.01% - 0.1%	2	4	10	20	50	100
1 - Rare	Improbable or unrealistic - Not expected in the mining industry but seen in other industries	< 0.01%	1	2	5	10	25	50

Consequence Category		Consequence descriptions					
		Low	Minor	Moderate	Significant	Major	Catastrophic
Harm to People	P	Near miss, near hit, no medical treatment, report only (RO)	Slightly injured, first aid treatment (FAI)	Medical treatment (MTI), disabling reversible impairment, restricted work (RWVI) or lost time (LTI)	Serious bodily injury or disabling irreversible impairment, permanent partial disability (PPD)	Single fatality incident. Total and permanent disability (TPD). Major irreversible health effects	Multiple fatality incident. Major injury / disease among multiple employees
Environmental	E	Negligible or reversible environmental impact Nil to minor remediation (typically a shift) No breach of regulations or requirement to report to regulators	Minor reversible environmental impact, minor remediation (typically < 5 days) Non-compliances and breaches of regulation that may result in a citation (NOV) May require reporting to the regulators	Incident resulting in moderate reversible onsite and/or off-site impact causing short term effect. Moderate remediation required (typically a month) Non-compliances and breaches of regulation that may result in prosecution or citation or punitive fine. Requirement or obligation to report to the regulators	Incident resulting in significant onsite or off-site environmental impact causing medium to long term environmental harm Significant remediation required (typically less than 12 months) Significant legal issues, non-compliances and breaches of regulation that results in a prosecution or citation or fine Moderate litigation issues involving many weeks of senior management time	A major incident resulting in regional environmental impact causing long term environmental harm Major long term remediation required (greater than 12 months) Major litigation or prosecution resulting in long term interruption to operations or loss of licence at a site	Incident resulting in catastrophic widespread regional environmental harm causing disastrous effect Major long term remediation required (over multiple years) Major litigation or prosecution, Loss of License to operate at Multiple sites
Finance (higher of cost or NPV)	F	<\$10,000	\$10,000 - \$100,000	\$100,000 - \$1 mil	\$1 mil - \$20 mil	\$20 mil-\$100 mil	>\$100 mil
Impact on reputation	R	Minor impact, no public concern; Market cap impact < \$20 M (< \$0.07 per share)	Local media or public concern; Market cap impact \$20 M - \$30 M (\$0.07 - \$0.12 per share)	Regional media or public concern. Local criticism; Market cap impact \$30 M - \$100 M (\$0.12 - \$0.40 per share)	National adverse media or public criticism; Market cap impact \$100 M - \$250 M (\$0.40 - \$1.00 per share)	International adverse media or public criticism. International public concern; Market cap impact \$250 M - \$500 M (\$1.00 - \$1.85 per share)	Significant international public or media criticism or condemnation; Market cap impact > \$500 M (> \$1.85 per share)
Law / Compliance / regulatory	C	Minor, one-off violations of law, regulation, permit or policy; minimal fines, penalties or costs	Recurring or systemic minor violations of law, regulation, permit or policy	Violations of law, regulation, permit or policy with moderate fines or penalties, Moderate Litigation, MSHA imminent danger order or similar	Significant violation of law or permit with material fines, penalties or costs. Serious dispute with strategic customer. Major Litigation	Material Litigation. Serious investigation by SEC, DOJ or foreign equivalent. Code of Conduct violations	Criminal investigation or proceedings involving officers or directors. Litigation with allegations of executive fraud or misappropriation
Strategic risk	SR	Event does not have a meaningful impact to Strategic Outlook	Event does not have meaningful impact to Strategic Outlook, but may require further monitoring	Event may have a material impact on near term outlook for a region or mine	Event has a material impact on strategic outlook for a region or basin that may require a change to operations to mitigate risk	Event causes mines in a region or basin to cease current operations	Event or threat such that BTU would cease to exist as an ongoing concern in coal operations

Risk Score	Notification	Level	Action (H&S)
<11	Crew / team	Same level	Develop a plan (formal or informal) with crew or continue with established plan (SOP etc.) that ensures the task can be completed safely. Team should remain aware for changing conditions.
11 to 30	Supervisor	+1	Develop a formal safe action plan with supervisor and others within the crew (SOP) that identifies all known hazards and details what controls need to be in place and how the task should be performed to ensure it can be completed safely.
31 to 50	Area manager or site GM	+2	Conduct a formalized risk review of existing work process and controls. Explore additional control options that eliminate, substitute or reduce the risk. Monitor controls for effectiveness during the task.
51 - 100	BU Mgt	+3	Controls should be reviewed to ensure risk is as low as reasonably practicable (ALARP), critical controls must be identified and monitored for effectiveness. If risk is not at ALARP, additional controls must be identified and a plan developed for implementation.
101 to 199	ELT	+4	Controls should be added / improved and an additional risk assessment completed for activity to proceed.
200 or greater	CEO	+5	Controls should be added / improved and an additional risk assessment completed for activity to proceed.

