# POST CLOSURE MANAGEMENT PLAN

**SITE**: Millennium Coal Pty Ltd

**DATE:** June 2019

**REF:** MIL-ENV-PCMP version 3

| Document Owner | Document Approver |
|---|---|
| Senior Environmental Advisor | Daryn Railey |
| **General Description** | |
| Millennium Mine Post Closure Management Plan in accordance with conditions F9 and F10 of Environmental Authority EPML00819213. | |
| V3 Revision - PCMP updated to address Material Particulars relevant to the management of a void or rehabilitation of land identified in DES correspondence 11 January 2019. | |

# Contents

## 1. Introduction

Peabody Australia (Peabody) operates eight open-cut and underground coal mines throughout Queensland (QLD) and New South Wales (NSW) producing a broad range of metallurgical and thermal coals for domestic and international customers. Millennium Coal Mine (MCM) is an open cut mining operation located approximately 140 km south-west of Mackay in Central Queensland. The nearest regional centre is Moranbah, which is located approximately 22 km to the west, as shown in **Figure 1**.

The project is operated by Millennium Coal Pty Limited (MCPL), a wholly owned subsidiary of Peabody Energy Australia (PEA). The mine has been operating since 2005 with approval to produce at a rate of 5.5 million tonnes per annum (Mtpa).

The run-of-mine (ROM) coal is currently extracted from four granted mining leases (ML) namely, ML70313 Millennium West, ML70344 Mountain Pit, ML70401 North Poitrel and ML70457 Mavis Downs. The ROM coal is washed in a coal handling and preparation plant (CHPP) on an adjoining infrastructure lease, ML70312 Millennium East. This CHPP is currently owned by BHP Mitsui Coal (100%) and is operated by the Red Mountain Infrastructure (RMI).

As part of Peabody's mine closure guideline, and to comply with conditions F9 and F10 of Environmental Authority (EA) EPML00819213, Millennium Coal is required to prepare a Post Closure Management Plan.

## 2. Purpose and Scope

The aim of the Post Closure Management Plan is to ensure compliance with the requirements set out in conditions F9 and F10 of EA EPML00819213 and detail the overarching post closure management of the site. Condition F9 states that the Post Closure Management will be in operation for the either at least 30 years following final coal processing on site or a shorter period if the site is proven to be geotechnically and geochemically stable and it can be demonstrated to the satisfaction of the administering authority that no release of contaminants for the site will result in environmental harm.

Based on information included within the Millennium Coal Residual Void Management Plan and Rehabilitation Management Plan, respectively, Peabody believes the site is already demonstrating geotechnical and geochemical stability. The Post Closure Management Plan is therefore likely to be in operation for significantly less than the 30-year period stated in the EA.

The requirements of conditions F6 and F7 are presented in **Table 1** below; along with a cross-reference to the Sections within this Plan that provide the information that meets these requirements.

Table 1 Requirements of Conditions F6 and F7 and Cross-references

| Condition | Requirement | Section Reference |
|---|---|---|
| F9 | A Post Closure Management Plan for the site must be prepared at least eighteen (18) months prior to the final coal processing on site and implemented for a nominal period of:<br><br>At least thirty (30) years following final coal processing on site; or<br><br>A shorter period if the site is proven to be geotechnically and geochemically stable and it can be demonstrated to the satisfaction of the administering authority that no release of contaminants for the site will result in environmental harm. | This Plan is the Post Closure Management Plan. The Plan was submitted to the QLD Department of Environment and Science (DES) for review and comment in late February 2018. The Plan has therefore been submitted within the required timeframe.<br><br>The term of the Plan is described above in Section 2. |
| F10(a) | A Post Closure Management Plan must include the following elements:<br><br>Operation and maintenance of: | |
| F10(a)(i) | Wastewater collection and reticulation systems; | Section 4.1 |
| F10(a)(ii) | Wastewater treatment systems; | Section 4.2 |
| F10(a)(iii) | The groundwater monitoring network; | Section 4.3 |
| F10(a)(iv) | Final cover systems; and | Section 4.4 |
| F10(a)(v) | Vegetation cover. | Section 4.5 |
| F10(b) | Monitoring of: | |
| F10(b)(i) | Surface water quality; | Section 5.1 |
| F10(b)(ii) | Groundwater quality; | Section 5.2 |
| F10(b)(iii) | Seepage rates; | Section 5.3 |
| F10(b)(iv) | Erosion rates; | Section 5.4 |
| F10(b)(v) | The integrity and effectiveness of final cover systems; and | Section 5.5 |
| F10(b)(vi) | The health and resilience of native vegetation cover. | Section 5.6 |

## 3. Life of Mine, Rehabilitation and Mine Closure Process

During the life of Millennium Mine, which commenced open cut coal mining operations in 2006, the intensity of mining operation (ROM production) increased from approximately 1 mtpa in 2006 to 4.4 mtpa in 2016. During this time the rehabilitation intensity increased as areas became available for reshaping, topsoil application and seeding. Given the inherent high strip ratio compared to other mining

operations in the local area, Millennium Mine could only maintain its production intensity for a finite period, which has resulted in the cessation of conventional truck and shovel mining operations in late September 2018. As conventional truck and shovel mining slowed the rehabilitation intensity increased year-on-year since 2015, and in 2018, Millennium Coal plans on completing approximately 380ha (528% increase compared to 2017) of rehabilitation utilising existing production equipment and personnel and contractors. Although conventional mining has ceased, and highwall mining is the only mining method being utilised at Millennium Coal until Q3 – Q4 2019, the rehabilitation intensity and planned Post Closure and rehabilitation maintenance intensity is being maintained. The planned rehabilitation schedule for the remainder of the active rehabilitation phase has been presented in **Figure 2** below.

## 4. Related Management Plans

This Plan is related to the Rehabilitation Management Plan and Residual Void Management Plan.

The Residual Void Management Plan presents the rehabilitation success criterion which informs this Post Closure Management Plan as appropriate. For example, the Residual Void Management Plan presents rehabilitation success indicators for vegetation completion criteria.

## 5. Stakeholder Consultation

This Plan provides for the operation, maintenance and monitoring of key land and water environmental aspects during the Post Closure phase of Millennium Mine. As the Plan will be implemented by Peabody, there are no other stakeholders directly affected by this Plan. Consultation with the landowner's representative has informed closure planning and this consultation will be ongoing.

Information on stakeholder consultation in respect to rehabilitation and closure objectives, goals, indicators and completion criteria is presented in the Final Void Management Plan.

## 6. Review

The Post Closure Management Plan is an active document and will be reviewed and amended on an ongoing basis due to the dynamic nature of the Millennium Mine Closure process, advancements in technical assessments (i.e. highwall stability, groundwater and rehabilitation monitoring), mine plan changes and ongoing stakeholder consultation input.

At a minimum, the review period of this Plan should not exceed one calendar year from the last review date on Page 1.

