ENGENY

MIDDLEMOUNT COAL PTY LTD

Middlemount Coal Mine

Erosion and Sediment Control Plan

BBNE00351_0034-REP-001-2

4 OCTOBER 2024

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0	30/11/2021	Client Issue	Nutan Gothwal	Ben Kiernan	Nutan Gothwal	Ben Kiernan
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2	4/10/2024	Client Issue	Nutan Gothwal	Ben Kiernan	Nutan Gothwal	Ben Kiernan
Signatures:						

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1. INTRODUCTION

This Erosion and Sediment Control Plan (ESC Plan) provides guidance in the management and application of erosion and sediment control techniques at the Middlemount Coal Mine (MCM). The main objectives for this ESC Plan are:

- define preferred ESC techniques to be implemented using a risk based decision tree tool.
- provide a practical/workable ESC Plan for site works.
- provide design criteria for future ESC structures.
- define ESC maintenance requirements; and,
- develop an ESC Plan to meet the relevant authority's requirements (including compliance with Conditions C33 to C34 of the Environmental Authority (EA) (DESI, 2024).

1.1 Background

Middlemount Coal Pty Ltd (MCPL) owns and operates the MCM, an existing open cut coal mine, located approximately 7 kilometres (km) to the south-west of the Middlemount township within the Isaac Regional Local Government Area, Queensland.

MCPL has approval to produce 5.7 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal designated under Mining Leases ML70379, ML70417, ML700014 and ML700027, and an EA - EMPL00716913 (DESI, 2024)).

The location of the mine and surrounding drainage features are shown in Figure 1.1 The layout of MCM is shown in Figure 1.2.

1.2 Purpose and Scope

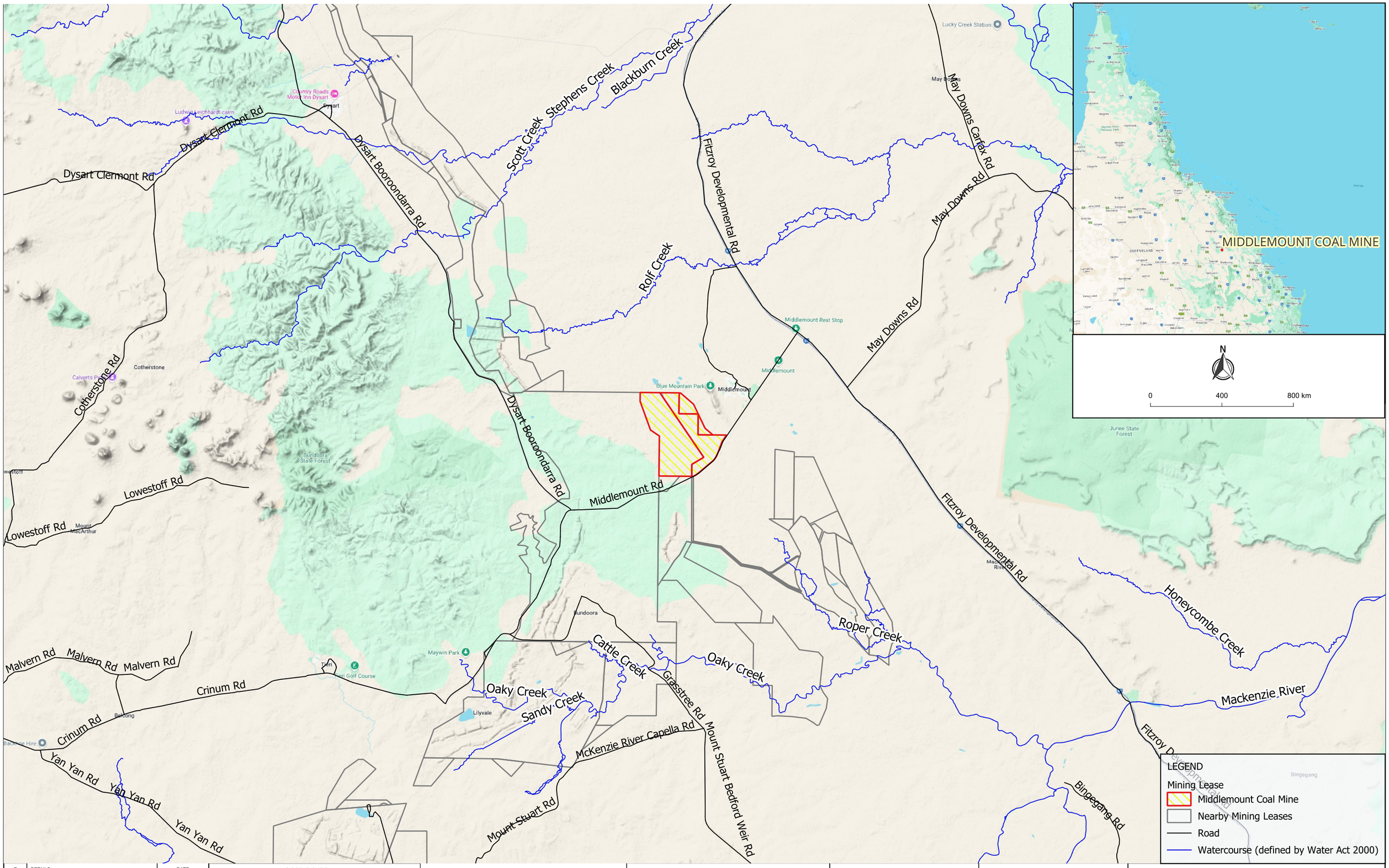
This ESC Plan has been prepared to meet the requirements of Conditions C34 and C35 of the EA-EPML00716913 for MCM (DESI, 2024).The primary purpose of this document is to develop strategies to manage on-site stormwater and catchment runoff water at MCM. With respect to on-site stormwater, the key objectives of erosion and sediment control plan at MCM are to:

- Examine and address all issues relevant to the generation, management, and mitigation of erosion and sediment transport at MCM.
- Provide guidance in erosion and sediment related issues and management techniques applicable to MCM.
- Determine the appropriate requirements for sediment and erosion control and management for all land uses at MCM.
- Provide that ESC structures are appropriately maintained.
- Minimise adverse effects on downstream waterways (including hydraulic and water quality impacts).
- Provide methods to assess compliance with conditions of the EA and legislation relating to surface waters; and,
- Comply with any relevant environmental license, authority or any other regulatory requirements.

The benefits of establishing an ESC Plan include:

- Minimise off site impacts (by-products of erosion).
- Deliver stable landforms that will not pollute downstream environments.
- Provide clear, concise and standardised practices for operations.
- Provide clarity for planners, supervisors and contractors, and
- Improve auditability and conformance to standards.

The management strategies for mine affected water (MAW), tailings return water and contaminated water are described in the site Water Management Plan (WMP) listed in Section 1.3.



R	DETAILS	DATE
1	Final Issue	12-09-2024

DRAWN	KZ	CHECKED	NG
APPROVED	BK	DATE	12-09-2024

NOTES:

SCALE - 1:300,000
GDA94 / MGA zone 55

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DATA SOURCE
QLD Government Open Data Source

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Figure 1.1

Middlemount Coal Pty Ltd
Erosion Sediment Control Plan
Locality and Regional Drainage

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BBNE00351_0034_001

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MWD2
North Dam
SD7
SD6.5
SD6
SD12
SD2
STD
NROM
SD3
MWD
RWD
SD1/SD1 Ext.
Flocc Cell 2
Flocc Cell 1
TSF1
TSF2

LEGEND
- Catchments
- Waterways
- Mining_leases

Water Infrastructure
- Mine-affected Water Storage
- On-site Stormwater Storage
- Tailings Storage / Flocc Cell

R	DETAILS	DATE
1	Final Issue	11-09-2024

DRAWN	KZ	CHECKED	NG
APPROVED	BK	DATE	11-09-2024

NOTES:

N
0 0.2 0.4 km
SCALE - 1:23,000
GDA94 / MGA zone 55

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DATA SOURCE
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Figure 1.2

Middlemount Coal Pty Ltd
Erosion Sediment Control Plan
Water Infrastructure, Catchments, and Local Drainage

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1.3 Related Documents

This ESC Plan forms part of the MCM Environmental Management System and should be read in conjunction with the following reports:

- MP 207-001 Water Management Plan (WRM, 2019).
- Operational Water Management Plan 2022. Middlemount Coal Mine (Engeny, 2022).
- Water Balance Model Development. Middlemount Coal Mine (Engeny, 2021).

In preparing this ESC Plan, the International Erosion Control Association's (IECA) *Best Practice Erosion and Sediment Control Guidelines* (IECA, 2008) (IECA, 2018) were considered and adopted as relevant.

1.4 Report Structure

This report is structured as follows:

- Section 2 describes the ESC framework including regulatory requirements, environmental values and water quality objectives.
- Section 3 describes the existing environment including expected soil characteristics.
- Section 4 outlines the principles of erosion and sediment control.
- Section 5 provides a description of erosion and sediment control measures and their application.
- Section 6 provides a description of the erosion and sediment control design criteria.
- Section 7 provides a description of routine inspection and maintenance process.
- Section 8 outlines the emergency and incident response process and
- Section 9 gives a list of references.
- Appendix A provides inspection proforma
- Appendix B provides design rainfall depth

1.5 Revisions and Updates

In accordance with Condition C33 of the MCM EA (DESI, 2024), this ESC Plan is to be reviewed, updated and submitted to the administering authority at an interval no greater than 3 years to ensure it remains current in relation to applicable reference documents, ESC techniques and application to MCM operations.

2. ESC FRAMEWORK

2.1 Regulatory Framework and Relevant Guidelines

The following regulatory framework and relevant guidelines are applicable to the ESC Plan for MCM operations:

- Environmental Protection Act (EPA) 1994 (DES (now DESI), 1994).
- Environmental Protection (Water) Policy 2009 (DES (now DESI), 2009).
- Queensland Water Quality Guidelines 2009 (DEHP (now DESI), 2013) .
- Water Act 2000 (DNRME (now DRDMW), 2000).
- Water Plan (Fitzroy Basin) 2011 (DES (now DESI), 2011).
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000).
- Best Practice Erosion and Sediment Control guidelines (IECA, 2008) (IECA, 2018).

2.2 Receiving Water Environmental Values

The Environmental Protection (Water) Policy 2009 (EPP (Water)), which is subordinate legislation to the Environmental Protection Act 1994 (EP Act), provides a framework for identifying environmental values (EVs) for a waterway and determine water quality objectives (WQOs) to protect or enhance those EVs. EVs for water are the qualities of water that make it suitable for supporting aquatic ecosystems and human water uses. These EVs are to be protected from the effects of habitat alteration, waste releases, contaminated runoff and changed flow to ensure healthy aquatic ecosystems and waterways that are safe for community use.

