MINING BY-PRODUCTS MANAGEMENT PLAN

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1. PURPOSE

This Mining By-Products Management Plan details how Middlemount Coal Pty Ltd (hereafter referred to as MCPL) will manage its mining by-products (ie. mining waste, coarse rejects and tailings) during mining operations. The plan aims to ensure all mining by-products are managed in accordance with Queensland coal mining industry standards and regulatory requirements including the requirements of Environmental Authority (EA) number EPML 00716913 (DEHP, 2017), to align with relevant technical guidelines (COA, 2016; DME; 1995 and DEHP, 2013), and in a manner that minimises the environmental and health risks.

2. SCOPE

This Management Plan applies to the management, placement and monitoring of mining by-products (mining waste, coarse rejects, and tailings) produced over the project life including:

- Characterisation of mining waste (overburden, inter-burden, floor, roof and partings), coarse rejects, and tailings;
- Placement, drying and reclamation of tailings in cells;
- Transport and placement of coarse rejects and dried tailings in the mine pit;
- Transport and placement of mining waste (spoil);
- Control of any environmental impacts;
- Emergency procedures;
- Recording of coarse rejects and tailings disposal; and,
- Periodic review.

This procedure must not be implemented by any site personnel without the involvement of the MCPL Environment Department.

3. DEFINITIONS

Acronym	Definition
Acid and Metalliferous Drainage	Any contaminated discharge resulting from mining and associated processing, which is formed through a series of chemical, physical and biological reactions when geological strata is exposed to oxygen and moisture as a result of ground disturbance activities.
AMD	Acid and Metalliferous drainage
ANC	Acid neutralising capacity, expressed as kg H_2SO_4 per tonne of sample.
CHPP	Coal Handling and Preparation Plant
Coarse Reject	Coarse coal waste produced through coal processing sourced from the D&R screen and the spirals rejects dewatering screen.
EA	Environmental Authority (EPML00716913)
EDMS	Environmental Database Management System
Hazardous substance	A substance which has the potential to harm the health of persons in the workplace and/or adversely impact the environment.
Mining By-Product	Any mining and coal handling and processing related waste, including: overburden, partings, coarse reject, tailings and miscellaneous waste rock material;
NAF	Non-Acid Forming. Geochemical classification criterion for a sample that will not generate acidic conditions.
NAF (Barren)	Non-Acid Forming. Geochemical classification criterion for a sample that will not generate acidic conditions. Barren of oxidisable sulfur.
NAG	Net Acid Generation
NAPP	Net Acid Producing Potential
PAF	Potentially Acid Forming. Geochemical classification criterion for a sample that has the potential to generate acidoc conditions.
ROM	Run of Mine
SSE	Site Senior Executive
Tailings	Fine coal waste produced through coal processing sourced from the Tailings Thickener underflow.
Uncertain	Geochemical classification criterion for a sample where the potential to generate acid conditions remains uncertain and may require further analysis.

4. BACKGROUND

The primary risk associated with mining by-products such as mine spoil and coal processing waste (coarse rejects and tailings) is the potential to form leachate known as Acid and Metalliferous Drainage (AMD). AMD may be described as a process involving a series of chemical, physical and biological reactions that take place within material that has been disturbed from its natural state, with the resulting products potentially including acidic, metalliferous and saline leachate.

This mining by-products management plan summarises the reactions involved in AMD in basic and non-scientific terms. It should be noted that there are many site-specific variables and highly complex chemical, physical and biological interactions that influence the process and outputs.

4.1. FORMATION OF AMD DUE TO DISTURBANCE

Ground disturbance and excavation results in material being exposed to atmospheric and climatic influences that are not present, or very limited, when the material is in its undisturbed state. In addition, the process of excavation breaks up the structure of the material from a compacted form to a loose form, which increases the surface area exposed to atmospheric and climatic influences.

If sulfide mineralisation is present in the material, it can react with oxygen and water when excavated. The reaction between sulfide mineralisation, oxygen and water results in oxidation of the sulfides. The oxidation process alters the chemistry of the sulfides and associated minerals and can release hydrogen ions into solution. This, in turn, lowers the pH of the water, producing an acidic leachate and can also mobilise sulfate salts.

The resulting acidic leachate has the potential to mobilise and dissolve metals/metalloids that are present in the excavated material. Metal mobilisation into solution occurs as a result of the low pH acid leachate. The lower the pH, the higher the likelihood that metals/metalloids will be mobilised into a dissolved form.

If sufficient buffering capacity exists in surrounding material and water, the acidity released into solution by the oxidation process can be neutralised, therefore effectively raising the pH which prevents the acid leachate and consequent mobilisation of metals/metalloids.

It is possible that the same reactions may be taking place in-situ prior to disturbance, however the reaction rates are likely to be minimal or nil due to the compacted nature of material and limited exposure to oxygen and/or water.

4.2. AMD CONCERNS

The primary concern with mining by-products is whether they will potentially generate acidic and saline leachate, which may impact surrounding watercourses. Furthermore, if metals/metalloids are present in the materials they may be mobilised into solution by the acidic leachate, further increasing environmental impacts. If AMD enters waterways, it can potentially have significant impacts on aquatic life; riparian vegetation; and water quality for substantial distances downstream. If not appropriately managed, AMD can occur during mining operations and continue for a substantial period after mine closure. The management of mining by-products should focus on the prevention or minimisation of AMD wherever possible as management and control can be difficult and costly.

Potential sources of AMD at Middlemount Mine may include (but is not limited to): coal seam partings, roof and floor, coarse rejects, tailings, ROM and product coal, and exposed coal faces in the pit.

5. PROCESS OVERVIEW

5.1. MINING WASTE

Mining waste is generated through the coal excavation process and includes overburden, interburden. It can also contain coal seam partings, roof and floor materials if these do not report with coal to the CHPP. All these mining waste components are disposed of within the mining pit and need to be treated in accordance with the risk of acid generation. Generally, overburden is placed in ex-pit spoil and interburden is placed in in-pit spoil.

5.2. COAL REJECTS (COARSE REJECTS AND TAILINGS)

5.2.1. General

The MCPL CHPP has a design capacity of 700tph and produces two product coal stream (PCI and Coke) and two waste streams (Coarse rejects and tailings). The CHPP materials flow is presented in Figure 1 below and rejects production statistics are presented in Table 1.

MCPL expects to produce approximately 27 Mt of rejects (coarse and tailings) with a rejects-to-product coal ratio (m/m) of 0.35:1. The total coarse reject and tailing masses are predicted to be approximately 15 and 12 Mt (dry), respectively.