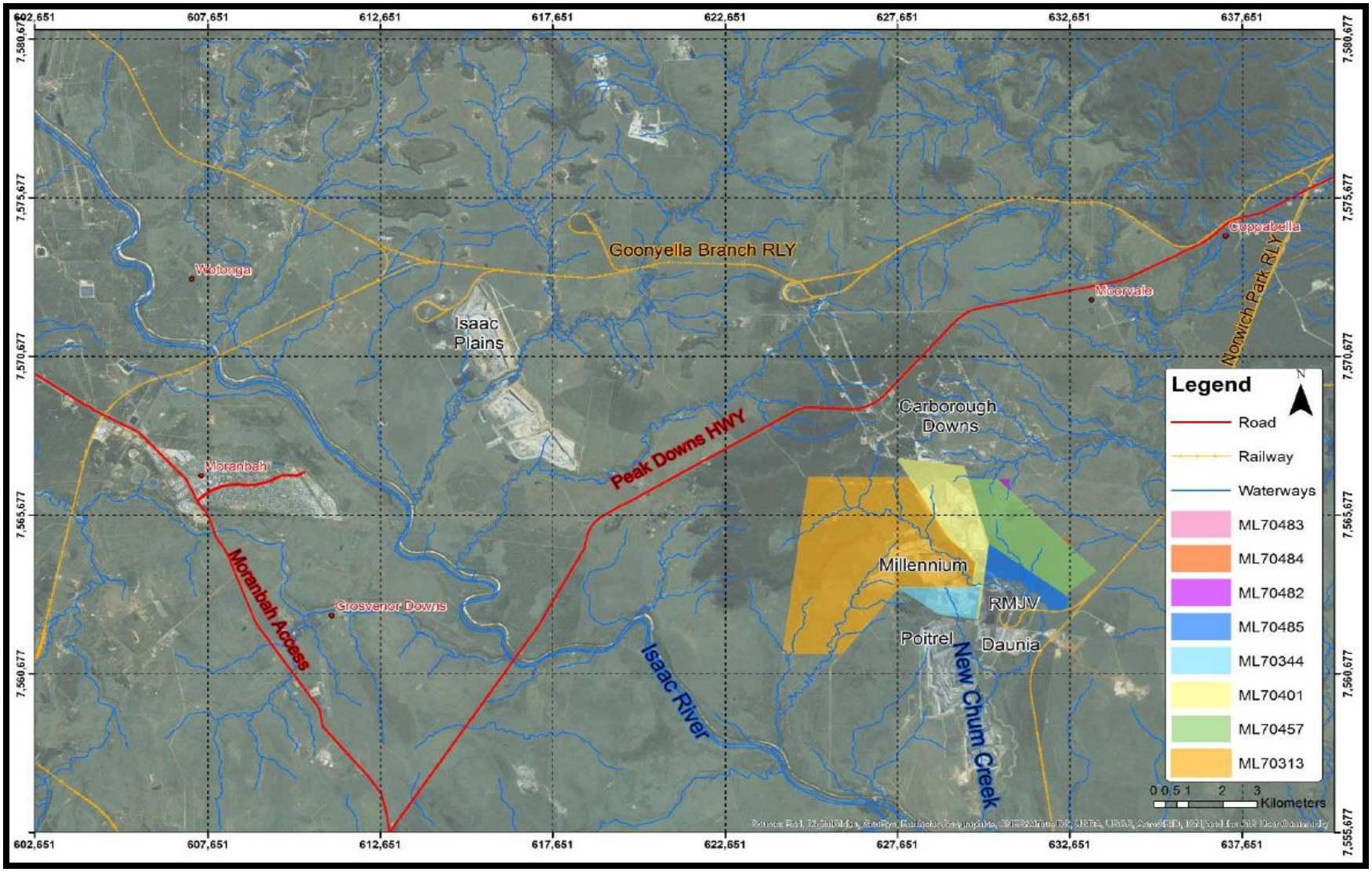


Figure 1 – Millennium Mine Locality and Mining Leases

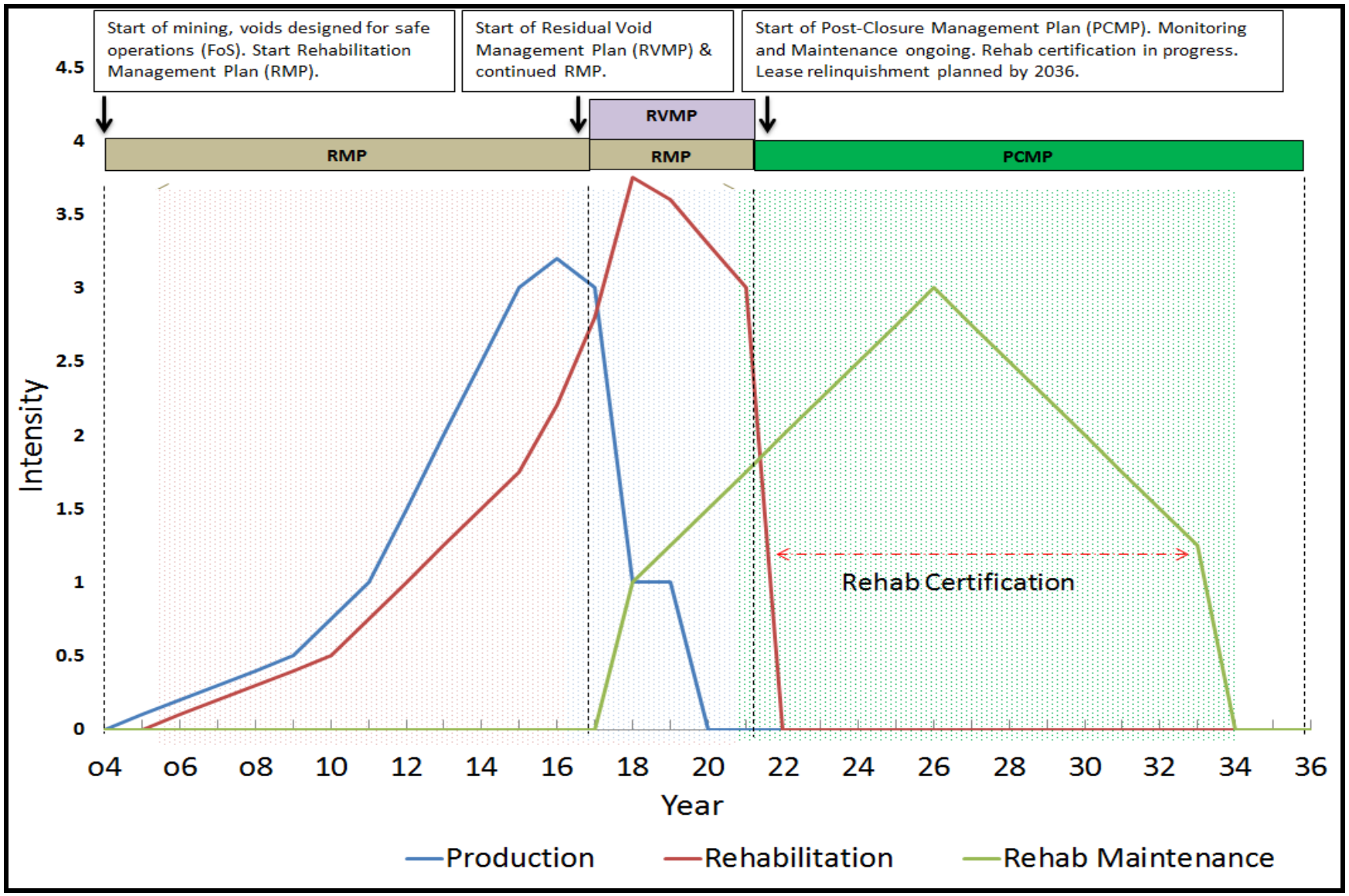


Figure 2 – Life of Mine, Rehabilitation and Mine Closure Process

# 7. Operation and Maintenance

## 7.1. Wastewater collection and reticulation systems

The operation and maintenance of all water systems at Millennium Mine will be conducted pursuant to the Millennium Mine Standard Operating Procedure – Dams (Document Number 0507-22-D), Millennium Mine Water Management Plan (September, 2017) and Environmental Authority (EPML00819213).

Water types at Millennium Mine are divided into five types, being:

- External water – water sourced from outside of the mining operations (i.e. SunWater);
- Groundwater – water that collects or flows beneath the earth's surface, filling the porous spaces in soil, sediments and rocks (i.e. overburden and coal seams) that enters the mine through the open cut voids (e.g. Millennium Pit and Mavis Pit);
- Worked water – water (i.e. external, groundwater, surface and/or diverted water) that has come in contact with exposed coal and/or coal waste (i.e. course rejects and tailings) which reduces the quality of the water, generally through the desorption of salts;
- Surface water - water from rainfall runoff within disturbed and undisturbed catchments that, if managed in accordance with the site's Erosion & Sediment Control Plan (ESCP), can be discharged from site. Surface water typically does not contain any potential contaminants (other than suspended sediment). Surface water also includes runoff from rehabilitated spoil areas, pre-strip areas and active/inactive spoil areas; and
- Diverted water – surface water that is diverted around the surrounding catchments and enters either directly or indirectly into receiving waters via naturally occurring drainage channels.

Worked water (i.e. wastewater) is generated through surface water runoff entering the open cut voids and runoff from coal (ROM) stockpiles, which are contained within the open cut voids and/or designated worked water storage dams, namely the Mavis ROM Dam. The primary worked water storages post mine closure will be Millennium A Pit, Millennium B Pit, Mavis D Pit and Mavis E Pit. Rehabilitation of the Mavis ROM coal stockpile will occur by 31 December 2021, which will remove the requirement for the Mavis ROM Dam to store worked water and will be converted into a stock watering dam.

Millennium Pit, although forming one void at crest level, consists of two distinct mining areas, being A Pit and B Pit. These separate areas occur due to a significant fault structure, known as

the Millennium A/B fault, which has resulted in the coal being lifted approximately 60m higher in A Pit compared to B Pit. This physical separation has resulted in Millennium B Pit being geologically separated from A Pit and acts as a large sink, which is conducive for storing water. Water within B Pit will enter into A Pit once the level has reached the crest of the A/B fault, which is at 160RL.