Roper Creek is located within the Mackenzie north-western tributaries region and is classified as a 'fresh' water source EPP (Water). The EVs selected for protection include:

- Aquatic ecosystem protection (moderately disturbed ecosystems).
- Stock watering.
- Human consumption.
- Primary, secondary and visual recreation.
- Drinking water.
- Industrial use.
- Cultural and spiritual values.

2.3 Strategic Approach

ESC needs to be evaluated and implemented for the following phases of work:

- Planning and design (non-operational); and,
- Operation and construction.

This ESC Plan does not specifically include techniques for rehabilitation, although many of the given techniques are relevant. Guidance should be sought as to the best techniques to adopt when rehabilitating the areas within the mine.

All parties (both MCM workers and contractors) involved in earthworks and civil construction (including mechanical, electrical and pipeline contractors) engaged on site will be given access to the ESC Plan and will be required to adhere to all aspects in the implementation of works undertaken, unless abnormal circumstances prohibit their use.

In addition, consideration should be given for the inclusion of this ESC Plan into tender documents and given to prospective tenders for mine related activities to enable efficient incorporation into daily mine operational procedures.

2.4 Responsibilities and Accountabilities

The management and implementation of the ESC Plan is administered through the following key personnel:

- Site Senior Executive - accountable for the application of this ESC Plan.
- Executive General Manager - responsible for enabling budgeting and resources and corporate oversight for operational activities.
- Environmental Department - responsible for documentation and revisions of the ESC Plan.
- Environmental Department - responsible for monitoring and auditing of this ESC Plan.
- Contractors engaged to undertake work on MCM - responsible for implementation and auditing of this ESC Plan.
- Site supervisors - responsible for implementation of this ESC Plan.
- Mine Services - responsible for maintenance & operations of the infrastructure including dams, pumps and pipelines.
- Mine Technical Services - responsible for capturing site surveys/ LiDAR.

3. EXISTING ENVIRONMENT

3.1 Drainage and Diversions

MCM tenement areas are drained by:

- Roper Creek, which is a defined water course under the Water Act 2000, passes through southern and western parts of the ML 70379.
- Roper Creek Diversion (Stage 1):
  - Diverts a reach of Roper Creek (defined watercourse) to enable pit progression in the south-western corner of the South Pit.
  - Approved under the EA (DESI, 2024) and constructed in 2020.
- Thirteen Mile Gully Diversion:
  - Diverts the upstream sub-catchments of Thirteen Mile Gully to Roper Creek, was constructed along the western boundary of ML 70379 in late 2014.
  - A licence to divert the flow of water of Thirteen Mile Gully was issued under the Queensland Water Act 2000 in May 2013 and a Sustainable Planning Act (SPA) approval was granted in July 2013.
  - Upstream of the diversion, the sub-catchments of Thirteen Mile Gully drain via two drainage features Drainage Line 1 (to the west) and Drainage Line 2 (to the north). The Department of Natural Resources and Mines (DNRM), now called Department of Regional Development, Manufacturing and Water (DRDMW) confirmed that these drainage lines are not watercourses, rather they are drainage features defined under the Water Act 2000 that facilitates overland flow (DNRM (now DRDMW), 2017).
- An unnamed tributary of Roper Creek which intersects the eastern extent of ML 70417, beyond the extent of the East Dump and joins Roper Creek about 4.2 km downstream of Dysart Middlemount Road.

Figure 1.1 shows the wider locality of the Roper Creek catchment and Figure 1.2 shows the drainage characteristics in the vicinity of the mine tenement areas. Roper Creek is an ephemeral watercourse. The catchment commences about 35 km to the west of the mine within the Bundoora State Forest. The creek traverses in an easterly direction across ML 70379 and ML 70417 before turning south-east to cross Dysart Middlemount Road and eventually into the Mackenzie River some 40 km to the south-east of MCM. The Mackenzie River is a major tributary of the Fitzroy River.

The total catchment area of Roper Creek to the downstream boundary of the MCM tenements, including the Thirteen Mile Gully catchment, is approximately 389 square kilometres (km^2). The catchment area of Thirteen Mile Gully to its confluence with Roper Creek is 55 km^2. ML 70379, ML 70417 and ML 700014 cover an area of approximately 33.8 km2 or 9% of the Roper Creek catchment to the downstream boundary of ML 70417, and 1.3% of the Roper Creek catchment to its confluence with the Mackenzie River. No water resource development, such as dams or major irrigation infrastructure, is located within the Roper Creek catchment.

The Roper Creek catchment upstream of Dysart Middlemount Road to the west of ML 70379 generally consists of moderately disturbed native forests with some cleared grazing land along the waterway corridor. The catchment downstream of Dysart Middlemount Road has been mostly cleared for grazing. Several coal mines also exist in the catchment as shown on Figure 1.1. Figure 1.2 also shows the existing drainage characteristics of Thirteen Mile Gully in the vicinity of the mine. In its natural state, Thirteen Mile Gully drained in a south-easterly direction across ML 70379 and ML 70417 and discharged into Roper Creek within ML 70417 about 350 metres (m) upstream of Dysart Middlemount Road.

3.2 Topography

In general, the majority of the floodplain area between Roper Creek and Thirteen Mile Gully is level with slopes typically less than 1%.

To the north-east of Thirteen Mile Gully, ground slopes are very gently inclined with ground slopes less than 2% except on some hill slopes where ground slopes can be up to 4%. Within the Thirteen Mile Gully floodplain, the ground slopes are gently inclined with slopes between 3% and 6%.

Within the southern infrastructure area ground slopes range from flat (less than 1%) on top of the ROM pad up to 50% on embankment batters and coal stockpiles.

3.3 Expected Soil Characteristics

3.3.1 Overburden Material

Overburden and interburden material at MCM is expected to consist mostly of weathered and fresh sandstone, siltstone, mudstone and claystone of Tertiary and Permian age, together with Tertiary and Quaternary unconsolidated clayey and sandy sediments. Upward fining sequences are common in each geological unit, and vertical and lateral changes of faces were observed indicating a terrestrial, fluvial sedimentary environment.

The top of the Permian strata is weathered to a depth of 5 m to 25 m beneath the Tertiary, with the base of weathering at an average depth of 44 m below ground level. The Tertiary strata include fissured plastic clay with sand but the upper part of the Tertiary sequence is characterised by paleochannel deposits comprising compact layers of silt and sand.

Laboratory tests undertaken by Parsons Brinckerhoff (PB) (PB, 2010) to assess the overburden material for potential acid mine drainage, heavy metal leaching and erosion potential indicated the following:

- Much of the overburden material would be considered sodic and hence the clay component of the overburden has a high potential to be dispersive. Slake durability testing undertaken by Ward (2010) also indicates that much of the spoil material will be dispersive. The Slake durability index of a large number of samples were low (<60%) to very low (<20%). While not all rocks with a low durability index are dispersive, the erosion potential of low durability index rocks is high. Hence, it is likely that overburden material at the MCM will be moderately to highly dispersive and erodible.
- Low to moderate values of salinity, between 202 µS/cm and 2,440 µS/cm, were recorded for the various overburden samples.
- There is a low to negligible risk of development of acid mine drainage from the overburden.

It is understood that outer slopes of overburden spoil dumps will generally be rehabilitated to slopes of approximately 25% (with rock mulch) and slopes on top of the dumps of up to 2%.

3.3.2 Soils

Six different soil types were mapped across the MCM by (PB, 2010), including:

- Yellow duplex (sodosol).
- Grey-brown duplex (sodosol).
- Brown uniform clay (vertosol).
- Alluvial soil (chromosol).
- Red lithosol (rudosol); and,
- Warwick (vertosol).

Topsoil's will be stripped prior to overburden placement and stockpiled for later rehabilitation works. This will leave exposed subsoils until the placement of overburden material.

Table 3.1 shows the topsoil and subsoil (Upper B horizon) characteristics and potential erosion and sediment control issues associated with each of the soil types (PB, 2010). In general, Yellow Duplex and Grey-brown Duplex will have moderate alkalinity, sodicity within the subsoils and are moderately to highly dispersive. Warwick soils are considered to have highly dispersive subsoils.

TABLE 3.1: SOIL CHARACTERISTICS

	Soil Characteristics	
Statistic	**Topsoil**	**Subsoil (Upper B horizon)**
Yellow Duplex (Sodosol)	• Sandy loam or sand • neutral to moderately acidic • very low salinity • non-cohesive • Negligible to slight potential for dispersivity • Moderate to high potential for erosion	• sandy clay • strongly alkaline • low salinity • Moderate to high potential for dispersivity
Grey-brown Duplex (Sodosol)	• sandy loam to clayey loam • neutral to slightly acidic • acidic A2 horizon in some locations • very low salinity • non-cohesive • Slight to moderate potential for dispersivity • Moderate to high potential for erosion	• silty or sandy clay • strongly alkaline • low to moderate salinity • Moderate to high potential for dispersivity
Brown Uniform Clay (Vertosol)	• sandy clay • high clay content • poor workability when wet • poorly drained area • mild to moderately alkaline • very low salinity	• sand clay • strongly alkaline • high potential for dispersivity
Alluvial Soil (Chromosol)	• sandy loam • neutral • very low salinity • dominated by non-cohesive sand • negligible potential for dispersivity • Moderate to high potential for erosion • patches of high clay content topsoil	• silty clay • neutral • very low salinity • negligible to slight potential for dispersivity
Red Lithosol (Rudosol)	• clay sandy loam to clay loam • neutral to strongly acidic • very low salinity • negligible to slight potential for dispersivity • surface rockiness • weathered rock at shallow depth	• weathered rock/sandy clay to clay loam • very strongly acidic • very low salinity • negligible to slight potential for dispersivity
Warwick (Vertosol)	• sandy clay to clay • neutral to very strongly acidic • very low salinity • high clay content • negligible to slight potential for dispersivity	• clay • strongly acidic • very low salinity • moderate to high potential for dispersivity

4. EROSION AND SEDIMENT CONTROL

4.1 Overview

This ESC Plan is intended to assist in the management, reduction and mitigation of erosion and consequent sediment transport at MCM.

Preventing unacceptable levels of sediments and contaminants from leaving the lease and entering the receiving waters is one of the most important functions of ESC, which is managed by compliance with the EA (DESI, 2024). As per IECA (2018) this ESCP adopts the three cornerstones of ESC as follows:

- **Drainage control** – prevention or reduction of soil erosion caused by concentrated flows and appropriate management and separation of the movement of catchment runoff water and on-site stormwater through the area of concern. There are three categories of drainage control as summaries in Table 4.1.

TABLE 4.1: DRAINAGE CONTROL CATEGORIES

Water Category	Description	Target Design Criteria
Clean Water	Runoff from undisturbed or rehabilitated areas.	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.	Managed in line with the IECA 2018.
Mine Water	Water exposed to coal or used in coal processing and runoff within mining infrastructure areas or coal stockpile areas. Mine water includes water associated with groundwater inflows into open cut pits.	Mine water storages to have sufficient freeboard to contain runoff for events (see mine water management plan for further detail).