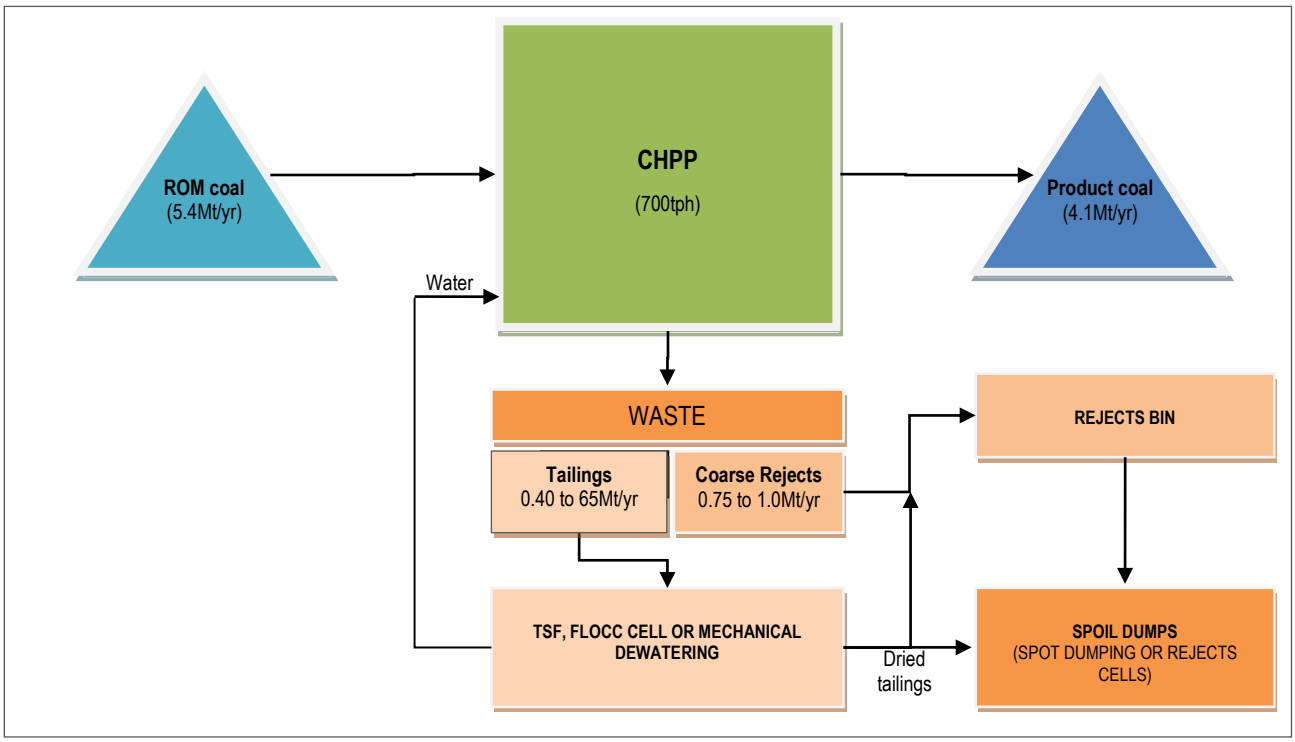

Figure 1: Materials process flow (adapted from Stage 2 EIS (PB, 2012))

Table 1: Rejects processing statistics

	Average	Maximum	Comments
ROM feed rate (tph)	**700**		**As received**
Coarse Rejects (tph)	**96**	**235**	**Rejects weigher**
Tailings (tph)	**58 to 70**	**120**	**Solids mass**
Rejects Belt Capacity (tph)	**-**	**450**	

5.2.2. Coarse Rejects

Coarse rejects are produced from the spirals/spirals reject dewatering screen and Dense Medium Cyclone via the drain and rinse screen. Rejects report via the rejects conveyor to the 240t rejects bin prior to trucking to the disposal locations in pit.

5.2.3. Tailings

Tailings (fine rejects) are produced from the CHPP thickener underflow. The tailings material is sourced from three plant processes (nominal flows shows):

- Flotation cell underflow (68tph);
- Screen bowl centrifuge effluent (6tph); and,
- Spiral rejects dewatering screen underflow (1tph).

Each of the three sources reports to the de-aeration tank prior to delivery to the Tailings Thickener. The tailings underflow (tailings) is pumped by a VSD drive pump to one of the following locations:

- TSF 2 ILF Cells (In Line Flocculation) consists of four cells within the existing and permitted TSF 2 footprint. The cells are used to hold tailings that have been flocculated in the pipeline immediately prior to deposition, for a short period prior to it being excavated and hauled for disposal in-pit.
- In-line flocculant cells – Consists of two emergency cells located between TSF 1 and Sediment Dam 1. These two cells are yet to be utilised, and if required, tailings will be pumped to in-line flocculant cells with flocculant added prior to discharge to accelerate dewatering of the material.

More detail on each of these options can be found in Section 7.

Tailings properties vary with the seam processed and associated product yield. The following provides a summary of recent properties:

Tailing Thickener underflow density	1.06 to 1.30 (avg. 1.11) t/m^3
Solids Mass flow	25 to 120 (avg 69) tph.

Other tailings data from German Creek includes (AMEC, 2000):

Tailings Permeability	$4x\ 10^{-8}$ m/s
Tailings Shear Strength (Ø)	32 Degrees
Tailings Cohesion (c)	0kPa

6. MINING BY-PRODUCT CHARACTERISATION

6.1. OVERVIEW

MCPL has completed a geochemical assessment of mining by-product materials with the following objectives:

- Characterising the mining by-product materials.
- Assess potential impacts associated with mining by-product materials.
- Develop management strategies for mining by-product materials.

MCPL engaged RGS Environmental Pty Ltd (RGS) to complete the study and the RGS report should be read where more material characterisation detail is required (RGS, 2013). The RGS report builds on previous work undertaken by RGS as well as work completed during the Stage 1 development and Stage 2 EIS (PB, 2011).

The RGS study included a detailed sampling (103 samples collected and analysed) and characterisation program including overburden, interburden, coal seams, coal seam roof/partings and floor, product coal, coarse rejects and tailings. Assessments included mine water contact testing, Acid Base Accounting, Kinetic Leach Column testing, Acid Neutralisation Capacity availability determination, multi-element composition of samples and leachate, site water and ground water quality assessment and recommendations of management strategies.

RGS was subsequently commissioned by MCPL to complete a review of geochemical monitoring data at Middlemount Coal Mine (RGS, 2016).

6.2. CHARACTERISATION RESULTS

The conclusions from the RGS 2013 study are:

- The majority of coal and mining waste materials are classified as Non-Acid Forming (NAF), have excess acid buffering capacity, and a high factor of safety with respect to potential for acid generation. Permian Interburden provides a useful source of acid buffering material that could be used as part of an improved management strategy for other Potentially Acid Forming (PAF) materials at the site.
- Most of the coarse reject and tailings material generated from processing coal from the Middlemount and Pisces seams, and some of the floor material from the Middlemount seam, are likely to be PAF and will require management.
- Surface runoff and seepage from most coal and mining waste materials generated on site is predicted to be pH neutral to slightly alkaline and show relatively low levels of salinity following surface exposure. Salinity levels in the mine water system and sediment dams may increase over time due to evapo-concentration of ongoing salt loads from coal and mining waste materials.
- Surface runoff and seepage from PAF coal and mining waste materials (including coarse rejects and tailings) generated at the site is expected to be acidic, with increased levels of salinity due to soluble sulfate, calcium and magnesium concentrations caused by sulfide oxidation and neutralisation.
- The concentration of soluble trace metals and major ions in runoff and seepage from most coal and mining waste materials is likely to be low, remain within applied water quality guideline criteria, and is unlikely to present any significant environmental risks for on-site or downstream water quality.
- The concentration of some soluble trace metals and major ions in runoff and seepage from PAF coal, coarse reject and tailings materials could be elevated if exposed to ongoing oxidising conditions.
- It is recommended that PAF materials (coarse rejects, tailings and Middlemount floor) be placed in-pit where practicable and mixed with Permian and/or covered with Permian spoil. PAF disposal locations should be placed at least 10 metres from the final landform and drain to the pit.
- Any PAF materials disposed of ex-pit should be mixed with Permian spoil at a ratio of 1:10, incorporate lime dosing and be covered with at least 10m of Permian prior to the final landform.

The conclusions from the RGS 2016 study are:

- The management of coarse reject and tailing materials at Middlemount Coal Mine by MCPL appears to be proceeding according to plan and there is currently no indication of significant AMD occurring either at the TSF or in-pit disposal areas.
- Monitoring data (ABA and NAG test results) confirm that coal, coarse rejects and tailings represent a range of material types ranging from NAF to PAF. The NAG test can significantly overestimate the acid generating capacity of PAF samples.
- Whilst initially pH neutral to alkaline, a significant proportion of the coarse rejects and tailings samples tested (76 %) have a reduced factor of safety and carry some risk of acid generation over time, if left unmanaged. Notwithstanding, it is expected that the management measures for coarse reject and tailing materials employed by MCPL are sufficiently robust to avoid significant potential impacts to surface water and groundwater resources at the site.
- Most coal samples are initially pH neutral to alkaline, but theoretically have a reduced factor of safety with respect to potential acid generation (albeit that most sulfur is likely to be present in a non-acid generating form (eg. organic sulfur). In addition, coal materials are stockpiled for a limited time at site prior to transport off-site to export markets. Therefore, the current measures for managing coal stockpile surface water and seepage (collection and monitoring - with lime dosing, if required) employed by MCPL are expected to be appropriate to address the relatively low level of risk to surface water and groundwater resources posed by these materials.
- Multi-element test results for coarse reject and tailing samples indicate that metals/metalloids are not significantly enriched in these materials compared to average crustal abundance.
- Surface water quality results at the TSF indicated that from April 2011 to January 2016, surface water remained pH neutral with excess alkalinity and within the required EA pH range (6.5 to 9.0). Surface water at the TSF was brackish and generally had elevated salinity and sulfate values towards the end of the monitoring period, most likely due to a combination of evapo-concentration of salts at the TSF and oxidation of sulfides in near-surface tailings. Dissolved (filterable) trace metal/metalloid concentrations at the TSF were low, which suggests that metal/metalloids are sparingly soluble in pH neutral surface contact water at the TSF.
- Despite the increased salinity and sulfate concentration in surface water at the TSF during the monitoring period, there was no corresponding increase in these parameters in groundwater at monitoring wells between the TSF embankment and Roper Creek, and both parameters remained within EA groundwater investigation trigger levels. The concentration of dissolved (filterable) trace metals/metalloids in groundwater was typically below the laboratory LoR and generally well below the EA groundwater investigation trigger levels.