Mavis Pit, although one void at the coal floor level, has been divided into two separate areas, being D Pit and E Pit. D Pit is the northern part of the open cut mining area and E Pit is the southern part of the open cut mining area. A portion of the northern end of the E Pit void has been backfilled to natural ground level, which has resulted in the void area reducing by approximately 45ha.

**Figure 3** details the final void pit lakes and post closure water storages (stock dams) and diverted water at Millennium Mine.

**Figure 4** details the final landform catchment boundaries and final void catchment areas.

Catchments areas and land use are detailed in **Table 2**.

**Table 2 – Catchment Areas and Land Use Areas**

| Final Void | Surface Catchment (ha) | | | | Additional Baseflow Catchment (ha) |
|---|---|---|---|---|---|
| | Natural | Mining pits | Rehabilitetd | Total area | |
| Millennium Pit | | | | | |
| Natural Case | 220 | 33 | - | 253 | 61 |
| Rehabilitated Case | 15 | 33 | 205 | 253 | 61 |
| Mavis D Pit | | | | | |
| Natural Case | 284 | 25 | - | 309 | - |
| Rehabilitated Case | 4 | 25 | 280 | 309 | - |
| Mavis E Pit | | | | | |
| Natural Case | 228 | 19 | - | 247 | - |
| Rehabilitated Case | 49 | 19 | 179 | 247 | - |

Note: Baseflow is only associated with the natural and rehabilitated catchments only. Mining pit areas have no baseflow.