- **Erosion control** – prevention or minimisation of soil erosion (from dispersive, non-dispersive or competent material) caused by rain drop impact and exacerbated overland flow on disturbed surfaces.
- **Sediment control** – trapping or retention of sediment either moving along the land surface, contained within runoff (i.e. from up-slope erosion) or from windborne particles.

Erosion control and sediment control are two very different activities. Erosion control measures concentrate on preventing, or at least reducing, soil erosion. Sediment control measures concentrate on trapping sediment displaced by up-slope soil erosion. In general, the most efficient and cost-effective way at minimising sedimentation is to minimise the extent, duration and severity of soil erosion. In addition, best practice sediment control measures cannot, on their own, be relied upon to provide adequate environmental protection.

Notwithstanding the above, due to the nature of open cut mining at MCM, large areas of exposed overburden dumps, generally placed at the angle of repose, will be potentially exposed for several years until they are rehabilitated. Sediment and drainage control will be the primary controls of these areas until rehabilitation occurs.

This ESC Plan is concerned with the management of ‘clean’ and ‘dirty’ water as described in Table 4.1. Standard ESC techniques and management principles are utilised in accordance with the IECA 2018.

4.2 Principles of ESC

For ESC to be effective, the following fundamentals are required (IECA, 2008) (IECA, 2018):

- Ensure ESC measures are designed and constructed effectively prior to site disturbance.
- Minimise the duration and extent of soil exposure by undertaking progressive rehabilitation of disturbed land as soon as practicable.

- Clearly identifying and delineating areas required to be disturbed and ensuring that disturbance is limited to those areas. Clearing as little vegetation as required and minimising machinery disturbance outside of these areas.
- Construction of diversion drains upslope of areas to be disturbed to direct clean runoff away from disturbed areas, where practicable. The diversion drains will be designed to ensure effective segregation of sediment-laden runoff and allow clean surface water to return to natural watercourses.
- Construction of other ESC works such as silt fences and sediment dams prior to works commencing within the area.
- Construction of catch drains to capture runoff from disturbed areas and rehabilitation areas and direct runoff into sediment dams.
- Progressively stripping and stockpiling topsoil for later use in rehabilitation.
- Level or gently sloping areas will be selected as stockpile sites, where required, to minimise erosion and potential soil loss where possible.
- Appropriate sediment controls will be installed upslope of stockpiles to divert water around the stockpiles and downslope of stockpiles to prevent soil loss.
- Construction of all temporary drains as earthen drains at typical grades no steeper than 5% to minimise velocity induced scouring, otherwise ensuring that adequate scour protection is provided. All drains are to be grassed to minimise erosion.
- Placement of geotextile liners and rock check dams in drains and sediment sumps as required to reduce water velocities and prevent scouring.
- Construction of graded banks on reshaped overburden areas to minimise erosion and re-direct runoff to catch drains and water disposal areas.
- Location of stockpiled material away from concentrated water flows.
- Construction of road and earthworks cut and fill batters at slopes of 1V:3H (vertical: horizontal) or less (where possible) to maximise long term stability.
- Inspection and maintenance of all sedimentation controls and rehabilitation areas are to be undertaken in accordance with (IECA, 2008), refer to Section 7. Follow up repair or redesign of ESCs that are not performing adequately.
- Maintenance of design capacity of sediment dams by removing built-up sediment.
- Flocculation of sediment dams as necessary to improve settlement of entrained sediment and to reduce total suspended solids (TSS) concentrations to less than 562 mg/L (flow <2m^3/s) 1062 mg/L (flow >2m^3/s) prior to release off site.
- Construction of drainage controls such as table drains at roadsides and on hardstand areas and toe drains on stockpiles; and,
- Immediate repair or redesign of erosion and sediment controls that are not performing adequately, as identified in field inspections.

4.3 Potential Sources of Erosion

Operations at MCM may result in the alteration of existing surface water flow patterns by mining activities and through diversion drains. ESC only applies to catchments where the only potential contaminant source is sediment. Erosion may occur due to the following mining activities:

- Overburden spoil dumps.
- Topsoil stockpile dumps.
- Cleared land ahead of mining or other mining related activities.
- Installation of services and infrastructure.
- Changes to drainage lines and/or catchment.
- Runoff from construction and maintenance on haul roads.
- Runoff from the construction of and maintenance of internal access roads.
- Vehicle and equipment movement; and,
- Disturbed areas not yet rehabilitated.

Potential erosion and sediment sources as well as the potential contaminants and impacts at MCM are presented in Table 4.2.

Although this ESC plan primarily focuses on erosion and sediment control where water is the causal factor, it should be recognised that, particularly in drier environments, wind also plays a significant role in erosion and the potential for sediment deposition to surrounding receiving environments.

TABLE 4.2: POTENTIAL EROSION AND SEDIMENT SOURCES

Disturbance category	Potential contaminant	Potential impacts
Spoil (overburden material)		
Available / Unavailable / Re-contoured	Unconsolidated material with varying quantities of saline and sediment pre-disposition. Bare areas vulnerable to storm activity. Acid mine drainage (AMD).	Sheet and rill erosion of potentially alkaline/ acidic/saline deposits leading to deposition of contaminants and sediment volumes. Sediments causing damage to receiving waters through reduction in water quality and degradation of in-stream habitats.
Topsoiled (to be revegetated)	Unconsolidated materials, sediment and turbidity.	Sheet and rill erosion leading to sedimentation of waterways and loss of valuable rehabilitation material.
Topsoiled, ripped and seeded	Unconsolidated materials, sediment and turbidity.	Minimal once established.
Topsoil		
Topsoil stripping area	Unconsolidated materials, bare areas vulnerable to storm activity.	Sheet, tunnel, rill and gully erosion leading to movement and deposition of sediments, deleteriously impacting on receiving waters.
Topsoil Stockpiles	Unconsolidated materials, sediment and turbidity.	Sheet, rill erosion leading to sedimentation of waterways and loss of valuable rehabilitation material.
Peripheral lands		
Exploratory and access tracks	Disturbance of natural landform resulting in possible bare landforms increasing sediments in natural runoff.	Exacerbation of rill and gully erosion leading to movement and deposition of sediments potentially causing damage to water quality and in stream habitat of receiving waters.
Haul Roads	Disturbed materials from surface of the road, erosion of table drain material vulnerable to storm activity.	Sedimentation of nearby watercourses.
Sediment runoff from hardstand areas.	Leaching and erosion of soils containing hydrocarbons and movement and release of hydrocarbons into surrounding environment.	Sedimentation of nearby watercourses.
Exploration Activity	Disturbed materials, sediment and turbidity.	Sedimentation of nearby watercourses.
Land clearing (woody vegetation)	Disturbed materials, sediment and turbidity.	Sedimentation of nearby watercourses.
Drainage channels	Disturbance of landform resulting in possible bare landforms increasing sediments in runoff.	Sheet, tunnel, rill and gully erosion leading to movement and deposition of sediments, deleteriously impacting on receiving waters.
Licenced stream diversions / levees	Disturbance of landform resulting in possible bare landforms increasing sediments in runoff.	Sheet, tunnel, rill and gully erosion leading to movement and deposition of sediments, deleteriously impacting on receiving waters.
Construction / excavation work	Disturbed materials, sediment and turbidity.	Sedimentation of nearby watercourses.

4.4 Erosion Potential

Undertaking an assessment for risk of erosion is essential to determine the appropriate ESC technique to apply. There are five main categories that need to be taken into consideration, all of which influence the erosion potential and the type of control measure(s) applicable:

- Soil classification.

- Average slope of disturbance area.
- Extent and duration of soil disturbance.
- Time of the year.
- Location within the catchment (and whether run-off from upslope can be controlled); and,
- Proximity to waterways.

MCM have developed an erosion and sediment control decision support tool that identifies the potential erosion and sediment risk for each catchment / work site (see Figure 4.1) and the end of line control measure to be implemented based on the level of risk (see Table 4.3). (NB multiple erosion controls may be implemented within a water catchment).