A summary of the material characterisations of the coal and mining by-product materials tested in 2013 is provided in Table 2 and summarised graphically in Figure 2 and in accordance with the classification system presented in Table 3 (from RGS 2013). General classifications may change with on-going monitoring and characterisation.

Table 2: Material characterisation summary

Material	pH[1]	EC[1] (µs/cm)	Acid-Base Accounting[2]	ANC (kg H_2SO_4) & Availability	Leachate Risk	Acid Production Risk	Acid Neutralising Potential
Overburden Sandy & clayey alluvium	8-9	150-700	NAF (Barren)	2-14	Low	Low	Low
Weathered & unweathered tertiary sandy clays and clays	7-9	250 - 1000	NAF (Barren)		Low	Low	Low
Inter-burden – Permian siltstone / sandstone	9-10	250-500	NAF (Barren)	>55 kg (88.5%)	Low	Low	High
Roof, Parting, Floor Middlemount	7.5-8.5	350-700	Roof – NAF (Barren)	N/A	Low	Low	Low
	6-8	300-950	Parting - NAF (Barren)		Low	Low	Low
	3.5-5.5	450-800	Floor - PAF		Low	High	Low
Pisces	9-10	300-450	Roof – NAF (Barren)		Low	Low	Low
	9-10	400-1000	Floor – NAF to PAF (Variable. Treat as PAF)		Low	Moderate	Low
ROM Coal – Middlemount	3-8	170-850	PAF (Low Capacity) Variable Results		Low	Low	Low
Pisces	7-9	100-500	NAF to Uncertain		Low	Low	Low
Product Coal Middlemount	2.5-8.5	100-2500	NAF (Barren) to PAF (Variable. Treat as PAF)		Low	Low	Low
Pisces	7-9	100-250	NAF (Barren)		Low	Low	Low
Coarse Rejects Middlemount	2.5-7.5	300-2250	PAF		Low[3]	High	Low
Pisces	7-9.5	400-550	NAF to PAF (Variable. Treat as PAF)	(92%)	Low[3]	High	Low
Tailings Middlemount	6.3-7.2	450-800	PAF		Low[3]	High	Low
Pisces	7-9.5	150-800	PAF	(91%)	Low[3]	High	Low

[1] pH and EC for 1:5 sample:water extracts. [2] Refer to Section 3 for more definitions. [3] To be confirmed by field testing.

Table 3: Geochemical classification criteria for mine materials (RGS, 2013)

Geochemical Classification	Total or Sulfide Sulfur(%)[1]	NAPP (kg H_2SO_4/t)	ANC: MPA Ratio	NAG_{pH}	NAG Capacity (kg H_2SO_4/t)
Non-Acid Forming (NAF) – Barren[2]	≤ 0.1	-	-	-	-
Non-Acid Forming (NAF)	> 0.1	≤ -5	≥ 2	-	-
Uncertain	> 0.1	> -5 and ≤ 5	< 2	≥ 4.5	≤ 5
Potentially Acid Forming (PAF) - Low Capacity	> 0.1	> 5 and ≤ 10	< 2	< 4.5	≤ 10
Potentially Acid Forming (PAF)	> 0.1	> 10	< 2	< 4.5	> 10

Notes:
1. If total sulfur or sulfide sulfur is less than or equal to 0.1 %, the NAPP and ANC/MPA ratio are not required for material classification as the sample is essentially barren of oxidisable sulfur.
2. A sample classified as NAF can be further described as 'barren' if the total sulfur and/or sulfide sulfur content is less than or equal to 0.1 per cent, as the sample essentially has negligible acid generating capacity.

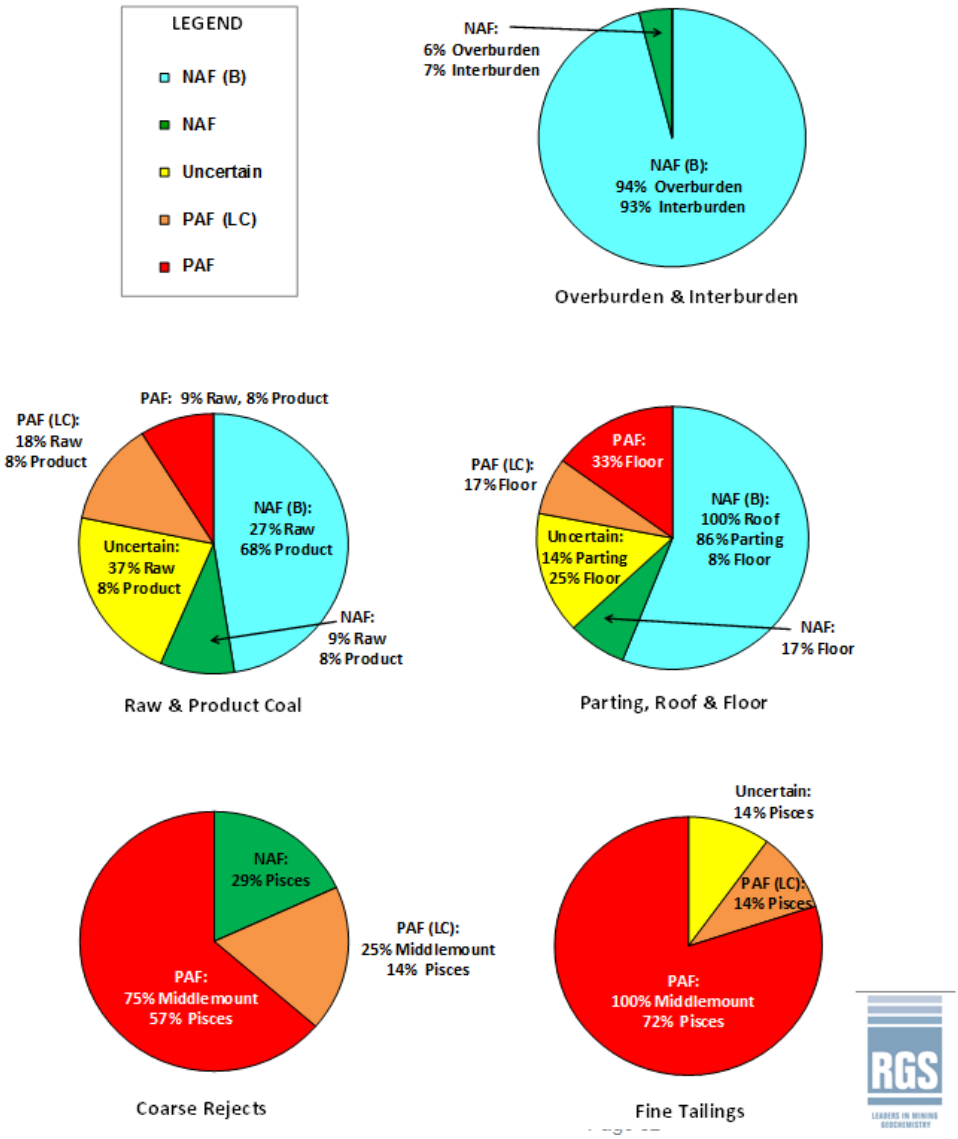

Figure 2: Geochemical classification of coal and mining by-product materials (from RGS 2013)

7. OPERATIONAL MANAGEMENT

7.1. MINING WASTE AND PROCESS WASTE DISPOSAL

All mining waste at the open pit is mined by excavator and truck or dozer push. As shown in Section 6, mining waste is NAF or acid neutralising with the exception of the Middlemount and Pisces seam floor. Coarse rejects and tailings (process wastes) have the potential to form AMD. To mitigate the risk from PAF material, the mining waste, coarse rejects and tailings disposal options are shown in Table 4 below. Each option is documented in more detail in this section.