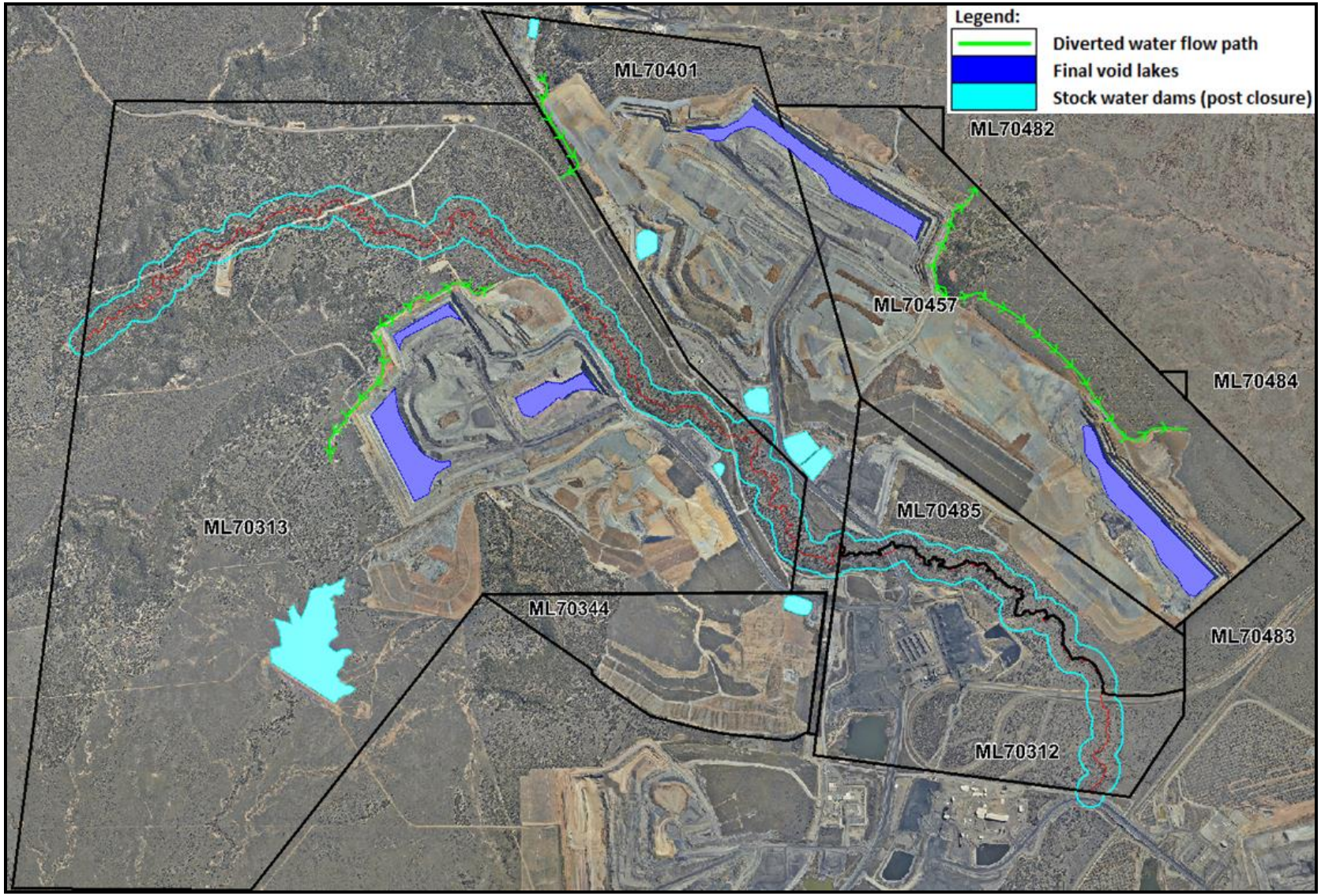


Figure 3 – Surface Water Management Overview

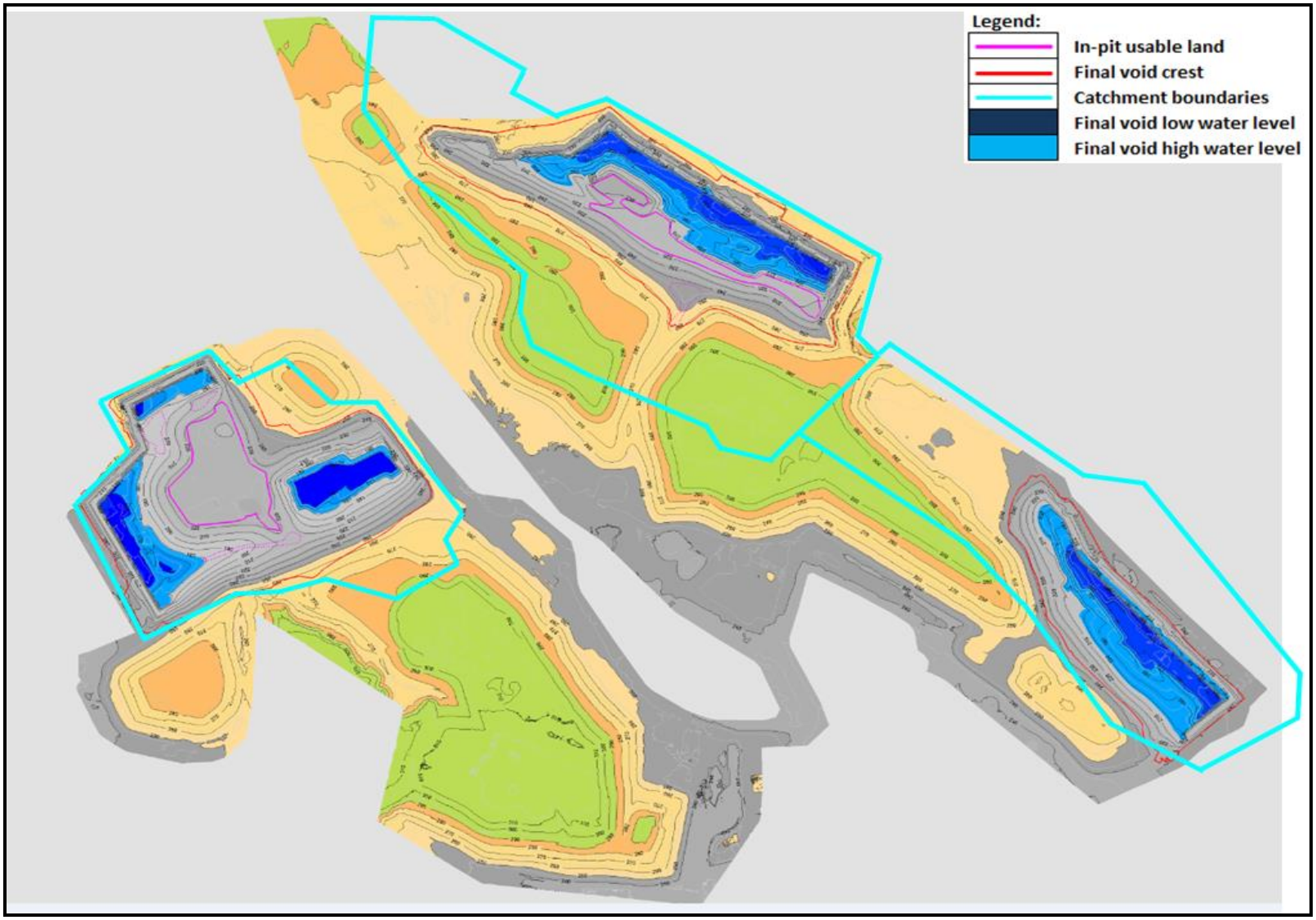


Figure 4 – Scenario 11 Final Landform and Void Catchment Areas

## 7.2. Wastewater treatment system

As detailed within the Millennium Mine Residual Void Management Plan (Millennium Coal, 2018) and Millennium Coal Mine - Stage 2 Final Void Modelling (Hatch, 2018), the treatment of mine affected water (wastewater) will not be necessary as each final void is capable of containing the modelled post closure water volume that accumulates in the voids due to rainfall and runoff. At the cessation of highwall mining, and the final coal being processed through the RMI CHPP, any mine affected water stored within the Mavis ROM Dam can be actively managed and dewatered into either Millennium B Pit or Mavis E Pit. Raw water from Western Dam can be utilised during the rehabilitation and decommissioning phase to provide effective dust suppression, if required.

Table 3 details the conceptual final void characteristics for each mining area at Millennium Mine.

**Table 3 – Millennium Mine Conceptual Final Void Characteristics**

| *Final Void* | *Catchment Area* (ha) | *Overflow Level* (mRL) | *Storage characteristics at overflow level* | | |
|---|---|---|---|---|---|
| | | | Volume (GL) | Surface Area (ha) | Max Depth (m) |
| Millennium Pit | 253 | 244 | 71 | 154 | 133 |
| Mavis D Pit | 309 | 256 | 52 | 130 | 126 |
| Mavis E Pit | 247 | 238 | 28 | 70 | 78 |

Note: Catchment area is the surface runoff catchment only with no additional baseflow.
Water within Mavis D and Mavis E Pits would overflow to the environment prior to joining as one large visible pit lake.

Based on the conceptual final void modelling completed by Hatch, below is a summary of each final void area that would constitute the wastewater system at Millennium Mine:

- Mavis D Pit
  - Will reach equilibrium after approximately 100 to 150 years;
  - Maximum water level of 202RL and minimum water level of 181RL will be reached due to seasonal fluctuations;
  - Final void crest level of approximately 256RL; and
  - The final void storage volume is approximately 52GL.

- **Mavis E Pit**
  - Will reach equilibrium after approximately 100 to 150 years;
  - Maximum water level of 179RL and minimum water level of 161RL will be reached due to seasonal fluctuations;
  - Final void crest level of approximately 238RL; and
  - The final void storage volume is approximately 28GL.
- **Millennium Pit**
  - Will reach equilibrium after approximately 100 to 150 years;
  - Maximum water level of 202RL and minimum water level of 174RL will be reached due to seasonal fluctuations;
  - Final void crest level of approximately 244RL; and
  - The final void storage volume is approximately 71GL.

## 7.3. Groundwater monitoring network

The operation and maintenance of the existing groundwater monitoring network will continue during the post closure phase of Millennium Mine up until 31 December 2021 when rehabilitation and decommissioning of the site is scheduled to be completed pursuant to the Millennium Mine Groundwater Monitoring Program (March 2017). Groundwater bores will be measured, and water samples obtained on a quarterly basis from MB2, MB8A and MB8B, MB9A and MB9B and MB10A and MB10B (refer **Figure 5**) during this post closure phase.

At the completion of rehabilitation and decommissioning, the frequency of sampling will be extended to annually, but will be subject to any amendments to the Environmental Authority.

Minimal maintenance of the groundwater monitoring network is required, but at times, weed spraying and/or slashing around the bores may be required and will occur on an as needed basis.

## 7.4. Final cover systems

Inert material (i.e. concrete, wood/timber) from the decommissioning phase during mine closure will be emplaced within the spoil dumps at either Millennium Pit or Mavis Pit. All

material will be emplaced at the toe of a spoil dump slope that has been allocated to be reshaped from 3:1 to 4:1 as part of the final landform design (refer Rehabilitation Management Plan for land forming methodology), which will ultimately bury this inert material as part of the normal rehabilitation process. Tailings coal waste are emplaced within dedicated disposal cells within the waste dumps that were designed within the advancing spoil dumps and coarse rejects are incorporated within the advancing spoil tip head. These tailings disposal cells are encapsulated/buried when the spoil dump is advanced vertically and/or the slope is reshaped from 3.3:1 to 4:1 as part of the final landform design (refer **Figure 6**).

The ongoing maintenance of these encapsulated/buried tailings disposal areas is highly unlikely to be required given the significant height and volume of spoil material that has encapsulated/buried each cell, but ongoing low wall monitoring and inspection will comprise LiDAR surveys completed on an annual basis during the rehabilitation and decommissioning phase which will confirm whether movement has occurred.