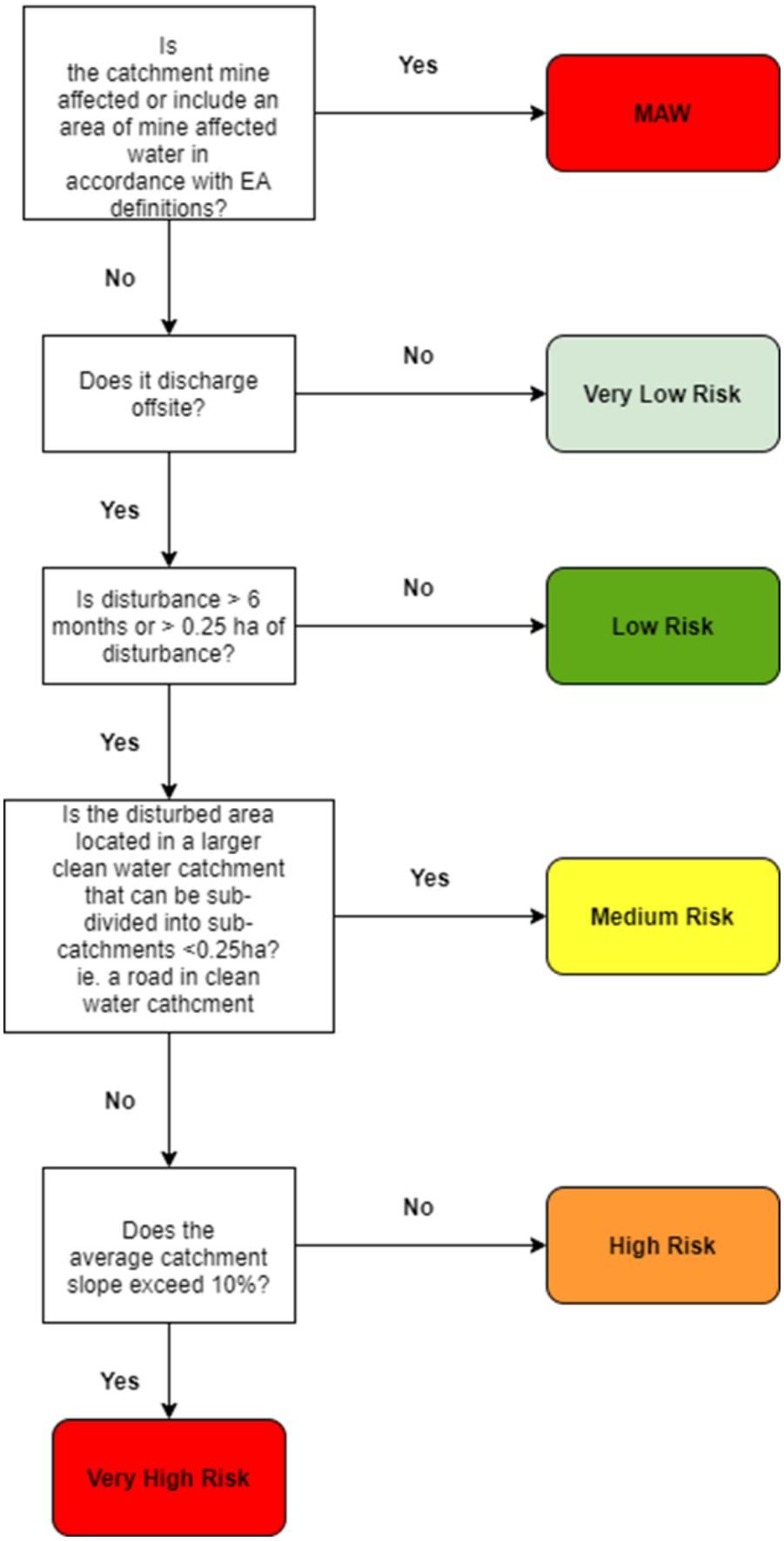

Figure 4.1: Risk Determination Decision Tree

TABLE 4.3: END CONTROL MEASURE BASED ON RISK

Risk Rating	Control	Typical Catchment
Very Low	Nil	Disturbed catchment discharging to another catchment, draining to pit
Low	Rehabilitation following works	Temporary disturbance, i.e., drill pad, laydown
Medium	Rock filter dams	Light vehicle road/haul road in clean water catchment
High	80th percentile IECA Type D Basin (Refer to Section 6.3.2)	Full disturbed areas but not dump faces, rehab slopes
Very High	90th percentile IECA Type D Basin (Refer to Section 6.3.2)	Non-rehab spoil
MAW	Refer WMP	ROM, in pit, tailings etc.

4.4.1 Soils

Soils are classified into three categories:

- Dispersive soil.
- Non-dispersive soil; and,
- Blocky / competent material.

MCM has a mixture of all three types of soils. The following is provided as background to identifying soil / material types.

Dispersive soils are structurally unstable in water and tend to break down into their constituent particles which consequently cloud the water. Dispersive soils are highly susceptible to erosion on slopes and drains when exposed. Dispersive soils should be treated or completely buried under a layer of non-dispersive soil before attempting any erosion control measures or rehabilitation activities.

Non-dispersive soils are characterised by large, water-stable aggregates separated by large pore spaces that absorb water rapidly. These soils are typically high in clay content although some clays are highly dispersive and break down when wet making them highly erodible (i.e., dispersive). Sandy soils are generally non-dispersive on gently sloping land, however, are dispersive when placed on steep slopes such as spoil piles.

Blocky / competent soil material is structurally sound and typically does not contribute a large portion of erosion problems or sediment runoff. These materials may be used to construct various erosion and sediment control techniques.

If there is uncertainty surrounding the soil type for any area of activity where this ESC Plan needs to be referenced, the MCM environmental personnel should be contacted, and appropriate steps undertaken to determine soil type. This may include undertaking suitable soil assessment as per published documentation (e.g., IECA 2018).

4.4.2 Slope

The steepness of the slope and slope 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. These slope categories of relevance to MCM are defined in Table 4.4.

TABLE 4.4: DEFINITION OF SLOPE CLASS

Slope Class	Approximate Slope Values			
	Tangent (% slope)		Degrees	
	Boundary	Average	Boundary	Average
Level	1	0.6	0º35	0º20’
Very Gently Inclined	3	1	1º45’	0º35
Gently Inclined	10	6	5º45’	3º
Moderately Inclined	32	20	18º	10º

4.4.3 Area and Duration

A principal of ESC is to minimise the extent and duration of soil disturbance. Therefore, mining schedules should aim to minimise the duration for which open soils are exposed to the erosive elements (wind, rain and flowing water). Reducing the period where soils are exposed to erosive elements during the construction phase lessens the opportunity for displaced sediment to enter into the surrounding environment.

Strategies to minimise increased risk of erosion during the operation phase of the mine site include:

- Minimise the extent of the disturbance.
- Prompt revegetation of non-operational disturbed area.
- Ensure both temporary earthworks and permanent land-shaping provide a landform that minimises erosion and
- Design temporary runoff collection, conveyance and disposal systems to minimise erosion prior to commencement.

4.4.4 Location Within the Localised Catchment

One of the major principals in achieving effective erosion and sediment control across any site is the necessity to separate run-off from undisturbed catchments and disturbed catchments. Disturbed sites positioned low in a localised catchment with the potential to receive overland or flood flows represent an increased erosion risk. It is therefore necessary to establish site drainage works to convey overland flows safely through or around a site during the disturbance period. Particular attention will need to be paid to the discharge areas of these diversions. MCM should consider the placement of the treatments recommended in this document where areas of concentrated flows are created.

4.4.5 Waterways

The proximity to watercourses may trigger an increased level of planning. Disturbances to existing waterways should be avoided wherever practical.

During operational phases the proximity of ESC measures to watercourses should be undertaken where practicable and reasonable. Design should take into account floodplain extent, soil conditions and flood immunity of the selected ESC measure.

Within this process any mitigation works required to minimise erosion and sediment transport will be detailed. Any discharges to a watercourse may be conditional based on the licence or conditions of the approval to operate.

For any diversion construction, a specific ESC measures will be investigated and developed during the design phase to ensure appropriate ESC measures are implemented throughout the construction process.

5. SELECTION OF EROSION AND SEDIMENT CONTROL TECHNIQUES

In order to effectively plan for the design and installation of control measures that will have minimal erosion and sediment associated impacts upon the surrounding environment, the following steps should be followed:

- Identify if the problem is associated with erosion or sedimentation.
- Where erosion is the issue, identify if particles are being detached by raindrop impact or flowing water or
- Where sedimentation is the issue, identify if particles are being transported by sheet flow or concentrated flow and
- Select appropriate erosion and sediment control techniques as shown in Figure 5.1. (NB multiple erosion controls may be implemented within a water catchment).

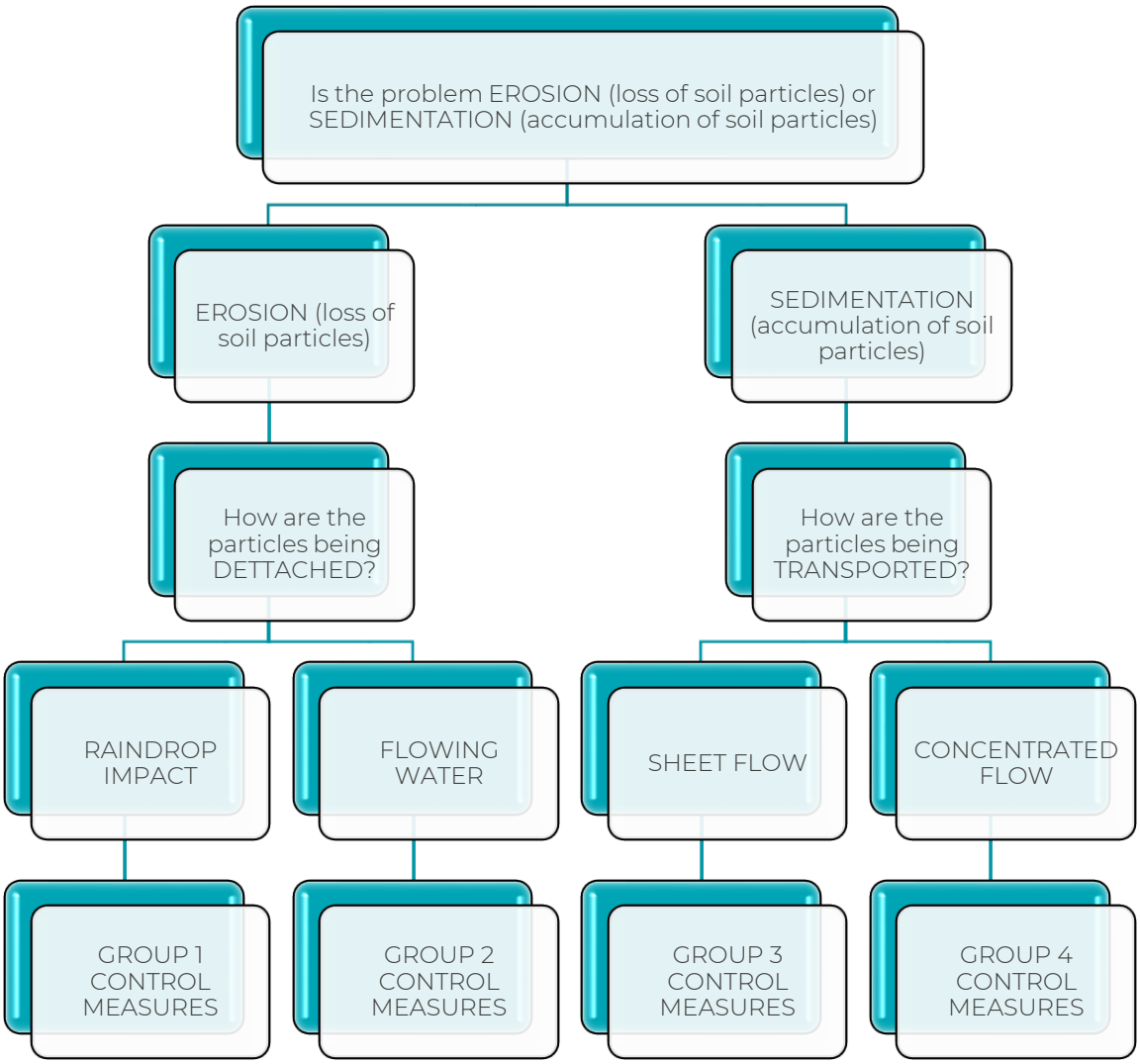

Figure 5.1: Erosion and Sediment Control Selection Procedure

The MCM ESC Plan has been designed to control and manage erosion and sedimentation through the construction and maintenance of a range of permanent and temporary structures designed to prevent the discharge of sediment laden water offsite.

5.1 Group 1 – Erosion Control (Raindrop Impact)

The following erosion control techniques are recommended for implementation where soil particles are being detached by raindrop impacts:

- Vegetation.
- Batter blankets.
- Soil surface mulching.
- Surface roughening; and,
- Geobinders.

5.2 Group 2 – Erosion Control (Flowing Water Impact)

The following erosion control techniques are recommended for implementation where soil particles are being detached by the impacts of flowing water:

- Up-slope diversions.
- Mid-slope diversions.
- Soft armour channels.
- Hard armour channels.
- In-stream diversions.
- Check dams.
- Batter drains.
- Grade control structures and flumes; and,
- Outlet dissipation structures.

5.3 Group 3 – Sedimentation Control (Sheet Flow)

The following erosion control techniques are recommended for implementation where soil particles are being detached by sheet flow:

- Vegetative buffers.
- Sediment barriers/filters; and,
- Site exit points.