APPENDIX F: Example of Sediment Dam Construction Certification

Certification of Sediment Basin Construction

BASIN IDENTIFICATION CODE/NUMBER:

LOCATION:

Legend: ✓ OK ✗ Not OK N/A Not applicable

Construction:

Item	Consideration	Assessment
1	Sediment basin located in accordance with approved plans.	.....
2	Embankment material compacted in accordance with specifications.	.....
3	Critical basin and spillway dimensions and elevations confirmed by as-constructed survey.	.....
4	Required freeboard adjacent embankments and spillway confirmed by as-constructed survey.	.....
5	Placement of rock on chute and upstream face of spillway in accordance with design details and standards.	.....
6	Placement of rock within energy dissipation zone downstream of spillway in accordance with design details and standard.	.....
7	All other sediment basin requirements in accordance with design details and standards.	.....
8	As-constructed plan prepared for basin and spillway.	.....

INSPECTION OFFICER DATE

SIGNATURE

Geotechnical:

Item	Consideration	Assessment
9	Suitable material used to form all embankments.	.....
10	Appropriate compaction achieved in embankment construction (if observed).	.....
11	No foreseeable concerns regarding stability or construction of the basin and spillway.	.....

INSPECTION OFFICER DATE

SIGNATURE

APPENDIX G: Wambo Topsoil Stripping Permit

TOPSOIL STRIPPING PERMIT

Prior to topsoil stripping the environmental delegate and the topsoil stripping supervisor shall conduct a site inspection of the area and complete the following form.

Topsoil Location:			
Topsoil Stripping Supervisor:		Environmental Delegate:	
Proposed Start Date:		Work Duration:	
Disturbance Area (ha):			

ALL PERMITS REQUIRE A PLAN SHOWING RELEVANT: STRIPPING LIMITS, STRIPPING DEPTHS, NO GO ZONES, DRAINAGE LINES, TOPSOIL TO BE SEGREGATED (WEEDS) AND ITEMS TO SALVAGE (STAG TREES, ROCKS, ETC).

Constraints	Y	N	N/A	Boundaries and Conditions	Y	N	N/A
Has a Surface Disturbance Permit been completed for the proposed works?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Is the topsoil getting stockpiled? If YES complete the questions below:			
Is stripping depth uniform across site?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Is the stockpile location clear of rocks and debris?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Will the topsoil stripping only occur during daylight hours?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Is the stockpile location of sufficient size to contain all stripped topsoil?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Are erosion and sediment controls in place?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Are multiple stockpiles required to separate soil type/quality?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Are soil types and quality uniform across the stripping area?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Is the stockpile location consistent with the MOP and future activity in the area?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Are soil moisture levels conducive to stripping? (Soil not too wet or dry)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Has timber been mulched?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Topsoil resource identification and an appropriate dump location determined?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Are equipment operators experienced in topsoil stripping	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

IF NO WAS ANSWERED TO ANY OF THE ABOVE; CONTROLS OR CONDITIONS RECORDED BELOW. ATTACH COPIES OF ALL ADDITIONAL WORKS

Conditions of Topsoil Stripping Permit (filled out by Environmental Delegate)

Topsoil Stripping Approval			
Role	Name	Signature	Date
Statutory Manager			
Environment and Community Manager			

PRIOR TO TOPSOIL STRIPPING COMPLETION SIGN OFF, THE STRIPPED AREA AND STOCKPILE AREAS ARE TO BE INSPECTED BY THE ENVIRONMENTAL DEPARTMENT. ANY OUTSTANDING WORKS TO BE COMMUNICATED TO THE WORKS SUPERVISOR.

TSP Completion Sign Off			
Role	Name	Signature	Date
Responsible Person			
Environment and Community Manager			