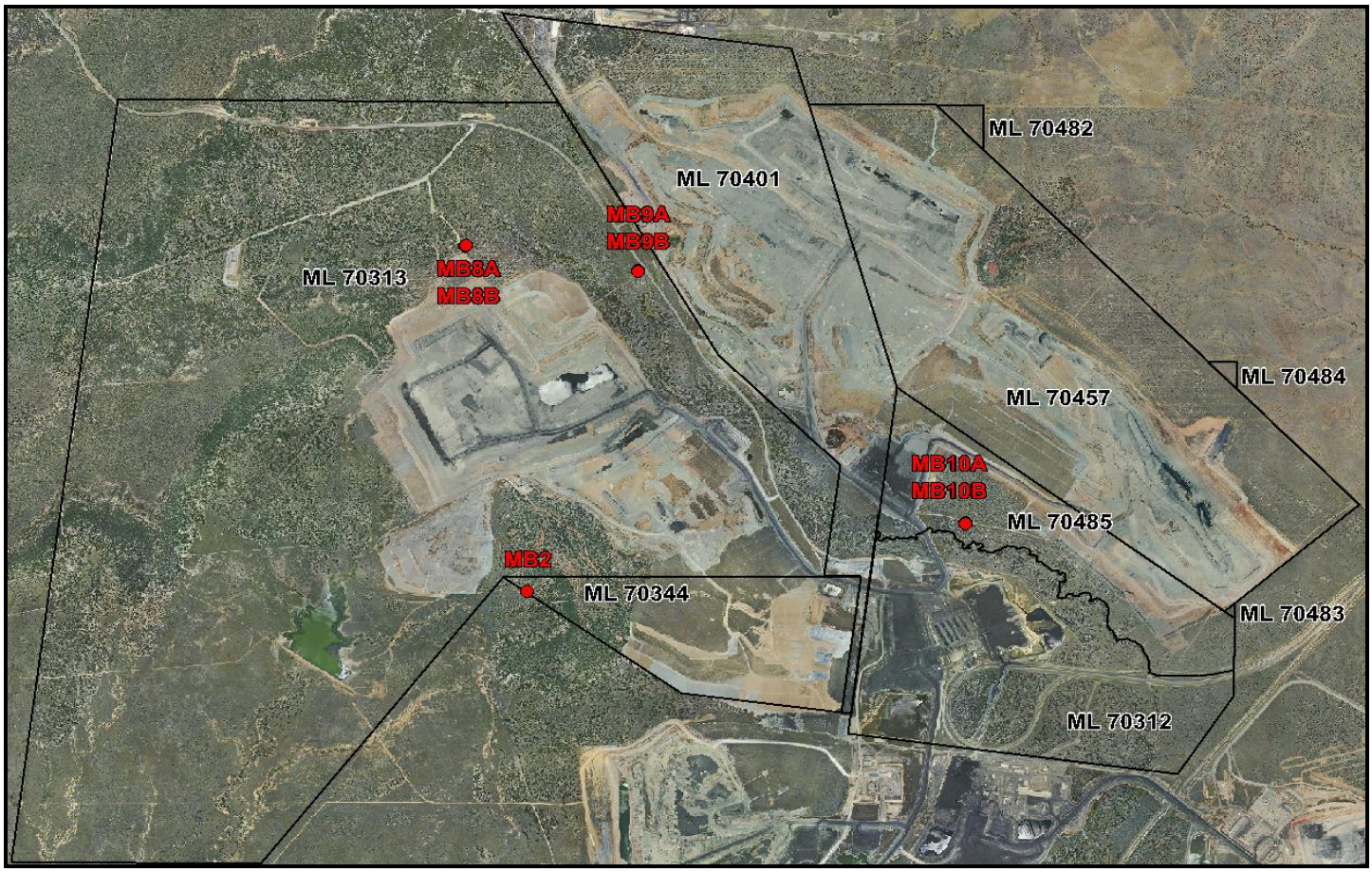


Figure 5– Groundwater Monitoring Network

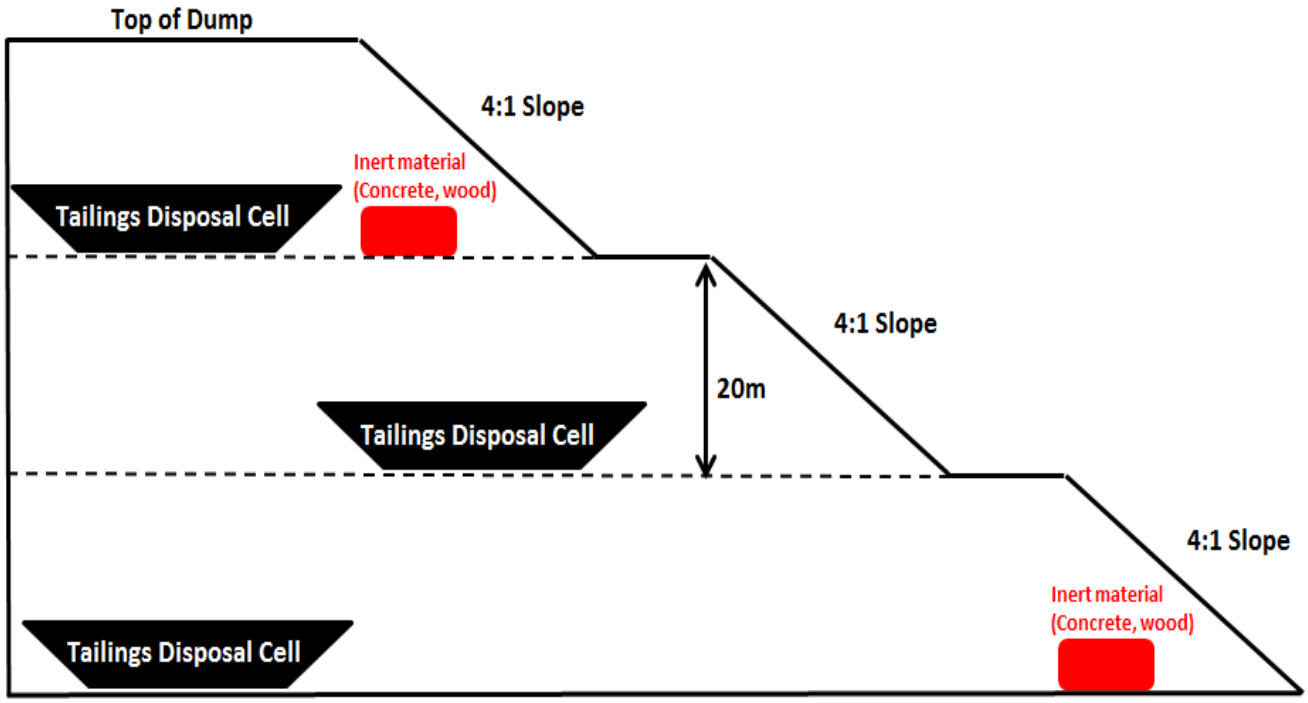


Figure 6 – Final Cover System Spoil Dump Profile

## 7.5. Vegetation cover

Rehabilitation and decommissioning of Millennium Mine is scheduled to be completed by 31 December 2021. Existing rehabilitation that has vegetation cover, and new rehabilitation that is still establishing vegetation, will be maintained on an annual basis based on visual, photographic and LiDAR monitoring. Based on previous rehabilitation and vegetation monitoring, it is possible that some maintenance (e.g. re-ripping, re-seeding, removal of sediment, replacement of topsoil) will be required within the first three (3) years of rehabilitation establishment, but this is highly dependent on vegetation strike and rainfall intensity experienced during the wet seasons following rehabilitation establishment.

Maintenance, repairs and vegetation cover success will be determined by the rehabilitation criteria contained within the Residual Void Management Plan for a period of time that is sufficient to demonstrate that vegetation is self-sustaining, stable and that landforms are non-polluting to the receiving environment. The determination of the vegetation cover success will be dependent on the annual rehabilitation monitoring program that Millennium Coal has undertaken since 2015.

# 8. Post Mining Land Use Areas and Land Capability Assessment

Prior to the introduction of mining, the land was used for cattle farming/grazing, with much of the area having been substantially cleared and seeded with improved pasture, namely Buffel and Rhodes Grass. Rehabilitation of the Millennium Mine disturbance area will return a stable landform capable of uses similar to those prior to mining. To achieve this, the nominated post-mine land use for the site is a mosaic of native bushland and grazing. The mosaic will, where possible, link remnant native vegetation and aim to return some conservation values.

Table 4 describes the final land use, rehabilitation approval schedule and land capability assessment, which if accepted by DES, will replace Table 17 in the Environmental Authority.

Table 5 describes the final land form design criteria that has been incorporated into the final landform designs (Scenario 11) that are present at Millennium Mine, and if acceptable by DES, will replace Table 18 in the Environmental Authority.

## Table 4 – Final Land Use and Rehabilitation Approval Schedule

| Description | Residual Void (including highwalls) | Spoil Dumps (External Batters)[1] | Spoil Dumps (Internal Batters)[2] | Runoff/Supply Dams | Riparian Zones (New Chum Creek)[3] | Roads[4] |
|---|---|---|---|---|---|---|
| **Surface Area (Ha)** | 389 | 1,267 | | | 237 | |
| **Pre-mine Land Use** | Grazing | Grazing | Grazing | Grazing | Grazing | Grazing |
| **Post-mine Land Use** | Water Storage / Native Bushland | Grazing / Native Bushland | Native Bushland / Grazing | Water storage | Native Bushland/Grazing | Grazing/Stock Vehicle Access |
| **Post-mine Capability Classification** | N/A | Class 3 or 4 grazing land | Class 3 or 4 grazing land | N/A | Class 2 grazing land | Class 3 or 4 grazing land |
| **Projective Rehabilitation Cover Range (%)[5]** | <75 | 75 | 5 (Native Bushland) 25 (Improved Pasture) | N/A | N/A | 75 |

**[1] All batters/slopes above natural ground level that are topsoiled and rehabilitated**

**[2] All batters/slopes below natural ground level that are topsoiled and rehabilitated**

**[3] 100m either side of New Chum Creek bed**

**[4] 10 - 12m stock vehicle access track remain post closure**

**[5] Mean value of litter, live, dead and competent rock/soil recorded in representative unmined plots**

**[6] Only for flat usable areas that have been rehabilitated (topsoil and seed applied) within the residual void area for cattle grazing**

Table 5 – Final Landform Design Criteria

| Disturbance Type | Surface Area (Ha) | Design Criteria |
|---|---|---|
| **Spoil Dumps (External Batters)[1]** | 1,267 | 1. Average slope angle 4:1 (H:V), but greater than 3:1 |
| **Spoil Dumps (Internal Batters)[2]** | | 1. Slope angle between 3:1 and 4:1 (H:V)<br>2. Reshaped only to high water level (RL) whilst maintaining stability and landform integrity |
| **Residual Void (including highwalls)** | 389 | 1. Highwall benched and geotechnically (rock mass) stable<br>2. Water storage for long-term Peabody and grazing security<br>3. In-pit cattle grazing on areas <10% slope angle<br>4. Lowwalls (internal batters) only reshaped to high water level (RL) whilst maintaining stability and landform integrity |
| **Roads** | 58 | 1. Reshape and rehabilitate that provides for 10 - 12m wide stock vehicle access |

[1] **All batters/slopes above natural ground level that are topsoiled and rehabilitated**
[2] **All batters/slopes below natural ground level that are topsoiled and rehabilitated**

## 9. Post Mining Land Capability Assessment

Prior to the introduction of mining, the land was used for cattle farming/grazing, with much of the area having been substantially cleared and seeded with improved pasture, namely Buffel and Rhodes Grass. Rehabilitation of the Millennium Mine disturbance area will return the land to low intensity grazing with areas of native bushland, as described in Table 4.