5.4 Group 4 – Sedimentation Control (Concentrated Flow)

The following erosion control techniques are recommended for implementation where soil particles are being detached by concentrated flow:

- Sediment curtains/turbidity barriers.
- Sediment traps; and,
- Sediment dams.

6. DESIGN CRITERIA

6.1 Overview

This section outlines the design criteria for various sediment and drainage control measures when being implemented at MCM.

6.2 Permanent Drainage

Permanent watercourse drainage (diversions) requiring a licence to disturb under the Water Act 2000 or approval to divert under the Environmental Protection Act 1994. Erosion control measures for these diversions are not specifically addressed in this ESC Plan.

Permanent drainage refers to diversion channels that will be in place at the end of mine life. These channels require a higher level of design to limit the potential maintenance liability once mining has ceased. Given this, it is recommended that permanent drainage channels be designed by a suitably qualified person in accordance with the DNRM guidelines entitled Guideline: Works that interfere with water in a watercourse—watercourse diversions (DNRM (now DRDMW), 2014).

Any permanent diversion should be designed such that it appears and functions as a natural feature in the landscape largely indistinguishable from the natural watercourses in the area (DNRM (now DRDMW), 2014). A natural channel or flow path has features that develop through geomorphologic processes, such as channel and floodplain capacity, meanders, riffles, and vegetation, to provide an environment where these conditions can continue to develop at a rate consistent with its environment. This is referred to as dynamic equilibrium. Similar features should be designed into the diversion channel in order to obtain a similar dynamic equilibrium.

Where the diversion is replacing an existing channel such as a gully, the existing gully should be used as a 'template' to design the diversion. That is, the diversion design should mimic the channel shape, floodplain capacity, bed slope etc. of the natural channel it replaces, where possible. Where the diversion collects an increased catchment of overland flow as it traverses downstream, a nearby natural channel that has a similar catchment area could be used as a template. Alternatively, the upper limits of stream powers, velocities and shear stresses for natural Bowen Basin watercourses, given in the DNRM (2014) guideline should be used.

For ALL permanent diversions, vegetation should be used as the primary method of stabilising channel banks, terraces and floodplain drainage paths as engineering methods may not limit the liability for long term maintenance cost post mining.

6.3 Temporary Drainage Controls

6.3.1 Drains

Drainage controls that are anticipated to last longer than 24 months would be designed to provide effective separation of catchment runoff water and on-site stormwater for a 10% Annual Exceedance Period (AEP) design storm. This may involve a combination of channels and floodplain levees. Temporary culvert crossings should have a hydraulic capacity of the 63% AEP design storm.

In general, dirty water drains are trapezoidal in shape with maximum side slopes of 1V:2H and grass lined. Where water velocities exceed allowable flow velocities for the given surface material as shown in Table 6.1 additional controls as noted below will be implemented. Rock protection and energy dissipation structures will be installed at the downstream outlets, where required, to prevent runoff causing scour or erosion in downstream drainage systems.

Clean water drains are designed to convey the peak flows from the required design rainfall event. In general, the drains are trapezoidal in shape with maximum side slopes of 1V:2H and vegetated and/or rock lined banks. Where peak design water velocities exceed allowable flow velocities for the given surfaced material as shown in Table 6.1 in a 10% AEP storm event, additional controls as noted below will be implemented. Rock protection and energy dissipation structures will be installed at the downstream outlets, where required, to prevent runoff causing scour or erosion in downstream drainage systems.

TABLE 6.1: ALLOWABLE FLOW VELOCITIES FOR OPEN EARTH LINED DRAINS

Soil Description	Allowable Velocity (m/s)	Comments
Extremely erodible soils	0.3	• Dispersive clays are highly erodible even at low flow velocities and therefore must either be treated (e.g., with gypsum) or covered with a minimum of 100mm of stable soil. • Highly erodible soils may include: Lithosols, Alluvials, Podzols, Siliceous sands, Soloths, Solodized solonetz, Grey podzolics, some Black earths, fine surface texture-contract soils and Soil Groups ML and CL. • Moderately erodible may include: Red earths, Red or Yellow podzolics, some Black earths, Grey or Brown clays, Prarie soils and Soil Groups SW, SP, SM, SC. • Erosion-resistant soils may include: Xanthozem, Euchrozem, Krasnozems, some Red earth soils and Soil Groups GW, GP, GM, GC, MH and CH.
Sandy Soils	0.45	
Highly erodible soils	0.4 to 0.5	
Sandy loam soils	0.5	
Moderately erodible soils	0.6	
Silty loam soils	0.6	
Low erodible soils	0.7	
Firm loam soils	0.7	
Stiff clay very colloidal soils	1.1	

The flow velocity can be reduced by either:

- Reducing the depth of flow (increasing the width of the channel).
- Reducing the bed slope.
- Reducing the peak discharge (reducing catchment area) or
- Increasing channel roughness (increased vegetation cover and/ or rock protection).

If the channel width, depth or gradient cannot be altered, then there are two options for controlling erosion as follows:

- Reduce the flow velocity through the placement of rock check dams; or
- Increase the effective scour resistance in the channel through the placement of an effective channel liner such as rock or an appropriate liner.

6.3.2 Sediment Dams

Sediment dams are constructed within dirty water catchments to capture and treat sediment laden water for treatment prior to discharge or reuse. Sediment dams will be installed where appropriate prior to any land disturbance activities occurring and maintained following completion of land disturbance activities. The design of each sediment dam will take into consideration the topsoil characteristics of the catchment, as well as the presence of any other potential pollutants.

Figure 6.1 shows a typical cross-section of a Type D sediment basin to be used at MCM. The following is of note:

- The sediment basins will have two zones: a settling zone to treat the sediment laden water; and a sediment storage zone for the collection of sediment that drops out of the water.
- The settling zone of the sediment basins will be sized to capture runoff from the contributing catchment area based on the 80th and 90th percentile 5-day duration rainfall, as informed by the decision tree risk rating. The volume of the sediment storage zone will be 50% of the settling zone. Note that the adopted sediment basins volumes mean that the capacity of the sediment basins will be exceeded, and water will spill to the receiving waters at least once in most years.

- Where possible, proposed sediment basins are located in old drainage channels such as old or abandoned creek channels that have been isolated due to mining activities to minimise the amount of excavation required for the storage and allow water to overflow or be pumped into a natural downstream channel after treatment.
- The sediment basins will be designed for a 5-day cycle whereby the sediment laden water fills the sediment basin, is treated and then pumped out to the receiving environment after a maximum of five days. Any water with less than adequate water quality (with TSS concentration greater than 562 mg/L (flow <2m/s) 1062 mg/L (flow >2m/s) will be pumped back to the mine WMS and reused on site. All sediment dams will be maintained in a drawn down state as far as practicable.
- Where sediment is known/expected to be dispersive, MCM will investigate flocculation options to assist in settling fine particles.
- Where possible, water should be dewatered onto well grassed areas where sufficient buffer zones/filter strips exists to minimise migration of sediments towards watercourses.
- De-silting of the sediment basin should be undertaken as required when the sediment storage zone is close to full and
- Adequate erosion protection will be required to manage bywash water over the spillway.

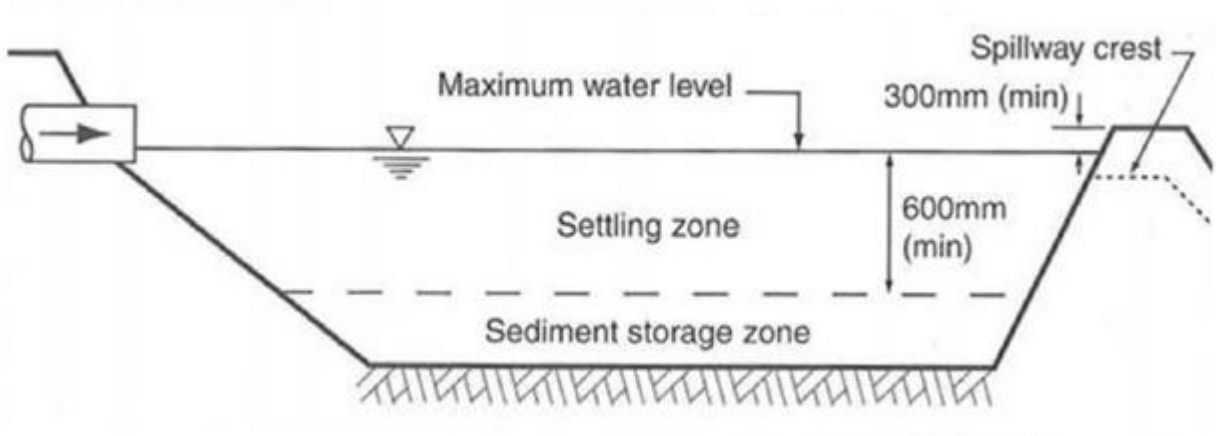

Figure 6.1: Typical Type D Sediment Basin Cross-Section (source: IECA, 2018)

Where the dams form part of permanent infrastructure, they will be designed with spillways suitable for conveyance of the 1% AEP peak flow event, with appropriate freeboard based on 1% AEP flood rise and a minimum 300 mm, assuming dams are full.

The minimum volume of the upper settling zone is defined by equation (1)

$$Vs = 10.R\ (Y\%, 5-day).Cv. \quad (1)$$

Where;

Vs = volume of settling zone (m3)

R (Y%,5-day) = Y%, 5-day rainfall depth (mm) (Refer to equation (2))

Cv = volumetric runoff coefficient (Refer to Table B31 of (IECA, 2018))

A = catchment area (ha)

$$R\ (Y\%, 5-day) = K1.I\ (1yr, 120\ hr) + K2 \quad (2)$$

Where;

K1 and K2 = constant (Refer to Table B28 of (IECA, 2018))

I (1yr,120 hr) = rainfall intensity for a 1 in 1 year ARI, 120 hr storm (mm/hr)

= 0.91 mm/hr

6.3.3 Check Dam Velocity Control Structures

A list of appropriate check dam velocity control structures is given in Table 6.2.

TABLE 6.2: CHECK DAM VELOCITY CONTROL STRUCTURES

Technique	Typical Use
Fibre roll	• Biodegradable logs. • Used in wide shallow drains where logs can be successfully anchored down. • Used in locations where it is desirable to integrate into the vegetation, such as vegetated channels. • Minor sediment trap.
Rock check dam	• Used in drains with a depth exceeding 0.5 m and a gradient less than 10%. • Minor sediment trap.
Recessed rock check dam	• Used in wide, high velocity, shallow channels where sandbag check dams would likely wash away. • Recessed into the soil maintain hydraulic capacity in the channel. • Minor sediment trap.
Sandbag check dam	• Used in shallow drains with a depth less than 50mm and gradient less than 10%. • These check dams are small and less likely to divert water out of the drain. • Minor sediment trap.
Triangular ditch check	• Commercially available, reusable product. • Commonly used to stabilise newly formed table drains. • Used in drains with less than 10% gradient. • Minor sediment trap.