On-going characterisation of the mining waste materials (including overburden, interburden, floor, roof and partings) will be completed on a project basis if new areas of the site are planned to be mined that have not been previously characterised. Ongoing characterisation of coarse rejects and tailings will be undertaken periodically to ensure that the material treatment suits the categorisation. This monitoring is discussed in Section 9.

Table 4: Mining waste and process waste disposal options

Material	Disposal Options					
	Ex Pit Spoil	**In-Pit Spoil**	**In-Pit spot dump in Permian** (10m from final landform surface)	**Ex-Pit spot dump** (10m from final landform surface)	**In-Pit Cells** (10m from final landform surface)	**TSF**
Overburden	Preferred	Preferred	N/A	N/A	N/A	N/A
Interburden	Preferred	Preferred	N/A	N/A	N/A	N/A
Coal Seam Partings & Roof (All Seams)	Acceptable (10m from final landform)	Preferred	Preferred	Acceptable	N/A	N/A
Coal Seam Floor (All Seams)	Avoid (Lime dosing and 10m of Permian cover)	Acceptable (10m from final landform)	Preferred	Avoid (Lime dosing and 10m of Permian cover)	N/A	N/A
Coarse Rejects	No	No	Preferred (Ideal 5:1, Min 3:1 Permian to Rejects)	Avoid (Min. 10:1 Permian spoil to rejects, lime dosing and 10m Permian cover required)	Acceptable (Lime dose as required)	N/A
Tailings	No	No	Acceptable (Lime Dose as required) – Caution – Tip head stability	No	Preferred (Dried and Lime dosed as required)	Acceptable
Co-mingled Coarse Rejects & Tailings	No	No	Preferred (Ideal 5:1, Min 3:1 Permian to Rejects)	Avoid (10:1 Permian spoil to rejects, lime dosing and 10m Permian cover required)	Acceptable (Lime dose as required)	N/A

7.1. OVERBURDEN AND INTERBURDEN

Overburden is classified as NAF and may be placed in any in-pit or ex-pit spoil dump. Dispersive material is to be preferentially placed away from the final landform surface.

Interburden is to be preferentially placed in-pit to provide the acid neutralisation capacity for spot-dumping of PAF materials and creation of Permian caps and bunds on rejects cells. Placement in ex-pit spoil may be used to neutralise any PAF material that is placed in the ex-pit spoil.

7.2. COAL SEAM PARTINGS AND ROOF

Coal seam partings and roof material is to be preferentially placed in in-pit spoil at least 10 metres from the final landform. Where required, this material may be placed in ex-pit spoil at least 10 metres from the final landform.

7.3. COAL SEAM FLOORS

Coal seam floor material is to be placed at least 10 metres from the final landform and preferentially spot dumped with Permian material within in-pit spoil.

In the event it is necessary to place the material in ex-pit spoil the floor material is to be lime dosed and covered with 10 metres of Permian spoil.

7.4. COARSE REJECTS

7.4.1. Handling

Coarse rejects are discharged to the 240t rejects bin via the rejects conveyor. Mine Haul trucks haul the rejects from the bin for disposal within the in-pit spoil dump.

Where rejects production exceeds haulage to in-pit disposal or wet-weather constrains pit access, rejects may be temporarily stored on the rejects pads. Stockpiled rejects are then loaded into haul trucks using front-end loaders or excavator for haulage to the disposal location in-pit.

To prevent hang-ups of material and minimise temporary stockpiling of rejects, the Coarse Rejects Bin is to be kept below 75% full and drawn down regularly when operating with Coarse Rejects only while the CHPP is running. The Bin is to be emptied prior to any planned shut-downs.

In the event that tailings are co-mingled with the coarse rejects on the rejects conveyor, the rejects bin is to be maintained below 50% capacity and is to be emptied regularly.

7.4.2. Water Management

Drainage from coarse rejects storage areas (rejects bin and temporary rejects storage locations) is to be contained on site. Water is to be returned to the Raw Water Dam for reuse as soon as practicable.

7.5. TAILINGS – IN-LINE FLOCCULANT CELLS

7.5.1. Cell Design Details

In-line flocculant (ILF) cells will be earth bunded structures designed to hold flocculated tailings temporarily whilst dewatering takes place and excavation/reclamation of dried tailings can occur. The ILF cells will have a minimum capacity of 1 week of CHPP production with additional allowance for rainfall and water management. All water produced is to be returned to the CHPP or the Raw Water Dam to supply plant make-up water.

Cell batters will be a maximum of 1:2 and a half metre base of coarse rejects or rock on the cell floor as a working surface sloping to the decant location. Access ramps will be less than 1:10 grade to enable truck access. Decant walls will be used if required to assist with dewatering.

Maintenance and repairs will be conducted at the completion of excavation cycles on an as required basis. This may include but is not limited to:

- Batter repairs
- Decant wall replacement
- Access ramp repairs

7.5.2. Operation

In-line flocculation cells are utilised whereby the tailings are dosed with flocculant to speed the dewatering process prior to placement in the cells. The dewatered tailings will then be excavated and transported to the pit for placement.

The addition of flocculant will accelerate the dewatering process and produce solids content ranging from 55 to 65%. Each cell will include a number of discharge points to enable sequential placement of tailings (DP1, then DP2 then DP3) to progress from towards the decant end of the cells as shown in Figure 3 and Figure 4. Sequential placement will allow the continual dewatering of tailings material as it accumulates to the cell operating capacity. Water liberated from the tailings will flow downhill to the decant pump.

The cells will be continually dewatered from the decant end to minimise drying time. Decanted water will be pumped to TSF1 from where it will be returned to the plant for make-up water. Water may also be recycled to the raw water dam.