## 10. Post Mining Usable and Non-usable Areas

The post-mining landform will be constructed and rehabilitated to ensure that a similar proportion of land suitability classification is established as the pre-mining landscape is attained (**Figure 7**).

There are currently no planned non-use mining areas, other than the highwalls and end walls (inclusive of the exclusion zone at the crest). These areas will be fundamentally stable; however, they will have no productive post-mining land use. The residual void may be used by Peabody for short, medium and long-term water storage for other Peabody sites and neighbouring sites (subject to commercial agreement) until the mining leases and/or land is relinquished back to underlying landowner or sold to an alternate landowner.

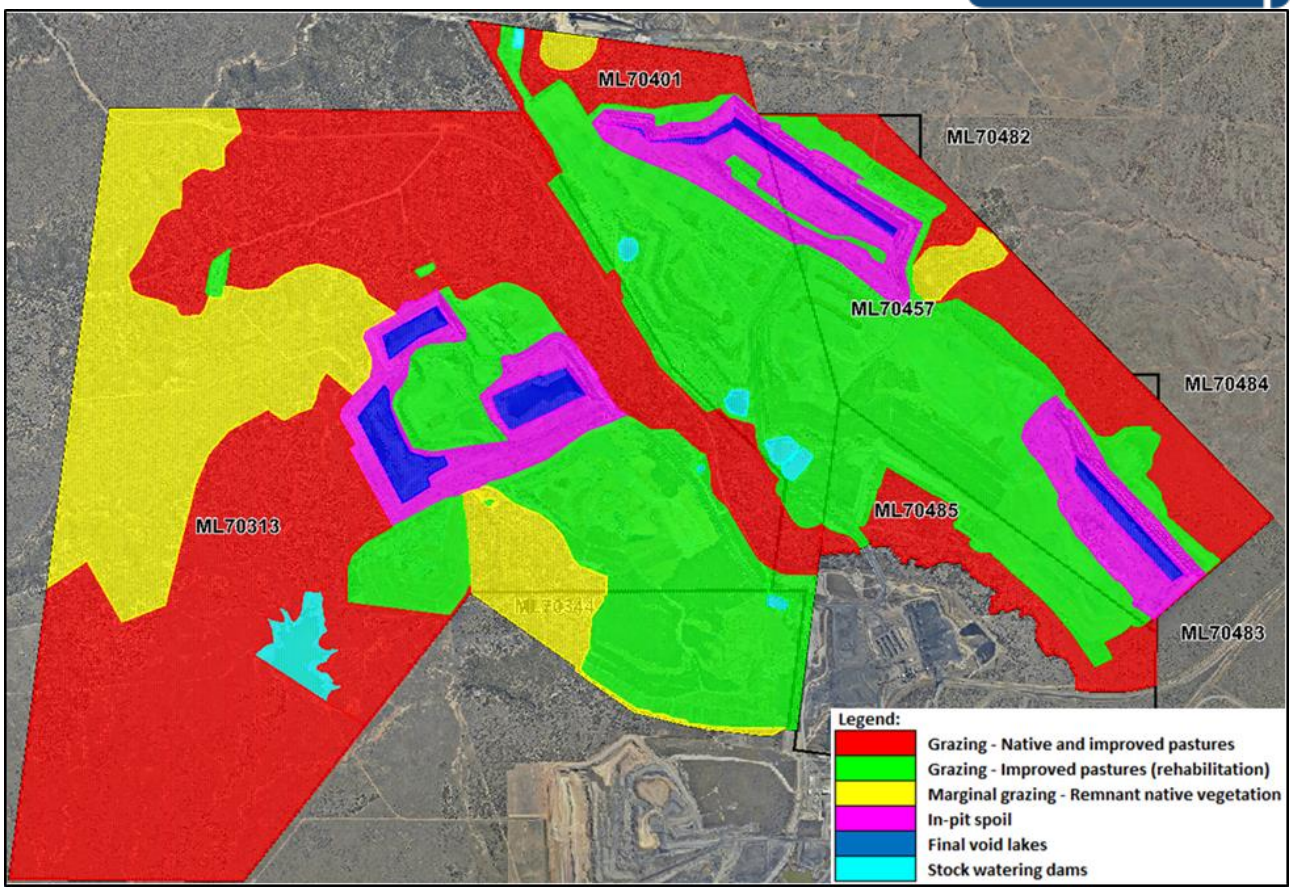


Figure 7: Post Mining Land Use

# 11. Monitoring

## 11.1. Surface water quality

Surface water monitoring, which includes quality and quantity, will be conducted on a quarterly basis from surface water storages pursuant to Table 7 of the Millennium Mine Environmental Authority until the end of rehabilitation and decommissioning, which is scheduled to conclude by 31 December 2021. At the completion of rehabilitation and decommissioning, it is proposed for surface water quality monitoring to occur annually during the term of this Plan.

Monitoring will be conducted by Peabody at each sediment dam, Mavis Northern ROM Dam, Mavis ROM Dam, Western Dam and, where safe access allows, in pit voids (refer **Figure 8**). Monitoring parameters will be analysed against **Table 6** from each onsite surface water storage and the water level (RL) recorded to determine stored water volumes in each water storage.

The quality of water contained within final voids is climate driven due to fluctuations of salinity of the bulk water volume, which have been estimated for the period when equilibrium of final void water levels has been reached. An EC range has been established using the total salt mass in each final void along with the long-term minimum and maximum volumes in each void.

### Mavis D Pit:

Once equilibrium has been reached within Mavis D Pit, which is estimated to occur between 100 to 150 years following cessation of mining, the EC level fluctuates with seasonal variance and is generally between 4,400 µS/cm (above average wet season) and 9,900 µS/cm (prolonged dry season, such as a drought).

### Mavis E Pit:

Once equilibrium has been reached within Mavis E Pit, which is estimated to occur between 100 to 150 years following cessation of mining, the EC level fluctuates with seasonal variance and is generally between 4,100 µS/cm (above average wet season) and 14,300 µS/cm (prolonged dry season, such as a drought).

### Millennium Pit:

Once equilibrium has been reached within Millennium Pit, which is estimated to occur within approximately 100 years, the EC level fluctuates with seasonal variance and is generally between 5,200 µS/cm (above average wet season) and 13,200 µS/cm (prolonged dry season, such as a drought).

Validation of modelled final void water quality will be an ongoing process at Millennium Mine given the complex nature of the chemical interactions experienced due to influences of spoil material, coal seams, insitu strata and evaporation.

Table 6 – Onsite Water Storage Contaminant Limits

| Quality Characteristics+ | Test Value | Contaminant Limit |
|---|---|---|
| pH (pH Unit) | Range | Greater than 4, less than 9^ |
| EC (µS/cm) | Maximum | 5,970# |
| Sulphate (mg/L) | Maximum | 1,000# |
| Fluoride (mg/L) | Maximum | 2.0# |
| Aluminium (mg/L) | Maximum | 5.0# |
| Arsenic (mg/L) | Maximum | 0.5# |
| Cadmium (mg/L) | Maximum | 0.01# |
| Cobalt (mg/L) | Maximum | 1.0# |
| Copper (mg/L) | Maximum | 1.0# |
| Lead (mg/L) | Maximum | 0.1# |
| Nickel (mg/L) | Maximum | 1.0# |
| Zinc (mg/L) | Maximum | 20# |

^ Page 4.2-15 of ANZECC & ARMCANZ (2000) "Soil and animal health will not generally be affected by water with pH in the range of 4-9".

# Contaminant limit based on ANZECC & ARMCANZ (2000) stock water quality guidelines.

+ Total measurements (unfiltered) must be taken and analysed.