6.3.4 Chute and Channel Linings

A list of appropriate channel and chute linings to provide effective scour protection is given in Table 6.3.

TABLE 6.3: SCOUR PROTECTION AND LINING TYPES FOR CHUTES AND CHANNELS

Technique	Typical Use
Cellular confinement system	• Typically used to stabilise chutes when the only local supply of rock consists of rock smaller than 200mm. • May be filled with small rocks and grassed to form a permanent reinforced grassed chute. • Also used to form a temporary construction access across dry sandy bed streams.
Grass lining	• Permanent protection of low to medium velocity chutes and channels. • Requires suitable growing medium and time to establish.
Hard armouring	• Hard armouring systems include corrugated sheet metal, reinforced concrete and shotcrete.

Technique	Typical Use
Rock mattresses	• Suitable high velocity chutes and spillways.
Rock lining	• High velocity drainage channels. • Drainage chutes. • Sediment basin spillways.

6.3.5 Outlet Structures

A list of appropriate outlet structures to be used at the end of chutes to provide effective scour protection is given in Table 6.4.

TABLE 6.4: OUTLET STRUCTURES

Technique	Typical / Use
Level spreader	• Conversion of minor concentrated flows back to sheet flow.
Rock protection	• Used at the end of Chute drains to dissipate energy and control scour. • Used as a permanent energy dissipater on pipe and culvert outlets.

6.3.6 Drainage Controls on Unsealed Roads

The following general principals should be followed in the design of drainage controls for unsealed roads:

- Stormwater runoff from unsealed roads should be allowed to shed at regular intervals. The runoff should be discharged into a sediment trap or released as sheet flow via a level spreader into adjacent grassland.
- Where stormwater runoff from unsealed roads collects within longitudinal drainage adjacent to the roadway, this water should ideally be discharged from the drain at regular intervals.
- Where table drains are steep and water cannot shed, such as through a cutting or into a river channel, the controls given in Table 6.2 and Table 6.3 should be considered.
- When access is required across a slope, the road should be sited as close as possible to the contour of the land. This allows upslope water runoff to pass evenly across the track, thus avoiding concentrated flow.
- When an access road diagonally traverses a slope, the road will likely collect and concentrate upslope stormwater runoff. The collected runoff will need to be shed at regular intervals using a level spreader or constructed drainage channels.
- Wherever practical, table drains should form wide U-shaped drains to minimise potential invert erosion. Deep V-shaped drains should be avoided where roads are constructed on steep slopes along a cutting.

6.3.7 Watercourse Crossings

Watercourse crossings may consist of fords, culverts or bridges. The following general principals should be followed in the design of drainage controls for watercourse crossings:

- Where fish passage is to be considered, a bridge structure is preferred otherwise a ford or buried box culvert with earth rock bed.
- Culvert designs should always consider the effects of debris blockages and potential erosive forces caused by overtopping flows. Ideally, culverts should have a flow capacity at least equal to the normal channel capacity of the watercourse when the water level is just below the crest of the culvert deck.
- Where possible, crossings of streams should be constructed at right angles to the flow and in locations where the channel is straight and has well defined banks.
- Crossings should be covered with a non-erodible material such as rock or gravel and the upstream and downstream batters should be armoured with rock to control erosion caused by overtopping flows.

6.3.8 Sediment Filter Fences and Other Temporary Sedimentation Control Methods

Sediment fences, sediment traps, rock check dams and other temporary erosion and sediment control measures described in the IECA 2018 will be installed in advance of, or in conjunction with, earthworks to prevent sediment laden water leaving the site or entering clean water systems. These temporary controls are intended to be used for short periods whilst more permanent erosion and sediment control structures are being constructed or during emergency scenarios where permanent structures are not deemed appropriate.

Where necessary, sediment filter fences or other temporary controls are constructed immediately downslope of areas to be disturbed to minimise the potential for sediment transport into receiving waterways.

Sediment filter fences are generally comprised of geotextile filter fabric with structural posts. Where practicable, the fences are erected along contours at approximately 20 m intervals with small returns to limit the catchment size. This is necessary as sediment fences and other temporary controls are prone to failure in larger storm events and should be designed to ensure a maximum of 50 L/s passes through the sediment fence during a storm event. Sediment fences are not to be installed in high flow areas where the effectiveness of the fences may be impeded (e.g., perpendicular across waterways or drains).

7. ROUTINE INSPECTION AND MAINTENANCE REQUIREMENTS

Maintenance and routine inspection are to be undertaken in accordance with (IECA, 2008) as follows. Prior to 1 November each year (prior to onset of wet season) and

- Weekly during construction and monthly during operations.
- Within 18 hours of a rainfall event exceeding 50 mm. This corresponds to rainfall depth for 2 Exceedances per Year (EY) – 18 hr.
- A site survey is recommended to be conducted to review the site drainage and dam sediment built up.

It is noted that all site and maintenance activities must be conducted only when it is safe to do so, and only in a manner that minimises safety risks to site personnel and general public. Inspection proforma is provided in Appendix A.

Monitoring and inspections of the site will include:

- Inspections of water levels, treatment requirements, silt build-up, scouring or erosion and the presence of hydrocarbons; and
- Revegetation progress of disturbed areas.

All ESC measures will be maintained in a functioning condition until individual areas have been deemed successfully rehabilitated. Where controls are observed to be not functioning correctly, the controls will be restored to meet the required standard. Where significant erosion is observed to be occurring on a regular basis, additional controls will be implemented.

Any failure of the control measure / reduction in effectiveness will be reported under Safety, Health & Environment Management System (SHEMS) Incident Reporting procedure, specifically Middlemount Site Operating Procedure (MSOP) 15 (investigating incidents) and MSOP 16 (giving notice of incident).

Appendix A includes a template inspection proforma to be completed during the monthly and annual inspections. The proforma allows for tracking of ESC performance and identification of ESCP actions. The required actions will also be entered into the sites SHEMS. The actions should be audited each year prior to the wet season to ensure they have been completed.

The inspection and monitoring regime should collect and record the following key information:

- The previous condition of the infrastructure and any recommendations or works actioned since the last inspection.
- The current condition of the ESC infrastructure.
- The ESC controls currently in place, and their condition and
- Recommendations on remedial measures or additional ESC controls.

Any failure of effectiveness of structure will be reported to the Environmental Department. The implementation plan should include the recommendations for the incident report.

7.1 Drains

Any signs of erosion along the length of either clean water or dirty water drains will be noted and remedial works undertaken as required. Where significant erosion is observed, additional erosion controls will be constructed, which may include the re-establishment of vegetative cover, installation of an erosion blanket or rock armouring.

7.2 Sediment Dams

Sediment dams require regular maintenance to retain their function as per design criteria. The required maintenance is determined through the visual inspections undertaken of the sediment dams on a routine basis or following rainfall (refer to Section 7).

The sediment dams will be drawn down to a level which ensures that the full settling zone volume is available within the dam, within five days after the rainfall event occurred. The sediment dams are also regularly de-silted when their storage capacity is reduced by the sediment storage zone volume (typically around 50%). The de-silting frequency is based on the amount of sediment being delivered into the sediment dam.

7.3 Temporary ESC Structures (Sediment Filter Fences)

Regular visual checks and repairs are made of temporary ESC structures, such as sediment filter fences, to maintain adequate function. Temporary structures will be removed when no longer required.

8. EMERGENCY RESPONSE

8.1 Emergency Response

The site emergency response plan must include a relevant TARP (trigger action response plan) for uncontrolled sediment release in surface waters. This is in accordance with MCM emergency procedures (MP014 Crisis Management Plan).

8.2 Incident Reporting Procedures

ESC incident reporting procedures at Middlemount are in accordance with site requirements and protocols. No additional measures are required by this Plan.

External reporting to be undertaken in compliance with the EA.

9. REFERENCES

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10. QUALIFICATIONS

(a) In preparing this document, including all relevant calculation and modelling, Engeny Australia Pty Ltd (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

(b) Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

(c) Engeny reserves the right to review and amend any aspect of the works performed including any opinions and recommendations from the works included or referred to in the works if:

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  (ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.

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(f) If any claim or demand is made by any person against Engeny on the basis of detriment sustained or alleged to have been sustained as a result of reliance upon the Report or information therein, Engeny will rely upon this provision as a defence to any such claim or demand.

(g) This Report does not provide legal advice.

APPENDIX A: INSPECTION PROFORMA

ESCP INSPECTION PROFORMA

Name of inspector			Date:				
Dam Name (location)			Time:				
Purpose/Function	Contain On-site Stormwater						
Embankment present	Y / N	If yes, please assess embankment condition -->					
Storage Type	Fully excavated / partially excavated						
Spillway	Y / N						
Storage Capacity (ML)		Sediment storage level (m AHD)					

RESERVOIR							
Water Level (m AHD)							
Water Quality	Y / NA	EC		µs/cm			
		pH					
		Turbidity		mg/L			
Desilting required	Y / N	Sediment depth (m)					
Dewatering destination		MAW storage / Off site					

INLET/OUTLET WORKS							
I/O - Type (e.g. pipe, drain) O - Release Valve O - Pontoon Pump I - Pumped inflow	Condition/ Pump source and destination						

SPILLWAY							
obstruction/debris, vegetation, erosion, siltation, defects							
Overall Condition	poor / fair / good						

UPSTREAM CATCHMENT DIVERSION WORKS							
obstruction/debris, vegetation, erosion, siltation, defects							
Overall Condition	poor / fair / good						

LINER SYSTEM (if applicable)							
Liner, fauna egress matting, leak detection sumps							
Overall Condition	poor / fair / good						

EMBANKMENT CONDITION							
SECTIONS	**DESCRIPTION**						Photo No.
CREST - cracking, subsidence, sinkholes, surface treatment							
Overall Condition	poor / fair / good						
U/S FACE - cracking, slips, bulging, erosion, vegetation, trees							Photo No.
Overall Condition	poor / fair / good						
D/S FACE - cracking, slips, bulging, erosion, vegetation, trees							Photo No.
Overall Condition	poor / fair / good						
D/S Toe - seepage, soaks, scalds, vegetation, trees							Photo No.
Overall Condition	poor / fair / good						

OBSERVATIONS & ACTIONS REQUIRED							

SEND PENDING ACTIONS TO:							**SENT (Y/N)**

ESCP INSPECTION PROFORMA

Inspecting Officer	
Date (DD/MM/YY)	
Time	
Mining Area	

WEATHER CONDITIONS

Previous 24-hour rainfall (mm)			
Current weather conditions	Clear / Rain / Overcast / Windy		

CATCHMENT DETAILS

Catchment ID			
Does the catchment drain off lease?	Yes / No / Partial		
Is the catchment disturbance > 6 months?	Yes / No	Duration (mon)	
Is the catchment disturbance > 0.25 ha?	Yes / No	Area (ha)	
Does the average catchment slope > 10%?	Yes / No		
Risk Rating	Low / Medium / High (Refer to Figure 4.1 and Table 4.3 of the ESCP)		