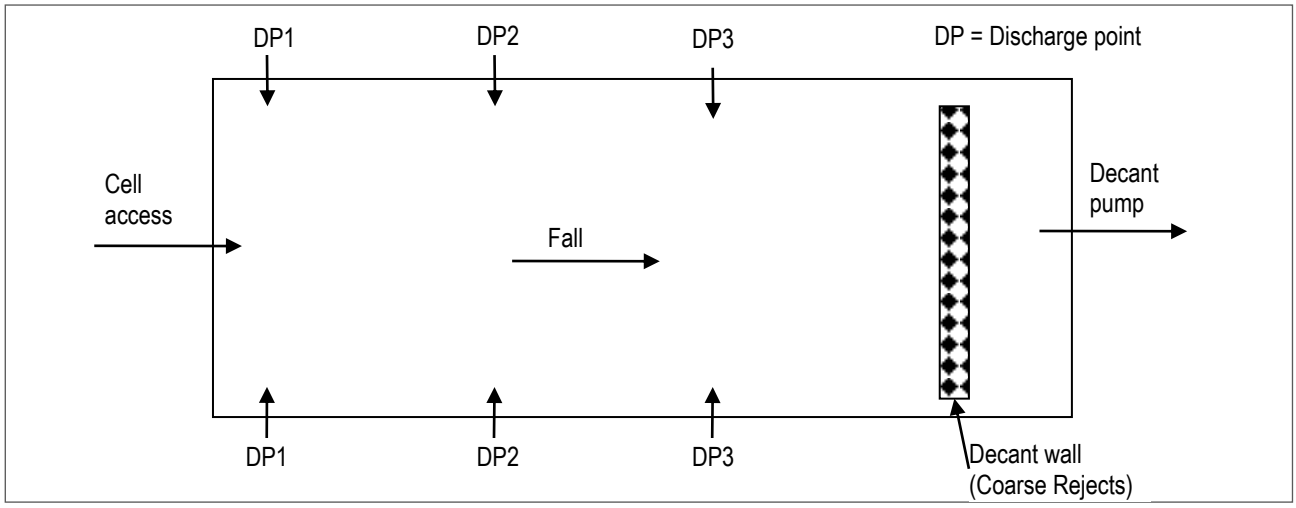

Figure 3: In-Line Flocculation Cell Schematic – Plan View

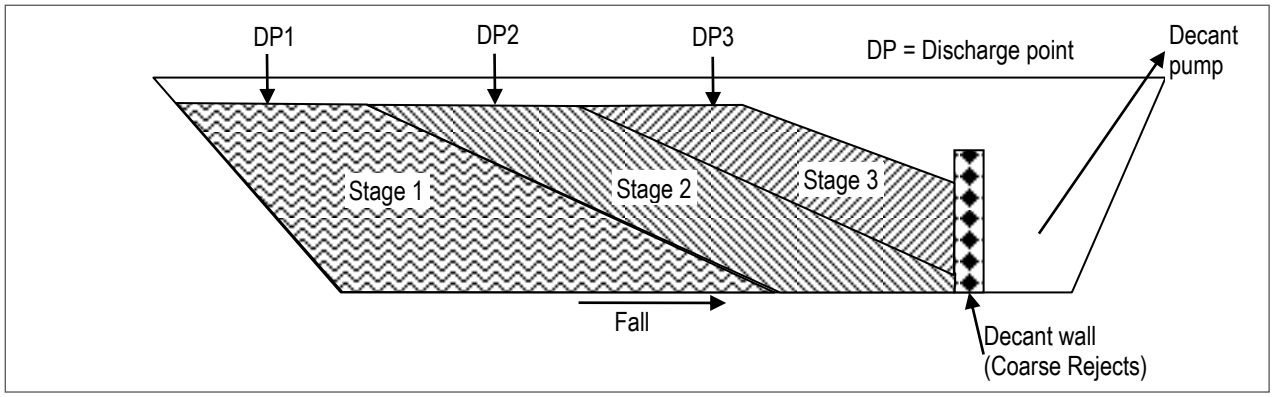

Figure 4: In-Line Flocculation cell schematic section view and placement stages (left to right)

Table 5: In-Line Flocculation cell details

ILF Cell	Design Capacity (includes DSA allowance) (m^3)	Operating Capacity (Tailings) (m^3)	Days to Fill (days)#	Drying Time (days)	Excavation Time (days)
1	TBC	Min 7 Days	7 Days (min)	7 Days (Est)	6 Days (Est)
2	TBC	Min 7 Days	7 Days (min)	7 Days (Est)	6 Days (Est)

Solids Specific Gravity – 1.6t/m^3, Plant operation 700tph for 23.5hrs per day

Following placement, cells will be dewatered and allowed to dry. Upon drying of the cells, the tailings will be excavated using excavators and trucks and trucked to the in-pit spot dumping or cell disposal locations as discussed in Section 7.7. Excavation will commence with trucks backing to the excavator, with cells wide enough for 40t, 6 wheel drive trucks to turn around on the cell floor. No out of sequence excavation of tailings will occur unless specifically authorised.

The in-line flocculation cells will operate in conjunction with TSF 1, where tailings will be placed in TSF 1 when insufficient capacity is available within the in-line flocculation cells.

Operational responsibilities will be as follows:

- Tailings discharge, including flocculation
- Dewatering

7.5.3. Water Management

Cells will include dedicated de-watering infrastructure including pumps, pipes and valving. Decant water will be continually drawn off and pumped to TSF 1 from where it will be returned to the plant or the Raw Water Dam.

Cells are designed with no external catchment minimise flooding potential, environmental risk and DSA requirements and will include sufficient DSA capacity in addition to the operational volumes.

7.6. TAILINGS - TAILINGS STORAGE FACILITY 1 AND 2

7.6.1. Operation and placement strategies

The peak tailings production at MCM is about 58 200 t/month of tailings. It is estimated the settled dry density of the tailings will be around 0.9 t/m^3, requiring 64 620m^3 of storage per month. Tailings will be placed into TSF2 Flocculation Cells in a manner that enables the decant water to be reclaimed and returned to the CHPP. This will involve discharge points being installed around the cells and grading to the return water pump(s). Placement will work progressively around the cell to facilitate dewatering and beaching towards the return water pump.

Where practicable, tailings may be reclaimed once dewatered in a cycle of fill, dry, reclaim (Table 6) and trucked to the in-pit spot dumping or cell disposal locations as discussed in Section 7.7.

The CHPP will be responsible for the operation of the tailings discharge and return water. Mine operations will be responsible for any reclamation.

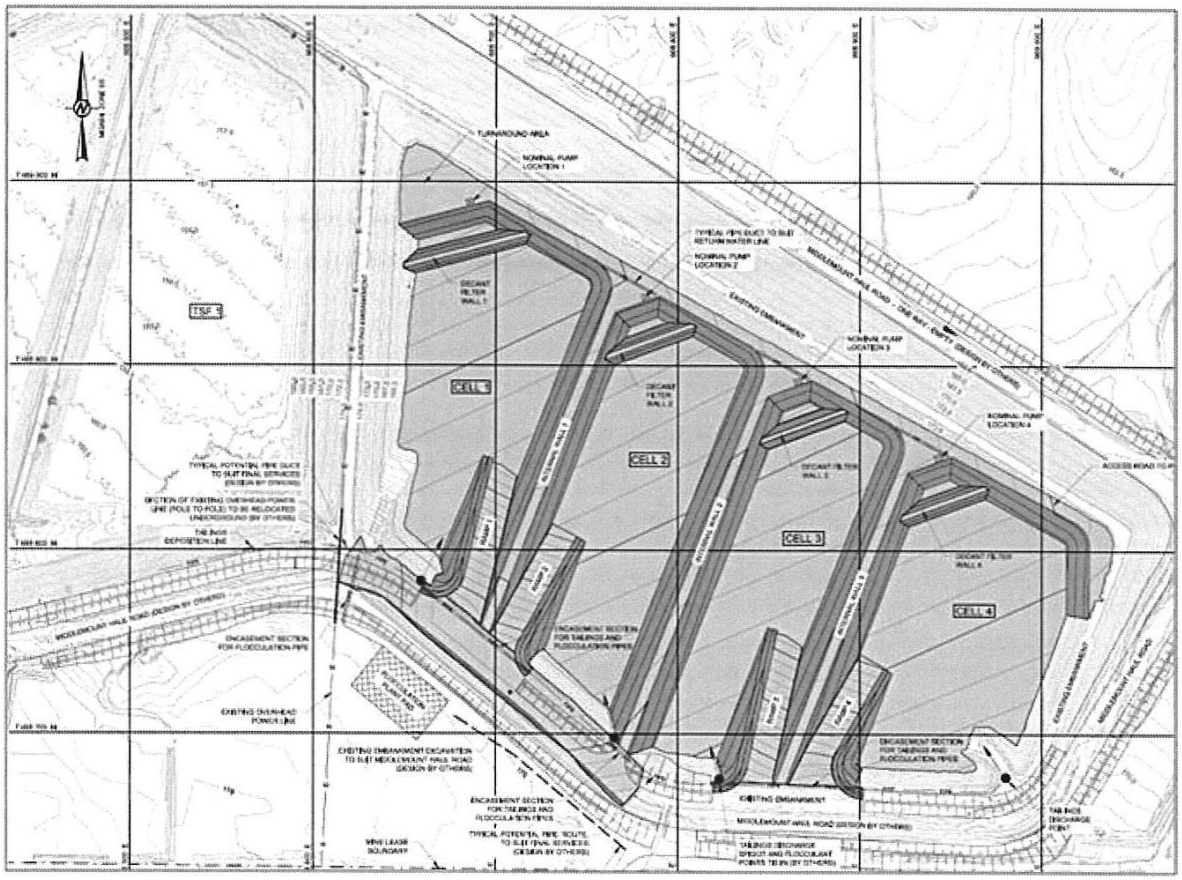

Figure 5: TSF 1 and TSF 2 showing the four-flocculation cell layout encapsulated within TSF 2

Table 6: Cell activities planning

Period	Cell 1	Cell 2	Cell 3	Cell 4
1	Fill	-	-	-
2	Drying	Fill	-	-
3	Reclaim	Drying	Fill	-
4	Reclaim/maintenance	Reclaim	Drying	Fill
5 – cycle restarts	Fill	Reclaim/maintenance	Reclaim	Drying

7.6.2. Water Management

Decant water will be drawn off the cells by the pontoon-based return water pump. Return water will be supplied to the plant in preference to raw water from the raw water dam. It is expected that 50% of the CHPP plant make-up water will be sourced from the TSF 1 return water with the remainder from the raw water dam.