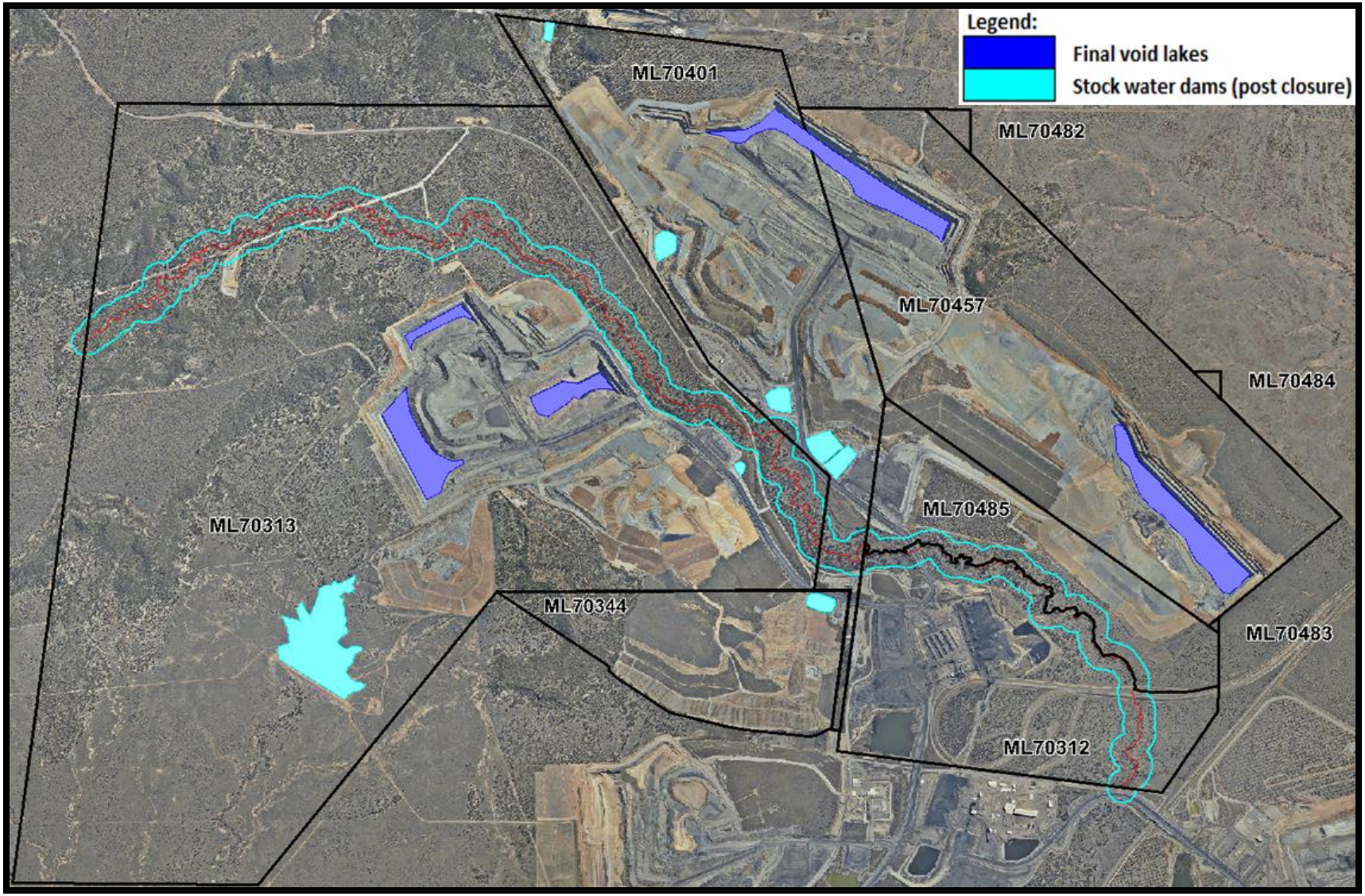


Figure 8 – Surface Water Monitoring Location

## 11.2. Groundwater quality

Groundwater monitoring, which includes standing water level, will be conducted on a quarterly basis from each existing monitoring bore, being: MB2 (water level only), MB8A, MB8B, MB9A, MB9B, MB10A and MB10B pursuant to **Table 7** during rehabilitation and decommissioning, which is scheduled to be completed by 31 December 2021 and the Millennium Mine Groundwater Monitoring Program (March 2017). The values presented in **Table 7** are based on JBT Consulting (2016) *Review and Assessment of the Millennium Mine Groundwater Monitoring Network & Data* (Appendix A). At the completion of rehabilitation and decommissioning, it is proposed that Peabody will undertake groundwater quality monitoring annually for the term of this Plan.

Monitoring of groundwater entering the final voids, which is negligible at Millennium Mine, will be carried out as per the Guideline – 'Quantify the Volume of Associated Water Taken Under a Mining Lease or Mineral Development Lease (January, 2017)' and the 'Water Accounting Framework' (WAF) due to the extremely low volumes of groundwater ingress that have been documented and reported as per the 2017 Associated Water report. Generally, groundwater ingress is via wetting of the exposed highwall near or along fault structures within either Millennium or Mavis Pit, which have been documented using photographic monitoring. The rate of seepage/wetting is generally less than evaporation and areas showing seepage/wetting will evaporate over a short time period.

**Table 7 – Groundwater Monitoring Criteria**

| Water Quality Indicators | Completion Criteria[1] | Value Type |
|---|---|---|
| Aluminium (mg/L) | 5 | Maximum |
| Arsenic (mg/L) | 5.0 | Maximum |
| $CO^3$ (mg/L) | 8 | Maximum |
| $HCO^3$ (mg/L) | 900 | Maximum |
| Iron (mg/L) | No Limit | Maximum |
| Magnesium (mg/L) | 190 | Maximum |
| Mercury (mg/L) | 0.002 | Maximum |
| Molybdenum (mg/L) | 0.15 | Maximum |

| | | |
|---|---|---|
| pH (pH Unit) | 6.5 – 9.0 | Minimum - Maximum |
| Potassium (mg/L) | 6 | Maximum |
| $SO^4$ (mg/L) | 70 | Maximum |
| Sodium (mg/L) | 500 | Maximum |
| Suspended Solids (Total) | 30 | Maximum |
| Petroleum Hydrocarbons (Total) (mg/L) | 0.1 | Maximum |

**Note:**

[1] Based on JBT Consulting (2016)

[2] ANZEEC stock water guidelines.

## 11.3. Seepage rates

Monitoring of seepage from groundwater entering the final voids, which is negligible at Millennium Mine, will be carried out as per the Guideline – 'Quantify the Volume of Associated Water Taken Under a Mining Lease or Mineral Development Lease (January, 2017)') and the 'Water Accounting Framework' (WAF) on an annual basis.

Saline seepage from spoil dumps, which has not been identified at Millennium Mine, will be monitored if detected as part of the ongoing surface water monitoring program of onsite water storage structures, which exclude the final voids.

A spoil water contribution assessment was completed as part of the Residual Void Management Plan by JBT Consulting (Millennium Mine Spoil Water Contribution to Millennium and Mavis Pit Final Voids, 2018 (**Appendix B**)), which identified that a significant volume (approximately 30 GL) of water within the final voids will be contained within the spoil that is located between the maximum and minimum water levels of each final void.

## 11.4. Erosion rates

Erosion monitoring is carried on an annual basis during the rehabilitation monitoring program, which includes the physical inspection of completed/established rehabilitation and the use of Light Detection and Ranging (LiDAR) monitoring technology to accurately measure the depth and rates of erosion or sediment deposition. The previous year's rehabilitation areas will be evaluated during the following year and an assessment of short-term erosion will be determined through the analysis of LiDAR monitoring. Flow accumulation mapping using ArcGIS hydrology tools to create a flow direction grid and raster showing preferential

flow of water into each cell of the final grid is utilised to access surface erosion due to be water flow. Change detection mapping using QTM and LiDAR representing two epochs for comparison of landform stability are compared and analysed for areas where change is greater than, or less than, a defined threshold of 50cm. The change in raster surface represents elevation change, either negative (erosion) or positive (deposition).

Physical erosion monitoring at each monitoring site is assessed within 10m either side of the transect centre line where the erosion intersects the transect, or where disturbance was significant such as rill and/or gully erosion is present. Erosion attributes are recorded pursuant to the Australian Soil and Land Survey Field Handbook (National Committee on Soil and Terrain, 2009), which includes:

- Type of erosion (wind, water, scald, sheet, rill, gully, tunnel and mass movement);
- State of erosion (active, partially stabilized or stabilized);
- Severity of erosion (dependent upon type of erosion present – present/absent and if present either minor, moderate, severe or very severe);
- Depth of erosion within gullies; and
- Areas adjacent to each transect or opportunistically identified during the site inspection, which are recorded separately.

The Millennium Mine Residual Void Management Plan details the mine closure rehabilitation success criteria for erosion stability, which is gully and rill erosion does not exceed 1.5m deep and extend from the top crest to the bottom toe of slopes.

## 11.5. Final cover system

As Millennium Mine does not have tailings waste co-disposal dams, final cover systems (i.e. capping) are not required. Monitoring of external rehabilitated slopes where coal waste material (i.e. tailings and course rejects) has been emplaced within dedicated disposal cells that were designed within the advancing spoil dumps, will be completed as part of the annual rehabilitation monitoring process. These buried disposal cells have been encapsulated when the spoil dump advances over them and the external slope of the spoil dump is reshaped from 3.3:1 (angle of repose) to 4:1 (25%) as part of the final landform design.