OUTSTANDING ACTIONS FROM PREVIOUS INSPECTION

Previous Inspection Date (DD/MM/YY)	

Action No.	Action Description	Priority (high/ medium/ low)	Personnel Responsible	Due Date (DD/MM/YY)
1				
2				
3				
4				

CURRENT ESC MEASURES INSPECTION

Location (Coordinates)	ESC Description	Condition (poor/ fair/ good)	Action Required (Y/N)	Action No.
Lat: Long:				
Lat: Long:				
Lat: Long:				
Lat: Long:				
Lat: Long:				
Lat: Long:				
Lat: Long:				

ACTIONS

Action No.	Action Description	Priority (high/ medium/ low)	Personnel Responsible	Due Date (DD/MM/YY)
1				
2				
3				
4				
5				
6				
7				

ADDITIONAL ESC MEASURES REQUIRED IN COMPLIANCE WITH ESCP

Location (Coordinates)	ESC Description	Priority (high/ medium/ low)	Personnel Responsible	Due Date (DD/MM/YY)
Lat: Long:				
Lat: Long:				
Lat: Long:				
Lat: Long:				
Lat: Long:				
Lat: Long:				
Lat: Long:				

DRAINAGE COMPLIANCE

Actions required to allow catchment to drain off lease:

OTHER COMMENTS AND RECOMMENDATIONS

INSTRUCTIONS FOR INSPECTION OFFICERS

Fill out each section clearly, ensuring all fields are completed before leaving the site.
Use GPS coordinates for the "Location of ESC Measure" section if additional ESC measures are proposed.
Prioritise high-risk areas based on slope, disturbed area, and the current condition of controls.
Photograph any areas requiring significant remediation or where conditions have deteriorated since the last inspection.

Source *Best Practice Erosion & Sediment Control. Book 1 (IECA, 2008)*
Reference *Chapter 7*
Link https://www.austieca.com.au/documents/item/1138

Part G: Drainage controls

Item	Consideration
47	Construction Drainage Plans (CDPs) are consistent with actual site conditions (i.e. current stage of works).
48	Drainage Control measures are consistent with the ESCP.
49	Drainage Control measures are being adequately maintained in proper working order at all times.
50	Adequate diversion/management of up-slope stormwater.
51	Up-slope "clean" water is being appropriately diverted around/through the site in a non-erosive manner.
52	Stormwater runoff diverted away from unstable slopes.
53	Flow diversion channels/banks stabilised against erosion.
54	Flow not unlawfully discharged onto an adjacent property.
55	Spacing of cross drainage (e.g. Catch Drains or Flow Diversion Banks) down long slopes is sufficient to prevent "rill" erosion.
56	Earth batters are free of "rill" erosion.
57	**Catch Drains:**
(a)	Adequate depth/width.
(b}	Adequate flow capacity is being maintained.
(c)	Stabilised against soil scour.
(d)	Clear of sediment deposition.
(e)	Appropriate grass length is being maintained.
(f)	Water discharges via a stable outlet.
58	**Channel Linings (mats):**
(a)	Lining is well anchored.
(b)	Mats overlap in direction of flow.
(c)	Lining is appropriate for flow conditions.
(d)	No damage to the mat by lateral inflows.
59	**Check Dams:**
(a)	Flow is passing over the dams and not around them.
(b)	Check Dams are not causing excessive channel restriction.
(c)	Rock Check Dams are not used in shallow drains.
(d)	Check Dams are appropriately spaced down the drain.
60	**Chutes (rock):**
(a)	Geotextile filter cloth is installed under the rock.
(b)	Rock placement has not reduced chute flow capacity.
(c)	Rock size appears adequate for expected flow velocity.
(d)	Water discharges via a stable outlet.
61	**Chutes (geotextile):**
(a)	Lining is well anchored.
(b)	Mats overlap in direction of flow.
(c)	Lining is appropriate for flow conditions.
(d)	Water discharges through a stable outlet.
62	**Level Spreaders:**
(a)	Outlet weir is level and undamaged.
(b)	No sediment deposition within *Level Spreader.*

(c) Discharges "sheet" flow to a stable, well-grassed outlet.

63 **Slope Drains:**

(a) Adequate erosion/sediment controls at pipe inlet.

(b) Pipes are well anchored.

(c) No obvious water leaks.

(d) Water discharges via a stable outlet.

64 **Stormwater Outlets:**

(a) Energy dissipation is appropriate for the conditions.

(b) Rock size is greater than 200mm.

(c) Soil erosion is being controlled.

65 **Temporary Watercourse Crossings:**

(a) Crossing type is appropriate for the stream conditions.

(b) Sediment runoff from the approach roads is controlled.

(c) Likely damage to the crossing and the stream caused by possible overtopping flows is considered acceptable.

Part H: Erosion controls

Item **Consideration**

66 Erosion control standard is consistent with requirements of regulatory authority.

67 Soil erosion is being controlled to a standard consistent with the level of environmental risk.

68 Erosion Control measures are consistent with the approved ESCP.

69 Disturbance to existing ground cover is being delayed as long as possible.

70 Raindrop impact erosion is being adequately controlled.

71 Earth batters are free of "rill" erosion.

72 Dust problems are being adequately controlled.

73 Erosion Control measures are being adequately maintained in proper working order at all times.

74 All disturbed areas are adequately stabilised given:

(a) Erosion hazard risk.

(b) Degree of downstream sediment control.

(c) Days since earthworks were finalised.

(d) Days before any soil disturbance will be re-worked.

75 **Erosion Control Blankets:**

(a) Blankets are well anchored.

(b) Blankets overlap in direction of stormwater flow.

(c) Blanket strength is appropriate for site conditions.

(d) Synthetic blanket reinforcing will not endanger wildlife.

(e) Blankets not damaged by lateral inflows.

(f) Blankets protected against movement by winds.

76 **Mulching (light):**

(a) Minimum 70% coverage of soil surface.

(b) Suitable tackifier used on steep slopes.

(c) Drainage controls preventing mulch displacement.

77 **Mulch (heavy):**

(a) Minimum 100% coverage of soil.

(b) Minimum depth adequate to control weeds.

(c) Drainage controls preventing mulch displacement.

78 **Soil Binders:**

(a) No adverse environmental impacts observed.

(b) No obvious over-spray.
(c) Soil binders applied during appropriate weather conditions.

Part I: Sediment controls

Item **Consideration**

79 Sediment is being controlled to a standard consistent with legislative requirements and the level of environmental risk.
80 Sediment Control is consistent with the approved ESCP.
81 Sediment Control is appropriate for the soil type.
82 No sub-catchment relies solely on "supplementary" sediment control traps.
83 Sediment Control measures are being adequately maintained in proper working order at all times.
84 Sediment control *Buffer Zones* are protected from traffic and are free of excessive sediment deposits.
85 Straw bales are not being used for sediment control, unless justified by exceptional circumstances.
86 Neighbouring properties are being adequately protected from sedimentation.
87 Collected sediment is being disposed of in an appropriate manner.
88 **Entry/Exit Points:**
(a) Control measures are appropriate for the site conditions.
(b) Control measures are constructed to appropriate standards.
(c) Excessive sediment removed from sediment traps.
(d) Excessive sedimentation is not evident on roadway.
(e) Stormwater drainage is controlled such that sediment is not being washed onto the adjacent roadway.
89 **Field (Drop) Inlet Controls:**
(a) Inlet control measures allow adequate ponding around stormwater inlets to capture sediment.
(b) The sediment control measures do not simply divert sediment-laden water downstream to an uncontrolled inlet.
(c) Sediment control measures will not cause a safety or local flood hazard.
(d) Sediment traps are appropriate for site conditions.
(e) Excessive sediment deposition is removed from all traps.
90 **Gully Inlet Controls:**
(a) Sediment traps are appropriate for the type of gully inlet, either "sag" or "on-grade" inlet.
(b) Sediment traps allow adequate ponding around or up-slope of stormwater inlets to capture sediment.
(c) Sediment traps do not simply divert sediment-laden water downstream to an uncontrolled inlet.
(d) Sediment control measures will not cause a safety, traffic or local flooding hazard.
(e) Excessive sediment deposition is removed from all traps.
91 **Table drain sediment traps:**
(a) Choice of sediment trap is appropriate for flow conditions.
(b) Excessive sediment is removed from all traps.
(c) Spill-through weir is set to an appropriate elevation.
(d) Spill-through weir has adequate width.
(e) Sediment Fence traps are formed in a tight U-shape that adequately prevents water bypassing the traps.
92 **Sediment Fences:**
(a) Choice of fabric is appropriate.
(b) Bottom of fabric is securely buried.
(c) Fabric is appropriately overlapped at joints.
(d) Fabric is appropriately attached to posts.
(e) Support posts are at correct spacing (2m or 3m with backing).
(f) Sediment Fence does not cause flow diversion/bypass.
(g) Sediment Fence has regular returns.
(h) Lower end(s) of fence is/are returned up the slope.

(i) Sediment Fences are free of damage.
U) All fences are free of excessive sediment deposition.
(k) Fences are adequately spaced from toe of fill banks.

93 **Filter Tube Sediment Traps:**

(a) Geometry and layout match design details.
(b) Sediment-laden water cannot bypass the filtration system.
(c) Filter Tubes do not need replacement.
(d) Filter Tubes and embankment are free of damage.

94 **Rock Filter Dams (Sediment Traps):**

(a) Geometry and layout match design details.
(b) Excessive sediment removed from up-slope of all traps.
(c) The filtration system is free from sediment blockage.
(d) Rock Filter Dam and spillway are free of damage.

95 **Sediment Weirs:**

(a) Geometry and layout match design details.
(b) Excessive sediment removed from up-slope of all traps.
(c) The filtration system is free from sediment blockage.
(d) Sediment Weir and splash pad (if any) are free of damage.

96 **Sediment Trench:**

(a) Trench geometry and layout match design details.
(b) Excessive sediment removed from the trench.
(c) Outlet structure (if any) is free from sediment blockage.
(d) The open trench does not represent a safety hazard.

97 **Sediment Controls for Non-Storm Runoff**

(a) Choice of sediment trap is appropriate for the site conditions and level of environmental risk.
(b) All sediment is being contained within trap.

98 **Sediment Basin (1): Location** .....

(a) Basin geometry and layout match design details.
(b) "As constructed" plans have been prepared.
(c) The basin does not represent a safety risk.
(d) De-watering is conducted in accordance with best practice.
(e) Excessive sediment removed from basin.
(f) Sediment depth marker is installed and maintained.
(g) Primary outlet structure is free from sediment blockage.
(h) Flow conditions are not compromised across the spillway.
(i) Emergency spillway has adequate scour control.
U) Adequate quantities of flocculant (if required) exist on-site.
(k) Soil erosion is adequately controlled at inlet points.
(l) The settled sediment layer is clearly visible through ponded water prior to discharge such water.