7.7. PAF Waste Placement

PAF waste material (including coarse rejects and tailings) will be preferentially placed within in-pit spoil via spot dumping with Permian inter-burden (Section 7.7.1) or disposed of in-pit cells (Section 7.7.2). In both cases the acid neutralisation capacity of the Permian spoil will be used to neutralise the potential acid formation capacity of the PAF material. All PAF material will be placed at least 10 metres from the final landform (Figure 6).

Where placement in ex-pit spoil is required, PAF material will be lime dosed, spot dumped and covered with Permian interburden. (Section 7.7.3)

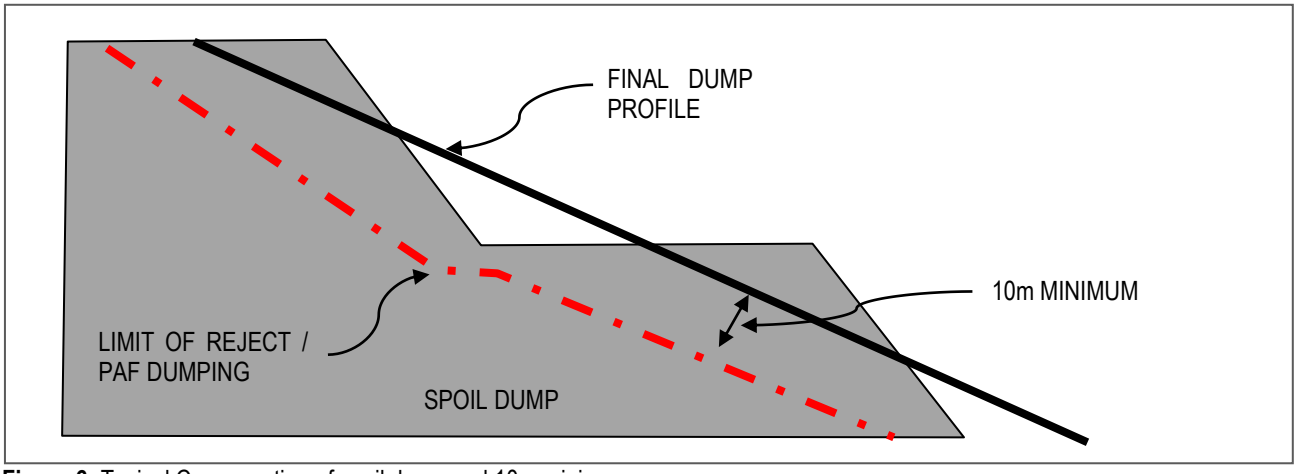

Figure 6: Typical Cross-section of spoil dump and 10m minimum cover.

7.7.1. Spot Dumping – In-pit Spoil

Spot dumping of PAF coarse reject/tailings materials and Permian spoil will occur within the boundaries of the open pit area (ie. internally draining bounds of the open pit spoil). The objective of the spot dumping is to enable the acid neutralising capacity of the spoil to neutralise the potential acid formation. As shown in Section 6, the Permian interburden has sufficient neutralising capacity to offset the potential acid formation. To provide a suitable factor of safety, PAF material will be mixed with a minimum of 3 parts Permian spoil by weight (Target of 5 parts Permian to 1 part PAF material).

All Spot dumping locations will drain internally to the open pit and be placed at least 10 metres from the final landform.

No coarse rejects or co-mingled coarse and fine rejects will be used as part of a tiphead safety bund, haul road or ramp.

In-pit spot dumping is to be designed in accordance with SP-212-004 Mining By-Products In-Pit Disposal.

7.7.2. In-Pit Cell Operations

As an alternative to spot dumping, cell based in-pit emplacements will be progressively constructed. These emplacements will be created within the Permian spoil in progressive in-pit dump designs. Cells will include a permeable floor for basal drainage and containing embankments of Permian spoil. Material will be tipped over dedicated tipheads and covered with 10m of Permian spoil. Cells are to be designed in accordance with SP-212-004 Mining By-Products In-Pit Disposal.

7.7.3. Spot Dumping - Ex-Pit Spoil

In certain circumstances placement of PAF in ex-pit spoil may be required. To control the PAF nature of the material, the PAF material will be spot dumped with Permian spoil at a ratio of 10:1 (Permian to PAF). The PAF material will be lime dosed and covered with 10 metres of Permian spoil.

No coarse rejects or co-mingled coarse and fine rejects will be used as part of a tiphead safety bund, haul road or ramp.

Specific approval from the Environment Department is required prior to placement of PAF in Ex-pit spoil

7.8. NAF Waste Placement

NAF coarse rejects and tailings materials will be treated the same as PAF coarse and fine rejects, being preferentially placed within in-pit spoil via spot dumping with Permian inter-burden (Section 7.7.1). The acid neutralisation capacity of the Permian spoil will be used to provide a factor of safety to NAF categorised Coarse and fine rejects. All NAF Coarse and fine rejects and coal seam floor material will be placed at least 10 metres from the final landform (Figure 6).

NAF overburden, interburden and coal seam partings and floor may be placed in in-pit or ex-pit spoil. Partings and floor are preferentially placed in-pit.

7.9. Coarse Rejects and Tailings Disposal Recording

A record of coarse rejects and tailings properties will be maintained, including Acid Base Account and monitoring results.

Monthly tonnages of coarse rejects and thickened tailings disposed will be recorded.

8. ENVIRONMENTAL ISSUES, IMPACTS AND CONTROL MEASURES

The environmental issues, impacts and controls are described in Table 7 below. The potential for AMD is considered to be the major risk and the following hierarchical of control strategies in order of priority can be categorised as:

1. prevention of impact;
2. minimisation of impact and/or likelihood through active or passive treatment impact; and
3. interception and control of impact.

The control measures will depend on topography, mining method, material type, soil/rock types, mineralogy, and available neutralisation resources. Control measures are documented in Table 7 below and have been integrated into the operational management as presented in Section 7.

Table 7: Environmental Issues, Impacts and Controls

Potential Issue	Potential Impact	Control Measures
AMD	• Contamination of surface water from spoil emplacement areas and stockpiles. • Contamination of stock, irrigation and domestic groundwater supplies. • Degradation of aquatic ecosystems. • Impact on recreation and aesthetics. • AMD from incorrect placement of PAF material.	• Minimise exposure of PAF materials to wetting and drying cycles by limiting rehandling of PAF mining waste, coarse rejects and tailings material and progressive covering of PAF material. • Selective handling and placement of materials, including neutralisation of PAF materials by mixing of PAF material with spoil with excess acid neutralisation capacity (eg. PAF with Permian spoil). Factor of safety applied to mixing with minimum of 3 Permian to 1 PAF by weight (target of 5 parts Permian to 1 part PAF material), based on geochemical characterisation assessment (RGS, 2013). • Development and communication of PAF disposal areas and methods. • Rehandling of incorrectly placed material (eg. within 10m of final landform surface). • Diversion of run-on water from PAF disposal locations. • Minimisation of water pondage on dump surfaces and subsequent infiltration. • Placement of PAF material at least 10 metres from final landform with NAF/Permian cover to minimise water movement through material and provide neutralising material. • Rapid dewatering of tailings and recycling of decant water to minimise the volume of decant water and the duration of exposure. Possible through mechanical dewatering or in-line flocculant cells. • RPEQ designed and certified tailings decant storages. • Chemical amelioration, eg. lime dosing, where required. • Disposal locations to be within the in-pit spoil and are internally draining to the mine pit. • Containment of mine affected water including leachate from PAF disposal locations and coal stockpiles. • Rehabilitation of spoil dumps to minimise leaching of water through spoil. • Rehabilitation of tailings dams and coal stockpiles. • Progressive characterisation of mining wastes, specifically coarse and tailings. • Tracking of PAF disposal locations. • Monitoring of leachate from in-pit disposal locations and coal stockpiles. • Monitoring of groundwater resources, specifically aquifers suitable for human or stock consumption. • Monitoring of upstream reference and downstream impact points and REMP monitoring. • Adoption of emergency response plans, including consideration of downstream landholders.