The ongoing maintenance and monitoring of these disposal areas is highly unlikely to be required given the significant height and volume of spoil material that will encapsulate each cell, but ongoing low wall monitoring and inspection will be completed as part of the annual

rehabilitation monitoring program. The effectiveness of the rehabilitation of the external spoil dump slopes will be determined as adequate when erosion (rills) are observed to be decreasing in size (depth and width) and/or are stable, which would indicate that the vegetative cover is sufficient to protect the underlying spoil material from being eroded and exposing the buried tailings disposal cells.

The Millennium Mine Residual Void Management Plan details the mine closure rehabilitation success criteria for erosion stability, with success determined as when gully and rill erosion does not exceed 1.5m deep and extend from the top crest to the bottom toe of slopes.

## 11.6. Native vegetation cover

Native vegetation cover monitoring is carried on an annual basis to assess the establishment of rehabilitation on the spoil dumps and areas disturbed by mining activities, relative to control sites. The monitoring program includes the physical inspection of completed/established rehabilitation and the use of control (analogue) sites. The mosaic nature of the completed rehabilitation at Millennium Mine will result in variable native vegetation cover on the top of spoil dumps, which are designed to provide future stock shade and resting areas. The integration of native vegetation will be completed through the use of native vegetation corridors, which have been established through the protection of large areas of vegetation, namely along New Chum Creek, which is protected 100m either side of the creek bed by the New Chum Creek Buffer Zone and surrounding rocky outcrops/escarpments that have not been disturbed as part of the mining operation (refer **Figure 9**).

Vegetation data collected during field assessment, such as woody species (shrubs, trees), is converted into stems per hectare based on the number of species identified within the survey quadrats and the overall transect vegetation structure to determine the vegetation community establishment and growth over a period of time. Lower story species density and richness is calculated from the percentage contribution data collected in each 2m x 2m quadrat along each transect and the overall composition of each transect is used by averaging the density contribution of each species identified.

The following data is obtained and analysed as part of the annual monitoring program:

- Transect establishment and photographic monitoring;
- Vegetative data collection and analysis;
- Ground and vegetative cover characteristics;
- Ground condition and landform stability analysis;

- Pasture productivity analysis;
- Soil condition and stability analysis; and
- Vegetation diversity and cover condition analysis.

Vegetation data compilation involves collecting a range of attributes at each monitoring location, which is 10m either side of each transect or from within a 2m x 2m quadrat, which has been established along the transect at 10m intervals (five quadrats at each monitoring transect).

Data collected from each transect consists of:

- Identification of woody upperstorey and midstorey species including species and number of individuals per height class (<1m, 1-2m, 2-4m, 4-6m, 6-8m, 8-10m and >10m);
- Total species inventory of flora species observed;
- Data attributes collected within each 2m x 2m quadrat;
- Lower storey species richness and number of individuals;
- Basal cover of each lower storey species identified (expressed as a percentage of standing live as determined by the ground cover characteristic assessment);
- Live standing material;
- Dead standing litter;
- Detached litter;
- Rock (>5cm diameter);
- Evidence of weeds and pests; and
- Bare ground.

As set out in Section 4.5 above, the Millennium Mine Rehabilitation Management Plan details the mine closure rehabilitation success criteria for grazing and natural bushland vegetation cover.

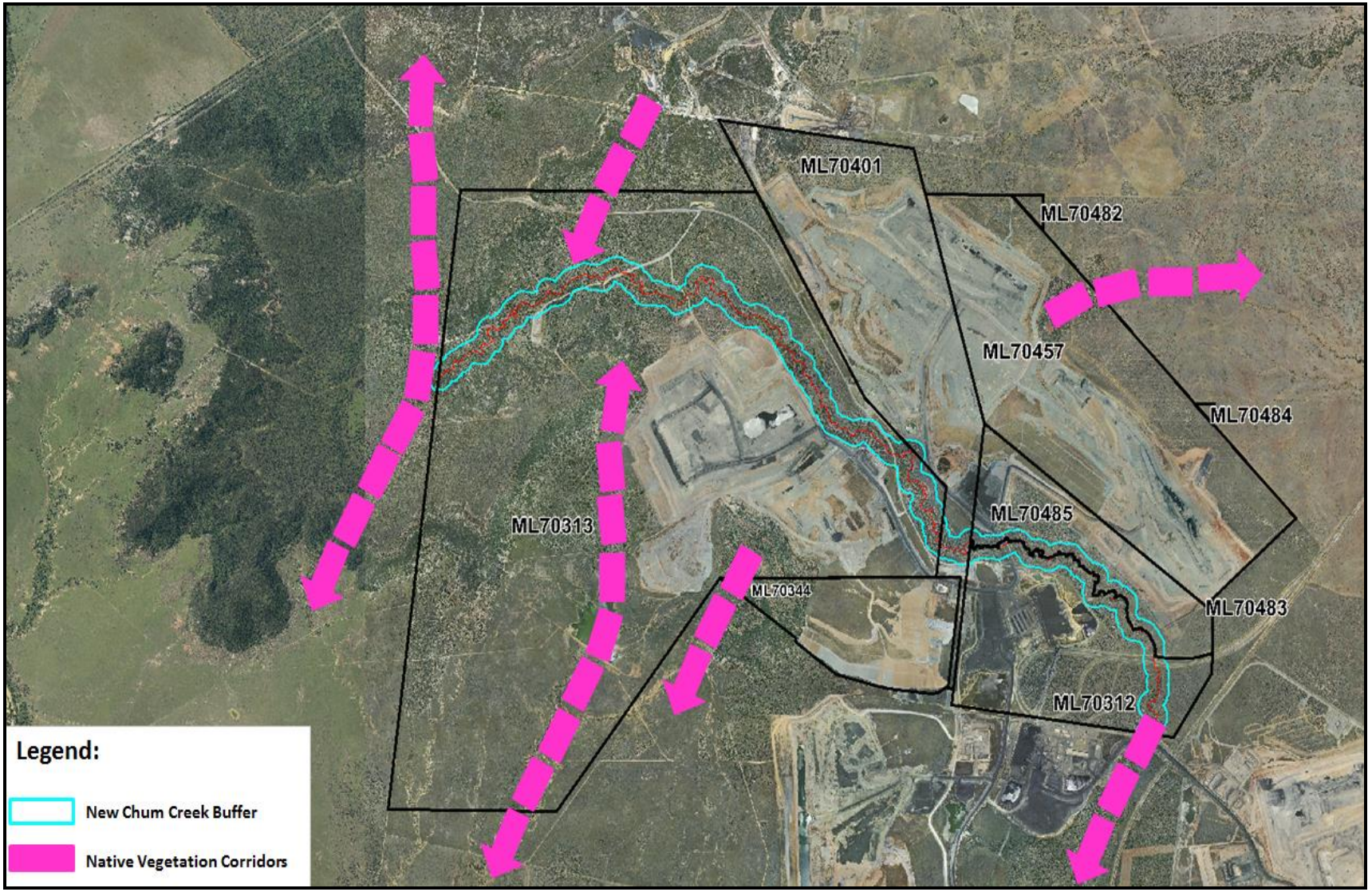


Figure 9 – Native Vegetation Corridors

## 12. References


| | |
|---|---|
| Millennium Coal, 2018 | Millennium Mine Residual Void Management Plan, 2018 |
| Department of Environment and Heritage Protection, 2017 | Millennium Coal Mine Environmental Authority EPML00819213, 2017 |
| Hatch, 2018 | Millennium Coal Mine – Stage 2 Final Void Modelling, 2018 |
| Millennium Coal, 2017 | Peabody Energy Australia, Millennium Coal Mine, Water Management Plan, 2017 |
| Millennium Coal, 2017 | Peabody Energy Australia, Millennium Coal Mine, Standard Operating Procedure - Dams, 2017 |
| Millennium Coal, 2017 | Millennium Mine Groundwater Monitoring Program, 2017 |
| JBT Consulting, 2016 | Millennium Mine Spoil Water Contribution to Millennium and Mavis Pit Final Voids, 2016 |

## 13. Appendix A

JBT (2016) Review and Assessment of the Millennium Mine Groundwater Monitoring Network & Data

## 14. Appendix B

JBT Consulting (2018) Millennium Mine Spoil Water Contribution to Millennium and Mavis Pit Final Voids