101 **Other Sediment Trap (1): Type** .....

(a) Choice of sediment trap is appropriate for the site conditions and level of environmental risk.
(b) The sediment trap allows adequate ponding to capture coarse sediment (Type 2 and Type 3 Sediment Traps).
(c) The sediment trap allows adequate filtration to capture fine sediment (Type 2 Sediment Traps).
(d) The sediment trap does not simply divert sediment-laden water downstream to an uncontrolled outlet.
(e) The sediment trap does not cause a safety, traffic or local flood hazard.
(f) Excessive sediment deposition is removed from all traps.

Part J: Instream works

Item	Consideration
105	All necessary State and local government approvals have been obtained.
106	Temporary Watercourse Crossings (e.g. construction access) have been reduced to the minimum practical number.
107	Instream disturbance is limited to the minimum necessary to complete the proposed works.
108	Timing and staging of instream works will minimise exposure of the site to storm and/or stream flows.
109	Instream works are occurring at a time of the year that will minimise overall potential environmental harm: (a) avoiding seasonal high flows; (b) avoiding periods of likely fish migration; (c) avoiding active bird migration periods (Ramsar wetlands).
110	Instream structures are not located on, or adjacent to, unstable or highly mobile channel bends.
111	Construction works are not unnecessarily disturbing instream or riparian vegetation.
112	Overbank disturbances are limited to only one bank wherever reasonable and practicable.
113	Stormwater runoff moving towards the channel from adjacent areas is being appropriately diverted around soil disturbances.
114	Erosion is not occurring as a result of stormwater passing down channel banks.
115	Normal channel flows are being diverted around in-bank disturbances as appropriate for the expected weather and channel flow conditions.
116	Appropriate temporary erosion control measures are being applied to disturbed areas.
117	Synthetic reinforced erosion control blankets/mats are not being used where there is a potential threat to wildlife.
118	Adopted instream sediment control measures are appropriate for the expected site and channel conditions.
119	Sediment Fences have not been placed in areas of actual or potential concentrated flow.
120	Appropriate material (spoil) de-watering procedures have been adopted.
121	Site stabilisation and rehabilitation is occurring as soon as practicable.
122	Appropriate site rehabilitation measures are being adopted.

Part K: Site stabilisation/revegetation

Item	Consideration
123	Site stabilisation/rehabilitation plan has been prepared.
124	Site stabilisation/revegetation is occurring in accordance with approved Plans and/or programming.
125	Exposed areas are adequately stabilised given the site conditions, environmental risk, and construction schedule.
126	Soil surfaces are suitably roughened prior to revegetation.
127	Excessive soil compaction is amended prior to revegetation.
128	Seedlings are appropriately stored prior to planting.
129	Seedlings are not excessively mature for their pot/tube size.
130	Drill seeding (if any) is being applied across the slope (not up and down the slope).
131	Newly seeded areas are developing an appropriate grass cover (not just strike rate), density and grass type.
132	No newly seeded areas require reseeding.
133	Soil erosion within revegetated areas is being adequately controlled (i.e. mulching) during the plant establishment phase.
134	Grass turfing is not being placed directly on compacted soil.
135	Water application is appropriate for the site conditions and water conservation requirements.
136	Soils are being appropriately prepared (i.e. pH, nutrients, and so on) prior to revegetation.
137	Revegetation is controlling soil erosion as required.
138	Newly seeded areas have been lightly mulched as specified.
139	Adequate heavy mulching placed around seedlings.
140	Newly established plants are being adequately maintained.
141	Weeds and grasses are being controlled around the base of newly established trees and shrubs.
142	Plants damaged by traffic or wind-rock are adequately supported or replaced.
143	Dead or severely damaged plants have been replaced.

Part L: Action summary

Item	Consideration	Yes or No Answer "Yes" if further action is required on site
144	Do any existing control measures require modification?	
145	Are additional ESC measures required on the site?	
146	Are alternative ESC measures required on the site?	
147	Is a revised ESCP required for the site?	
148	Is further water quality monitoring required?	
149	Do any ESC measures need repairs or de-silting?	
150	Is additional erosion control (minimum 70% cover) required?	
151	Will the underlying cause of any non-compliance need further investigation?	
152	Will it be necessary for the site to adopt an alternative Code of Practice better suited to the site conditions or work activities?	
153	Will further site inspections be required?	

APPENDIX B: MCM INTENSITY FREQUENCY DURATION

All Design Rainfall Depth (mm)
Issued: 2-Oct-24
Location Label:
Requested Latitude -22.85 Longitude 148.65
Nearest gri Latitude 22.8375 (S Longitude 148.6625 (E)
Exceedances per Year (EY)
Annual Exceedance Probability (AEP)

Duration	Duration in min	12EY	6EY	4EY	3EY	2EY	63.20%	50%	0.5EY	20%	0.2EY	10%	5%	2%	1%	1 in 200	1 in 500	1 in 1000	1 in 2000
1 min	1	0.695	0.893	1.22	1.45	1.76	2.27	2.54	2.82	3.37	3.44	3.94	4.49	5.22	5.77	6.72	7.98	9.04	10.2
2 min	2	1.19	1.52	2.09	2.47	2.98	3.81	4.27	4.74	5.74	5.86	6.76	7.77	9.1	10.1	11.7	14	15.9	17.8
3 min	3	1.66	2.14	2.94	3.48	4.2	5.38	6.03	6.7	8.09	8.25	9.51	10.9	12.7	14.2	16.4	19.6	22.2	24.9
4 min	4	2.1	2.7	3.72	4.42	5.35	6.87	7.7	8.54	10.3	10.5	12.1	13.8	16.1	17.9	20.7	24.7	28	31.5
5 min	5	2.5	3.22	4.43	5.27	6.4	8.26	9.24	10.3	12.3	12.6	14.4	16.5	19.2	21.2	24.7	29.4	33.3	37.5
10 min	10	4.01	5.18	7.18	8.57	10.5	13.8	15.4	17.1	20.4	20.8	23.8	27.1	31.4	34.7	40.5	48.1	54.4	61.3
15 min	15	5.05	6.52	9.05	10.8	13.4	17.7	19.8	22	26.2	26.8	30.6	34.8	40.3	44.5	51.9	61.6	69.8	78.7
20 min	20	5.81	7.5	10.4	12.5	15.5	20.7	23.1	25.7	30.7	31.3	35.7	40.7	47.2	52.2	60.8	72.2	81.8	92.2
25 min	25	6.42	8.27	11.5	13.9	17.2	23	25.7	28.6	34.2	34.9	39.9	45.5	52.8	58.5	68.1	80.9	91.6	103
30 min	30	6.91	8.9	12.4	14.9	18.6	25	27.9	31	37.1	37.9	43.4	49.4	57.5	63.7	74.2	88.2	99.9	113
45 min	45	8	10.3	14.4	17.3	21.6	29.2	32.6	36.2	43.6	44.5	51.1	58.5	68.3	75.8	88.2	105	119	134
1 hour	60	8.78	11.3	15.7	19	23.7	32.1	35.9	39.9	48.2	49.1	56.6	64.9	76	84.7	98.4	117	133	149
1.5 hour	90	9.89	12.7	17.6	21.3	26.6	36.1	40.5	44.9	54.5	55.6	64.3	74.1	87.2	97.4	113	135	153	172
2 hour	120	10.7	13.7	19.1	23	28.7	38.9	43.6	48.4	59	60.2	69.8	80.7	95.3	107	124	148	167	188
3 hour	180	12	15.3	21.2	25.5	31.7	42.9	48.2	53.5	65.6	66.9	77.9	90.3	107	121	140	167	189	213
4.5 hour	270	13.4	17.1	23.6	28.3	35.1	47.2	53.2	59	72.7	74.2	86.7	101	120	136	158	188	213	240
6 hour	360	14.5	18.5	25.4	30.5	37.7	50.5	57	63.3	78.3	79.9	93.5	109	131	148	173	205	232	261
9 hour	540	16.4	20.8	28.5	34	42	55.8	63.2	70.1	87.3	89	105	122	147	168	196	232	263	296
12 hour	720	17.9	22.7	31	36.9	45.4	60.2	68.2	75.7	94.6	96.5	114	133	161	184	215	255	288	325
18 hour	1080	20.3	25.7	34.9	41.4	50.8	67.1	76.4	84.8	107	109	128	150	184	211	246	292	330	372
24 hour	1440	22.2	28	37.9	44.9	55	72.7	82.9	92.1	116	119	140	165	202	233	271	322	365	411
30 hour	1800	23.8	29.8	40.3	47.8	58.5	77.4	88.5	98.2	125	127	151	177	218	252	292	348	395	447
36 hour	2160	25.1	31.3	42.3	50.2	61.5	81.4	93.3	104	132	135	159	187	232	268	311	371	421	478
48 hour	2880	27.1	33.7	45.5	54	66.2	88	101	112	144	147	174	205	255	296	342	409	464	525
72 hour	4320	29.7	36.7	49.5	59	72.6	97.5	113	125	162	165	196	231	289	336	387	461	523	588
96 hour	5760	31.1	38.3	51.7	61.8	76.7	104	120	134	173	177	211	249	311	362	415	493	557	626
120 hour	7200	31.8	39.1	52.9	63.5	79.3	109	126	140	182	185	221	261	325	378	432	512	577	650
144 hour	8640	32.1	39.5	53.5	64.3	81	112	130	144	187	191	228	270	334	387	442	522	586	664
168 hour	10080	32.1	39.6	53.6	64.6	82.1	114	132	147	191	195	233	275	339	391	447	526	589	672

Australian Rainfall and Runoff terminology

Frequency Descriptor	EY	AEP (%)	AEP (1 in x)	ARI	Uses in Engineering Design
	12				
Very frequent	**6**	99.75	1.002	0.17	Water sensitive urban design
	4	98.17	1.02	0.25	
	3	95.02	1.05	0.33	
	2	86.47	1.16	0.50	
Frequent	**1**	**63.2**	1.58	1.00	Stormwater/pit and pipe design
	0.69	**50.00**	2	1.44	
	0.5	39.35	2.54	2.00	
	0.22	**20.00**	5	4.48	
	0.2	18.13	5.52	5.00	
Infrequent	0.11	**10.00**	10.00	9.49	Floodplain management and waterway design
	0.05	**5.00**	20	20.0	
	0.02	**2.00**	50	50.0	
	0.01	**1.00**	**100**	100	
Rare	0.005	0.50	**200**	200	
	0.002	0.20	**500**	500	
	0.001	0.10	**1000**	1000	
Extremely Rare	0.0005	0.05	**2000**	2000	Design of high-consequence infrastructure (eg major dams)
	0.0002	0.02	5000	5000	
			↓		
Extreme			PMP		