Potential Issue	Potential Impact	Control Measures
Dust from PAF materials	• Toxicity to the receiving environment. • Transport of contaminants to the receiving environment.	• Minimise exposure of PAF materials to wetting and drying cycles by limiting rehandling of PAF rejects and waste and progressive covering of PAF material. • Dust suppression of PAF disposal locations. • Neutralisation of PAF materials by mixing of PAF material with spoil with excess acid neutralisation capacity (eg. PAF with Permian spoil). Factor of safety applied to mixing with a minimum of 3 Permian to 1 PAF based on geochemical characterisation assessment (RGS, 2013). • Placement of PAF material at least 10 metres from final landform with NAF/Permian cover. • Rapid dewatering of tailings and recycling of decant water to minimise the volume of decant water and the duration of exposure. Possible through mechanical dewatering or in-line flocculant cells. To provide working surfaces for tailings reclamation without wet/boggy sub-stratum. • Rehabilitation of spoil dumps to minimise leaching of water through spoil. • Rehabilitation of tailings dams and coal stockpiles. • Monitoring and analysis of dust emissions. • Dewatering of tailings prior to transport to minimise spills of wet material.
Release of tailings from Tailings Storage Facilities	• Release of tailings and/or tailings decant water to Roper creek. • Sediment load increased in Roper Creek. • Contamination of water from release of water with some or all of the following; low pH, high EC, elevated metal or sulfate concentration • Metal accumulation in plants and animals. • Contamination of stock drinking supplies. • Contamination of soil. • Loss of human and/or animal life.	• Certified design and construction of the Tailings Storage Facilities. • Annual inspection by Registered Professional Engineer of Queensland (RPEQ). • Routine inspections and repairs. • Maintenance of Design Storage Allowance. • Reclamation of tailings and/or alternative dewatering of tailings prior to placement within in-pit spoil with available acid neutralisation capacity.
Interaction of PAF with rehabilitation	• Interaction of PAF with rehabilitation.	• PAF material to be co-disposed with spoil with acid neutralisation potential. • 10 metre buffer maintained from PAF disposal locations to the final rehabilitation profile. • Rehabilitation monitoring.
Metals/metalloids leachate	• Leaching of metals/metalloids via AMD.	• Waste characterisation and contact testing (RGS 2013). • Progressive characterisation of coal and mining waste and review to determine the potential leachate risk (RGS, 2016). • Disposal of PAF material with spoil with available acid neutralisation capacity.

Potential Issue	Potential Impact	Control Measures
Dust from Overburden	• Toxicity to the receiving environment	• Progressive recontouring and rehabilitation of spoil dumps. • Dust suppression. • Rehabilitation of spoil dumps to minimise leaching of water through spoil. • Rehabilitation of tailings dams and coal stockpiles. • Monitoring and analysis of dust emissions.
Spoil run-off	• Contamination of surface water from spoil run-off	• Progressive recontouring and rehabilitation of spoil dumps. • Rehabilitation of spoil dumps to minimise leaching of water through spoil. • Rehabilitation of tailings dams and coal stockpiles. • Installation and maintenance of drainage and sediment and erosion control structures to control and treat run-off from spoil piles.

9. MONITORING

Monitoring of water and solid materials will form an important part of the on-site management of mine by-products. The monitoring program is primarily aimed at identifying PAF coarse reject and tailing materials and potential impacts to ensure that management practices are appropriate or are modified accordingly. Monitoring will be conducted by trained on site personnel or by specialist consultants as engaged by MCPL.

Ongoing characterisation of coarse rejects and tailings materials will be completed. Leachate from coarse rejects and tailings placed at spoil disposal areas and tailings decant water will be included in the site water quality monitoring program.

Monitoring will include characterisation of mining waste materials (including overburden, interburden, floor, roof and partings) on a project basis, if new areas of the site are planned to be mined that have not been previously characterised.

This monitoring program schedule is provided in Table 8. For samples of solid materials, approximately 2kg should be collected and placed in appropriately labelled plastic sample buckets before sending to the laboratory. All sample batches should be accompanied by a hard copy of a completed laboratory Chain of Custody document.

The monitoring program will be revised as part data and management plan reviews and as more site-specific data becomes available.

9.1. Coal Processing and Mining Waste Sampling and Characterisation

Sampling and characterisation of mining waste (overburden, interburden, floor, partings and roof materials), coal processing waste (coarse rejects and tailings) and coal will be undertaken periodically as part of the monitoring program to assess the risk of AMD associated with any PAF materials. The aim the program is to quantify the characteristics of materials, assess potential impacts and confirm or modify management strategies associated with the material.

Table 8 below details the monitoring program. Additional monitoring will include routine ground water, regulated structures (TSF) inspections and rehabilitation monitoring.

Table 8: Mining waste, process waste, coal and water quality monitoring program

Frequency	Sample Source	Sample Point	Analysis	Comments
Monthly	Middlemount Seam, Tralee Seam Pisces Seam or blend.	1. Tailings thickener underflow 2. Coarse rejects	pH, EC, total sulfur, ANC and chromium reducible sulfur (CRS).	Source of coal (seam, strip) to be recorded to develop spatial understanding of rejects by source. Frequency to be reviewed annually or if materials are consistently NAF.
	TSF and ILF cell decant water	TSF 1, ILF Cell 1 & 2 and TSF 2 if receiving tailings.	pH, EC in-situ	
Quarterly	Middlemount Seam, Tralee Seam Pisces Seam or blend.	1. Tailings thickener underflow 2. Coarse rejects	pH, EC, total sulfur, ANC and CRS. 1:5 water extract water quality (dissolved Ag, Al, As, Ca, Cd, Cl, Co, Cr, Cu, F, Fe, Pb, Hg, K, Ni, Mg, Mn, Mo, Na, Se, U, V, Zn and SO_4).	Source of coal to be recorded to develop spatial understanding of rejects by source. Frequency to be reviewed annually or if materials are consistently NAF.
	TSF and ILF cell decant water	TSF 1, ILF Cell 1 & 2 and TSF 2 if receiving tailings.	pH, EC, dissolved Ag, Al, As, Ca, Cd, Cl, Co, Cr, Cu, F, Fe, Pb, Hg, K, Ni, Mg, Mn, Mo, Na, Se, U, V, Zn and SO_4 as per EA Table C3).	
	Middlemount Seam, Tralee Seam Pisces Seam	ROM Coal	pH, EC, total sulfur, ANC and CRS.	

Frequency	Sample Source	Sample Point	Analysis	Comments
Opportunistic	Leachate from disposal locations		pH, EC, dissolved Ag, Al, As, Ca, Cd, Cl, Co, Cr, Cu, F, Fe, Pb, Hg, K, Ni, Mg, Mn, Mo, Na, Se, U, V, Zn and SO_4 (as per EA Table C3).	If possible. Locations to include in-pit cells and pit water.
Project Based	Overburden, interburden, floor, partings and roof of all seams	Overburden, interburden, floor, partings and roof from exploration drill core.	pH, EC, total sulfur and CRS, as required. 1:5 water extract water quality (dissolved Ag, Al, As, Ca, Cd, Cl, Co, Cr, Cu, F, Fe, Pb, Hg, K, Ni, Mg, Mn, Mo, Na, Se, U, V, Zn and SO_4). Column leach testing as required.	One-off sampling for new project areas to focus on spatial distribution rather than strict timing.
As Required	All sample sources	Additional sampling will be undertaken on an as-needs basis.		

#ICPMS/CV FIMS – analytical methods required to achieve laboratory Limit of Reporting (LOR).

Coarse rejects, tailings and potential PAF mining waste material monitoring records shall be kept including the following:

- Sample date and time
- Sampler
- Sample location
- Sample source (seam, strip and block)
- In-situ parameters pH, EC and temperature (water only)
- Visual observations. Key indicators of AMD presence include (but are not limited to):
    - Turbidity
    - Colour, (eg. particularly red coloured, unnaturally clear water;
    - odour, (eg. sulfurous);
    - precipitate formation (eg. orange-brown iron oxide precipitates);
    - corrosion of concrete or steel structures.
- Lab results as per Table 8 above.

Form FR-212-003 will be used for material characterisation sampling

9.2. Related Monitoring

Other monitoring that may interaction with mining by-product management includes groundwater, regulated structures, rehabilitation monitoring and general inspections. Items considered include:

- Water quality – groundwater;
- Water quality – surface water;
- Seepage/leachate production and quality;
- Visual inspections;
- Soil geochemistry; and,
- Vegetation coverage and establishment.

All monitoring results will be used to assist with the ongoing development and implementation of mining by-products management strategies. The Environment Department will be responsible for communicating the outcomes of review and risk of AMD. If management practices are not effective, changes to the management will be made and implemented. All relevant personnel employed at the site will undergo training in relation to mining by-products management.

9.3. Monitoring Data Recording

All monitoring data shall be kept in the EDMS database.

10. CONTINGENCY AND EMERGENCY PLANS

If any personnel suspect AMD, it should be reported to the Site Senior Executive (SSE) and Environment Department immediately.

10.1. OPERATIONAL CONTINGENCIES

Contingencies have been developed for scenarios that may occur throughout the life of the operation. Each scenario may have more than one contingency of which a portion of the contingencies may be enacted in that event based on the site conditions at the time. The scenarios and contingencies are presented in Table 9.

Table 9: Operational Contingencies

Scenario	Possible Contingencies
Insufficient Permian for spot placement of PAF material	• In-pit cell construction and possible lime dosing. • Ex-pit spot dumping with lime dosing. • Tailings diverted to TSF 1 or 2.
Incorrect placement of PAF within 10m of final landform	• Incident Investigation. • Removal and relocation of PAF material to suitable dump location. • Assessment of potential or real impacts.
Wet-weather preventing access to disposal locations	• Temporary storage of rejects at temporary rejects stockpiles. • Halt CHPP production.
Mechanical dewatering equipment malfunction	• Temporary placement of tailings in the TSF 1 or 2. • Future reclamation to provide sufficient emergency capacity in TSF 1 or 2.
Abnormal monitoring results	• Investigation into cause of results and mitigation measures required.
AMD indicators found	• Incident investigation. • Soil and water sampling to be conducted. • AMD source treated (removed, ameliorated, etc). • Interception/mitigation measures installed based on expert advice.

10.2. EMERGENCY RESPONSE

If any personnel suspect the presence of AMD, it should be reported to the Site Senior Executive (SSE) and the Environment Department as soon as practicable and within 24 hours. The Emergency Preparedness and Response Management Plan (MP-104-001) should also be consulted. Emergencies relating to regulated dams shall be managed in accordance with regulated dam guidelines and operational plans.

Any uncontrolled release of contaminants shall be managed in accordance with the following general principles:

1. **Isolate**
   - Isolate access to the spill and sources of spill (valves, etc) where possible.
2. **Notify**
   - Notify Supervisor and Environment Department or SSE.
   - The Environmental Department, in consultation with the SSE, shall consider the need to contact downstream landholders, DEHP and other stakeholders. The Emergency Preparedness and Response Management Plan (MP-104-001) should also be consulted.
3. **Contain**
   - Prevent spill spreading or entering waterways (eg. by bunding). Amelioration with lime may also be required.
4. **Control the release**
   - Control the release source (drain, etc). May be completed in conjunction with Item 3.
5. **Reclaim**
   - Reclaim released material and/or contaminated material where the impact is justified. Caution is to be applied around watercourses and with potentially acidic water/material and specialist advice may need to be sought.

The Site Environment Department shall commence an investigation into the reported AMD and may include visual inspections, soil and water monitoring and possible test pits. Where AMD is deemed likely, the Environment Department will engage a suitably

qualified consultant to advise on appropriate actions that may include sampling programs to determine if AMD is occurring as well as containment, mitigation and remedial actions to prevent further AMD impacts. The Environment Department should review the current Mining By-Products Management Plan, site practices and monitoring records. Management plans and site practices are to be amended as required.

Where an incident occurs that results in an emergency or incident which results in, or may result in, environmental harm or the release of contaminants not in accordance with the sites environmental authority, the administering authority must be notified in writing within 24 hours (EA Condition A8).

Furthermore, not more than 10 business days following the initial notification of an emergency, incident or information about circumstances which result or may result in environmental harm or the release of contaminants, or within 24 hours after receiving the results from analysed samples, written advice must be provided to the administering authority (EA Condition A9 and A10).

11. PERIODIC REVIEW & CONTINUAL IMPROVEMENT

This Management Plan will be reviewed every two years in addition to on an 'as needs' basis if mining by-product management issues arise. Reviews will include consideration of monitoring results. Any changes in operational practices will be incorporated into the documentation and communicated to responsible employees and contractors.

Suitable criteria to establish whether mining by-products management practices are effective are as follows:

- no complaints in relation to mining by-products management;
- full compliance with the requirements of this Mining By-Products Management Plan;
- no uncontrolled release of contaminated leachate; and
- continual improvement in mining by-products management practices.

Reviews will be undertaken by the Environment Department and/or specialist consultants and will include discussions with site personnel and contractors.

12. COMMUNICATION / TRAINING

All matters relating to Mining by-products must be referred to and managed by the MCPL Environment Department.

All relevant personnel employed at the Middlemount Coal Project will undergo training in relation to coarse rejects and tailings management.

13. REFERENCES

📖 COA, 2016. *Leading Practice Sustainable Development Program for the Mining Industry. Managing Acid and Metalliferous Drainage*. September. Commonwealth of Australia, Canberra ACT.

📖 DEHP, 2013. *Application Requirements for Activities with Impacts to Land Guideline.* Queensland Department of Environment and Heritage Protection.

📖 DEHP, 2017. Environmental Authority EPML00716913. Issued to Ribfield Pty Ltd and Middlemount Coal Pty Ltd by the Queensland Department of Environment and Heritage Protection. 22 August.

📖 DME, 1995. *Draft Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland, Technical Guideline – Assessment and Management of Acid Drainage and Saline/Sodic Wastes*. Queensland Department of Minerals and Energy (DME).

📖 INAP, 2009. *Global Acid Rock Drainage Guide (GARD Guide)*. Document prepared by Golder Associates on behalf of the International Network on Acid Prevention (INAP). June 2009 (http://www.inap.com.au/).

📖 Parsons Brinkerhoff, 2011. Middlemount Coal Project – Stage 2 EIS.

📖 RGS Environmental, 2013. Middlemount Coal Project – Geochemical Assessment of Coal and Mining Waste Materials (unpublished).

📖 RGS Environmental, 2016. Middlemount Coal Mine – Review of Geochemical Monitoring Data (unpublished).

MCPL's HSEC Standards

- Environmental Management Plan, Middlemount Coal Mine
- Environmental Authority Number EPML00716913
- SP-207-002 Water Management Site Practice
- SP-212-004 Mining By-Products In-Pit Disposal.
- MP-214-001 Regulated dams operational management plan
- MP-104-001 Emergency Preparedness and Response
- FR-212-003 – Mining By-Products Sampling Form
- Plan of Operations – as amended from time to time

14. RECORDS

All records associated with the Mining By-Products Management Plan will be maintained in a central location.

Records relating to this standard shall be maintained in accordance with MP-500-001 Document Control, Development and Data Management and SP-505-001 Records Management.

15. INDEXING AND KEYWORDS

Document Type	Vocation	Process	Regulation	AS4804
Management Plan	Mining	Exploration		Policy
SOP	Mechanical	Overburden		Planning
Site Practices	Electrical	Coal		Implement
Form	Technical	CHPP		Measure
Risk Assessment	Administration	Engineering		Review

16. RECORD OF REVIEW

Rev	Date	Revision description	By	Check	Approved
0	08.03.10	Draft	KH	PT	
1	08.05.10	Initial	KH	SS	SS
2	24.06.10	Name changed from Mining Waste Management Plan to Mining By-Products Management Plan	AC	SS	SS
3	02.08.10	Inclusion of reference to new SP-212-002 Coarse and Fine Rejects	AC	SS	SS
4	06.01.11	New logo	AC	SS	SS
5	21.08.13	Major revision. Inclusion of Geochemical characterisation work on mining waste, coarse rejects and tailings	GC	LW	
6	25.06.16	Update to include diagram of TSF 2 Flocculant Cells	LW	LW	
7	09.04.18	Review and update of Mining By-Products Management Plan by RGS Environmental	RGS	SF	